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APPLICATION	
NEXT ASSY	USED ON

REVISION HISTORY

PART NO.	ZONE	REV	DESCRIPTION	DATE	APPROVAL

QC SUBMITTAL
AUGUST 2, 2013
NOT FOR CONSTRUCTION

TECHNICAL SPECIFICATION FOR DRAWING 76K39267

EDDR# _____

DOCUMENT INFORMATION: (TITLE, NUMBER, REV, DATE)

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RS&H
Reynolds, Smith and Hills
Merritt Island, Florida
Architecture – Engineering and Planning

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M–199 TOLERANCES ON:

FRACTIONS	DECIMALS	ANGLES
± 1/16	1 PL ± .060 2 PL ± .030 3 PL ± .010	1 PL + .1

THIRD ANGLE PROJECTION

CAD MAINTAINED.
CHANGES SHALL BE INCORPORATED ONLY BY THE DESIGN ACTIVITY.

SOFTWARE: AUTOCAD

FILENAME: 79K39268.dwg

MATERIAL:

HEAT TREATMENT:

FINAL PROTECTIVE FINISH:

ORIGINAL DATE OF DRAWING: 2013/06/19

APPROVED

A&E PM : R. PRUSS

NASA PM/LDE: M. HARTNETT

NASA BrMgr: P. YU

JOHN F. KENNEDY SPACE CENTER, NASA
KENNEDY SPACE CENTER, FLORIDA

MODIFY VEHICLE ASSEMBLY BUILDING HIGH BAY 3 FOR SLS

SIZE	CAGE CODE	DWG NO	REV
A	22264	79K39268	

SCALE	UNIT WEIGHT	SHEET	OF
NOTED		1	849

KSC FORM 21–2C NS (REV 06/04)

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SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.1 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval and information only. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit the following items to the Contracting Officer:

Utility Outage Requests; G
Utility Connection Requests; G
Excavation Permits; G
Welding Permits; G
Burning Permits; G

1.2 WORK COVERED BY CONTRACT DOCUMENTS

1.2.1 Project Description

The work to be performed under this contract requires providing the labor, equipment, and materials to modify the existing Vehicle Assembly Building (VAB) and construct new vehicle access platforms and related systems for the new Space Launch System (SLS). The primary deconstruction, demolition, and construction site is the VAB at Kennedy Space Center, Florida.

The work consists of demolition of existing structural and component systems; modification and reuse of existing structural components; construction and installation of new structural, mechanical, and electrical materials, systems, and equipment; reinstallation of modified and unmodified systems.

The work consists of removal and storage of existing system components, equipment, and materials for reuse/reinstallation; demolition of system components and structure not to be reused; modification of structural elements and installation of new structural elements; reinstallation of salvaged equipment and materials, and installation of new systems, equipment, and materials.

Demolition and construction will take place in High Bay (HB) 3 with some ancillary systems, such as electrical and communication cable tray connecting HB3 to the Launch Control Center (LCC). A total of eleven new vehicle access platforms, vehicle specific inserts, and related mechanical, electrical, and life safety systems will be constructed. Additional modifications to related existing systems will also be constructed.

1.3 CONTRACT DRAWINGS

The following drawings accompany this specification and are a part thereof.

Drawing No. 79K39267
Sheets 1 through TBD

Five sets of full size contract drawings, maps, and specifications will be furnished to the Contractor without charge. Reference publications will not be furnished.

The Contractor shall immediately check furnished drawings and notify the Government of any discrepancies.

1.4 PROJECT ENVIRONMENTAL GOALS

The Contractor shall distribute copies of the Environmental Goals to each subcontractor and the Contracting Officer. The overall goal for design, construction, and operation is to produce a facility that meets the functional program needs and incorporates the principles of sustainability. Specifically:

a. Preserve and restore the site ecosystem and biodiversity; avoid site degradation and erosion. Minimize offsite environmental impact.

b. Use the minimum amount of energy, water, and materials feasible to meet the design intent. Select energy and water efficient equipment and strategies.

c. Use environmentally preferable products and decrease toxicity level of materials used.

d. Use renewable energy and material resources.

e. Optimize operational performance (through commissioning efforts) in order to ensure energy efficient equipment operates as intended. Consider the durability, maintainability, and flexibility of facility systems.

f. Manage construction site and storage of materials to ensure no negative impact on the indoor environmental quality of the facility.

g. Reduce construction waste through reuse, recycling, and supplier take-back.

1.5 OCCUPANCY OF PREMISES

The VAB will be occupied during performance of work under this Contract.

Before work is started, the Contractor shall arrange with the Contracting Officer a sequence of procedure, means of access, space for storage of materials and equipment, and use of approaches, corridors, and stairways.

1.6 EXISTING WORK

In addition to "FAR 52.236-9, Protection of Existing Vegetation, Structures, Equipment, Utilities, and Improvements":

a. Remove or alter existing work in such a manner as to prevent

injury or damage to any portions of the existing work which remain.

b. Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as approved by the Contracting Officer. At the completion of operations, existing work shall be in a condition equal to or better than that which existed before new work started.

1.7 ON-SITE PERMITS

1.7.1 Utility Outage Requests and Utility Connection Requests

Notify the Contracting Officer at least 72 hours prior to starting excavation work. The Contractor is responsible for marking and verifying all utilities not marked.

The Contractor shall verify the elevations of existing piping, utilities, and any type of underground obstruction not indicated or specified to be removed. But indicated in locations to be transversed by piping, ducts, and other work to be installed. Verify elevations before installing new work closer than nearest manhole or other structure at which an adjustment in grade can be made.

Work shall be scheduled to hold outages to a minimum.

1.7.2 Excavation, Welding, and Burning Permits

ACTIVITY	SUBMISSION DATE	SUBMISSION FORM
Burning Permits	24 hours prior to work	Call 861-5050
Excavation Permits	14 calendar days prior to work	Email Project Inspector
Welding Permits	24 hours prior to work	Call (321) 861-5050

Permits shall be posted at a conspicuous location in the construction area.

Burning of trash or rubbish is not permitted on project site.

1.8 LOCATION OF UNDERGROUND UTILITIES

Obtain digging permits prior to start of excavation by contacting the Contracting Officer 15 calendar days in advance.

1.8.1 Notification Prior to Excavation

Notify the Contracting Officer at least 48 hours prior to starting excavation work.

1.9 SALVAGE MATERIAL AND EQUIPMENT

Items designated by the Contracting Officer to be salvaged shall remain the property of the Government.

The salvaged property shall be segregated, itemized, delivered, and off-loaded at the Government designated storage area located within 10 miles of the construction site.

The Contractor shall maintain property control records for material or equipment designated as salvage. The Contractor's system of property control may be used if approved by the Contracting Officer. The Contractor shall be responsible for storage and protection of salvaged materials and equipment until disposition by the Contracting Officer.

1.10 First Article Demonstration Test

Prior to completion of all platform segments, the Contractor shall test two full platform (two segments) to validate all systems function as designed. The platform segments shall be complete per the contract drawings and shall have all systems attached. The Contractor shall submit a written test procedure for approval.

The Contractor shall construct a twenty foot tall test fixture that can support two platform halves in both the fully retracted and fully extended positions. The geometry of the test fixture shall duplicate the support rail layout in the VAB HB3. The Contractor shall design the test article to meet all applicable design codes and submit to the Contracting Officer for approval. The test article is required to support the self-weight of the platforms with a 25,000 pound load (per platform segment) and provide the mounting rails shown in the design drawings. The test fixture shall have connections for all commodity connections, including but not limited to electrical system, communication system, fire protection system, and mechanical piping. Specific connection requirements are specified in their respective
specification sections.

The test fixture shall have a hoist system to vertically relocate the platform.

The test article shall have functioning rigid push chain assemblies installed to demonstrate the ability for the platform to extend and retract.

The Contractor shall submit for approval the design of the demonstration facility/structure prior to beginning construction.

Forty five (45) days prior to beginning the demonstration the Contractor shall submit the demonstration procedure for approval.

Fourteen (14) days notice shall be given prior to the demonstration.

All systems shall be tested at the direction of the Contracting Officer. Each system shall be approved by the Contracting Officer prior to acceptance of the system for continued construction.

Upon completion of the First Article Demonstration Test, the Contracting Officer shall provide approval to complete construction of the remaining platform segments and to begin installation of the platforms in the VAB.

1.10.1 General Notes

1. All testing shall occur with the Contracting Officer present. Any testing performed without the Contracting Officer shall not count

towards the testing requirements described in this document.
2. First Article Test unit shall require two platform halves and four insert segments (two inserts for level A and two inserts for level F) of Levels A and F. All other platform and insert segments require additional load and functional testing per section 1.11, "Installed Functional Test".
3. First Article Demonstration Test shall occur at the Contractor's facility or other location selected by the Contractor. Testing on Kennedy Space Center property is not allowed.
4. All platform components, completed assemblies, and in-work fabrication components shall be protected from the elements at all times.
5. Testing and fabrication of platform and insert systems shall not occur until successful completion of platform planking and deck system tests. Reference MIP-2 and MIP-3 on sheet V-006, drawing number 79K39267.
6. Test Article support fixture shall support the platforms in the same manner as the VAB. The Contractor shall provide a test fixture that utilizes the platform support rails installed per the contract drawings. Vertical support rails do not need to be production pieces but need to be fabricated to the tolerances specified on the contract drawings. The horizontal platform support rails shall be final production rails that stay with the support platform half. Test fixture shall be designed by a registered Professional Engineer in the state where testing shall occur and must be approved by Contracting Officer prior to beginning fabrication of the test fixture.
7. The Contractor shall perform the test requirements in the order listed below. The Contractor may submit a deviation waiver request to propose an alternate test sequence, but acceptability is at the discretion of the Contracting Officer.
8. Unless otherwise noted, all tests shall be performed with the platform segments installed in the test fixture and suspended above the ground a minimum of 4'-0" above grade, except during the vertical translation demonstration using the Contractor's lifting device.
9. The contracting Officer shall have 5 days following each test to review the test results and generate any punch list items. The Contractor shall then resolve the punch list items. The Contracting Officer shall inspect/review the corrections to make sure the fixes resolve the punch list items. If the punch list items are deemed to be resolved then the test shall be considered complete.

1.10.2 Testing Requirements

1. (Fire Protection) The Contractor shall perform a demonstration test of the fire protection system per the testing requirements in specification section 21 13 29.00. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.
2. (Structural) Tie-off and Guardrails Demonstration: The Contractor shall demonstrate the installation and removal of guardrails by personnel properly suited in fall protection gear using the platform tie-offs located per the contract documents. Test can be performed while the platform is on the ground. The Contractor shall verify that the designed tie-off locations are located to allow appropriate access for the installation and removal operations. If the locations of the tie-offs do not allow for appropriate access to the guardrail locations then the Contractor shall move the tie offs to locations determined by the contracting officer and retest. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.
3. (Structural/Mechanical) Platform Vertical Movement Demonstration:

Contractor shall demonstrate vertical movement and pinning of the platform in the test fixture. The test shall be run with all commodity hoses connected and pressure in hoses. The Contractor shall move the platform segment up 10 feet and make the corbel connections. Then the Contractor shall disconnect the corbel connections and relocate the platform segment down 10 feet and connect the corbel connections. The Contractor shall perform a total of 5 cycles. One cycle consists of the Contractor moving the platform to the desired location, pinning the platform, removing the pins, and then moving the platform to the next location. The Contractor shall use either four (4) individual lifting devices sequenced together or one single lift devices attached to the four design lift points such that the load is applied vertically at each lift point. The platform shall remain level (differential corner displacements shall be less than 3/16") during the movement operation. The Contractor shall also verify platform squaring/alignment prior to removing pins and moving. Platform shall remain square within 1/8 inch. The Contractor shall record the time to perform each cycle and demonstrate the ability to perform one cycle in 24 hours (time limit does not include time to verify squaring of platform). The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

4. (Structural) Platform Insert/Rigging Demonstration: The Contractor shall verify/demonstrate the ability to install and remove the inserts for Levels A and F from the platform test fixture. A minimum of 5 installation and removal cycles is required. One cycle consists of the installation and removal of the system. Inserts shall be removed with an overhead crane at the lift points designed into the system. The Contractor shall demonstrate the ability to install an insert within 8 hours. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

5. (Structural) Load Cycles on Platform: The Contractor shall demonstrate how the platform will react with a test weight moved around to various installation locations on the platform and insert. Test can be performed with the platform supported on the ground in a manner similar to how the platform will be supported by the support rails. The Contractor shall test with a simulated piece of equipment matching Toucan Series Mast-Style Boom Lift model E33MJ footprint, wheel layout, wheel size and weight. Test shall require 500 cycles of movement across floor in both the perpendicular and parallel directions to the planking. Decking system shall be deemed acceptable if there is no permanent deformation and the overall deflection is less than the design deflection +20%. The Contractor shall perform a mag-particle weld inspection on the inserts and platform framing connections following completion of all rolling load testing. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

6. (Structural) SRB 360° Insert Demonstration: The Contractor shall verify/demonstrate the ability to install and remove the SRB 360° Insert for Level F. A minimum of five (5) installation and removal cycles is required. One cycle consists of the installation and removal of the system. Inserts shall be removed with an overhead crane at the lift points designed into the system. The Contractor shall demonstrate the ability to install an insert within 4 hours. The Contractor shall also demonstrate the functionality of the flip platforms and removable guardrails. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

7. (Structural) Core Mate Flip Demonstration: The Contractor shall demonstrate the operation of the core mate flip on the Level F insert. The Contractor shall perform five (5) movement cycles where each cycle includes the flip down for use and flip up for storage movement. The Contractor shall perform actuation of flip for use within 2 hours. The Contractor

shall not proceed with further testing until receiving approval from the Contracting Officer.

8. (Structural) Maintenance Platform Accessibility: The Contractor shall demonstrate that all maintained parts are accessible from the maintenance access platform located below the extensible platforms. The Contractor shall demonstrate that all connections that connect the maintenance items to the platform and that all access points on the parts can be accessed from the platform. The Contractor shall perform demonstration within 2 hours. Test shall be performed under the direction of the Contracting Officer. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

9. (Mechanical) Hinged Rails Demonstration Test: The Contractor shall demonstrate the ability of the hinged rails to extend and retract. The Contractor shall record time to actuate the rail into position. A total of five (5) extension and retraction cycles shall be performed per rail. The platform shall be extended and then retracted after each cycle. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

10. (Mechanical) Extension/Retraction of the Platform Demonstration: The Contractor shall test / demonstrate the extension and retraction ability of the platform segments under platform self-power. Test requires mating of platform segments to each other. Platform segments shall be extended within 6 minutes each. Extension and retraction test shall be run a total of ten (10) times unloaded. Platforms shall then be loaded with a 2000 lb test load located at three (3) locations identified by the Contracting Officer's Representative at the time of the test. The platforms shall be extended and retracted a total of ten (10) times for each load location. The Contractor shall verify alignment with opposite extended platform. The Contractor shall also demonstrate manual extension and retraction operation (4 hour time limit). Complete one test for each loading location and one unloaded condition. The pneumatic systems shall be pressurized to their operating pressures during extension/retraction testing. The Contractor shall verify the functionality of the hose management system during each test. The platform shall extend and retract the entire length of travel smoothly, without any noticeable jerking, bumping, grinding, or any visible hang ups and jams. If movement is not smooth, then the platform shall be adjusted and the test rerun. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

11. (Mechanical) Lateral Movement Demonstration: The Contractor shall perform a lateral movement demonstration of a platform segment using the screw jacks. The Contractor shall purposely set the platform segment out of alignment by 2 inches and then reset to the required location. The test shall be repeated four (4) times with separate offsets being made at both sides. The Contractor shall record the amount of time required to reset the platform. The Contractor shall also perform a lateral movement demonstration with the platforms extended. One platform shall be set in the correct alignment and the other platform segment shall be extended outward with a 2-inch out-of-alignment setting. The Contractor shall adjust the out of alignment platform segment using the screw jacks to properly mate the platform segments together. The Contractor shall repeat this test two (2) times. The Contractor shall verify the hose management system maintains position without deformation during lateral movement test. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

12. (Mechanical) Pneumatic Commodity Line Leak Check: The Contractor shall perform a leak check of the pneumatic commodity lines per NASA specifications following the extension and retraction testing. The Contractor shall test the lines in both the extended and retracted position. This test shall not be performed until after the extension and

retraction cycle testing is complete. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.
13. (Mechanical) Fire Protection Line Leak Check: The Contractor shall perform a leak check of the 5" fire protection supply line per NASA specifications following the extension and retraction testing. The fire protection supply line shall be pressurized with air to the maximum system pressure. The Contractor shall test the lines in both the extended and retracted position. This test shall not be performed until after the extension and retraction cycle testing is complete. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.
14. (Mechanical/Electrical) Limit Switch Demonstration: The Contractor shall test / demonstrate the limit switch capabilities of one, unloaded platform half. The Contractor shall perform this five (5) times. The Contractor shall verify all warning lights, horns, etc. function while platform is extended. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.
15. (Mechanical/Electrical) Drive Brake Demonstration: The Contractor shall demonstrate the brake functionality. The platform shall be unloaded and extended manually. The platform load indicator shall be set to manual actuation. The test shall verify that the brake is holding 50% more than the rated load moved by the rigid push chain. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.
16. (Mechanical) Hard Stop Demonstration: The Contractor shall test / demonstrate the hard stop capabilities of one platform half. The Contractor shall over-ride rigid push chain limit switches and run platform at operation speed into hard stop. The Contractor shall perform this test once. The Contractor shall perform a weld inspection of the platform hard stop and rigid push chain connection framing after testing. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

Final Test shall not be performed until all other tests are complete and directed by the Contracting Officer.

17. Hoist Failure Test: Test shall simulate one hoist failing causing the platform to tilt and potentially bind against the rail system. Test shall utilize one platform half in the retracted position. Test shall require four (4) individual support cables with the ability to safely and quickly disconnect the rear right corner (rear refers to the corner away from the vehicle). Platform shall not have personnel or equipment on the platforms for this test. The platform shall not deflect more than 12 inches vertically at any point. The Contractor shall be aware that the support rail may become deformed due to the test and repair or replacement of a rail section(s) may be required. Localized repairs to the platform structure and components may also be required. The Contractor shall perform a weld inspection of the platform and insert. The Contractor shall not install tested platform segment in the VAB without approval from the Contracting Officer.

1.11 INSTALLED FUNCTIONAL TEST

1.11.1 General Notes

1. All testing shall occur with the Contracting Officer present. Any testing performed without the Contracting Officer shall not count towards the testing requirements described in this document.
2. Testing is required for each installed platform segment. Testing of

each segment shall occur before installing the next (lower) platform segment.
3. VAB demonstration testing shall not occur until after the completion of the First Article Demonstration and after approval from the Contracting Officer.
4. The Contractor shall perform the test requirements in the order listed below. The Contractor may submit a deviation waiver request to propose an alternate test sequence, but acceptability is at the discretion of the Contracting Officer.
5. The Contracting Officer shall have 5 days following each test to review the test results and generate any punch list items. The Contractor shall then resolve the punch list items. The Contracting Officer shall inspect/review the corrections to make sure they resolve the punch list items. If the punch list items are deemed to be resolved then the test shall be considered complete.

1.11.2 Testing Requirements

1. (Structural) Platform Fit-Check and Vertical Movement: The Contractor shall verify installed platform fits the support rails per the requirements on the contract drawings. Platform corbels shall travel along the rail freely with no continuous touching or grinding during the vertical movement of the platform. The hoist shall be used to move the platform vertically to the installed position. The Contractor shall verify corbel pin installation and alignment with elevator landing platforms (installed by others). The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.
2. (Structural) Platform Insert/Rigging Demonstration: The Contractor shall verify/demonstrate the ability to install and remove the inserts for each platform level. A minimum of two (2) installation and removal cycles is required. One cycle consists of the installation and removal of the system. Inserts shall be removed with the VAB facility overhead crane at the lift points designed into the system. The Contractor shall demonstrate the ability to install an insert within 8 hours. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.
3. (Structural) Insert Flip Demonstration: The Contractor shall demonstrate the operation of all flip platforms on the inserts. The Contractor shall perform 2 movement cycles where each cycle includes the flip down for use and flip up for storage movement. The Contractor shall perform actuation of flip for use within 2 hours. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.
4. (Structural) Platform Proof Load Test: The Contractor shall demonstrate the load capacity of the platform. The platform shall be installed in the VAB High Bay using the connection pins.
31,250 pounds of weight shall be located at the middle of the platform over an 18-feet by 10-feet area. The deflection of the perimeter beams and the beams adjacent to the load shall be measured. Platform shall have no deflection after removing the load. The Contractor shall perform a weld inspection of the platform and visually inspect all bolted connections between the W36 to W36 connections and the connection between platform structure and the X-Y rollers. A posttest inspection report and repair procedure, if required, shall be submitted to the Contracting Officer for approval. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer. Note: Proof load test is only required after initial installation and is not required following subsequent platform moves.
5. (Structural) Load Cycles on Platform: The Contractor shall demonstrate

how the platform will react with a test weight rolled around the platform and insert. The Contractor shall test with the elevator weights on a cart, both provided by the Government. Test shall require ten (10) cycles of movement across floor both perpendicular and parallel to planking for both pieces of equipment. The platform deflection and squaring shall be checked after each load cycle. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

6. (Mechanical) Hinged Rails Demonstration Test: The Contractor shall demonstrate the ability of the hinged rails to extend and retract. The Contractor shall record the time to actuate the rail into position. A total of two (2) extension and retraction cycles shall be performed. The platform shall be extended and then retracted after each cycle. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

7. (Mechanical) Extension/Retraction of the Platform Demonstration: The Contractor shall test / demonstrate the extension and retraction ability of the platform segments under platform self-power. Test requires mating of platform segments to each other. Platform segments shall be extended within 6 minutes each. Extension and retraction test shall be run a total of two (2) times unloaded. Platforms shall then be loaded with a 2000 lb test load located at three (3) locations identified by the Contracting Officer's Representative at the time of the test. The platforms shall be extended and retracted a total of two (2) times for each load location. The Contractor shall verify alignment with opposite extended platform. The Contractor shall also demonstrate manual extension and retraction operation (4 hour time limit). Complete one test for each loading location and unloaded condition. The Contractor shall verify the hose management system maintains position without deformation during each test. The platform shall extend and retract smoothly and without any visible hang ups or jams. If movement is not smooth, then the platform shall be adjusted and the test rerun. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

8. (Mechanical) Lateral Movement Demonstration: The Contractor shall perform a lateral movement demonstration of a platform segment using the screw jacks. The Contractor shall purposely set the platform segment out of alignment by 2-inches and then reset to the required location. The test shall be repeated two (2) times with the offset being made at both sides. The Contractor shall record the amount of time required to reset the platform. The Contractor shall also perform a lateral movement demonstration with the platforms extended. One platform shall be set in the correct alignment and the other platform segment shall be extended outward with a 2-inch out-of-alignment setting. The Contractor shall adjust the out-of-alignment platform segment using the screw jacks to properly mate the platform segments together. The Contractor shall repeat this test (2) times. The Contractor shall verify the hose management system maintains position without deformation during lateral movement test. The Contractor shall set the platform to proper alignment prior to moving to the next test. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

9. (Mechanical) Pneumatic Commodity Line Leak Check: The Contractor shall perform a leak check of the pneumatic commodity lines per NASA specifications following the extension and retraction testing. The Contractor shall test the lines in both the extended and retracted position. This test shall not be performed until after the extension and retraction cycle testing is complete. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

10. (Mechanical) Fire Protection Line Leak Check: The Contractor shall perform a leak check of the 5" fire protection supply line per NASA specifications following the extension and retraction testing. The fire

protection supply line shall be pressurized with air to the maximum system pressure. The Contractor shall test the lines in both the extended and retracted position. This test shall not be performed until after the extension and retraction cycle testing is complete. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

11. (Mechanical/Electrical) Limit Switch Demonstration: The Contractor shall test / demonstrate the limit switch capabilities of one, unloaded platform half. The Contractor shall perform this two (2) times. The Contractor shall verify all control function devices including but not limited to: warning lights, horns, operator buttons, E-stops, limit bypasses, cam switches, and proximity switches and other items to demonstrate the full function of the control. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

12. (Mechanical/Electrical) Drive Brake Demonstration: The Contractor shall demonstrate the brake functionality. The platform shall be unloaded and extended manually. The platform load indicator shall be set to manual actuation. The test shall verify that the brake is holding 50% more than the rated load moved by the rigid push chain. The Contractor shall not proceed with further testing until receiving approval from the Contracting Officer.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

-- End of Section --

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DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 33 00

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SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

The Contracting Officer may request submittals in addition to those specified when deemed necessary to adequately describe the work covered in the respective sections.

Units of weights and measures used on all submittals are to be the same as those used in the contract drawings.

Each submittal is to be complete and in sufficient detail to allow ready determination of compliance with contract requirements.

Contractor's Quality Control (CQC) System Manager and the Designer of Record, if applicable, to check and approve all items prior to submittal and stamp, sign, and date indicating action taken. Proposed deviations from the contract requirements are to be clearly identified. Include within submittals items such as: Contractor's, manufacturer's, or fabricator's drawings; descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves; test reports; test cylinders; samples; operations and maintenance (O&M) manuals (including parts list); certifications; warranties; and other such required submittals.

Submittals requiring Government approval are to be scheduled and made prior to the acquisition of the material or equipment covered thereby. Pick up and dispose of samples not incorporated into the work in accordance with manufacturer's Material Safety Data Sheets (MSDS) and in compliance with existing laws and regulations.

1.2 DEFINITIONS

1.2.1 Submittal Descriptions (SD)

Submittals requirements are specified in the technical sections. Submittals are identified by Submittal Description (SD) numbers and titles as follows:

SD-01 Preconstruction Submittals

Submittals which are required prior to start of construction (work), issuance of contract notice to proceed, or commencing work on site, or the start of the next major phase of the construction on a multi-phase contract, includes schedules, tabular list of data, or tabular list including location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work.

Certificates of insurance

Surety bonds

List of proposed Subcontractors

List of proposed products

Construction progress schedule

Network Analysis Schedule (NAS)

Submittal register

Schedule of prices

Health and safety plan

Work plan

Quality Control(QC) plan

Environmental protection plan

SD-02 Shop Drawings

Drawings, diagrams and schedules specifically prepared to illustrate some portion of the work.

Diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project.

Drawings prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

SD-03 Product Data

Catalog cuts, illustrations, schedules, diagrams, performance charts, instructions and brochures illustrating size, physical appearance and other characteristics of materials, systems or equipment for some portion of the work.

Samples of warranty language when the contract requires extended product warranties.

SD-04 Samples

Fabricated or unfabricated physical examples of materials, equipment or workmanship that illustrate functional and aesthetic characteristics of a material or product and establish standards by which the work can be judged.

Color samples from the manufacturer's standard line (or custom color samples if specified) to be used in selecting or approving colors for the project.

Field samples and mock-ups constructed on the project site establish standards by which the ensuring work can be judged. Includes assemblies or portions of assemblies which are to be incorporated into the project and those which will be removed at conclusion of the work.

SD-05 Design Data

Design calculations, mix designs, analyses or other data pertaining to a part of work.

Design submittals, design substantiation submittals and extensions of design submittals.

SD-06 Test Reports

Report signed by authorized official of testing laboratory that a material, product or system identical to the material, product or system to be provided has been tested in accord with specified requirements. (Testing must have been within three years of date of contract award for the project.)

Report which includes findings of a test required to be performed by the Contractor on an actual portion of the work or prototype prepared for the project before shipment to job site.

Report which includes finding of a test made at the job site or on sample taken from the job site, on portion of work during or after installation.

Investigation reports.

Daily logs and checklists.

Final acceptance test and operational test procedure.

SD-07 Certificates

Statements printed on the manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements. Must be dated after award of project contract and clearly name the project.

Document required of Contractor, or of a manufacturer, supplier, installer or Subcontractor through Contractor, the purpose of which is to further quality of orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel qualifications.

Confined space entry permits.

Text of posted operating instructions.

SD-08 Manufacturer's Instructions

Preprinted material describing installation of a product, system or material, including special notices and (MSDS)concerning impedances, hazards and safety precautions.

SD-09 Manufacturer's Field Reports

Documentation of the testing and verification actions taken by manufacturer's representative at the job site, in the vicinity of the job site, or on a sample taken from the job site, on a portion of the work, during or after installation, to confirm compliance with manufacturer's standards or instructions. The documentation must be

signed by an authorized official of a testing laboratory or agency and must state the test results; and indicate whether the material, product, or system has passed or failed the test.

Factory test reports.

SD-10 Operation and Maintenance Data

Data that is furnished by the manufacturer, or the system provider, to the equipment operating and maintenance personnel, including manufacturer's help and product line documentation necessary to maintain and install equipment. This data is needed by operating and maintenance personnel for the safe and efficient operation, maintenance and repair of the item.

This data is intended to be incorporated in an operations and maintenance manual or control system.

SD-11 Closeout Submittals

Documentation to record compliance with technical or administrative requirements or to establish an administrative mechanism.

Special requirements necessary to properly close out a construction contract. For example, Record Drawings and as-built drawings. Also, submittal requirements necessary to properly close out a major phase of construction on a multi-phase contract.

Interim "DD Form 250" with cost breakout for all assets 30 days prior to facility turnover.

1.2.2 Approving Authority

Office or designated person authorized to approve submittal.

1.2.3 Work

As used in this section, on- and off-site construction required by contract documents, including labor necessary to produce submittals, except those SD-01 Pre-Construction Submittals noted above, construction, materials, products, equipment, and systems incorporated or to be incorporated in such construction.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor QC approval and for information only. Submit the following in accordance with this section.

SD-01 Preconstruction Submittals

Submittal Register; G

1.3.1 Submittal Register

Prepare and maintain a submittal register as the work progresses. Use electronic submittal register program furnished by the Contracting Officer or any other format approved by the Contracting Officer. The Contracting Officer will provide the initial submittal register.

The Contractor is to track all submittals by maintaining a complete list, including completion of all data columns, including dates on which submittals are received and returned by the Contracting Officer.

1.3.2 Warranty Management Plan

At least 30 days before the planned pre-warranty conference, submit the warranty management plan. Include within the warranty management plan all required actions and documents to assure that the Government receives all warranties to which it is entitled. The plan must be in narrative form and contain sufficient detail to render it suitable for use by future maintenance and repair personnel, whether tradesmen, or of engineering background, not necessarily familiar with this contract. The term "status" as indicated below must include due date and whether item has been submitted or was accomplished. Warranty information made available during the construction phase must be submitted to the Contracting Officer for approval prior to each pay estimate. Assemble approved information in a binder and turn over to the Government upon acceptance of the work. The construction warranty period will begin on the date of project acceptance and continue for the full product warranty period. A joint 4 month and 9 month warranty inspection will be conducted, measured from time of acceptance, by the Contractor, Contracting Officer and the Customer Representative. Include within the warranty management plan , but not limited to, the following:

a. Roles and responsibilities of all personnel associated with the warranty process, including points of contact and telephone numbers within the organizations of the Contractors, subContractors, manufacturers or suppliers involved.

b. Furnish with each warranty the name, address, and telephone number of each of the guarantor's representatives nearest to the project location.

c. Listing and status of delivery of all Certificates of Warranty for extended warranty items, to include HVAC balancing, pumps, motors, transformers, and for all commissioned systems such as fire protection and alarm systems, sprinkler systems, etc.

d. A list for each warranted equipment, item, feature of construction or system indicating:

(1) Name of item.
(2) Model and serial numbers.
(3) Location where installed.
(4) Name and phone numbers of manufacturers or suppliers.
(5) Names, addresses and telephone numbers of sources of spare parts.
(6) Warranties and terms of warranty. Include one-year overall warranty of construction, including the starting date of warranty of construction. Items which have extended warranties must be indicated with separate warranty expiration dates.
(7) Cross-reference to warranty certificates as applicable.
(8) Starting point and duration of warranty period.
(9) Summary of maintenance procedures required to continue the warranty in force.
(10) Cross-reference to specific pertinent Operation and Maintenance manuals.
(11) Organization, names and phone numbers of persons to call for warranty service.

(12) Typical response time and repair time expected for various warranted equipment.

e. The Contractor's plans for attendance at the 4 and 9 month post-construction warranty inspections conducted by the Government.

f. Procedure and status of tagging of all equipment covered by extended warranties.

g. Copies of instructions to be posted near selected pieces of equipment where operation is critical for warranty and/or safety reasons.

1.3.3 Performance Bond

The Contractor's Performance Bond must remain effective throughout the construction period.

a. In the event the Contractor fails to commence and diligently pursue any construction warranty work required, the Contracting Officer will have the work performed by others, and after completion of the work, will charge the remaining construction warranty funds of expenses incurred by the Government while performing the work, including, but not limited to administrative expenses.

b. In the event sufficient funds are not available to cover the construction warranty work performed by the Government at the Contractor's expense, the Contracting Officer will have the right to recoup expenses from the bonding company.

c. Following oral or written notification of required construction warranty repair work, respond in a timely manner. Written verification will follow oral instructions. Failure of the Contractor to respond will be cause for the Contracting Officer to proceed against the Contractor.

1.3.4 Pre-Warranty Conference

Prior to contract completion, and at a time designated by the Contracting Officer, meet with the Contracting Officer to develop a mutual understanding with respect to the requirements of this section. Communication procedures for Contractor notification of construction warranty defects, priorities with respect to the type of defect, reasonable time required for Contractor response, and other details deemed necessary by the Contracting Officer for the execution of the construction warranty will be established/reviewed at this meeting. In connection with these requirements and at the time of the Contractor's quality control completion inspection, furnish the name, telephone number and address of a licensed and bonded company which is authorized to initiate and pursue construction warranty work action on behalf of the Contractor. This point of contact will be located within the local service area of the warranted construction, be continuously available, and be responsive to Government inquiry on warranty work action and status. This requirement does not relieve the Contractor of any of its responsibilities in connection with other portions of this provision.

1.3.5 Contractor's Response to Construction Warranty Service Requirements

Following oral or written notification by the Contracting Officer, respond to construction warranty service requirements in accordance with the

"Construction Warranty Service Priority List" and the three categories of priorities listed below. Submit a report on any warranty item that has been repaired during the warranty period. Include within the report the cause of the problem, date reported, corrective action taken, and when the repair was completed. If the Contractor does not perform the construction warranty within the timeframes specified, the Government will perform the work and backcharge the construction warranty payment item established.

a. First Priority Code 1. Perform onsite inspection to evaluate situation, and determine course of action within 4 hours, initiate work within 6 hours and work continuously to completion or relief.

b. Second Priority Code 2. Perform onsite inspection to evaluate situation, and determine course of action within 8 hours, initiate work within 24 hours and work continuously to completion or relief.

c. Third Priority Code 3. All other work to be initiated within 3 work days and work continuously to completion or relief.

1.3.6 Warranty Tags

At the time of installation, tag each warranted item with a durable, oil and water resistant tag approved by the Contracting Officer. Attach each tag with a copper wire and spray with a silicone waterproof coating. Also, submit two record copies of the warranty tags showing the layout and design. The date of acceptance and the QC signature must remain blank until the project is accepted for beneficial occupancy. Show the following information on the tag.

Type of product/material	
Model number	
Serial number	
Contract number	
Warranty period from/to	
Inspector's signature	
Construction Contractor	
Address	
Telephone number	
Warranty contact	
Address	
Telephone number	
Warranty response time priority code	

WARNING - PROJECT PERSONNEL TO PERFORM ONLY OPERATIONAL MAINTENANCE DURING THE WARRANTY PERIOD.

1.4 SUBMITTAL REGISTER

Prepare and maintain a submittal register as the work progresses. Use electronic submittal register program furnished by the Contracting Officer or any other format approved by the Contracting Officer. The contracting officer will provide the initial submittal register.

The Contractor is to track all submittals by maintaining a complete list, including completion of all data columns, including dates on which submittals are received and returned by the Contracting Officer.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

-- End of Section --

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DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 42 00

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SECTION 01 42 00

SOURCES FOR REFERENCE PUBLICATIONS

PART 1 GENERAL

1.1 REFERENCES

Various publications are referenced in other sections of the specifications to establish requirements for the work. These references are identified in each section by document number, date and title. The document number used in the citation is the number assigned by the standards producing organization, (e.g. ASTM B564 Nickel Alloy Forgings). However, when the standards producing organization has not assigned a number to a document, an identifying number has been assigned for reference purposes.

1.2 ORDERING INFORMATION

The addresses of the standards publishing organizations whose documents are referenced in other sections of these specifications are listed below, and if the source of the publications is different from the address of the sponsoring organization, that information is also provided. Documents listed in the specifications with numbers which were not assigned by the standards producing organization should be ordered from the source by title rather than by number.

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)
38800 Country Club Drive
Farmington Hills, MI 48331
Ph: 248-848-3700
Fax: 248-848-3701
E-mail: bkstore@concrete.org
Internet: http://www.concrete.org

ACOUSTICAL SOCIETY OF AMERICA (ASA)
2 Huntington Quadrangle, Suite 1NO1
Melville, NY 11747-4502
Ph: 516-576-2360
Fax: 516-576-2377
E-mail: asa@aip.org
Internet: http://asa.aip.org

AIR MOVEMENT AND CONTROL ASSOCIATION INTERNATIONAL (AMCA)
30 West University Drive
Arlington Heights, IL 60004-1893
Ph: 847-394-0150
Fax: 847-253-0088
E-mail: amca@amca.org
Internet: http://www.amca.org

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)
2111 Wilson Blvd, Suite 500
Arlington, VA 22201
Ph: 703-524-8800
Fax: 703-528-3816

E-mail: fdietz@ahrinet.org
Internet: http://www.ahrinet.org

ALUMINUM ASSOCIATION (AA)
National Headquarters
1525 Wilson Boulevard, Suite 600
Arlington, VA 22209
Ph: 703-358-2960
Fax: 703-358-2961
Internet: http://www.aluminum.org

AMERICAN ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)
1827 Walden Office Square
Suite 550
Schaumburg, IL 60173-5774
Ph: 847-303-5664
Fax: 847-303-5774
E-mail: webmaster@aamanet.org
Internet: http://www.aamanet.org

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)
444 North Capital Street, NW, Suite 249
Washington, DC 20001
Ph: 202-624-5800
Fax: 202-624-5806
E-Mail: info@aashto.org
Internet: http://www.aashto.org

AMERICAN BEARING MANUFACTURERS ASSOCIATION (ABMA)
2025 M Street, NW, Suite 800
Washington, DC 20036
Ph: 202-367-1155
Fax: 202-367-2155
E-mail: info@americanbearings.org
Internet: http://www.abma-dc.org

AMERICAN HARDBOARD ASSOCIATION (AHA)
1210 West Northwest Highway
Palatine, IL 60067
Ph: 847-934-8800
Fax: 847-934-8803
E-mail: aha@hardboard.org
Internet: http://www.hardboard.org

AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA)
2700 Prosperity Ave., Suite 250
Fairfax, VA 22031
Tel: 703-849-8888
Fax: 703-207-3561
E-mail: infonet@aiha.org
Internet http://www.aiha.org

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)
One East Wacker Drive, Suite 700
Chicago, IL 60601-1802
Ph: 312-670-2400
Fax: 312-670-5403
Publications: 800-644-2400

E-mail: pubs@aisc.org
Internet: http://www.aisc.org

AMERICAN IRON AND STEEL INSTITUTE (AISI)
1140 Connecticut Avenue, NW, Suite 705
Washington, DC 20036
Ph: 202-452-7100
Fax: 202-463-6577
E-mail: webmaster@steel.org
Internet: http://www.steel.org

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
1819 L Street, NW, 6th Floor
Washington, DC 20036
Ph: 202-293-8020
Fax: 202-293-9287
E-mail: info@ansi.org
Internet: http://www.ansi.org/

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)
1711 Arlingate Lane
P.O. Box 28518
Columbus, OH 43228-0518
Ph: 800-222-2768; 614-274-6003
Fax: 614-274-6899
E-mail: webmaster@asnt.org
Internet: http://www.asnt.org

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)
1801 Alexander Bell Drive
Reston, VA 20191-4400
Ph: 703-295-6300 - 800-548-2723
Fax: 703-295-6333
E-mail: member@asce.org
Internet: http://www.asce.org

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)
1791 Tullie Circle, NE
Atlanta, GA 30329
Ph: 800-527-4723 or 404-636-8400
Fax: 404-321-5478
E-mail: ashrae@ashrae.org
Internet: http://www.ashrae.org

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)
1800 East Oakton Street
Des Plaines, IL 60018-2187
Ph: 847-699-2929
Fax: 847-768-3434
E-mail: customerservice@asse.org
Internet: http://www.asse.org

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)
901 Canterbury, Suite A
Westlake, OH 44145
Ph: 440-835-3040
Fax: 440-835-3488
E-mail: info@asse-plumbing.org

Internet: http://www.asse-plumbing.org

AMERICAN WATER WORKS ASSOCIATION (AWWA)
6666 West Quincy Avenue
Denver, CO 80235
Ph: 800-926-7337
Fax: 303-347-0804
E-mail: smorrison@awwa.org
Internet: http://www.awwa.org

AMERICAN WELDING SOCIETY (AWS)
550 N.W. LeJeune Road
Miami, FL 33126
Ph: 800-443-9353 - 305-443-9353
Fax: 305-443-7559
E-mail: info@aws.org or customerservice@awspubs.com
Internet: http://www.aws.org

ASME INTERNATIONAL (ASME)
Three Park Avenue, M/S 10E
New York, NY 10016-5990
Ph: 800-854-7179 or 800-843-2763
Fax: 212-591-7674
E-mail: infocentral@asme.org
Internet: http://www.asme.org

ASSOCIATED AIR BALANCE COUNCIL (AABC)
1518 K Street, NW
Washington, DC 20005
Ph: 202-737-0202
Fax: 202-638-4833
E-mail: info@aabc.com
Internet: http://www.aabchq.com

ASTM INTERNATIONAL (ASTM)
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959
Ph: 610-832-9585
Fax: 610-832-9555
E-mail: service@astm.org
Internet: http://www.astm.org

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)
355 Lexington Avenue
15th Floor
New York, NY 10017
Ph: 212-297-2122
Fax: 212-370-9047
E-mail: assocmgmt@aol.com
Internet: http://www.buildershardware.com

CALIFORNIA ENERGY COMMISSION (CEC)
Media and Public Communications Office
1516 Ninth Street, MS-29
Sacramento, CA 95814-5512
Ph: 916-654-4287
Internet: http://www.energy.ca.gov/

COMPRESSED GAS ASSOCIATION (CGA)
4221 Walney Road, 5th Floor
Chantilly, VA 20151
Ph: 703-788-2700
Fax: 703-961-1831
E-mail: cga@cganet.com
Internet: http://www.cganet.com

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)
933 North Plum Grove Road
Schaumburg, IL 60173-4758
Ph: 847-517-1200 or 800-328-6306
Fax: 847-517-1206
Internet: http://www.crsi.org/

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)
8720 Red Oak Boulevard, Suite 201
Charlotte, NC 28217-3992
Ph: 704-676-1190
Fax: 704-676-1199
Internet: www.mhia.org/psc/PSC_Products_Cranes.cfm

ELECTRONIC INDUSTRIES ALLIANCE (EIA)
2500 Wilson Boulevard
Arlington, VA 22201-3834
Ph: 703-907-7500
Fax: 703-907-7501
E-mail: infor@ecaus.org
Internet: http://www.eia.org

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)
25 North Broadway
Tarrytown, NY 10591
Ph: 914-332-0040
Fax: 914-332-1541
E-mail: inquiries@ejma.org
Internet: http://www.ejma.org

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PART 2 PRODUCTS

Not used

PART 3 EXECUTION

Not used

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ENVIRONMENTAL PROTECTION

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.

FLORIDA ADMINISTRATIVE CODE (FAC)

Chapter 62-710	Used Oil Management
Chapter 62-730	Hazardous Waste
Chapter 62-737	Mercury Containing Lamps and Devices Destined for Recycling
Chapter 62-770	Petroleum Contamination Site Clean Up Criteria

JOHN F. KENNEDY SPACE CENTER (KSC)

KNPR 8500.1	(2010; Rev B) KSC Environmental Requirements
NPR 8530.1A	(2009; Change 3) Affirmative Procurement Program and Plan for Environmentally Preferable Products

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

33 CFR 328	Definitions of Waters of the United States
40 CFR 247	Comprehensive Procurement Guideline for Products Containing Recovered Materials
40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 273	Standards For Universal Waste Management
40 CFR 279	Standards for the Management of Used Oil

40 CFR 302	Designation, Reportable Quantities, and Notification
40 CFR 355	Emergency Planning and Notification
40 CFR 68	Chemical Accident Prevention Provisions
40 CFR 761	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions

1.2 DEFINITIONS

1.2.1 Biobased Content

"Biobased content" is calculated as the weight of the biobased material divided by the total weight of the product, and is expressed as a percentage by weight.

1.2.2 Biobased Materials

"Biobased Materials" include fuels, chemicals, building materials or electric power or heat produced from biomass as defined by the Biomass R&D Act. Minimum biobased content shall be as defined in the U.S. Farm Bill.

1.2.3 Life-Cycle Cost Analysis

"Life-cycle cost analysis" is a comparison of the amortized annual cost of using a product with respect to a product that it not Comprehensive Procurement Guideline (CPG) compliant, biobased, environmentally preferable, energy-efficient, water-efficient, recycled-content, and non-ozone depleting or are non-toxic or less toxic. Cost under consideration include capital costs, installation costs, operating costs, maintenance costs, and disposal costs discounted over the lifetime of the product.

1.2.4 Environmental Pollution and Damage

Environmental pollution and damage is the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade the environment aesthetically, culturally and/or historically.

1.2.5 Environmental Protection

Environmental protection is the prevention/control of pollution and habitat disruption that may occur to the environment during construction. The control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.2.6 Contractor Generated Hazardous Waste

Contractor generated hazardous waste means materials that, if abandoned or disposed of, may meet the definition of a hazardous waste. These waste

streams would typically consist of material brought on site by the Contractor to execute work, but are not fully consumed during the course of construction. Examples include, but are not limited to, excess paint thinners (i.e. methyl ethyl ketone, toluene etc.), waste thinners,excess paints, excess solvents, waste solvents, and excess pesticides, and contaminated pesticide equipment rinse water.

1.2.7 Land Application for Discharge Water

The term "Land Application" for discharge water implies that the Contractor must discharge water at a rate which allows the water to percolate into the soil. No sheeting action, soil erosion, discharge into storm sewers, discharge into defined drainage areas, or discharge into the "waters of the United States" must occur. Land Application must be in compliance with applicable Federal, State, and local laws and regulations.

1.2.8 Surface Discharge

The term "Surface Discharge" implies that the water is discharged with possible sheeting action and subsequent soil erosion may occur. Waters that are surface discharged may terminate in drainage ditches, storm sewers,creeks, and/or "waters of the United States" and would require a permit to discharge water from the governing agency.

1.2.9 Waters of the United States

All waters which are under the jurisdiction of the Clean Water Act, as defined in 33 CFR 328.

1.2.10 Wetlands

Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, and bogs. Official determination of whether or not an area is classified as a wetland must be done in accordance with KSC Environmental.

1.3 GENERAL REQUIREMENTS

Minimize environmental pollution and damage that may occur as the result of construction operations. The environmental resources within the project boundaries and those affected outside the limits of permanent work must be protected during the entire duration of this contract. Comply with Federal, State, and local environmental laws and regulations. Delays resulting from failure to comply with environmental laws and regulations shall be the Contractor's responsibility.

1.4 SUBCONTRACTORS

Ensure compliance with this section by subcontractors.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Environmental Protection Plan; G

1.6 ENVIRONMENTAL PROTECTION PLAN

Prior to commencing construction activities or delivery of materials to the site, submit an Environmental Protection Plan for review and approval by the Contracting Officer. The purpose of the Environmental Protection Plan is to present a comprehensive overview of known or potential environmental issues which the Contractor must address during construction. Issues of concern must be defined within the Environmental Protection Plan as outlined in this section. Address each topic at a level of detail commensurate with the environmental issue and required construction task(s). Topics or issues which are not identified in this section, but are considered necessary, must be identified and discussed after those items formally identified in this section. Prior to submittal of the Environmental Protection Plan, meet with the Contracting Officer for the purpose of discussing the implementation of the initial Environmental Protection Plan; possible subsequent additions and revisions to the plan including reporting requirements; and methods for administration of the Contractor's Environmental Plans. The Environmental Protection Plan must be current and maintained onsite by the Contractor.

1.6.1 Compliance

No requirement in this Section will relieve the Contractor of Federal, State, and local environmental protection laws and regulations. During Construction, the Contractor shall be responsible for identifying, implementing, and submitting for approval additional requirements to be included in the Environmental Protection Plan.

1.6.2 Contents

Include in the Environmental Protection Plan, but not limit it to, the following:

a. Name(s) of person(s) within the Contractor's organization who is(are) responsible for ensuring adherence to the Environmental Protection Plan.

b. Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from the site, if applicable.

c. Name(s) and qualifications of person(s) responsible for training the Contractor's environmental protection personnel.

d. Description of the Contractor's environmental protection personnel training program.

e. An erosion and sediment control plan which identifies the type and location of the erosion and sediment controls to be provided. The plan must include monitoring and reporting requirements to assure that the control measures are in compliance with the erosion and sediment control plan, Federal, State, and local laws and regulations. A Storm Water Pollution Prevention Plan (SWPPP) may be substituted for this plan.

f. Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plan

shall include measures to minimize the amount of mud transported onto paved public roads by vehicles or runoff.

g. Work area plan showing the proposed activity in each portion of the area and identifying the areas of limited use or nonuse. Plan should include measures for marking the limits of use areas including methods for protection of features to be preserved within authorized work areas.

h. The Contractor's spill control plan shall include the procedures, instructions, and reports in accordance with the contract clause "spill" to be used in the event of an unforeseen spill of a substance regulated by 40 CFR 68, 40 CFR 302, 40 CFR 355, or regulated under State or Local laws and regulations. The Contractor's spill control plan supplements the requirements of KNPR 8500.1, Rev B, KSC Requirements. Include in this plan, as a minimum:

(1) The name of the individual who shall report spills or hazardous substance releases and who shall follow up with complete documentation. This individual shall immediately notify the Contracting Officer and the Environmental Assurance Branch in addition to the legally required Federal, State, and local reporting channels (including the National Response Center 1-800-424-8802) if a reportable quantity is released to the environment. Include in the plan a list of the required reporting channels and telephone numbers.

(2) The name and qualifications of the individual who shall be responsible for implementing and supervising the containment and cleanup.

(3) Training requirements for Contractor's personnel and methods of accomplishing the training.

(4) A list of materials and equipment to be immediately available at the job site, tailored to cleanup work of the potential hazard(s) identified.

(5) The names and locations of suppliers of containment materials and locations of additional fuel oil recovery, cleanup, restoration, and material-placement equipment available in case of an unforeseen spill emergency.

(6) The methods and procedures to be used for expeditious contaminant cleanup.

i. A Non-hazardous Solid Waste Disposal Plan identifying methods and locations for solid waste disposal including clearing debris and schedules for disposal.

(1) Identify subcontractors responsible for the transportation and disposal of solid waste. Submit licenses or permits for solid waste disposal sites that are not a commercial operating facility.

(2) Evidence of the disposal facility's acceptance of the solid waste must be attached to this plan during the construction. Attach a copy of each of the Non-hazardous Solid Waste Diversion Reports to the disposal plan. Non-hazardous Solid Waste Diversion Reports shall be submitted using KSC Form 7-648NS (Rev. 12/08) to the Contracting Officer by December 31 of each year or at the closeout

of the project, whichever occurs first.

(3) Indicate in the report the total amount of waste generated and total amount of waste diverted in cubic yards or tons along with the percent that was diverted.

(4) A recycling and solid waste minimization plan with a list of measures to reduce consumption of energy and natural resources. Detail in the plan the Contractor's actions to comply with and to participate in Federal, State, Regional, and local government sponsored recycling programs to reduce the volume of solid waste at the source.

j. A Hazardous Waste Management Plan that identifies processes, operations and safety procedures that are site specific for the location and nature of hazardous and controlled waste, which includes and not limited to chemicals, paints, removed paints and coatings, solvents, aerosol cans, petroleum, oil and lubricant (POL) products, lamps, ballasts, mercury switches, etc. and their containers, as defined in 40 CFR 261, 40 CFR 273, 40 CFR 279, or 40 CFR 761.

k. An Air Pollution Control Plan detailing provisions to assure that dust, debris, materials, trash, etc., do not become air borne and travel off the project site.

l. A Contaminant Prevention Plan that: identifies potentially hazardous substances to be used on the job site; identifies the intended actions to prevent introduction of such materials into the air, water, or ground; and details provisions for compliance with Federal, State, and local laws and regulations for storage and handling of these materials. In support of KNPR 8500.1, Rev B, KSC Requirements., a copy of the Material Safety Data Sheets (MSDS) and the maximum quantity of each hazardous material to be onsite must be included in the contaminant prevention plan. Update the plan as new hazardous materials are brought onsite or removed from the site.

m. A waste water management plan that identifies the methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines. If a settling/retention pond is required, the plan must include the design of the pond including drawings, removal plan, and testing requirements for possible pollutants. If land application will be the method of disposal for the waste water, the plan must include a sketch showing the location for land application along with a description of the pretreatment methods to be implemented. If surface discharge will be the method of disposal, include a copy of the permit and associated documents as an attachment prior to discharging the waste water. If disposal is to a sanitary sewer, the plan must include documentation that the Waste Water Treatment Plant Operator has approved the flow rate, volume, and type of discharge.

1.6.3 Appendix

Attach to the Environmental Protection Plan, as an appendix, copies of environmental permits, permit application packages, approvals to construct, notifications, certifications, reports, and termination documents.

1.7 PROTECTION FEATURES

This paragraph supplements the Contract Clause PROTECTION OF EXISTING VEGETATION, STRUCTURES, EQUIPMENT, UTILITIES, AND IMPROVEMENTS. Prior to start of onsite construction activities, the Contractor and the Contracting Officer will make a joint condition survey. Immediately following the survey, the Contractor shall prepare a brief report including a plan describing the features requiring protection under the provisions of the Contract Clauses, which are not specifically identified on the drawings as environmental features requiring protection along with the condition of trees, shrubs and grassed areas immediately adjacent to the site of work and adjacent to the Contractor's assigned storage area and access route(s), as applicable. This survey report will be signed by both the the Contractor and the Contracting Officer upon mutual agreement as to its accuracy and completeness. The Contractor must protect those environmental features included in the survey report and indicated on the drawings, regardless of interference which their preservation may cause to the work under the contract.

1.8 ENVIRONMENTAL ASSESSMENT OF CONTRACT DEVIATIONS

Deviations from the drawings,plans and specifications, requested by the Contractor and which may have an environmental impact, will be subject to approval by the Contracting Officer and may require an extended review, processing, and approval time. The Contracting Officer reserves the right to disapprove alternate methods, even if they are more cost effective, if the Contracting Officer determines that the proposed alternate method will have an adverse environmental impact.

1.9 NOTIFICATION

The Contracting Officer will notify the Contractor in writing of observed noncompliance with Federal, State or local environmental laws or regulations, permits, and other elements of the Contractor's Environmental Protection plan. After receipt of such notice, the Contractor shall inform the Contracting Officer of the proposed corrective action and take such action when approved by the Contracting Officer. The Contracting Officer may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions will be granted or equitable adjustments allowed for such suspensions. This is in addition to other actions the Contracting Officer may take under the contract, or in accordance with the Federal Acquisition Regulation or Federal Law.

PART 2 PRODUCTS

2.1 OBJECTIVE

Government procurement policy is to acquire goods and services through the use of sustainable environmental practices, including acquisition of biobased content/material, environmentally preferable, energy-efficient, water-efficient, recycled-content, and non-ozone depleting or are non-toxic or less toxic alternatives where such products and services meet agency performance requirements.

2.2 SUSTAINABLE ACQUISITION

The Contractor shall consider products that have a lesser or reduced adverse effect on human health and the environment, and provide products and materials with the least effect on the environment, determined by

life-cycle cost analysis or other methods in accordance with NPR 8530.1A Affirmative Procurement Program and Plan for Environmentally Preferable Products. These comparisons shall consider raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance and disposal of products.

The Contractor shall ensure that products and materials being purchased comply, to the greatest extent practicable, with specific requirements regarding environmental attributes. These attributes include:

a. EPA's CPG and recommendations concerning EPA's list of designated products listed in 40 CFR 247.
b. Biobased products as defined by the United States Department of Agriculture.
c. Energy-efficiency requirements regarding Energy Star.

2.2.1 Prohibited Materials

The use of the following materials is prohibited:

a. Products containing asbestos
b. Products containing urea formaldehyde
c. Products containing polychlorinated biphenyls
d. Products containing chlorinated fluorocarbons
e. Solder or flux containing more than 0.2 percent lead and domestic water pipe or pipe fittings containing more than 8 percent lead
f. Paint containing more than 0.06 percent lead

2.2.2 EPA Designated Items Incorporated in the Work

Various sections of the specifications contain requirements for materials that have been designated by EPA in 40 CFR 247 as being products which are or can be made with recovered or recycled materials. These items, when incorporated into the work under this contract, shall contain at least the specified percentage of recycled or recovered materials unless adequate justification (non-availability) for non-use is provided. When a designated item is specified as an option to a non-designated item, the designated item requirements apply only if the designated item is used in the work.

Many products listed in 40 CFR 247 have been designated or proposed by EPA to include recycled or recovered materials that may be used by the Contractor in performing the work but will not be incorporated into the work. These products include office products, temporary traffic control products, and pallets. It is recommended that these non-construction products, when used in the conduct of the work, contain the highest practicable percentage of recycled or recovered materials and that these products be recycled when no longer needed.

2.2.3 Waiver

Procurement of EPA-designated (CPG) materials which do not meet the minimum recovered material standards require a waiver, approved by the Environmental Manager. A request for Waiver Form (KSC 28-825 NS) must be submitted for the purchase of items that are on the CPG list but are replaced with items that do not meet minimum standards.

PART 3 EXECUTION

3.1 LAND RESOURCES

Confine activities to areas defined by the drawings and specifications.

Identify land resources to be preserved within the work area prior to the beginning of construction. Do not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without approval, except in areas indicated on the drawings or specified to be cleared. Ropes, cables, or guys will not be fastened to or attached to trees for anchorage unless specifically authorized. Provide effective protection for land and vegetation resources, as defined in the following subparagraphs. Remove stone, soil, or other materials displaced into uncleared areas.

3.1.1 Work Area Limits

Mark the areas that need not be disturbed under this contract prior to commencing construction activities. Mark or fence isolated areas within the general work area which are not to be disturbed. Protect monuments and markers before construction operations commence. Where construction operations are to be conducted during darkness, markers must be visible in the dark. The Contractor's personnel must be knowledgeable of the purpose for marking and protecting particular objects.

3.1.2 Landscape

Trees, shrubs, vines, grasses, land forms and other landscape features indicated and defined on the drawings to be preserved must be clearly identified by marking, fencing, or wrapping with boards, or other approved techniques. Restore landscape features damaged or destroyed during construction operations outside the limits of the approved work area.

3.1.3 Erosion and Sediment Controls

The Contractor shall be responsible for providing erosion and sediment control measures in accordance with Federal, State, and local laws and regulations is the Contractor's responsibility. Select and maintain the erosion and sediment controls such that water quality standards are not violated as a result of construction activities. The area of bare soil exposed by construction operations should be kept to a minimum. The Contractor shall construct or install temporary and permanent erosion and sediment control best management practices (BMPs). BMPs may include, but not be limited to, vegetation cover, stream bank stabilization, slope stabilization, silt fences, construction of terraces, interceptor channels, sediment traps, inlet and outfall protection, diversion channels, and sedimentation basins. The Contractor's best management practices must also be in accordance with the National Pollutant Discharge Elimination System (NPDES) Storm Water Pollution Prevention Plan (SWPPP) which may be reviewed at the NASA Environmental Assurance Branch. Remove temporary measures after the area has been stabilized.

3.1.4 Contractor Facilities and Work Areas

Place field offices, staging areas, stockpile storage, and temporary buildings in areas designated on the drawings or as directed by the Contracting Officer. Temporary movement or relocation of Contractor facilities will be made only when approved.

3.2 WATER RESOURCES

Monitor all water areas affected by construction activities to prevent pollution of surface and ground waters. Do not apply toxic or hazardous chemicals to soil or vegetation.

3.2.1 Wetlands

Do not enter, disturb, destroy, or allow discharge of contaminants into wetlands.

3.3 AIR RESOURCES

Equipment operation, activities, or processes shall be in accordance with Federal and State air emission and performance laws and standards.

3.3.1 Particulates

Dust particles; aerosols and gaseous by-products from construction activities; and processing and preparation of materials must be controlled at all times, including weekends, holidays and hours when work is not in progress. Maintain work areas within or outside the project boundaries free from particulates which would cause the Federal, State, and local air pollution standards to be exceeded or which would cause a hazard or a nuisance. Perform particulate control as the work proceeds and whenever a particulate nuisance or hazard occurs. Comply with State and local visibility regulations.

3.3.2 Burning

Burning is prohibited on the Government premises.

3.4 CHEMICAL MATERIALS MANAGEMENT AND WASTE DISPOSAL

Contractor shall develop and maintain procedures, instructions, and reports to be used in the event of an unforeseen spill of a substance regulated by 40 CFR 68, 40 CFR 302, 40 CFR 355, and/or regulated under State or local laws and regulations (e.g. Chapter 62-770, F.A.C.). The procedures, instructions, and reports shall supplement the requirements of KNPR 8500.1, Rev. B, KSC Requirements. At a minimum, the Contractor shall:

(1) Identify the individual who will report any spills, or hazardous substance releases and who will follow up with complete documentation. This individual will immediately notify the Contracting Officer and the Environmental Assurance Branch in addition to the legally required Federal, State, and local reporting channels (including the National Response Center at 1-800-424-8802) if the reportable quantity is released to the environment. Provide a list of the required reporting channels and telephone numbers.

(2) Identify the individual (including qualifications) who will be responsible for the implementing and supervising spill containment and cleanup.

(3) Identify training requirements including the name(s) and qualifications of individuals responsible for training Contractor personnel. Include a description of the methods to accomplish the training requirements.

(4) Identify the materials and equipment to be immediately available at the job site, tailored to contain and cleanup identified spill hazards.

(5) Identify the names and locations of suppliers of containment materials and locations of additional fuel recovery, cleanup, restoration, and material-placement equipment available in the event of an unforeseen spill emergency.

(6) Identify methods and procedures to be used for expeditious contaminant containment cleanup.

Contractor shall develop and maintain procedures to assure dust, debris, materials, trash, etc. do not become airborne and travel off the project site.

Contractor shall identify potentially hazardous substances to be used on the job site; identify the intended actions to prevent introduction of such materials into the air, water, or ground; and detail provisions for compliance with Federal, State, and local laws and regulations for storage and handling of identified potentially hazardous substances. In support of KNPR 8500.1, Rev. B, KSC Requirements, copies of Material Safety Data Sheets (MSDS) and the maximum quantities of each hazardous material to be onsite at any given time must be maintained onsite.

Disposal of wastes will be as directed below, unless otherwise specified in other sections or shown on the drawings.

3.4.1 Solid Wastes

Solid wastes (excluding clearing debris) shall be placed in containers which are emptied on a regular schedule. Handling, storage, and disposal must be conducted to prevent contamination. Employ segregation measures so that no hazardous or toxic waste will become co-mingled with solid waste.

Waste items not requiring special handling, or which cannot be resold or recycled, shall be disposed of in receptacles slated for disposal in either the KSC landfill or the Brevard County landfill. The physical dimensions of the waste shall be within the handling capabilities of the landfill disposal equipment. The physical dimensions for the landfill handling capabilities are 8 feet in length x 8 feet in width.

The KSC landfill is an unlined Class III landfill with permit restrictions and limited capacity. The landfill is opened Tuesdays and Thursdays between 7:30am to 11:00am and 12:00pm to 3:00pm. Only the following items listed will be accepted at the landfill:

(1) Asphalt: Asphalt removed from parking lots, driveways and roadways.

(2) Blast Media: The blast media must be as free from debris as possible and determined non-hazardous for acceptance into the KSC landfill. The Spent Sandblast Media Disposal Form must accompany the blast media to the landfill and will be reviewed by the landfill operator. Blasting media determined to be hazardous waste must be managed as hazardous waste.

(3) Carpeting: Carpet may be disposed of in the KSC landfill.

(4) Construction and Demolition Debris: Materials considered not water soluble and non-hazardous in nature, including but not limited to steel, brick, glass, concrete, asphalt, pipe, gypsum wallboard and lumber. This includes rocks, soils, tree remains and other vegetative matter, which normally results from land clearing or development. Scrap metal from demolition projects should be managed according to guidance provided in this section for recyclable material.

(5) Fiberglass: Fiberglass is accepted.

(6) Glass (except for Light Bulbs or Lamps): Glass is accepted.

(7) Non-Friable Asbestos: Also referred to as Non-Regulated Asbestos Containing Materials (NRACM) are handled on a case-by-case basis. KSC policy allows for the disposal of NRACM only. In order to dispose of non-friable asbestos, the Contractor shall complete and submit the KSC/Schwartz Road Landfill Non-Friable Asbestos Form 28-1024, which can be obtained from the Contracting Officer or the Contracting Officer's designee. The form shall be sent to NASA EAB, TA-BIB through the Contracting Officer.

The following scheduling procedures shall be followed before NRACM wastes are accepted at the landfill:

a. The waste generator/hauler shall make arrangements with the landfill operator a minimum of 24 hours before disposal of NRACM waste and shall inform the operator of the quantity of the waste and the scheduled date the shipment will arrive at the landfill.

b. NRACM will be accepted at the landfill with prior arrangement with the scale house attendant (minimum of 24 hours notification) Tuesdays or Thursdays during regular landfill hours, but will not be accepted later than 1400 hours.

(8) Pallets (Unserviceable Wood and Plastics): Pallets that are not reusable or recycled are accepted.

(9) Wood: Miscellaneous non-pressure treated wood items are accepted.

(10) Yard Waste (Vegetation): Vegetation from maintenance activities is accepted.

The following wastes are not authorized for disposal at the KSC landfill:

(1) Any waste not permitted by DEP regulations to be disposed of in a Class III landfill as defined in Rule 62-701.200(14) FAC.

(2) Putrescible (brown bag) office waste.

(3) Chromated Copper Arsenate (CCA) treated wood.

(4) Liquid or non-liquid polychlorinated biphenyls (PCBs) (with exception of PCB Bulk Product Waste).

(5) Friable Asbestos.

(6) Hazardous wastes as specified by the U.S. Environmental Protection Agency (EPA); EPA defines hazardous waste as those wastes that exhibit flammability, corrosivity, reactivity, and/or toxicity characteristics; (Per EPA's list of hazardous wastes, 40 CFR 261, Subpart D, and most recent revision thereof).

(7) Biomedical waste.

(8) Liquid wastes, including oil (containerized or non-containerized).

(9) Lead-acid batteries.

(10) Tires, other than "shredded waste tires".

(11) White goods (i.e. appliances).

(12) Unpainted Concrete: Unpainted concrete shall be stockpiled at the Diverted Aggregate Recycling and Collection Yard (DARCY) located at the KSC landfill.

3.4.2 Chemicals and Chemical Wastes

Dispense chemicals ensuring no spillage to the ground or water. Perform and document periodic inspections of dispensing areas to identify leakage and initiate corrective action. This documentation will be periodically reviewed by the Government. Collect chemical waste in corrosion resistant, compatible containers. Collection drums must be monitored and removed to a staging or storage area when contents are within 6 inches of the top. Wastes shall be classified, managed, stored, and disposed of in accordance with KNPR 8500.1 KSC Environmental Requirements as well as Federal, State, and local laws and regulations.

3.4.3 Contractor Generated Hazardous Wastes/Excess Hazardous Materials

Hazardous and controlled waste shall be managed in accordance with all applicable statutes, rules, orders, and regulations which may include but are not limited to 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 273, 40 CFR 279, 40 CFR 761, and KNPR 8500.1 KSC Environmental Requirements. Inorganic Zinc (IOZ) paint waste shall be separated from all other hazardous and controlled wastes and managed in accordance with KNPR 8500.1, Rev. B and the associated KSC Environmental Fact Sheet. In no case shall the Contractor or the Contractor's representative transport hazardous waste from KSC.

The Contractor shall be responsible for identifying processes and operations and the location and nature of all potentially hazardous and controlled waste including chemicals, paints, removed paints and coatings, solvents, aerosol cans, petroleum, oil and lubricant (POL) products, lamps, mercury switches, etc. and their containers, as defined in 40 CFR 261, 40 CFR 273, 40 CFR 279, or 40 CFR 761. The Contractor shall prepare copies of Material Safety Data Sheets (MSDS) and a completed KSC Form 25-551 "Process Waste Questionnaire" (PWQ) for each material which may be generated as a waste and provide these to the Contracting Officer (CO) thirty (30) days before the start of the waste generation process. No substances shall be delivered to KSC without the appropriate Material Safety Data Sheets.

The Contractor shall obtain a Technical Response Package (TRP) from the CO within thirty (30) days after receipt of the PWQ. The TRP will contain a hazard determination and analytical, packaging, labeling, and disposal requirements according to KNPR 8500.1 (as revised) and will provide site-specific waste management requirements to be followed by the Contractor.

The Government will provide DOT-compliant storage containers and labels. The CO will arrange for the containers to be available at the KSC Supply Building, M6-744, at the request of the Contractor. The Contractor shall request storage containers in writing from the CO a minimum of three (3) days before the required need date. The Contractor shall be responsible for transporting the containers from Building M6-744 to the project site. The Contractor shall establish an on-site satellite waste accumulation area within 50 feet (ft) of and within sight of any point where hazardous or controlled wastes may be generated. If a satellite accumulation area must

be more than 50 ft from the point of generation, or out of sight of the generator, the Contractor shall provide a written request to the CO thirty (30) days before the start of the waste generating process. The CO will send a notification to the NASA Environmental Assurance Branch (EAB), TA-A4B, for their review and concurrence. The Contractor shall not place the satellite site in service before receiving written approval of the variance. The Contractor shall store potential or identified hazardous and/or controlled wastes in the appropriate properly labeled containers inside the accumulation area in accordance with KNPR 8500.1, Rev. B (as revised).

The Environmental Protection Agency (EPA) has set the following standards for wastes collected at satellite accumulation areas:

a. Hazardous wastes at satellite accumulation areas must be collected
in approved containers.
b. No more than 55 gallons per waste stream of hazardous waste or 1 quart per stream of acutely hazardous wastes may be accumulated.
c. Containers must be labeled with the words "Hazardous Waste" and with other words which identify the contents of the drum.
d. The waste being placed in the container must be compatible with the container.
e. A container holding hazardous waste must be always be kept closed
during accumulation except when adding or removing waste.
f. The site must be equipped with emergency equipment per 40 CFR 265.32.
g. A written contingency plan must be maintained for the site.
h. Personnel generating and managing the waste must have hazardous waste training per 40 CFR 265.16. The Contracting Officer may be any
time during the course of the contract performance period require the
Contractor to provide individual training records for any employee involved in the performance of this contract, and the contents of the
course of courses completed to satisfy the training requirements. Attendance at KSC Training Course QG-211 "Hazardous Waste Management"
will satisfy the above training requirements.

If more than 55 gallons per waste stream of hazardous waste are generated at a satellite accumulation site, documentation, including the waste type, quantity, locations and organization responsible for the waste shall be provided on KSC Form 28-809 "Waste Support Request", to the Contracting Officer Waste Management. The Contractor shall fax the waste support request to the Contracting Officer and KSC Waste Management at fax 867-9390.

If a hazardous/non-hazardous waste determination cannot be made by process knowledge and no MSDS is available for the waste stream, the container of waste shall be marked with a Hazardous Waste Determination In Progress (HWDIP) label until chemical analysis is completed. At the request of the Contractor, the CO will provide any analytical support required by the TRP. The CO will arrange for all sampling and testing of potentially hazardous or controlled waste.

Universal Waste (UW) - The EPA established Universal Waste regulations

to ease the requirements for managing hazardous wastes that can be recycled. Items which meet the definition of UW can be collected and managed under requirements found in 40 CFR 273 and Chapter 62-730 and Chapter 62-737, FAC. Waste streams currently adopted by the State for management as UW are batteries, mercury-containing lamps and devices, and certain pesticides.

UW generators are called handlers and must comply with the following requirements:

a. Handlers shall manage UW using the PWQ/TRP.
b. Handlers shall manage UW in a way that prevents releases to the environment. Non-leaking containers in good condition shall be used if the UW is damaged or leaking.
c. Handlers shall use the KSC Universal Waste Label and shall not accumulate universal wastes for more than six months.
d. Handlers shall clearly show the length of time that the wastes have been accumulated by marking or labeling the container with the earliest date that the waste was generated or received.
e. Handlers shall be familiar with proper waste handling and emergency response procedures. Attendance at the KSC training course QG-299 "Universal Waste Rule" will satisfy the above.

Used Oil - Any lubricant that has been refined from crude oil (or synthetic oil) that has been "used", and as a result of such use is contaminated by physical or chemical impurities shall be considered Used Oil. Used oil is managed according to regulations established in 40 CFR 279 and Chapter 62-710, FAC. The following waste generator standards shall apply to the management of used oil:

a. Used oil containers, tanks and associated piping must be marked "Used Oil".
b. Used oil containers, tanks and associated piping must be in good condition with no severe rusting, structural defects, deterioration, or leaks.
c. Used oil containers must be kept in secondary containment.
d. Containers storing used oil must be sealed or otherwise protected from the weather and stored on an oil-impermeable surface such as polyethylene sheeting, rigid plastic secondary containment, or epoxy-coated concrete.

Within 48 hours of having waste ready for disposal, the Contractor shall contact the CO to have KSC Waste Management pick-up and remove hazardous waste. Documentation including the waste type, quantity, locations, and organization responsible for the waste will be provided on KSC Form 28-809 "Waste Support Request" to KSC Waste Management when requesting waste disposal. The Contractor shall fax the waste support request to the Contracting Officer and to KSC Waste Management at fax 867-9390.

3.4.4 Fuel and Lubricants

Storage, fueling and lubrication of equipment and motor vehicles must be conducted in a manner that affords the maximum protection against spill and evaporation. Manage and store fuel, lubricants and oil in accordance with Federal, State, Regional, and local laws and regulations.

3.4.5 Waste Water

Disposal of waste water will be as specified below.

a. Waste water from construction activities, such as onsite material processing, concrete curing, foundation and concrete clean-up, water used in concrete trucks, forms, etc. will not be allowed to enter water ways or to be discharged prior to being treated to remove pollutants. Dispose of the construction related waste water off-Government property in accordance with Federal, State, Regional and Local laws and regulations.

b. Water generated from the flushing of lines after disinfection or disinfection in conjunction with hydrostatic testing shall be discharged into the sanitary sewer with prior approval from the Institutional Services Contractor (ISC). To obtain approval, the Contractor shall submit a PWQ for the wastewater to IHA Waste Management..

3.5 RECYCLING AND WASTE MINIMIZATION

3.5.1 Reuse

First consideration shall be given to salvage for reuse since little or no re-processing is necessary for this method, and less pollution is created when items are reused in their original form. Sale or donation of waste suitable for reuse shall be considered. Salvaged materials, other than those specified in other sections to be salvaged and reinstalled, shall not be used in this project.

3.5.2 Recycle

Waste materials not suitable for reuse, but having value as being recyclable, shall be made available for recycling whenever economically feasible. For additional information, please contact the NASA/KSC Recycling Manager.

The Contractor shall participate in State and local government sponsored recycling programs. The Contractor is further encouraged to minimize solid waste generation throughout the duration of the project in accordance with environmental contract clause, Article J-8-21. Concrete that can be recycled shall be sent to the DARCY. The DARCY can accept unpainted concrete (free of staining) without analytical testing. DARCY can also accept painted or coated concrete as long as one of the three conditions below is met:

- Total Metal and PCB laboratory analytical results do not exceed the Florida Department of Environmental Protection (FDEP) Soil Cleanup Target Levels, Residential, as referenced in Table II of Chapter 62-777 Florida Administrative Code.
- Paint and coating MSDS indicate products do not contain heavy metals or PCBs.
- Total PCB concentration is less than 50 ppm and the paint/coating is completely removed from the concrete.

The contractor shall manage recyclable concrete in accordance with KNPR 8500.1 Rev. B and the DARCY Fact Sheet.

3.6 NON-HAZARDOUS SOLID WASTE DIVERSION REPORT

The Contractor shall maintain an inventory of non-hazardous solid waste diversion and disposal of construction and demolition debris.

Non-hazardous Solid Waste Diversion Reports shall be submitted using KSC Form 7-648NS (Rev. 12/08) to the Contracting Officer by December 31 of each year or the closeout of the project, whichever comes first. Include the following in the report:

a. Construction and Demolition (C&D) Debris Disposed = _____ in cubic yards or tons, as appropriate.

b. Construction and Demolition (C&D) Debris Recycled = _____ in cubic yards or tons, as appropriate.

c. Total C&D Debris Generated = _____ in cubic yards or tons, as appropriate.

d. Waste Sent to Waste-To-Energy Incineration Plant (This amount should not be included in the recycled amount) = _____ in cubic yards or tons, as appropriate.

3.7 BIOLOGICAL RESOURCES

Minimize interference with, disturbance to, and damage to fish, wildlife, and plants including their habitat. The protection of threatened and endangered animal and plant species, including their habitat, is the Contractor's responsibility in accordance with Federal, State, Regional, and local laws and regulations.

3.8 TRAINING OF CONTRACTOR PERSONNEL

The Contractor's personnel must be trained in environmental protection and pollution control. Conduct environmental protection/pollution control meetings for personnel prior to commencing construction activities. Additional meetings must be conducted for new personnel and when site conditions change. Include in the training and meeting agenda: methods of detecting and avoiding pollution; familiarization with statutory and contractual pollution standards; installation and care of devices, vegetative covers, and instruments required for monitoring purposes to ensure adequate and continuous environmental protection/pollution control; anticipated hazardous or toxic chemicals or wastes, and other regulated contaminants; recognition and protection of archaeological sites, artifacts, wetlands, and endangered species and their habitat that are known to be in the area.

3.9 MONITORING WELLS

The Contractor shall locate monitoring wells at or adjacent to the project site during the preconstruction survey described in 1.7 of this Section. The Contractor shall protect and prevent the disturbance of these monitoring wells during construction. Disturbance or destruction of any monitoring well during construction shall be replaced at the Contractors expense. Monitoring wells shall be replaced in accordance with the St. Johns River Water Management District, the Florida Department of Environmental Protection and the Contracting Officer's procedures and requirements.

3.10 POST CONSTRUCTION CLEANUP

The Contractor will clean up areas used for construction in accordance with Contract Clause: "Cleaning Up". Unless otherwise instructed in writing by the Contracting Officer, obliterate signs of temporary construction

facilities such as haul roads, work area, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other vestiges of construction prior to final acceptance of the work. The disturbed area must be graded, filled and the entire area seeded unless otherwise indicated.

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OPERATION AND MAINTENANCE DATA

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 E1971	(2005; R 2011) Stewardship for the Cleaning of Commercial and Institutional Buildings

1.2 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, stressing and enhancing the importance of system interactions, troubleshooting, and long-term preventative maintenance and operation. The subcontractors must compile and prepare data and deliver to the Contractor prior to the training of Government personnel. The Contractor must compile and prepare aggregate O&M data including clarifying and updating the original sequences of operation to as-built conditions. 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. Submit in accordance with this section and Section 01 33 00 SUBMITTAL PROCEDURES.

1.2.1 Package Quality

Documents must be fully legible. Poor quality copies and material with hole punches obliterating the text or drawings will not be accepted.

1.2.2 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, except as follows. Commissioned items without a specified data package requirement in the individual technical sections must use Data Package 5. Commissioned items with a Data Package 1 or 2 requirement must use instead Data Package 5.

1.2.3 Changes to Submittals

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

requirement.

1.2.4 Review and Approval

The Government's Commissioning Authority (CA) must review the commissioned systems and equipment submittals for completeness and applicability. The Government must verify that the systems and equipment provided meet the requirements of the Contract documents and design intent, particularly as they relate to functionality, energy performance, water performance, maintainability, sustainability, system cost, indoor environmental quality, and local environmental impacts. This work is in addition to the normal review procedures for O&M data.

1.3 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 E1971.

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 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:

1.3.4.1 Product Submittal Data

Provide a copy of all SD-03 Product Data submittals required in the applicable technical sections.

1.3.4.2 Manufacturer's Instructions

Provide a copy of all SD-08 Manufacturer's Instructions submittals required in the applicable technical sections.

1.3.4.3 O&M Submittal Data

Provide a copy of all SD-10 Operation and Maintenance Data submittals required in the applicable technical sections.

1.3.4.4 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

1.3.4.5 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.

1.3.4.6 Personnel Training Requirements

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

1.3.4.7 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.

1.3.4.8 Testing and Performance Data

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

1.3.4.9 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.

e. Full print out of all schedules and set points after testing and acceptance of the system.

f. Full as-built print out of software program.

g. Electronic File:

(1) Assemble each manual into a composite electronically indexed file in PDF format. Provide HDD's, DVD's or CD's as appropriate, so that each one contains all maintenance and record files, and also the Project Record Documents and Training Videos, of the entire program for this facility.

(2) Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.

(3) Link the index to separate files within the composite of files. Book mark maintenance and record files, that have a Table of Contents, according to the Table of Contents

h. Marking of all system sensors and thermostats on the as-built floor plan and mechanical drawings with their control system designations.

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:

1.5.1 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

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DIVISION 01 - GENERAL REQUIREMENTS

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RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

This guide specification establishes acceptance requirements to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that will shorten the design life of the equipment. These requirements utilize Predictive Testing & Inspection (PT&I) technologies and are essential elements in the Government's Reliability Centered Building and Equipment Acceptance Program.

This guide specification is not intended to limit the inspection and acceptance process to the use of PT&I techniques. This guide is intended to supplement comprehensive and detailed commissioning and quality control specifications.

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.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Quality Control Plan; G

Material, Equipment, and Fixture Lists; G

SD-02 Shop Drawings

Connection Diagrams; G

Fabrication Drawings; G

Installation Drawings; G

SD-03 Product Data

Manufacturer's Catalog Data; G

Equipment Foundation Data; G

Specific Equipment Data; G

Spare Parts List; G

Warranty; G

SD-05 Design Data

Design Analysis and Calculations; G

SD-06 Test Reports

Automatic Transfer Test; G

Battery Impedance Test; G

Breaker Timing Test; G

Contact Resistance Test; G

Infrared Thermography Test; G

Insulation Resistance Test; G

Visual Inspection; G

SD-07 Certificates

Certificates; G

SD-08 Manufacturer's Instructions

Manufacturer's Instructions; G

SD-10 Operation and Maintenance Data

Operations and Maintenance Manuals; G

SD-11 Closeout Submittals

Acceptance Documentation; G

Record Drawings; G

Baseline Data Report; G

1.4 DESIGN DATA

Submit applicable design analysis and calculations for the equipment listed below as instructed to by the project specification.

a. Batteries (General)

b. Battery Chargers

c. Breakers:

(1) General

(2) Air Magnetic

e. Cables:

(1) General

(2) Low Voltage (600V Maximum)

f. Electrical Automatic Transfer Switches

g. Electrical Control Panels

h. Electrical Distribution Panels

i. Electrical Relays

j. Electrical Starters

k. Transformers

1.5 QUALITY ASSURANCE

Submit a Quality Control plan outlining the intended methods of receiving, testing, and installing equipment. The RCBEA GUIDE specifies minimum test equipment requirements. Use trained and adequately certified personnel in the appropriate acceptance testing PT&I technologies to ensure that the results are accurate and consistent. Submit the following as part of the quality control plan for all required acceptance testing:

a. List of all test equipment used, including its manufacturer, model number, calibration date, certificate of calibration, and serial number.

b. Certificates of test personnel qualifications and certifications.

1.6 WARRANTY

Furnish workmanship and performance warranty for the work performed for a period not less than 1 years from the date of Government acceptance of the work; issued directly to the Government. Perform corrective action that becomes necessary because of defective materials and workmanship while system 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 Contractor. Provide a 1 year minimum contractor installation warranty.

PART 2 PRODUCTS

2.1 PRODUCT DATA

Submit material, equipment, and fixture lists for all equipment, materials, and fixtures planned for use to complete the job before commencing work. Include at a minimum, the item's description, quantity, manufacturer's style or catalog numbers, and specification and drawing reference numbers. Provide a complete list of construction equipment to be used.

2.1.1 Manufacturer Product Data

Submit fabrication drawings for equipment and specialties consisting of fabrication and assembly details to be performed in the factory. Show connection diagrams and assemblies in switchgear fabrication drawings

Submit for all equipment listed. Include 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, equipment performance data charts and curves, etc. in adequate detail to demonstrate compliance with contract requirements. Include manufacturer's recommended installation instructions and procedures. If vibration isolation is specified for a unit, include vibration isolator literature containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Submit for each specified component.

Submit manufacturer's catalog data and equipment foundation data (as applicable) for the following equipment:

Include plan dimensions of foundations and relative elevations, equipment weight and operating loads, horizontal and vertical loads, horizontal and vertical clearances for installation, and size and location of anchor bolts.

a. Batteries (General)

b. Battery Chargers

c. Breakers:

(1) General

2) Air Magnetic

d. Cables:

(1) General

(2) Low Voltage (600V Maximum)

e. Electrical Automatic Transfer Switches

f. Electrical Control Panels

g. Electrical Distribution Panels

h. Electrical Relays

i. Electrical Starters

j. Transformers

2.1.2 Certification Data

Submit applicable certificates for the equipment listed below showing conformance with test requirements, laboratory certifications, etc. as instructed by the project specification.

a. Batteries (General)

b. Battery Chargers

c. Breakers:

(1) General

(2) Air Magnetic

d. Cables:

(1) General

(2) Low Voltage (600V Maximum)

e. Electrical Automatic Transfer Switches

f. Electrical Control Panels

g. Electrical Distribution Panels

h. Electrical Relays

i. Electrical Starters

j. Transformers

2.1.3 Specific Equipment Data

Submit the following information for all equipment listed below: location of installation, NASA Identification number, date of installation (required or actual acceptance date), and applicable NASA reference drawing number. Unless explicitly stated in submitted manufacturer's literature, provide and submit the following specific equipment data:

a. Batteries (General)

(1) Battery identification (Type)

b. Battery Chargers

(1) Battery charger type

(2) Battery charger specifications

c. Breakers- General, and Air Magnetic

(1) Breaker type

(2) Breaker Specifications (including current transformer ratios)

d. Cables- Low Voltage

(1) Power cable type

e. Electrical Automatic Transfer Switch (ATS)

(1) ATS Identification (Type)

f. Electrical Control Panel

(1) Electrical Control Panel Type (NEMA enclosure type)

(2) Voltage configuration (120/240 VAC, 12/24 VDC, etc.)

(3) Amperage

(4) Dimensions

(5) Weight

(6) UL certification

(7) EMI levels (if applicable)

g. Electrical Distribution Panel

(1) Electrical Control Panel Type (NEMA enclosure type)

(2) Voltage configuration (120/240 VAC, 12/24 VDC, etc.)

(3) Amperage (panel main bus maximum)

(4) Dimensions

(5) Weight

(6) UL certification

(7) EMI levels (if applicable)

(8) Number of circuit breaker positions (outputs)

(9) Electrical Distribution Panel impedance

h. Electrical Relays

(1) Electrical relay type (NEMA enclosure type)

(2) Voltage configuration

(3) Time over current curves (time delay curves)

(4) Phase and ground operating curves (shapes)

(5) Dimensions, Weight

(6) UL certification, EMI levels (if applicable)

(7) Number and types of output relays

(8) Current loading

i. Electrical Starters

(1) Electrical Starter Type (NEMA enclosure type)

(2) Amperage and voltage configuration (25A-60A, <600V and ¼-50HP,

etc.)

(3) Overload settings

(4) Dimensions, Weight

(5) UL certification, EMI levels (if applicable)

j. Electric Switch, All Types

(1) Switch type

(2) Switch specifications

v. Transformers

(1) Transformer Type

(2) Winding resistance

(3) Transformer impedance

(4) Load loss at rated voltage and current

(5) Current loading

2.1.4 Extra Materials

Submit spare parts list data for each different item of material and equipment specified, after approval of detail drawings and not later than one month 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 12 months operation, and a list of the parts recommended by the manufacturer to be replaced after 1 and 5 year(s) of service.

PART 3 EXECUTION

3.1 INSTALLATION

Submit installation drawings for all installed equipment consisting of equipment layouts including assembly, applicable manufacturer's instructions, installation details and electrical connection diagrams; layout and installation details including support structures, conduit and related system components. Include on the drawings any information required to demonstrate that the system has been coordinated and will properly function within the electrical system, and show equipment relationship to other parts of the work, including clearances required for operation and maintenance.

Submit connection diagrams for electrical equipment, panels, conduit, and specialties indicating the relations and connections of devices and apparatus by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Submit record drawings, at least 14 days after completion of equipment installation and acceptance testing. Update electrical system drawings to reflect final record as-built conditions after all related work is

completed.

3.2 EXAMINATION

Perform visual inspection on the equipment listed below. Correct all abnormalities or defects as directed by the Contracting Officer.

a. Batteries (General)

b. Battery Chargers

c. Breakers:

(1) General

(2) Air magnetic

d. Cables:

(1) General

(2) Low voltage (600V Maximum)

e. Electrical Automatic Transfer Switches

f. Electrical Control Panels

g. Electrical Distribution Panels

h. Electrical Relays

i. Electrical Starters

j. Transformers

3.3 FIELD QUALITY CONTROL AND ACCEPTANCE TESTING

Deliver equipment and services that meet the contract requirements and specifications. Ensure all equipment is free of latent manufacturing and installation defects, and acceptance criteria are met. Perform acceptance testing as defined in this specification and the RCBEA GUIDE, using both traditional and PT&I technologies. The Government will observe and monitor the acceptance testing, analysis and documentation as part of the Government's Quality Assurance Program. Not until the requirements of acceptance are met will the equipment or facility be accepted by the Government.

3.3.1 Predictive Testing and Inspection Tests

Perform the following PT&I Tests in accordance with the requirements and criteria established in the RCBEA GUIDE. Include test point locations in all submitted reports.

Provide final test reports to the Contracting Officer. Provide reports with a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Report Data - Forward to the Systems Engineer for inclusion in the Maintenance Information Database.

a. Perform Automatic Transfer Test for:

(1) Electrical Automatic Transfer Switch

b. Perform Battery Impedance Test for:

(1) Batteries (General)

c. Perform Breaker Timing Test for:

(1) Breakers- General

(2) Breakers- Air Magnetic

d. Perform Contact Resistance Test for:

(1) Battery Chargers

(2) Breakers- General

(3) Breakers- Air Magnetic

(4) Electrical Automatic Transfer Switch

(5) Electrical Control Panel

(6) Electrical Distribution Panel

(7) Electrical Relays

(8) Electrical Starters

e. Perform Infrared Thermography Test for:

(1) Electrical Control Panels

(2) Electrical Distribution Panel

(3) Electrical Starters

(4) Transformers

(5) Batteries (General)

(6) Battery Chargers

(7) Breakers- General

(8) Electrical Automatic Transfer Switch

q. Perform Insulation Resistance Test for:

(1) Breakers- General

(2) Breakers- Air Magnetic

(3) Cables (General)

(4) Cables- Low Voltage (600V Maximum)

(5) Electrical Automatic Transfer Switch

(6) Electrical Relays

(7) Electrical Control Panel

(8) Electrical Distribution Panel

(9) Electrical Starters

3.3.2 Baseline Data from Verification Testing

Upon completion of all PT&I tests submit baseline data report to the Contracting Officer. Include a summary of all performance data, set points, operating parameters and PT&I test results obtained for equipment and building systems.

3.4 OPERATIONS AND MAINTENANCE

Submit manufacturer's operations and maintenance manuals for the following equipment:

a. Batteries (General)

b. Battery Chargers

c. Breakers:

(1) General

(2) Air Magnetic

d. Cables:

(1) General

(2) Low Voltage (600V Maximum)

e. Electrical Automatic Transfer Switches

f. Electrical Control Panels

g. Electrical Distribution Panels

h. Electrical Relays

i. Electrical Starters

Submit six complete copies of operations and maintenance manuals 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. Include the manufacturer's name, model number, parts list, routine maintenance procedures, possible breakdowns and repairs, trouble shooting guide, and a brief description of all equipment and their basic operating features. Include piping and equipment layouts and simplified wiring and control diagrams of the system as installed. Where available, provide technical manuals in electronic format with Standard Graphics Markup Language. When electronic format publications are provided, only two copies of the document are required. Submit operations and maintenance manuals 30 calendar days prior to testing any equipment.

3.5 ACCEPTANCE DOCUMENTATION

Upon completion of the project and acceptance testing the Contracting Officer will provide acceptance documentation to the Contractor. Complete, sign and date this documentation and submit back to the Contracting Officer for processing and approval.

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SECTION 02 41 00

DEMOLITION

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 Guideline K	(2009) Guideline for Containers for Recovered Non-Flammable Fluorocarbon Refrigerants

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 347	(2004; Errata 2008; Errata 2012) Guide to Formwork for Concrete

AMERICAN SOCIETY OF SAFETY ENGINEERS (ASSE/SAFE)

ASSE/SAFE A10.6	(2006) Safety Requirements for Demolition Operations

JOHN F. KENNEDY SPACE CENTER (KSC)

KNPR 8715.7	(Rev. A-1) KSC Construction Contractor Safety and Health Practices and Procedural Requirements

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

40 CFR 61	National Emission Standards for Hazardous Air Pollutants
40 CFR 82	Protection of Stratospheric Ozone

1.2 PROJECT DESCRIPTION

1.2.1 Demolition/Deconstruction Plan

Prepare a Demolition Plan and submit proposed demolition, and removal procedures for approval before work is started. Include in the plan procedures for careful removal and disposition of materials specified to be salvaged, 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. Identify components and materials to be salvaged for reuse or recycling with reference to paragraph Existing Facilities to be Removed. Append tracking forms for all removed materials indicating type, quantities, condition, destination, and end use. Coordinate with Waste Management

Plan. 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. Provide procedures for safe conduct of the work in accordance with KNPR 8715.7, Rev A-1. Plan shall be approved by Contracting Officer prior to work beginning.

1.2.2 General Requirements

Do not begin demolition until authorization is received from the Contracting Officer. The work of this section is to be performed in a manner that maximizes salvage and recycling of materials. Remove rubbish and debris from the project site; do not allow accumulations inside or outside the buildings. The work includes demolition, salvage of identified items and materials, and removal of resulting rubbish and debris. Remove rubbish and debris from Government property daily, unless otherwise directed. Store materials that cannot be removed daily in areas specified by the Contracting Officer. In the interest of occupational safety and health, perform the work in accordance with KNPR 8715.7, Rev. A-1.

1.3 ITEMS TO REMAIN IN PLACE

Take necessary precautions to avoid damage to existing items to remain in place, to be reused, or to remain the property of the Government. Repair or replace damaged items as approved by the Contracting Officer. Coordinate the work of this section with all other work indicated. Construct and maintain shoring, bracing, and supports as required. Ensure that structural elements are not overloaded. Increase structural supports or add new supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract. Do not overload structural elements . Provide new supports and reinforcement for existing construction weakened by demolition, deconstruction, or removal work. Repairs, reinforcement, or structural replacement require approval by the Contracting Officer prior to performing such work.

1.3.1 Existing Construction Limits and Protection

Do not disturb existing construction beyond the extent indicated or necessary for installation of new construction. Provide temporary shoring and bracing for support of building components to prevent settlement or other movement. Provide protective measures to control accumulation and migration of dust and dirt in all work areas. Remove dust, dirt, and debris from work areas daily.

1.3.2 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.

1.3.3 Utility Service

Maintain existing utilities indicated to stay in service and protect against damage during demolition and deconstruction operations. Prior to start of work, the Government will disconnect and seal utilities serving each area of alteration or removal upon written request from the Contractor.

1.3.4 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, must remain standing without additional bracing, shoring, or lateral support until demolished or deconstructed, unless directed otherwise by the Contracting Officer. Ensure that no elements determined to be unstable are left unsupported and place and secure bracing, shoring, or lateral supports as may be required as a result of any cutting, removal, deconstruction, or demolition work performed under this contract.

1.4 BURNING

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

1.5 AVAILABILITY OF WORK AREAS

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

Schedule	
Area	Date

1.6 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Existing Conditions; G

SD-07 Certificates

Demolition Plan; G

Notification; G

SD-11 Closeout Submittals

Receipts

1.7 QUALITY ASSURANCE

Submit timely notification of demolition projects to Federal, State, regional, and local authorities in accordance with 40 CFR 61, Subpart M. Notify the the Contracting Officer in writing 10 working days prior to the commencement of work in accordance with 40 CFR 61, Subpart M. Comply with

federal, state, and local hauling and disposal regulations. In addition to the requirements of the "Contract Clauses," conform to the safety requirements contained in ASSE/SAFE A10.6. Comply with the Environmental Protection Agency requirements specified. Use of explosives will not be permitted.

1.7.1 Dust and Debris Control

Prevent the spread of dust and debris to occupied portions of the building and avoid the creation of a nuisance or hazard 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. Vacuum and dust the work area daily. Sweep pavements as often as necessary to control the spread of debris that may result in foreign object damage.

1.8 PROTECTION

1.8.1 Protection of Personnel

Before, during and after the demolition work continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the project 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.

The Contractor shall protect personnel from demolition activities impacting paints and coatings that contain hazardous metals and Polychlorinated Biphenyls (PCBs). Equipment, work practices and controls to prevent exposure to workers, adjacent unprotected personnel and the environment shall be described in the Hazardous Metal and PCB Compliance and Health and Safety Plan submitted in accordance with Section 02 83 13.00 20 Hazardous Metals and Polychlorinated Biphenyls (PCBs) in Construction. Establish and implement a respiratory protection program as required in accordance with Section 02 83 13.00 20 Hazardous Metals and Polychlorinated Biphenyls (PCBs) in Construction.

1.9 RELOCATIONS

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

1.10 EXISTING CONDITIONS

Before beginning any demolition or deconstruction work, survey the site and examine the drawings and specifications to determine the extent of the work. Record existing conditions in the presence of the Contracting Officer showing the condition of structures and other facilities adjacent to areas of alteration or removal. Photographs sized 4 inch will be acceptable as a record of existing conditions. Include in the record the elevation of the top of foundation walls, finish floor elevations, possible conflicting electrical conduits, plumbing lines, alarms systems, the location and extent of existing cracks and other damage and description of surface conditions that exist prior to before starting work. It is the Contractor's responsibility to verify and document all required outages which will be required during the course of work, and to note these outages

on the record document. Submit survey results.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 EXISTING FACILITIES TO BE REMOVED

Inspect and evaluate existing structures onsite for reuse. Existing construction scheduled to be removed for reuse shall be disassembled. Dismantled and removed materials are to be separated, set aside, and prepared as specified, and stored or delivered to a collection point for reuse, remanufacture, recycling, or other disposal, as specified. Materials shall be designated for reuse onsite whenever possible.

3.1.1 Structures

a. Remove existing structures indicated to be removed to grade. Interior walls, other than retaining walls and partitions, shall be removed to top of concrete slab on ground.

b. Demolish Deconstruct structures in a systematic manner from the top of the structure to the ground. Complete demolition work above each tier or floor before the supporting members on the lower level are disturbed. Demolish concrete and masonry walls in small sections. Remove structural framing members and lower to ground by means of derricks, platforms hoists, or other suitable methods as approved by the Contracting Officer.

c. Locate demolition and deconstruction equipment throughout the structure and remove materials so as to not impose excessive loads to supporting walls, floors, or framing.

3.1.2 Utilities and Related Equipment

3.1.2.1 General Requirements

Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by the Contracting Officer. Do not interrupt existing utilities serving facilities occupied and used by the Government except when approved in writing and then only after temporary utility services have been approved and provided. Do not begin demolition or deconstruction work until all utility disconnections have been made. Shut off and cap utilities for future use, as indicated.

3.1.2.2 Disconnecting Existing Utilities

Remove existing utilities, as indicated 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 but are not indicated on the drawings, notify the Contracting Officer prior to further work in that area. Remove meters and related equipment and deliver to a location in accordance with instructions of the Contracting Officer.

3.1.3 Chain Link Fencing

Remove chain link fencing, gates and other related salvaged items scheduled for removal and transport to designated areas. Remove gates as whole units. Cut chain link fabric to 25 foot lengths and store in rolls off the ground.

3.1.4 Paving and Slabs

Sawcut concrete and asphaltic concrete paving and slabs as indicated to a depth below grade. Provide neat sawcuts at limits of pavement removal as indicated. Pavement and slabs designated to be recycled and utilized in this project shall be moved, ground and stored as directed by the Contracting Officer. Pavement and slabs not to be used in this project shall be removed from the Installation at Contractor's expense.

3.1.5 Masonry

Sawcut and remove masonry so as to prevent damage to surfaces to remain, and to facilitate the installation of new work. Where new masonry adjoins existing, the new work shall abut or tie into the existing construction as indicated. Provide square, straight edges and corners where existing masonry adjoins new work and other locations.

3.1.6 Concrete

Saw concrete along straight lines to a depth of a minimum 2 inch. 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.

3.1.7 Structural Steel

Dismantle structural steel at field connections and in a manner that will prevent bending or damage. Salvage for recycle structural steel, steel joists, girders, angles, plates, columns and shapes. Structrural steel with paint or coating materials containing Polychlorinated Biphenyls (PCBs) at concentrations greater than 50 parts per million (ppm) shall not be salvaged and recycled. These materials shall be disposed of as PCB Bulk Product in accordance with Section 01 57 20.00 10, ENVIRONMENTAL PROTECTION.Flame-cutting torches are permitted when other methods of dismantling are not practical. Torch cutting shall be performed in accordance with Section 02 83 13.00 20, HAZARDOUS METALS AND POLYCHLORINATED BYPHENOLS (PCBs) IN CONSTRUCTION. Transport steel joists and girders as whole units and not dismantled. Transport structural steel shapes to a designated storage area as directed by the Contracting Officer, stacked according to size, type of member and length, and stored off the ground, protected from the weather.

3.1.8 Miscellaneous Metal

Salvage shop-fabricated items such as access doors and frames, steel gratings, metal ladders, wire mesh partitions, metal railings, metal windows and similar items as whole units. Salvage light-gage and cold-formed metal framing, such as steel studs, steel trusses, metal gutters, roofing and siding, metal toilet partitions, toilet accessories and similar items. Recycle scrap metal as part of demolition and

deconstruction operations. Provide separate containers to collect scrap metal and transport to a scrap metal collection or recycling facility. Metal items and scrap metal with paint or coating materials containing PCBs at concentrations greater than 50 ppm shall not be salvaged and recycled. These materials shall be disposed of as PCB Bulk Product in accordance with Section 01 57 20.00 10, ENVIRONMENTAL PROTECTION.

3.1.9 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, using on-site materials when available. 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. Provide a Class A finish per ACI 347-4 where equipment pads are removed. Patching shall be as specified and indicated, and shall include:

a. Concrete and Masonry: Completely fill holes and depressions, left as a result of removals in existing masonry walls to remain, 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.

3.1.10 Air Conditioning Equipment

Remove air conditioning, refrigeration, and other equipment containing refrigerants without releasing chlorofluorocarbon refrigerants to the atmosphere in accordance with the Clean Air Act Amendment of 1990. Recover all refrigerants prior to removing air conditioning, refrigeration, and other equipment containing refrigerants and dispose of in accordance with the paragraph entitled "Disposal of Ozone Depleting Substance (ODS)." Turn in salvaged Class I ODS refrigerants as specified in paragraph, "Salvaged Materials and Equipment."

3.1.11 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)."

3.1.12 Locksets on Swinging Doors

Remove all locksets from all swinging doors indicated to be removed and disposed of. Deliver the locksets and related items to a designated location for receipt by the Contracting Officer after removal.

3.1.13 Mechanical Equipment and Fixtures

Disconnect mechanical hardware at the nearest connection to existing services to remain, unless otherwise noted. Disconnect mechanical equipment and fixtures at fittings. Remove service valves attached to the unit. Salvage each item of equipment and fixtures as a whole unit; listed, indexed, tagged, and stored. Salvage each unit with its normal operating auxiliary equipment. Transport salvaged equipment and fixtures, including motors and machines, to a designated storage area as directed by the Contracting Officer. Do not remove equipment until approved. Do not offer low-efficiency equipment for reuse; provide to recycling service for disassembly and recycling of parts.

3.1.13.1 Preparation for Storage

Remove water, dirt, dust, and foreign matter from units; tanks, piping and fixtures shall be drained; interiors, if previously used to store flammable, explosive, or other dangerous liquids, shall be steam cleaned. Seal openings with caps, plates, or plugs. Secure motors attached by flexible connections to the unit. Change lubricating systems with the proper oil or grease.

3.1.13.2 Piping

Disconnect piping at unions, flanges and valves, and fittings as required to reduce the pipe into straight lengths for practical storage. Store salvaged piping according to size and type. If the piping that remains can become pressurized due to upstream valve failure, end caps, blind flanges, or other types of plugs or fittings with a pressure gage and bleed valve shall be attached to the open end of the pipe to ensure positive leak control. Carefully dismantle piping that previously contained gas, gasoline, oil, or other dangerous fluids, with precautions taken to prevent injury to persons and property. Store piping outdoors until all fumes and residues are removed. Box prefabricated supports, hangers, plates, valves, and specialty items according to size and type. Wrap sprinkler heads individually in plastic bags before boxing. Classify piping not designated for salvage, or not reusable, as scrap metal.

3.1.13.3 Ducts

Classify removed duct work as scrap metal.

3.1.13.4 Fixtures, Motors and Machines

Remove and salvage fixtures, motors and machines associated with plumbing, heating, air conditioning, refrigeration, and other mechanical system installations. Salvage, box and store auxiliary units and accessories with the main motor and machines. Tag salvaged items for identification, storage, and protection from damage. Classify broken, damaged, or otherwise unserviceable units and not caused to be broken, damaged, or otherwise unserviceable as debris to be disposed of by the Contractor.

3.1.14 Electrical Equipment and Fixtures

Salvage motors, motor controllers, and operating and control equipment that are attached to the driven equipment. Salvage wiring systems and components. Box loose items and tag for identification. Disconnect primary, secondary, control, communication, and signal circuits at the point of attachment to their distribution system.

3.1.14.1 Fixtures

Remove and salvage electrical fixtures. Salvage unprotected glassware from the fixture and salvage separately. Salvage incandescent, mercury-vapor, and fluorescent lamps and fluorescent ballasts manufactured prior to 1978, boxed and tagged for identification, and protected from breakage.

3.1.14.2 Electrical Devices

Remove and salvage switches, switchgear, transformers, conductors including wire and nonmetallic sheathed and flexible armored cable, regulators, meters, instruments, plates, circuit breakers, panelboards, outlet boxes, and similar items. Box and tag these items for identification according to type and size.

3.1.14.3 Wiring Ducts or Troughs

Remove and salvage wiring ducts or troughs. Dismantle plug-in ducts and wiring troughs into unit lengths. Remove plug-in or disconnecting devices from the busway and store separately.

3.1.14.4 Conduit and Miscellaneous Items

Salvage conduit except where embedded in concrete or masonry. Consider corroded, bent, or damaged conduit as scrap metal. Sort straight and undamaged lengths of conduit according to size and type. Classify supports, knobs, tubes, cleats, and straps as debris to be removed and disposed.

3.1.15 Elevators and Hoists

Remove elevators, hoists, and similar conveying equipment and salvage as whole units, to the most practical extent. Remove and prepare items for salvage without damage to any of the various parts. Salvage and store rails for structural steel with the equipment as an integral part of the unit.

3.1.16 Items With Unique/Regulated Disposal Requirements

Remove and dispose of items with unique or regulated disposal requirements in the manner dictated by law or in the most environmentally responsible manner.

3.2 DISPOSITION OF MATERIAL

3.2.1 Title to Materials

Except for salvaged items specified in related Sections, and for materials or equipment scheduled for salvage, all materials and equipment removed and not reused or salvaged, shall become the property of the Contractor and shall be removed from Government property. Title to materials resulting from demolition and deconstruction, and materials and equipment to be removed, is vested in the Contractor upon approval by the Contracting Officer of the Contractor's demolition, deconstruction, and removal procedures, and authorization by the Contracting Officer to begin demolition and deconstruction. The Government will not be responsible for the condition or loss of, or damage to, such property after contract award. Showing for sale or selling materials and equipment on site is

prohibited.

3.2.2 Reuse of Materials and Equipment

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

3.2.3 Salvaged Materials and Equipment

Remove materials and equipment that are listed in the Demolition Plan to be removed by the Contractor and that are to remain the property of the Government, and deliver to a storage site, as directed within 2 miles of the work site.

a. Salvage items and material to the maximum extent possible.

b. Store all materials salvaged for the Contractor as approved by the Contracting Officer and remove from Government property before completion of the contract. On site sales of salvaged material is prohibited.

c. Remove salvaged items to remain the property of the Government 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 must be repaired or replaced to match existing items. Properly identify the contents of containers. .

d. Remove the following items reserved as property of the using service prior to commencement of work under this contract: .

e. Remove historical items in a manner to prevent damage. Deliver the following historical items to the Government for disposition: Corner stones, contents of corner stones, and document boxes wherever located on the site.

f. Remove and capture all Class I ODS refrigerants in accordance with the Clean Air Act Amendment of 1990, and turn in to the Contracting Officer.

3.2.4 Disposal of Ozone Depleting Substance (ODS)

Class I and Class II ODS are defined in Section, 602(a) and (b), of The Clean Air Act. Prevent discharge of Class I and Class II ODS to the atmosphere. Place recovered ODS in cylinders meeting AHRI Guideline K suitable for the type ODS (filled to no more than 80 percent capacity) and provide appropriate labeling. Recovered ODS shall be turned over to the Contracting Officer. Products, equipment and appliances containing ODS in a sealed, self-contained system (e.g. residential refrigerators and window air conditioners) shall be disposed of in accordance with 40 CFR 82. Submit Receipts or bills of lading, as specified. Submit a shipping receipt or bill of lading for all containers of ozone depleting substance (ODS) shipped to the Defense Depot, Richmond, Virginia.

3.2.4.1 Special Instructions

No more than one type of ODS is permitted in each container. A warning/hazardous label shall be applied to the containers in accordance with Department of Transportation regulations. All cylinders including but not limited to fire extinguishers, spheres, or canisters containing an ODS shall have a tag with the following information:

a. Activity name and unit identification code

b. Activity point of contact and phone number

c. Type of ODS and pounds of ODS contained

d. Date of shipment

3.2.4.2 Fire Suppression Containers

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

3.2.5 Unsalvageable and Non-Recyclable Material

Dispose of unsalvageable and non-recyclable noncombustible material in the disposal area located on the plans. The fill in the disposal area shall remain below elevation and after disposal is completed, the disposal area shall be uniformly graded to drain.

3.3 CLEANUP

Remove debris and rubbish from basement and similar excavations. Remove and transport the debris in a manner that prevents spillage on streets or adjacent areas. Apply local regulations regarding hauling and disposal.

3.4 DISPOSAL OF REMOVED MATERIALS

3.4.1 Regulation of Removed Materials

Dispose of debris, rubbish, scrap, and other nonsalvageable materials resulting from removal operations with all applicable federal, state and local regulations as contractually specified in the Waste Management Plan.

3.4.2 Burning on Government Property

Burning of materials removed from demolished structures will not be permitted on Government property.

3.4.3 Removal to Spoil Areas on Government Property

Transport noncombustible materials removed from demolition and deconstruction structures to designated spoil areas on Government property.

3.4.4 Removal from Government Property

Transport waste materials removed from demolished and deconstructed structures, except waste soil, from Government property for legal disposal. Dispose of waste soil as directed.

3.5 REUSE OF SALVAGED ITEMS

Recondition salvaged materials and equipment designated for reuse before installation. Replace items damaged during removal and salvage operations or restore them as necessary to usable condition.

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SECTION 02 82 13.00 98

ASBESTOS ABATEMENT

PART 1 GENERAL

1.1 SUMMARY

This section specifies the asbestos abatement requirements and the Contractor's applicable asbestos procedures, which include:

a. Demolition or salvage of structures where asbestos is present

b. Removal or encapsulation of materials containing asbestos

c. Construction, alteration, repair, maintenance, or renovation of structures, substrates, or portions thereof, that contain asbestos

d. Installation of products containing asbestos

e. Asbestos spill/emergency cleanup

f. Transportation

g. Disposal

h. Storage

i. Containment of and housekeeping activities involving asbestos or products containing asbestos, on the site or location at which construction activities are performed

Under OSHA, Asbestos Abatement work is categorized into four classes:

Class I Work: Activities involving the removal of Thermal System Insulation (TSI) and surfacing Asbestos Containing Materials (ACM) and Presumed Asbestos Containing Material (PACM).

Class II Work: Activities involving the removal of ACM that is not TSI or surfacing material. This includes wallboard, floor tile and sheeting, roofing, siding, shingles, and construction mastics.

Class III Work: Repair and Maintenance operations, where ACM, including TSI and surfacing ACM and PCM, is likely to be disturbed.

Class IV Work: Maintenance and custodial activities during which employees contact but do not disturb ACM or PACM and activities to clean up dust, waste, and debris from Class I,II, and III activities.

Conduct abatement work in accordance with the Class I, II, III, or IV Methods of Compliance as required by 29 CFR 1910, 29 CFR 1926, 40 CFR 61-SUBPART M, 49 CFR 171, 49 CFR 172, FAC CHAPTER 62-257, and FL-STAT 469. Submit all required training certifications prior to commencement of work, and experience of Contractor's "Competent Person," Supervisor, and workers.

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.

COMPRESSED GAS ASSOCIATION (CGA)

CGA G-7.1	(2011) Commodity Specification for Air; 5th Edition

FLORIDA ADMINISTRATIVE CODE (FAC)

FAC CHAPTER 62-257	(2008) Florida Administrative Code, Asbestos Program

FLORIDA STATUTES (FL-STAT)

FL-STAT 469	(2010) Asbestos Abatement

JOHN F. KENNEDY SPACE CENTER (KSC)

KNPR 8500.1	(2010; Rev B) KSC Environmental Requirements
KNPR 1840.19	(2011; Rev C-1) KSC Industrial Hygiene Programs
KNPR 8715.3	KSC Safety Practices Procedural Requirements

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH (NIOSH)

NIOSH 7400	(1994) Standard Test Method for Asbestos and Other Fibers by PCM
NIOSH 2003-154	(2003; 4th Ed; Supple 3) NIOSH Manual of Analytical Methods

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

29 CFR 1910	Occupational Safety and Health Standards
29 CFR 1926	Safety and Health Regulations for Construction
40 CFR 61-SUBPART M	National Emission Standard for Asbestos
40 CFR 763	Asbestos
49 CFR 171	General Information, Regulations, and Definitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements

1.3 DEFINITIONS

FLAC - Florida Licensed Asbestos Consultant as defined within the FL-STAT 469 ASBESTOS ABATEMENT.

IH - Contractor's independent Industrial Hygienist. This person is responsible for the oversight, approval of the abatement procedures and the health, safety, and welfare of those who it effects.

1.4 ADMINISTRATIVE REQUIREMENTS

1.4.1 Licenses And Permits

Submit a copy of asbestos consultant's license to the Contracts Administrator. Ensure that the FLAC possesses a current license and complies with all Federal, State and Local Regulations. Only those consultants who are certified and licensed by DBPR are permitted to perform Asbestos Surveys or abatement specifications and plans as per Florida Statute 469.

Also submit a copy of Asbestos Contractor's License. Possession of a current asbestos contractor's license is mandatory, as well as securing all necessary licenses and permits associated with asbestos removal, transportation, and disposal as may be required by Federal, State, and local regulations. Only those Contractors who are certified and licensed by the State of Florida DBPR will be permitted to perform asbestos abatement activities at Kennedy Space Center.

Obtain and submit a copy of waste disposal permit and all disposal shipping manifests and tickets as they are obtained.

1.4.2 Certificates

Submit the following certificates:

a. Certification of participation (documentation showing current and 2 previous consecutive PAT test round results) in a proficiency analytical test (PAT) program such as or equivalent to the American Industrial Hygiene Association PAT or Asbestos Analytical Registry (AAR) accreditation certificate and Interlab QA/QC Program participation for the independent air monitoring agency selected by the Contractor before starting work.

b. Training Certifications and accreditation certificates for the independent air monitoring agency's on-site personnel and a copy of independent air monitoring agency's Quality Control Program.

c. Certification documents by the Contractor verifying that employees have been provided current respirator fit test, training, and medical examinations in compliance with 29 CFR 1926.

1.4.3 Material Safety Data Sheets (MSDS)

Submit Material Safety Data Sheets (MSDS) as required for materials to be used on the specified project.

1.4.4 Notification

When applicable, submit Florida Department of Environmental Protection

(DEP) "Notice of Demolition or Asbestos Renovation" (DEP Form 62-257.900(1)) to DEP District Office. A copy of the notification is to be provided to the Government as part of the Implementation Plan.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Asbestos Consultant's License; G

Asbestos Contractor's License; G

Training Certifications; G

Implementation Plan; G

Air Monitoring Plan; G

Contingency Plan for Emergencies; G

Written (OSHA Compliant) Respiratory Protection Plan; G

Work Schedule; G

Notification of Demolition/Renovation; G

SD-02 Shop Drawings

Coordination Drawings; G

SD-06 Test Reports

Initial Exposure Assessments; G

Notification of Demolition/Renovation; G

Air Monitoring Reports

Work Site Entry Logs; G

Daily Site Inspection Logs

Waste Inventory; G

Waste Shipment Record (WSR); G

SD-07 Certificates

Training Certifications; G

Proficiency Analytical Test; G

SD-08 Manufacturer's Instructions

Material Safety Data Sheets; G

Implementation Plan; G

SD-11 Closeout Submittals

Waste Disposal Permit; G

Disposal Shipping Manifests and Tickets; G

Daily Site Inspection Logs

Negative Pressure Logs

OSHA Compliance Inspection Records

Air Monitoring Reports; G

Independent Monitoring Data

Calibration Records; G

Waste Stream Inventory; G

1.6 IMPLEMENTATION PLAN

Prepare and submit a detailed, written Implementation Plan created, signed and sealed by a FLAC to the Government for approval, prior to the start of work, that includes the following:

a. Coordination drawings, in .DWG or .DGN electronic format, including site specific drawings of proposed work areas, clean room/change areas, mini-enclosures, shower, equipment room, waste loading/staging areas, locations of High Efficiency Particulate Air (HEPA) filtered negative pressure devices and exhaust points, work areas, emergency egress, and areas to be modified.

b. A copy of the applicable DEP Notification of Demolition/Renovation (DEP Form 62-257.900(1)).

c. Plan of action, including proposed procedures to be used in complying with the requirements of this specification, 29 CFR 1926, and other applicable regulatory requirements, sequence of asbestos abatement work, the interfaces of trades involved in the performance of work, posting of licenses, permits, etc., methods to be used to assure the safety of building occupants and visitors to the site, disposal plan including location of approved disposal site, a detailed description of the methods employed to control pollution, and a detailed work schedule. Expand upon the method for removal of ACM, the use of portable HEPA ventilation systems, closing out of the buildings HVAC system, method of removal to prohibit visible emissions in the work area, and packaging of removed debris.

d. Details of the decontamination areas and procedures, locations of staging areas, posting of warning signs, and details of negative air system to be used in the work area.

e. Sketch(s) or drawing(s) of complete contract area(s) showing the shower room, clean room, drum staging area, decontamination and containment

areas, the negative air system, and exits. Indicate designation of the "Competent Person" (CP), and Site Supervisor.

1.6.1 Air Monitoring Plan

Provide a written Air Monitoring Plan to be prepared under the direction of and signed/stamped by a Certified Industrial Hygienist (C.I.H.) or FLAC specifying the air monitoring criteria and an action plan for implementation by the Competent Person. Identify in the plan the Competent Person to be on site at all times (unless otherwise authorized by the Contracts Administrator) during asbestos abatement operations. The FLAC or his/her representative/competent person is responsible for ensuring applicable regulatory compliance during all phases of the asbestos abatement activities. The competent person has the authority to stop work for unsafe conditions and for not adhering to applicable regulations. Provide a qualified back-up person in the event that the Competent Person is absent from job site.

Provide certification that the Contractor, his staff, and abatement workers (including Supervisors) have attended and successfully completed (an) asbestos abatement course(s) including refresher courses as set forth in FL-STAT 469 and in accordance with 29 CFR 1926 and 40 CFR 763.

Provide a written (OSHA compliant) Respiratory Protection Plan in accordance with 29 CFR 1910 including training in the care, use, and maintenance of respirators and fit test certification.

Provide a written description of respiratory equipment (name, type, model number) and protective clothing provided to the abatement workers.

1.6.2 Personnel Examination

Provide documentation that all personnel assigned to the abatement project have been examined annually by a physician. Submit the physician's written opinion containing the results of the employee's medical examination in compliance with 29 CFR 1926. Establish, maintain, and make readily available for review all work site entry logs of all personnel entering and leaving the regulated work area by the on-site competent person indicating the date and time of entry and egress.

1.6.3 Procedures for enforcement of Personal Hygiene Practices

Prepare and submit a contingency plan for emergencies including fire, accident, power failure, heating or cooling, negative air system failure, respirator supplied air system failure, or any other event that may require modification of the work area isolation procedures. Include in the plan specific procedures for decontamination or work area isolation, safe exiting, and the need for medical attention in the event of an emergency.

1.6.4 Additional Procedures

Submit any additional procedures (fall protection, confined space, etc.) and policies that are in effect to ensure worker safety and environmental, KNPR 8500.1, KNPR 8715.3, requirements are met.

1.7 AIR MONITORING REPORTS

Obtain the services of an independent Air Monitoring Agency accredited by the American Industrial Hygiene Association (AIHA), for analysis of

airborne asbestos concentration levels. Provide a copy of the monitoring agency's Quality Control Program to Contracts Administrator prior to commencement of the abatement activities. Ensure the individual performing the on-site air monitoring meets the requirements as set forth in FL-STAT 469 and 40 CFR 763, and performs sample collections in accordance with the approved Air Monitoring Plan.

Perform all Air Monitoring under the direction of the FLAC using an independent Air Monitoring Contractor, in compliance with Florida Statute 469 requirements.

Calibrate pumps before and after each air sample and submit calibration records to the Government.

Submit daily Air Monitoring Reports. Include in the Air Monitoring Report the following information for each sample:

a. Sample identification, Sample location

b. Employee Name, Employee ID Number

c. Description of task being monitored

d. Exposure level results in (f/cc)

e. Monitoring instrument identification number

f. Pre-calibration, post calibration, and average flow rate of each sample

g. Sample date, start and stop times

h. Type of protective devices worn (if any)

i. Project identification number, Facility number and name

j. Sampling and Analytical Methods used

k. Contact name and company, and name of individual performing the sampling

1.7.1 Air Sample Analytical Method

Airborne fiber sampling and analytical procedures are to be analyzed by Phase Contrast Microscopy (PCM) in accordance with 29 CFR 1926 and NIOSH 2003-154 7400 method.

1.7.2 Air Sampling Rate, Volumes and Frequency

Conduct daily monitoring utilizing sample rates, volumes and frequency in accordance with 29 CFR 1926 and retain for final submittal at closeout. The minimum number of samples or sample volumes may not be less than those specified below:

Type of Sample	Volume	Minimum No. Samples	Location
Prior to set-up (within 24 hrs)	1200L	2	Regulated Area
Personal, During work	400L	2	Personal B.Z.

Type of Sample	Volume	Minimum No. Samples	Location
Area samples, Adjacent to work area	1200L	2	Regulated Area
Area samples at Negative Air Unit Exhaust	1200L	1	In area of outlets

1.8 WORKER PROTECTION

Perform Initial Exposure Assessments and Employee Exposure Monitoring in accordance with 29 CFR 1926, part 1926.1101, with input and approval of the FLAC.

Select and provide respiratory protection to employees and ensure they are utilized in accordance with 29 CFR 1926.

Submit the Work schedule indicating the work days, hours, and the number of workers per shift. Include a bar chart to identify the individual milestones through to the completion of the project (i.e., number of days to complete work site preparation, number of days to complete ACM removal, number of days to complete final cleaning and lockdown, etc.).

Submit the OSHA compliance inspection records as part of the closeout documents.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 TEMPORARY UTILITIES AND SERVICES

The Government will make available at the work site, water at hose bibs and 120 Volt AC at receptacles for the Contractor's use. Provide water proof safety lighting where necessary for safe, adequate illumination.

Ensure all electrical equipment to be used inside the work areas is powered from an Underwriters Laboratory (UL) approved Ground Fault Circuit Interrupter (GFCI). Do not exceed the manufacturers limits per GFCI. Make all necessary connections and restore the site connections to their original condition or better, prior to project completion.

Ensure all energized or pressurized systems inside the work area have been locked out, tagged out or otherwise rendered safe.

Provide temporary water from the existing building water source to control the generation of airborne dust, to allow for area, personnel, and equipment decontamination, and to supply decontamination unit needs. Also provide a backflow preventer at the source.

Provide temporary sanitary drainage piping to the decontamination unit sump and to the shower unit at a minimum slope of 2.0 percent, and temporary drainage piping to waste water pump and existing drain in accordance with local standards and as approved by the Contracts Administrator.

3.2 WORK AREA PREPARATION

The Government will re-arrange equipment and storage areas to the extent of

providing a direct and unobstructed path to the work area(s). During ACM removal, confine equipment and employees to the designated work area(s).

Unless otherwise directed by the Contracts Administrator, the Contractor is to establish and maintain a 25-foot access control barrier zone(s) around the designated work area(s). Interference with the functional operation of the building occupants outside these areas is not permitted.

Ensure all building supply and return air ducts from the mechanical system are isolated to eliminate air flow into or out of containment area(s).

3.2.1 Pre-Cleaning

Shut down HVAC systems and seal all critical barriers prior to initiating pre-cleaning actions. Seal, with 6 mil minimum thickness plastic sheeting, all openings, including but not limited to, windows, corridors, doorways, elevator openings, skylights, ducts, grilles, diffusers, and any other penetrations between the contaminated work areas and uncontaminated areas.

Pre-clean all movable objects identified as contaminated by the Contracts Administrator or his/her representative within the work area using a HEPA filtered vacuum and wet cleaning methods as appropriate. Remove these objects after cleaning and store in a protected area.

Pre-clean all surfaces in the work area using HEPA filtered vacuums and/or wet cleaning methods as appropriate. Methods that would raise dust, such as dry sweeping or vacuuming with equipment not equipped with HEPA filters, are PROHIBITED. Pay detailed attention to machinery or areas behind grilles and gratings.

Do not remove or otherwise disturb asbestos containing building materials during the pre-cleaning phase.

3.2.2 Work Area(s) Notification

Inform all other Contractors and personnel on the site of the abatement work of the nature of the Contractor's work with ACM and/or PACM, of the existence of and requirements pertaining to regulated areas, and the measures taken to ensure that employees of such other Contractor employers are not exposed to asbestos in accordance with 29 CFR 1926.

Use industry controls and work practice methods in accordance with 29 CFR 1926. Ensure daily site inspection logs are posted at the jobsite by the on-site competent person.

Use flame resistant, 6 mil polyethylene sheeting when constructing Negative Pressure Enclosures (NPE) or decontamination areas.

3.3 WASTE LOAD-OUT UNIT

Establish a waste load-out unit to provide for interim secure storage. Include an equipment room for storage of asbestos-contaminated items (drums, tools, equipment). Decontaminate all equipment and waste containers prior to being taken out of the work area(s).

All asbestos-containing waste material is to be sealed in leak-tight disposal containers. Thoroughly wet all waste within the disposal containers. Maintain proper labeling protocols for all running and final inventory of filled disposable containers.

3.4 SIGNS AND MARKINGS

Post signs prior to commencing asbestos work as required in 29 CFR 1926. Post signs at the perimeter of the asbestos work areas, along the route of the temporary waste material holding (Drum Staging) area, and at all entrances to asbestos work areas. Ensure signs are conspicuous and legible.

Post telephone numbers and locations of emergency services including, but not limited to, fire, ambulance, doctor, and hospital, at the regulated area.

Post one copy of all permits at the work site perimeter in a accessible location outside the regulated area.

Post one copy of the Abatement Contractors current license at the work site perimeter in a accessible location outside the regulated area.

Post hazard communication notification signs in accordance with KNPR 1840.19 requirements.

3.5 NEGATIVE AIR SYSTEM

Construct Negative Pressure Enclosures (NPE's) as required by 29 CFR 1926.

Duct each of the negative air units through the containment barrier walls to the outside of the work area(s). When the building is occupied, ensure that the ducts exhaust into the outside air; otherwise, they may exhaust into an area of the building beyond the critical barriers. Never exhaust the units into the work area(s).

Provide each unit with temporary back-up electrical power (120 Volt AC) in the event of power failures or outages.

3.5.1 Testing

Design the negative air system to provide a minimum of four (4) air changes per hour and test before any work is begun. After the work area has been prepared, the decontamination unit set up, and the negative air units(s) installed, test the system. Prior to beginning abatement activities, an Asbestos Abatement Pre-Work Inspection checklist (KSC Form 28-1230NS) will be completed by the KSC IH to verify the adequacy of the containment system and work area. Once activated, ensure the negative air exhaust unit(s) remain in operation until final clearance air monitoring has been performed and the KSC IH has approved their shutdown/removal. Maintain daily negative pressure logs for review by the FLAC and submit as part of the closeout documents.

Install a differential pressure meter or manometer to continuously measure pressure differential between inside and outside the work area for all Class I activities which utilize a NPE. Maintain a minimum pressure differential of 0.02 inch of water column.

3.6 RESPIRATORY PROTECTION

Instruct and train each worker involved in asbestos abatement in proper respirator use and care. Fit all respirators by approved qualitative or quantitative test. Use respiratory protection appropriate for the fiber level encountered in the Work Area and as specified herein, or as required

for other situations encountered.

3.6.1 Air Quality for Supplied Air Respiratory Systems

The Contractor is to provide air used for breathing in Type "C" supplied air respiratory systems that meets or exceeds CGA G-7.1, standards for Grade D air.

3.7 REMOVAL OF ASBESTOS

Use industry controls and work practices for all operations in accordance with 29 CFR 1926 Methods of Compliance for Class I, II, III, or IV asbestos work. The FLAC or his/her representative are responsible for these practices.

Ensure all Class I, II, III and IV work is supervised by an on site Competent Person at all times that work is in progress.

Following removal of contaminated items and asbestos material, seal the edges of adjacent surfaces, which were exposed when asbestos was removed, with an asbestos bridging sealant/encapsulant.

3.8 DAILY HOUSEKEEPING

Maintain a clean work area in accordance with 29 CFR 1926. Perform the following housekeeping functions at the end of each shift or prior to leaving the work site unattended:

a. Prepare contaminated waste for disposal by packaging the waste and removing it from the work area.

b. HEPA vacuum the work area.

c. Visually inspect polyethylene in the work area and other high traffic areas.

3.9 CLEANING PROCEDURES

Clean the work area at the end of each day's abatement activities. Designate a separate, secured area within the work area for storage of debris until it can be properly disposed. Secure the work area after termination of the work day to prevent entry. Regularly dispose and replace disposable supplies, such as mop heads, sponges, and rags. Clean all equipment by HEPA vacuuming and wet wiping.

Clean all work areas in which abatement operations have been completed, starting at the ceiling and working down to the floors, by HEPA vacuuming and wet wiping. Prior to removal of worksite access controls and re-occupancy inspection by the Government, and upon satisfactory final clearance air sampling, and removal of polyethylene sheeting, perform a final cleaning (wet wipe) of all surfaces within the work area.

3.10 INSPECTION

Do not commence removal of asbestos materials prior to satisfactory, concurrence to proceed on the Asbestos Abatement Pre-Work Inspection (checklist KSC Form 28-1230NS).

3.10.1 Initial Inspection

The Contractor and the independent IH will conduct a walk-through of the work area prior to beginning the abatement work to review existing conditions and ensure safe and practical conditions for the work to be implemented. Any damage to structures, surfaces, and equipment, which could be misconstrued as damage resulting from work, is to be documented by the Contractor and immediately submitted to the Contracts Administrator.

Perform background sampling for work areas in accordance with 29 CFR 1926 prior to beginning the abatement work.

3.10.2 Daily Inspection

Maintain a work site entry log of all personnel who enter the regulated work area. Through continuous surveillance and inspections of the worksite, ensure the integrity of containment, proper function of the negative pressure system, and posting of signs and labels. Also ensure, through frequent inspections during each work shift, that negative pressure is maintained, appropriate work practices are followed, appropriate protective clothing and equipment are used, and worker decontamination procedures are being followed.

Ensure that critical barriers and negative pressure enclosures remain effectively sealed and taped. Take immediate action to remedy defects immediately upon discovery. Details of the inspections are to be included in the Contractor's daily inspection log and posted in an accessible location outside the regulated area to ensure that access control barriers and engineering controls are maintained.

Provide updated copies of the Air Monitoring Reports, daily site inspection logs and waste stream inventory to the Contracts Administrator at the end of each week of the abatement work.

NASA/Kennedy Space Center reserves the right to conduct periodic inspections and air monitoring in the work area(s). If the work area is unsafe as determined by the NASA/KSC Safety or the NASA/IH Office, the Contracts Administrator will require the Contractor to stop work until the unsafe conditions are corrected.

3.10.3 Final Inspection

The thoroughness of asbestos removal is to be evaluated by visually inspecting the affected surfaces for residual asbestos material and accumulated dust followed by air sampling. Evidence of residual asbestos or asbestos debris on any adjacent surfaces upon completion of the work is not acceptable.

Upon completion of the work, a thorough visual inspection of the work area shall be conducted by the Abatement Contractor to ensure no residual asbestos material, dust or debris remains. Document final inspections on the Asbestos Abatement Clearance Inspection Checklist (KSC Form 28-1231NS), and submit to Contracts Administrator for approval.

If applicable, final aggressive air sampling is to be performed by the KSC IH for each NPE work area after completion of a satisfactory visual inspection. The clearance criteria is 0.01 fibers per cubic centimeter (f/cc) of air as determined by PCM. Satisfactory fiber counts from all final samples are to be less than 0.01 f/cc. If any of the final air

samples contain greater than 0.01 f/cc, repeat the final cleaning operation and re-test the area until satisfactory clearance levels are obtained.

Collect five (5) PCM final air samples for the first 5,000 square feet of containment plus one (1) additional PCM final air sample for each additional 5,000 square feet or one (1) air sample per room, whichever is greater. The number of final air samples may be reduced for small enclosures of less than approximately 2500 square feet. In no case may fewer than two (2) final samples be collected for any enclosure.

Ensure clearance air sample volumes meet the minimum volumes as indicated for analysis by NIOSH 7400 method.

3.11 ASBESTOS WASTE AND CONTAMINATED MATERIALS

3.11.1 Removal of Asbestos Waste Materials

For purposes of this paragraph, asbestos waste materials are defined as those materials which contain or have been contaminated by asbestos and are not planned to be encapsulated and remain at the job site. They are primarily removed asbestos, disposable clothing and safety equipment, polyethylene sheeting, contaminated amended water, vacuum cleaner contents, and filtration media.

Contain all asbestos waste material in two (2) 6 mil polyethylene disposal bags, or two (2) 6 mil disposal bags and a sealed leak-tight container such as, but not limited to, a steel or fiberboard drum. Pack the asbestos waste material while still wet. Clean the external surface of the waste containers by HEPA vacuuming and wet wiping before moving from the work area. Protect the interior of truck or dumpster with two layers of polyethylene sheeting.

3.11.1.1 Waste Inventory

Maintain Waste Inventory records of all generated waste drums or containers indicating the location and approximate quantity of material in each container. Clearly label and mark all disposal containers, dumpsters, and trucks, in accordance with 40 CFR 61-SUBPART M, 29 CFR 1910 of OSHA's Hazard Communications Standard, and 49 CFR 171 and 49 CFR 172, Hazardous Substances.

Provide conspicuous, legible labels, affixed to plastic bags and drums indicating the name of the waste generator and the location (facility name and number) where the waste was generated.

For non-friable asbestos that will be disposed at the KSC/Schwartz Road Landfill, provide a completed landfill disposal verification form (KSC Form 28-1064NS) to Contracts Administration. NOTE: Friable ACM is not permitted for disposal at KSC/Schwartz Road Landfill.

Provide a Waste Shipment Record (WSR) to the waste site owner in accordance with the instructions in 40 CFR 61-SUBPART M.

3.11.2 Work Area Disposal

After final inspection has been completed and the work area is approved for release, shut off and remove the Negative Air System units. Unseal all entrances and exits, dispose of all plastic sheeting, tape, and any other trash and debris in sealable plastic bags, or in drums and move to the

staging area for disposal. After final wet wipe of the work area and satisfactory clearance air sampling, dismantle critical barriers and the decontamination unit.

3.11.3 Decontamination Area And Support Area Disposal

Dismantle the decontamination area after the work area is released by the Contracts Administrator for re-occupancy. Vacuum all surfaces of the decontamination unit before it is disassembled.

3.12 WASTE TRANSPORTATION AND DISPOSAL

Transport and dispose of asbestos waste in full compliance with 40 CFR 61-SUBPART M, SUBPART A, 49 CFR 171 and 49 CFR 172.

3.13 ASBESTOS ABATEMENT NOTICE AND CHECKLIST

An Asbestos Abatement Pre-Work Inspection form (KSC Form 28-1230NS) and an Asbestos Abatement Clearance Checklist (KSC Form 28-1231NS) will be provided by the Contracts Administrator. Notify KSC IH and the Contracts Administrator at least three days prior to the planned commencement of work. Coordinate all Pre-Work and Clearance Site inspections with KSC IH. The completed forms are to be used to establish approval of the containment, work practices and final acceptance/re-occupancy of the work area(s).

3.14 FINAL ACCEPTANCE

3.14.1 Closeout Submittals

Within 10 days after the completion of work, submit to the Contracts Administrator a written summary and copies of the following items:

a. Waste Disposal Permit

b. Disposal Shipping Manifests and Tickets

c. Daily Site Inspection Logs

d. Negative Pressure Logs

e. OSHA Compliance Inspection Records

f. Air Monitoring Reports

g. Independent Monitoring Data

h. Calibration Records

i. Waste Stream Inventory

The work will not be considered complete until the asbestos materials identified herein have been abated, the areas cleaned, satisfactory clearance air monitoring completed, all asbestos contaminated waste has been properly disposed of, and all project close out documents have been received and approved by the Contracts Administrator.

-- End of Section --

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HAZARDOUS METALS AND POLYCHLORINATED BIPHENYLS (PCBs) IN CONSTRUCTION

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 INDUSTRIAL HYGIENE ASSOCIATION (AIHA)

AIHA Z88.6	(2006) Respiratory Protection - Respirator Use-Physical Qualifications for Personnel

JOHN F. KENNEDY SPACE CENTER (KSC)

KNPR 1840.19	(2011; Rev C-1) KSC Industrial Hygiene Programs
KNPR 8500.1	(2010; Rev B) KSC Environmental Requirements

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

29 CFR 1926.103	Respiratory Protection
29 CFR 1926.1126	Chromium (VI)
29 CFR 1926.1127	Cadmium
29 CFR 1926.21	Safety Training and Education
29 CFR 1926.33	Access to Employee Exposure and Medical Records
29 CFR 1926.55	Gases, Vapors, Fumes, Dusts, and Mists
29 CFR 1926.59	Hazard Communication
29 CFR 1926.62	Lead
29 CFR 1926.65	Hazardous Waste Operations and Emergency Response
40 CFR 260	Hazardous Waste Management System: General
40 CFR 261	Identification and Listing of Hazardous Waste
40 CFR 262	Standards Applicable to Generators of Hazardous Waste
40 CFR 263	Standards Applicable to Transporters of

	Hazardous Waste
40 CFR 264	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 265	Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities
40 CFR 761	Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions
49 CFR 172	Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements
49 CFR 178	Specifications for Packagings
UNDERWRITERS LABORATORIES (UL)	
UL 586	(2009) Standard for High-Efficiency Particulate, Air Filter Units

1.2 DEFINITIONS

1.2.1 Action Level

Employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8 hour period.

Employee exposure, without regard to use of respirators, to an airborne concentration of cadmium or chromium (VI) of 2.5 micrograms per cubic meter of air averaged over an 8 hour period.

1.2.2 Area Sampling

Sampling of hazardous metals and PCB concentrations within the control area and inside the physical boundaries which is representative of the airborne hazardous metals and PCB concentrations but is not collected in the breathing zone of personnel (approximately 5 to 6 feet above the floor).

1.2.3 Cadmium Permissible Exposure Limit (PEL)

Five micrograms per cubic meter of air as an 8 hour time-weighted average as determined by 29 CFR 1926.1127.

1.2.4 Chromium (VI) Permissible Exposure Limit (PEL)

Five micrograms per cubic meter of air as an 8 hour time weighted average as determined by 29 CFR 1926.1126.

1.2.5 Competent Person (CP)

As used in this section, refers to a person employed by the Contractor who is trained in the recognition and control of hazardous metals and PCB

hazards in accordance with current Federal, State, and local regulations and has the authority to take prompt corrective actions to control the hazard. A Certified Industrial Hygienist (CIH) certified by the American Board of Industrial Hygiene or a Certified Safety Professional (CSP) certified by the Board of Certified Safety Professionals is the best choice.

1.2.6 Contaminated Room

Refers to a room for removal of contaminated personal protective equipment (PPE).

1.2.7 Decontamination Shower Facility

A facility that encompasses a clean clothing storage room, and contaminated clothing storage and disposal rooms, with a shower facility in between.

1.2.8 Hazardous Metal

Metals and metal compounds that negatively affect human health. Hazardous metal include but are not limited to lead, cadmium, chromium (VI) and mercury.

1.2.9 High Efficiency Particulate Arrestor (HEPA) Filter Equipment

HEPA filtered vacuuming equipment with a UL 586 filter system capable of collecting and retaining lead-contaminated particulate. A high efficiency particulate filter demonstrates at least 99.97 percent efficiency against 0.3 micron or larger size particles.

1.2.10 Lead

Metallic lead, inorganic lead compounds, and organic lead soaps. Excludes other forms of organic lead compounds.

1.2.11 Control Area

A system of control methods to prevent the spread of hazardous metals and PCB dust, paint chips or debris to adjacent areas that may include temporary containment, floor or ground cover protection, physical boundaries, and warning signs to prevent unauthorized entry of personnel. HEPA filtered local exhaust equipment may be used as engineering controls to further reduce personnel exposures or building/outdoor environmental contamination.

1.2.12 Lead Permissible Exposure Limit (PEL)

Fifty micrograms per cubic meter of air as an 8 hour time weighted average as determined by 29 CFR 1926.62. If an employee is exposed for more than eight hours in a work day, the PEL shall be determined by the following formula:

PEL (micrograms/cubic meter of air) = 400/No. hrs worked per day

1.2.13 Material Containing Lead/Paint with Lead (MCL/PWL)

Material, including paint, which contains lead as determined by the testing laboratory using a valid test method. The requirements of this section does not apply if no detectable levels of lead are found using a quantitative method for analyzing paint or MCL using laboratory instruments with

specified limits of detection (usually 0.01 percent). An X-Ray Fluorescence (XRF) instrument is not considered a valid test method.

1.2.14 Mercury Permissible Exposure Limit (PEL)

0.1 milligrams per cubic meter of air as an 8 hour time weighted average as determined by 29 CFR 1926.55.

1.2.15 PCB Permissible Exposure Limit (PEL)

Five hundred micrograms per cubic meter of air as an 8 hour time weighted average as identified in 29 CFR 1926.55.

1.2.16 Personal Sampling

Sampling of airborne hazardous metal and PCB concentrations within the breathing zone of an employee to determine the 8 hour time weighted average concentration in accordance with 29 CFR 1926.62, 29 CFR 1926.55, 29 CFR 1926.1126 and 29 CFR 1926.1127. Samples shall be representative of the employees' work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of 6 to 9 inches and centered at the nose or mouth of an employee.

1.2.17 Physical Boundary

Area physically roped or partitioned off around lead control area to limit unauthorized entry of personnel.

1.3 DESCRIPTION

1.3.1 Description of Work

Construction activities impacting PWL or material containing hazardous metals and PCBs which are covered by this specification include the demolition or removal of material containing hazardous metal and PCBs in paints and coatings, located on support structures in the Vehicle Assembly Building Highbay 3 and as indicated on the drawings.

1.3.2 Coordination with Other Work

The contractor shall coordinate with work being performed in adjacent areas. Coordination procedures shall be explained in the Plan and shall describe how the Contractor will prevent hazardous metal and PCB exposure to other contractors or Government personnel performing work unrelated to hazardous metal and PCB activities.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Occupational and Environmental Assessment Data Report (if objective data is used to justify excluding the initial occupational exposure assessment); G

Hazardous Metal and PCB Compliance and Health and Safety Plan including CP approval (signature, date, and certification number); G

Competent Person qualifications; G

Training Certification of workers and supervisors; G

Hazardous Metal and PCB Waste Management Plan; G

Certification of Medical Examinations; G

SD-06 Test Reports

Sampling results; G

Occupational and Environmental Assessment Data Report; G

SD-07 Certificates

Testing laboratory qualifications; G

Clearance Certification; G

1.5 QUALITY ASSURANCE

1.5.1 Qualifications

1.5.1.1 Competent Person (CP)

Submit name, address, and telephone number of the CP selected to perform responsibilities specified in paragraph entitled "Competent Person (CP) Responsibilities." Provide documented construction project-related experience with implementation of OSHA's Hazardous Metal and PCB in Construction standards (29 CFR 1926.62, 29 CFR 1926.55, 29 CFR 1926.1126 and 29 CFR 1926.1127) which shows ability to assess occupational and environmental exposure to Hazardous Metal and PCB, experience with the use of respirators, personal protective equipment and other exposure reduction methods to protect employee health. Submit proper documentation that the CP is trained and licensed or certified in accordance with Federal, State and local laws.

1.5.1.2 Training Certification

Submit a certificate for each worker and supervisor, signed and dated by the training provider, stating that the employee has received the required training specified in 29 CFR 1926.62, 29 CFR 1926.1126 and 29 CFR 1926.1127 and is certified to perform or supervise hazardous metal removal or demolition activities.

1.5.1.3 Testing Laboratory

Submit the name, address, and telephone number of the testing laboratory selected to perform the air and wipe analysis, testing, and reporting of airborne concentrations of hazardous metals and PCBs. Use a laboratory participating in the EPA
National Lead Laboratory Accreditation Program (NLLAP) by being accredited by either the American Association for Laboratory Accreditation (A2LA) or the American Industrial Hygiene Association (AIHA) and that is successfully

participating in the Environmental Lead Proficiency Analytical Testing (ELPAT) program to perform sample analysis. Laboratories selected to perform blood analysis shall be OSHA approved.

1.5.2 Requirements

1.5.2.1 Competent Person (CP) Responsibilities

a. Verify training meets all Federal, State, and local requirements.

b. Review and approve Hazardous Metal and PCB Compliance and Health and Safety Plan for conformance to the applicable referenced standards.

c. Continuously inspect hazardous metal and PCB work for conformance with the approved plan.

d. Perform (or oversee performance of) air sampling. Recommend upgrades or downgrades (whichever is appropriate based on exposure) on the use of PPE (respirators included) and engineering controls.

e. Ensure work is performed in strict accordance with specifications.

f. Control work to prevent hazardous exposure to human beings and to the environment.

g. Supervise final cleaning of the control area, take clearance wipe samples; review clearance sample results and make recommendations for further cleaning.

h. Certify the conditions of the work as called for elsewhere in this specification.

1.5.2.2 Hazardous Metal and PCB Compliance and Health and Safety Plan

Submit a detailed job-specific plan of the work procedures to be used in the disturbance of paint, coatings or materials containing hazardous metals or PCBs. The plan shall include a sketch showing the location, size, and details of control areas, critical barriers, physical boundaries, location and details of decontamination facilities, viewing ports, and mechanical ventilation system. Include a description of equipment and materials, work practices, controls and job responsibilities for each activity from which hazardous metals or PCBs are emitted. Include in the plan, eating, drinking, smoking, hygiene facilities and sanitary procedures, interface of trades, sequencing of hazardous metals and PCB related work, collected waste water and dust containing hazardous metals and PCB and debris, air sampling, respirators, personal protective equipment, and a detailed description of the method of containment of the operation to ensure that hazardous metals and PCB are not released outside of the control area. Include site preparation, cleanup and clearance procedures. Include occupational and environmental sampling, training and strategy, sampling and analysis, strategy and methodology, frequency of sampling, duration of sampling, and qualifications of sampling personnel in the air sampling portion of the plan. Include a description of arrangements made among contractors on multicontractor worksites to inform affected employees and to clarify responsibilities to control exposures.

Work may involve the disturbance of concrete, masonry and tile that will result in the release of respirable silica. The plan shall address work procedures and controls to address silica exposure.

1.5.2.3 Occupational and Environmental Assessment Data Report

If initial monitoring is necessary, submit occupational and environmental sampling results to the Contracting Officer within three working days of collection, signed by the testing laboratory employee performing the analysis, the employee that performed the sampling, and the CP.

In order to reduce the full implementation of 29 CFR 1926.62, 29 CFR 1926.1126 or 29 CFR 1926.1127, the Contractor shall provide documentation. Submit a report that supports the determination to reduce full implementation of the requirements of 29 CFR 1926.62, 29 CFR 1926.1126 or 29 CFR 1926.1127 and supporting the Hazardous Metal and PCB Compliance and Health and Safety Plan.

a. The initial monitoring shall represent each job classification, or if working conditions are similar to previous jobs by the same employer, provide previously collected exposure data that can be used to estimate worker exposures per 29 CFR 1926.62, 29 CFR 1926.1126 or 29 CFR 1926.1127. The data shall represent the worker's regular daily exposure to lead, cadmium or chromium (VI) for stated work.

b. Submit worker exposure data gathered during the task based trigger operations of 29 CFR 1926.62, 29 CFR 1926.1126 or 29 CFR 1926.1127 with a complete process description. This includes manual demolition, manual scraping, manual sanding, heat gun, power tool cleaning, rivet busting, cleanup of dry expendable abrasives, abrasive blast enclosure removal, abrasive blasting, welding, cutting and torch burning where lead, cadmium or chromium (VI) containing coatings are present.

c. The initial assessment shall determine the requirement for further monitoring and the need to fully implement the control and protective requirements including the Hazardous Metal and PCB Compliance and Health and Safety Plan per 29 CFR 1926.62, 29 CFR 1926.1126 or 29 CFR 1926.1127.

1.5.2.4 Medical Examinations

Initial medical surveillance as required by 29 CFR 1926.62, 29 CFR 1926.1126 or 29 CFR 1926.1127 shall be made available to employees exposed to lead, cadmium or chromium (VI) above the action level. Full medical surveillance shall be made available to employees on an annual basis who are or may be exposed to lead, cadmium or chromium (VI) in excess of the action level for more than 30 days a year or as required by 29 CFR 1926.62, 29 CFR 1926.1126 or 29 CFR 1926.1127. Adequate records shall show that employees meet the medical surveillance requirements of 29 CFR 1926.33, 29 CFR 1926.62, 29 CFR 1926.1126 or 29 CFR 1926.1127 and 29 CFR 1926.103. Provide medical surveillance to all personnel exposed to lead as indicated in 29 CFR 1926.62, 29 CFR 1926.1126 or 29 CFR 1926.1127. Maintain complete and accurate medical records of employees for the duration of employment plus 30 years.

1.5.2.5 Training

Train each employee performing work that disturbs hazardous metals and PCBs, who performs hazardous metal and PCB disposal, and air sampling operations prior to the time of initial job assignment and annually thereafter, in accordance with 29 CFR 1926.21, 29 CFR 1926.62, 29 CFR 1926.1126 or 29 CFR 1926.1127 and State and local regulations.

1.5.2.6 Respiratory Protection Program

a. Provide each employee required to wear a respirator a respirator fit test at the time of initial fitting and at least annually thereafter as required by 29 CFR 1926.62, 29 CFR 1926.1126 or 29 CFR 1926.1127.

b. Establish and implement a respiratory protection program as required by AIHA Z88.6, 29 CFR 1926.103, 29 CFR 1926.62, and 29 CFR 1926.55, 29 CFR 1926.1126, 29 CFR 1926.1127 and KSC Respiratory Protection Program.

1.5.2.7 Hazard Communication Program

Establish and implement a Hazard Communication Program as required by 29 CFR 1926.59.

1.5.2.8 Hazardous Metal and PCB Waste Management

The Hazardous Metal and PCB Waste Management Plan shall supplement the waste management plans submitted in accordance with Section 01 57 20.00 10, ENVIRONMENTAL PROTECTION PLAN and comply with Federal, State, and local hazardous waste regulations and address:

a. Identification and classification of wastes associated with the work.

b. Estimated quantities of wastes to be generated and disposed of.

c. Names and qualifications of each contractor that will be transporting, storing, treating, and disposing of the wastes. Include the facility location and operator and a 24-hour point of contact.

d. Names and qualifications (experience and training) of personnel who will be working on-site with hazardous wastes.

e. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.

f. Spill prevention, containment, and cleanup contingency measures including a health and safety plan to be implemented in accordance with 29 CFR 1926.65.

g. Work plan and schedule for waste containment, removal and disposal. Proper containment of the waste includes using acceptable waste containers (e.g., 55-gallon drums) as well as proper marking/labeling of the containers. Wastes shall be cleaned up and containerized daily.

h. Include processes that may alter or treat waste rendering a hazardous waste non hazardous.

1.5.2.9 Environmental, Safety and Health Compliance

In addition to the detailed requirements of this specification, comply with laws, ordinances, rules, and regulations of Federal, State, and local authorities regarding hazardous metal and PCBs. Comply with the requirements of the current issue of 29 CFR 1926.62, 29 CFR 1926.1126 or 29 CFR 1926.1127. Submit matters regarding interpretation of standards to the Contracting Officer for resolution before starting work. Where specification requirements and the referenced documents vary, the most

stringent requirement shall apply. The following KSC requirements regarding removing, handling, storing, transporting, and disposing of hazardous metal and PCB-contaminated materials apply:

a. KNPR 1840.19 KSC Industrial Hygiene Program

b. KNPR 8500.1 (2010; Rev B) KSC Environmental Requirements

1.5.3 Pre-Construction Conference

Along with the CP, meet with the Contracting Officer to discuss in detail the Hazardous Metal and PCB Waste Management Plan and the Hazardous Metal and PCB Compliance and Health and Safety Plan, including procedures and precautions for the work.

1.6 EQUIPMENT

1.6.1 Respirators

Furnish appropriate respirators approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services, for use in atmospheres containing hazardous metal or PCB dust, fume and mist.
Respirators shall comply with the requirements of 29 CFR 1926.62, 29 CFR 1926.103, 29 CFR 1926.1126 and 29 CFR 1926.1127.

1.6.2 Special Protective Clothing

Furnish personnel who will be exposed to hazardous metal and PCB dust with proper disposable protective whole body clothing, head covering, gloves, eye, and foot coverings as required by 29 CFR 1926.62, 29 CFR 1926.1126 and 29 CFR 1926.1127. Furnish proper disposable plastic or rubber gloves to protect hands. Reduce the level of protection only after obtaining approval from the CP.

1.6.3 Rental Equipment Notification

If rental equipment is to be used during hazardous metal and PCB handling and disposal, notify the rental agency in writing concerning the intended use of the equipment.

1.6.4 Vacuum Filters

UL 586 labeled HEPA filters.

1.6.5 Equipment for Government Personnel

Furnish the Contracting Officer with two complete sets of personal protective equipment (PPE) daily, as required herein, for entry into and inspection of the hazardous metal and PCB removal work within the controlled area. Personal protective equipment shall include disposable whole body covering, including appropriate foot, head, eye, and hand protection. PPE shall remain the property of the Contractor. The Government will provide respiratory protection for the Contracting Officer.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Protection of Existing Work to Remain

Perform work without damage or contamination of adjacent areas. Where existing work is damaged or contaminated, restore work to its original condition or better as determined by the Contracting Officer.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Protection

3.1.1.1 Notification

a. Notify the Contracting Officer 20 days prior to the start of hazardous metal and PCB work.

b. The CP shall notify the facility managers of hazardous operations requiring establishment of control areas. Facility managers will forward notifications to facility tenant management points of contact and the MESC IH Office.
The Notification shall include:

(a) Estimated start date and times.
(b) Facility number and name.
(c) Work location.
(d) Project Identification Number.
(e) Contact Name and Phone Number (Construction Management Point of Contact).
(f) Brief description of work or operation to be conducted.

3.1.1.2 Control Area

a. Physical Boundary - Provide physical boundaries around the control area by roping off the area designated in the work plan or providing curtains, portable partitions or other enclosures to ensure that hazardous metal and PCBs will not escape outside of the control area.

b. Warning Signs - Provide warning signs at approaches to control areas. Locate signs at such a distance that personnel may read the sign and take precautions before entering the area. Signs shall comply with the requirements of 29 CFR 1926.62, 29 CFR 1926.1126 and 29 CFR 1926.1127.

In addition, signage shall identify the type of work in progress, project identification number and provide the name and phone number of a point of contact for project information and for notification in the event of an emergency.

3.1.1.3 Furnishings

The Government will remove furniture and equipment from the building before hazardous metal and PCB work begins.

3.1.1.4 Heating, Ventilating and Air Conditioning (HVAC) Systems

Shut down, lock out, and isolate HVAC systems that supply, exhaust, or pass through the control areas. Seal intake and exhaust vents in the control area with 6 mil plastic sheet and tape. Seal seams in HVAC components that pass through the control area.

3.1.1.5 Decontamination Shower Facility

Provide clean and contaminated change rooms and shower facilities in accordance with this specification and 29 CFR 1926.62.

3.1.1.6 Eye Wash Station

Where eyes may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes shall be provided within the work area.

3.1.1.7 Mechanical Ventilation System

a. To the extent feasible, use local exhaust ventilation or other collection systems, approved by the CP. Local exhaust ventilation systems shall be evaluated and maintained in accordance with 29 CFR 1926.62.

b. Vent local exhaust outside the building and away from building ventilation intakes or ensure system is connected to HEPA filters.

c. Use locally exhausted, power actuated tools or manual hand tools.

3.1.1.8 Personnel Protection

Personnel shall wear and use protective clothing and equipment as specified herein. Eating, smoking, or drinking or application of cosmetics is not permitted in the control area. No one will be permitted in the control area unless they have been appropriately trained and provided with protective equipment.

3.2 ERECTION

3.2.1 Control Area Requirements

Establish a control area by completely establishing barriers and physical boundaries around the area or structure where paint and coating removal operations will be performed.

3.3 APPLICATION

3.3.1 Hazardous Metal and PCB Work

Perform hazardous metal and PCB work in accordance with approved Hazardous Metal and PCB Compliance and Health and Safety Plan. Use procedures and equipment required to limit occupational exposure and environmental contamination with hazardous metals and PCBs when the work is performed in accordance with 29 CFR 1926.62,29 CFR 1926.1126 and 29 CFR 1925.1127 and as specified herein. Dispose of paint, coatings or materials coating, hazardous metals and PCBs and associated waste in compliance with Federal, State, and local requirements.

3.3.2 Paint with Hazardous Metals and PCBs or Material Containing Hazardous Metals and PCBs Removal

Manual or power sanding or grinding of hazardous metals and PCBs surfaces or materials is not permitted unless tools are equipped with HEPA attachments or wet methods. The dry sanding or grinding of surfaces that contain hazardous metals and PCBs is prohibited. Provide methodology for removing hazardous metals and PCBs in the Hazardous Metal and PCB Compliance and Health and Safety Plan. Select hazardous metals and PCBs removal processes to minimize contamination of work areas outside the control area with contaminated dust or other contaminated debris or waste and to ensure that unprotected personnel are not exposed to hazardous concentrations . Describe this removal process in the Hazardous Metal and PCB Compliance and Health and Safety Plan.

Remove paints and coatings 6 inches to either side of areas where torch cutting or abrasive grindings will occur.

3.3.2.1 Paint with Hazardous Metal and PCBs or Material Containing Hazardous Metals and PCBs - Indoor Removal

Perform manual, mechanical removal and thermal cutting in the control areas using enclosures, barriers or containments. Collect residue for disposal in accordance with Federal, State, and local requirements.

3.3.3 Personnel Exiting Procedures

Whenever personnel exit the controlled area, they shall perform the following procedures and shall not leave the work place wearing clothing or equipment worn in the control area:

a. Vacuum clothing before entering the contaminated change room.

b. Remove protective clothing in the contaminated change room, and place them in an approved impermeable disposal bag.

c. Wash hands and face at the site, don appropriate disposable or uncontaminated reusable clothing, move to an appropriate shower facility, shower.

d. Change to clean clothes prior to leaving the clean clothes storage area.

3.4 FIELD QUALITY CONTROL

3.4.1 Tests

3.4.1.1 Air and Wipe Sampling

Conduct sampling for hazardous metals and PCBs in accordance with 29 CFR 1926.62, 29 CFR 1926.55, 29 CFR 1926.1126 and 29 CFR 1926.1127 and as specified herein. Air and wipe sampling shall be directed or performed by the CP.

a. The CP shall be on the job site directing the air and wipe sampling and inspecting the paint, coatings or materials containing hazardous metals and PCBs removal work to ensure that the requirements of the contract have been satisfied during the entire operation.

b. Collect personal air samples on employees who are anticipated to have the greatest risk of exposure as determined by the CP. In addition, collect air samples on at least twenty-five percent of the work crew or a minimum of two employees, whichever is greater, during each work shift.

c. Submit results of air samples, signed by the CP, within 72 hours after the air samples are taken.

d. Conduct area air sampling every three months, on each shift in which paint and coating removal operations are performed, in areas immediately adjacent to the control area. Sufficient area monitoring shall be conducted to ensure unprotected personnel are not exposed at or above action levels. If an action level of air is reached or exceeded, stop work, correct the conditions(s) causing the increased levels. Notify the Contracting Officer immediately. Determine if condition(s) require further change in work methods. Removal work shall resume only after the CP and the Contracting Officer give approval.

e. Surface Wipe Samples - Collect surface wipe samples on floors at a location no greater than 10 feet outside the control area at a frequency of once every three months while removal work is conducted. Surface wipe results shall meet criteria in paragraph "Clearance Certification.

3.4.1.2 Testing of Material Containing Hazardous Metal and PCB Residue

Test residue in accordance with 40 CFR 261 and 40 CFR 761 for hazardous waste and PCBs.

3.5 CLEANING AND DISPOSAL

3.5.1 Cleanup

Maintain surfaces of the control area free of accumulations of dust and debris. Restrict the spread of dust and debris; keep waste from being distributed over the work area. Do not dry sweep or use pressurized air to clean up the area. At the end of each shift and when the paint and coating removal operation has been completed, clean the controlled area of visible contamination by vacuuming with a HEPA filtered vacuum cleaner, wet mopping the area and wet wiping the area as indicated by the Hazardous Metal and PCB Compliance and Health and Safety Plan. Reclean areas showing dust or debris. After visible dust and debris are removed, wet wipe and HEPA vacuum surfaces in the controlled area. If adjacent areas become contaminated during the work, clean, visually inspect, and then wipe sample contaminated areas. The CP shall then certify in writing that the area has been cleaned of hazardous metal and PCB contamination before clearance testing.

3.5.1.1 Clearance Certification

The CP shall certify in writing that air samples collected outside the control area during paint removal operations are less than action levels for lead, cadmium and chromium (VI); the respiratory protection used for the employees was adequate; the work procedures were performed in accordance with 29 CFR 1926.62, 29 CFR 1926.1126 and 29 CFR 1926.1127; and that there were no visible accumulations of material and dust containing hazardous metals and PCBs left in the work site. Do not remove the control area or roped off boundary and warning signs prior to the Contracting Officer's acknowledgement of receipt of the CP certification.

Certify surface wipe samples are not significantly greater than the initial surface loading determined prior to work.

Clear the control area in industrial facilities of visible dust and debris.

3.5.2 Disposal

Waste streams shall be disposed of in accordance with KNPR 8500.1 KSC Environmental Requirements.

a. Material, whether hazardous or non-hazardous shall be disposed in accordance with laws and provisions and Federal, State or local regulations. Ensure waste is properly characterized. The Technical Response Package provided by the Contracting Officer and result of each waste characterization (TCLP for RCRA materials) will dictate disposal requirements.

b. Contractor is responsible for segregation of waste. Collect hazardous metal and PCB contaminated waste, scrap, debris, bags, containers, equipment, and contaminated clothing that may produce airborne concentrations of hazardous metal and PCB particles. Label the containers in accordance with 29 CFR 1926.62, 29 CFR 1926.1126, 29 CFR 1926.1127 and 40 CFR 261.

c. Store waste materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon drums. Properly label each drum to identify the type of waste (49 CFR 172) and the date the drum was filled. For hazardous waste, the collection drum requires marking/labeling in accordance with 40 CFR 262 during the accumulation/collection timeframe. The Contracting Officer or an authorized representative will assign an area for interim storage of waste-containing drums. Do not store hazardous waste drums in interim storage longer than 90 calendar days from the date affixed to each drum.

e. Handle and store, hazardous metal and PCB contaminated waste in accordance with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, 40 CFR 265, 40 CFR 761 and KNPR 8500.1, Rev. B, KSC Requirements.

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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 182	(2005; R 2009) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats
AASHTO M 322M/M 322	(2010) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI/MCP-1	(2012) Manual of Concrete Practice Part 1
ACI/MCP-2	(2012) Manual of Concrete Practice Part 2
ACI/MCP-3	(2012) Manual of Concrete Practice Part 3
ACI/MCP-4	(2012) Manual of Concrete Practice Part 4

AMERICAN HARDBOARD ASSOCIATION (AHA)

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

AMERICAN WELDING SOCIETY (AWS)

AWS D1.4/D1.4M	(2011) Structural Welding Code - Reinforcing Steel

ASTM INTERNATIONAL (ASTM)

ASTM A185/A185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A496/A496M	(2007) Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
ASTM A497/A497M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
ASTM A53/A53M	(2012) Standard Specification for Pipe,

	Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A615/A615M	(2012) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A82/A82M	(2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM C1107/C1107M	(2011) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C143/C143M	(2010a) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2011) Standard Specification for Portland Cement
ASTM C156	(2011) Standard Test Method for Water Retention by Concrete Curing Materials
ASTM C171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2010) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2010b) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C192/C192M	(2007) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231/C231M	(2010) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C233/C233M	(2011) Standard Test Method for Air-Entraining Admixtures for Concrete
ASTM C260/C260M	(2010a) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2012) Petrographic Examination of Aggregates for Concrete
ASTM C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C31/C31M	(2010) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2011a) Standard Specification for Concrete Aggregates

ASTM C330/C330M	(2009) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C39/C39M	(2012) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42/C42M	(2012) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C494/C494M	(2011) Standard Specification for Chemical Admixtures for Concrete
ASTM C881/C881M	(2010) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM C932	(2006) Standard Specification for Surface-Applied Bonding Compounds for Exterior Plastering
ASTM C94/C94M	(2012) Standard Specification for Ready-Mixed Concrete
ASTM D1557	(2009) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D1751	(2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2004a; R 2008) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion
ASTM D6690	(2007) Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM D7116	(2005) Standard Specification for Joint Sealants, Hot Applied, Jet Fuel Resistant Types, for Portland Cement Concrete Pavement
ASTM E1745	(2011) Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
ASTM E329	(2011c) Standard Specification for Agencies Engaged in the Testing and/or

Inspection of Materials Used in Construction

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

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

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST PS 1 (2009) DOC Voluntary Product Standard PS 1-07, Structural Plywood

U.S. DEPARTMENT OF COMMERCE (DOC)

DOC/NIST PS1 (1995) Construction and Industrial Plywood with Typical APA Trademarks

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS SS-S-200 (Rev E; Am 1; Notice 1) Sealant, Joint, Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement

1.2 DEFINITIONS

a. "Cementitious material" as used herein must include all portland cement, pozzolan, fly ash, ground granulated blast-furnace slag.

b. "Exposed to public view" means situated so that it can be seen from eye level from a public location after completion of the building. A public location is accessible to persons not responsible for operation or maintenance of the building.

c. "Chemical admixtures" are materials in the form of powder or fluids that are added to the concrete to give it certain characteristics not obtainable with plain concrete mixes.

d. "Workability (or consistence)" is the ability of a fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, chemical admixtures, aggregate (shape and size distribution), cementitious content and age (level of hydration).

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. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings for concrete formwork must be submitted by the Contractor in accordance with paragraph entitled, "Shop Drawings," of this section, to include the following:

Reinforcing steel; G

Column Forms; G

Wall Forms; G

Floor Forms; G

Ceiling Forms; G

Wood Forms; G

Special Construction; G

Reproductions of contract drawings are unacceptable.

Provide erection drawings for concrete Formwork that show placement of reinforcement and accessories, with reference to the contract drawings.

SD-03 Product Data

Joint sealants;

Submit manufacturer's product data, indicating VOC content. Manufacturer's catalog data for the following items must include printed instructions for admixtures, bonding agents, epoxy-resin adhesive binders, waterstops, and liquid chemical floor hardeners.

Joint filler;

Ready-Mix Concrete
Vapor barrier
Bonding Materials
Concrete Curing Materials
Reinforcement Materials
Cement
Portland Cement
Epoxy Bonding Compound
Reinforcement

SD-05 Design Data

Concrete mix design; G

Thirty days minimum prior to concrete placement, submit a mix design for each strength and type of concrete. Submit a complete list of materials including type; brand; source and amount of cement, and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which produce a range of strength encompassing those required for each class and type of concrete required. If source material changes, resubmit mix proportion data using revised source material. Provide only materials that have been proven by trial mix studies to meet the requirements of this specification, unless otherwise approved in writing by the Contracting Officer. Indicate clearly in the submittal where each mix design is used when more than one mix design is submitted.

Calculations

SD-06 Test Reports

Concrete mix design; G
Compressive strength tests
Slump
Air Entrainment
Air Content

SD-07 Certificates

Curing concrete elements
Material Safety Data Sheets

SD-08 Manufacturer's Instructions

Submit mill certificates for Steel Bar according to the paragraph entitled, "Fabrication," of this section.

Provide certificates for concrete that are in accordance with the paragraph entitled, "Classification and Quality of Concrete," of this section. Provide certificates that contain project name and number, date, name of Contractor, name of concrete testing service, source of concrete aggregates, material manufacturer, brand name of manufactured materials, material name, values as specified for each material, and test results.

SD-11 Closeout Submittals

1.4 DELIVERY, STORAGE, AND HANDLING

Do not deliver concrete until , vapor barrier, forms, reinforcement, embedded items, and chamfer strips are in place and ready for concrete placement. ACI/MCP-2 for job site storage of materials. Protect materials from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags removed. Do not store concrete curing compounds or sealers with materials that have a high capacity to adsorb volatile organic compound (VOC) emissions. Do not store concrete curing compounds or sealers in occupied spaces.

1.4.1 Reinforcement

Store reinforcement of different sizes and shapes in separate piles or racks raised above the ground to avoid excessive rusting. Protect from contaminants such as grease, oil, and dirt. Ensure bar sizes can be accurately identified after bundles are broken and tags removed.

1.5 QUALITY ASSURANCE

1.5.1 Design Data

1.5.1.1 Formwork Calculations

ACI/MCP-4, include design calculations indicating arrangements of forms, sizes and grades of supports (lumber), panels, and related components. Furnish drawings and calculations of shorting and re-shorting methods proposed for floor and roof slabs, spandrel beams, and other horizontal

concrete members.

1.5.2 Drawings

1.5.2.1 Shop Drawings

Fabrication Drawings for concrete formwork for Reinforcement Materials, Column Forms, Wall Forms, Floor Forms, Ceiling Forms and for Special Construction must indicate concrete pressure calculations with both live and dead loads, along with material types. Provide all design calculations in accordance with ACI/MCP-2 and ACI/MCP-3.

1.5.2.2 Formwork

Drawings showing details of formwork including, but not limited to; joints, supports, studding and shoring, and sequence of form and shoring removal. Reproductions of contract drawings are unacceptable.

Design, fabricate, erect, support, brace, and maintain formwork so that it is capable of supporting without failure all vertical and lateral loads that may reasonably be anticipated to be applied to the formwork.

1.5.2.3 Reinforcing Steel

ACI/MCP-4. Indicate bending diagrams, assembly diagrams, splicing and laps of bars, shapes, dimensions, and details of bar reinforcing, accessories, and concrete cover. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars.

1.5.3 Control Submittals

1.5.3.1 Curing Concrete Elements

Submit proposed materials and methods for curing concrete elements.

1.5.3.2 Material Safety Data Sheets

Submit Material Safety Data Sheets (MSDS) for all materials that are regulated for hazardous health effects. Prominently post the MSDS at the construction site.

1.5.4 Test Reports

1.5.4.1 Concrete Mix Design

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix must be suitable for the job conditions. Include mill test and all other test for cement, aggregates, and admixtures in the laboratory test reports. Provide maximum nominal aggregate size, gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Submit test reports along with the concrete mix design. Obtain approval before concrete placement.

1.6 QUALIFICATIONS FOR CONCRETE TESTING SERVICE

Perform concrete testing by an approved laboratory and inspection service experienced in sampling and testing concrete. Testing agency must meet the requirements of ASTM E329.

1.7 CONCRETE SAMPLING AND TESTING

Testing by the Contractor must include sampling and testing concrete materials proposed for use in the work and testing the design mix for each class of concrete. Perform quality control testing during construction.

Sample and test concrete aggregate materials proposed for use in the work in accordance with ASTM C33/C33M.

Sample and test portland cement in accordance with ASTM C150/C150M.

Sample and test air-entraining admixtures in accordance with ASTM C233/C233M.

Testing must be performed by a Grade I Testing Technician.

PART 2 PRODUCTS

2.1 MATERIALS FOR FORMS

Provide wood, plywood, or steel. Use plywood or steel forms where a smooth form finish is required.

2.1.1 Wood Forms

Provide lumber that is square edged or tongue-and-groove boards, free of raised grain, knotholes, or other surface defects. Provide plywood that complies with DOC/NIST PS1, B-B concrete form panels or better or AHA A135.4, hardboard for smooth form lining.

2.1.1.1 Concrete Form Plywood

Provide plywood that conforms to NIST PS 1, B-B, concrete form, not less than 5/8-inch thick.

2.1.2 Steel Forms

Provide steel form surfaces that do not contain irregularities, dents, or sags.

2.2 FORM TIES AND ACCESSORIES

The use of wire alone is prohibited. Provide form ties and accessories that do not reduce the effective cover of the reinforcement.

2.3 CONCRETE

2.3.1 Contractor-Furnished Mix Design

ACI/MCP-1, ACI/MCP-2, and ACI/MCP-3 except as otherwise specified. Indicate the compressive strength (f'c) of the concrete for each portion of the structure(s) and as specified below.

Location	f'c (Min. 28-Day Comp. Strength (psi)	ASTM C33/C33M Maximum Nominal Aggregate (Size No.)	Range of Slump (inches)	Maximum Water-Cement Ratio (by weight)	Air Entr. (percent)
Concrete all locations	4000	57	1-4	0.50	6

Maximum slump shown above may be increased 1 inch for methods of consolidation other than vibration. Slump may be increased to 8 inches when superplasticizers are used. Provide air entrainment using air-entraining admixture. Provide air entrainment within plus or minus 1.5 percent of the value specified.

Proportion concrete mixes for strength at 28 days.

2.3.1.1 Mix Proportions for Normal Weight Concrete

Trial design batches, mixture proportioning studies, and testing requirements for various classes and types of concrete specified are the responsibility of the Contractor. Base mixture proportions on compressive strength as determined by test specimens fabricated in accordance with ASTM C192/C192M and tested in accordance with ASTM C39/C39M. Samples of all materials used in mixture proportioning studies must be representative of those proposed for use in the project and must be accompanied by the manufacturer's or producer's test report indicating compliance with these specifications. Base trial mixtures having proportions, consistencies, and air content suitable for the work on methodology described in ACI/MCP-1. In the trial mixture, use at least three different water-cement ratios for each type of mixture, which must produce a range of strength encompassing those required for each class and type of concrete required on the project. The maximum water-cement ratio required must be based on equivalent water-cement ratio calculations as determined by the conversion from the weight ratio of water to cement plus pozzolan, and ground granulated blast-furnace slag by weight equivalency method. Design laboratory trial mixture for maximum permitted slump and air content. Each combination of material proposed for use must have separate trial mixture, except for accelerator or retarder use can be provided without separate trial mixture. Report the temperature of concrete in each trial batch. For each water-cement ratio, at least three test cylinders for each test age must be made and cured in accordance with ASTM C192/C192M and tested in accordance with ASTM C39/C39M for 7 and 28 days. From these results, plot a curve showing the relationship between water-cement ratio and strength for each set of trial mix studies. In addition, plot a curve showing the relationship between 7 and 28 day strengths.

2.3.1.2 Required Average Strength of Mix Design

The selected mixture must produce an average compressive strength exceeding the specified strength by the amount indicated in ACI/MCP-2. When a concrete production facility has a record of at least 15 consecutive tests, the standard deviation must be calculated and the required average compressive strength must be determined in accordance with ACI/MCP-2. When a concrete production facility does not have a suitable record of tests to establish a standard deviation, the required average strength must follow ACI/MCP-2 requirements.

2.3.2 Ready-Mix Concrete

Provide concrete that meets the requirements of ASTM C94/C94M.

Ready-mixed concrete manufacturer must provide duplicate delivery tickets with each load of concrete delivered. Provide delivery tickets with the following information in addition to that required by ASTM C94/C94M:

Type and brand cement

Cement content in 94-pound bags per cubic yard of concrete

Maximum size of aggregate

Amount and brand name of admixtures

Total water content expressed by water/cement ratio

2.3.3 Concrete Curing Materials

2.3.3.1 Absorptive Cover

Provide burlap, cotton mats, and other absorbent materials for curing concrete, as described in ACI 308R.

2.3.3.2 Moisture-Retaining Cover

Provide waterproof paper cover for curing concrete conforming to ASTM C171, regular or white, or polyethylene sheeting conforming to ASTM C171, or polyethylene-coated burlap consisting of a laminate of burlap and a white opaque polyethylene film permanently bonded to the burlap; burlap must conform to ASTM C171, Class 3, and polyethylene film must conform to ASTM C171. When tested for water retention in accordance with ASTM C156, weight of water lost 72 hours after application of moisture retaining covering material must not exceed 0.039 gram per square centimeter of the mortar specimen surface.

2.3.3.3 Membrane-Forming Curing Compound

Provide liquid type compound conforming to ASTM C309, Type 1, clear, Type 1D with fugitive dye for interior work and Type 2, white, pigmented for exterior work.

2.4 MATERIALS

2.4.1 Cement

2.4.1.1 Portland Cement

Provide cement that conforms to ASTM C150/C150M, Type I, or II. Use one brand and type of cement for formed concrete having exposed-to-view finished surfaces.

2.4.2 Water

Minimize the amount of water in the mix. The amount of water must not exceed 45 percent by weight of cementitious materials , and in general, improve workability by adjusting the grading rather than by adding water.

Water must be fresh, clean, and potable; free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances deleterious to concrete.

2.4.3 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.

Aggregates must not possess properties or constituents that are known to have specific unfavorable effects in concrete when tested in accordance with ASTM C295/C295M.

2.4.3.1 Aggregates/Combined Aggregate Gradation Floor Slabs Only

ASTM C33/C33M, uniformly graded and as follows: Nominal maximum aggregate size of 1 inch. A combined sieve analysis must indicate a well graded aggregate from coarsest to finest with not more than 18 percent and not less than 8 percent retained on an individual sieve, except that less than 8 percent may be retained on coarsest sieve and on No. 50 (0.3mm) sieve, and less than 8 percent may be retained on sieves finer than No. 50. Provide sand that is at least 50 percent natural sand.

2.4.3.2 Aggregates for Lightweight Concrete

ASTM C330/C330M.

2.4.4 Nonshrink Grout

ASTM C1107/C1107M. Non-Metallic Grout.

2.4.5 Admixtures

ASTM C494/C494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water-reducing and accelerating admixture. Do not use calcium chloride admixtures.

2.4.5.1 Air-Entraining

ASTM C260/C260M.

2.4.6 Vapor Barrier

ASTM E1745 Class A polyethylene sheeting, minimum 10 mil thickness or other equivalent material.

2.4.7 Impervious Sheeting

ASTM C171; waterproof paper, clear or white polyethylene sheeting, or polyethylene-coated burlap.

2.4.8 Pervious Sheeting

AASHTO M 182.

2.4.9 Liquid Membrane-Forming Compound

ASTM C309, white-pigmented, Type 2, Class B.

2.4.10 Liquid Chemical Sealer-Hardener Compound

Provide surface treatments containing certain chemicals, including sodium silicate and the fluosilicates of magnesium and zinc. Provide compound that does not reduce the adhesion of resilient flooring, tile, paint, roofing, waterproofing, or other material applied to concrete.

2.4.11 Expansion/Contraction Joint Filler

ASTM D1751, ASTM D1752, cork or 100 percent post-consumer paper meeting ASTM D1752 (subparagraphs 5.1 to 5.4). Material must be 1/2 inch thick, unless otherwise indicated.

2.4.11.1 Preformed Joint Filler Strips

Provide nonextruding and resilient bituminous type filler strips conforming to ASTM D1751.

2.4.12 Joint Sealants

2.4.12.1 Horizontal Surfaces, 3 Percent Slope, Maximum

ASTM D6690 or ASTM C920, Type M, Class 25, Use T. ASTM D7116 for surfaces subjected to jet fuel.

2.4.12.2 Joint Sealant Compound

Provide cold-applied, two-component, elastomeric polymer type compound conforming to FS SS-S-200.

2.4.13 Epoxy Bonding Compound

ASTM C881/C881M. Provide Type I for bonding hardened concrete to hardened concrete; Type II for bonding freshly mixed concrete to hardened concrete; and Type III as a binder in epoxy mortar or concrete, or for use in bonding skid-resistant materials to hardened concrete. Provide Grade 1 or 2 for horizontal surfaces and Grade 3 for vertical surfaces. Provide Class A if placement temperature is below 40 degrees F; Class B if placement temperature is between 40 and 60 degrees F; or Class C if placement temperature is above 60 degrees F.

2.5 REINFORCEMENT

2.5.1 Reinforcing Bars

ACI/MCP-2 unless otherwise specified. Use deformed steel. ASTM A615/A615M and AASHTO M 322M/M 322 with the bars marked A, S, W, Grade 60;

2.5.2 Wire

ASTM A82/A82M or ASTM A496/A496M.

2.5.2.1 Welded Wire Fabric

ASTM A185/A185M or ASTM A497/A497M. Provide flat sheets of welded wire

fabric for slabs and toppings.

2.5.2.2 Steel Wire

Wire must conform to ASTM A82/A82M.

2.5.3 Reinforcing Bar Supports

Provide bar ties and supports of coated or non corrodible material.

2.5.4 Dowels for Load Transfer in Floors

Provide dowels for load transfer in floors of the type, design, weight, and dimensions indicated. Provide dowel bars that are plain-billet steel conforming to ASTM A615/A615M, Grade 40. Provide dowel pipe that is steel conforming to ASTM A53/A53M.

2.5.5 Supports for Reinforcement

Supports include bolsters, chairs, spacers, and other devices necessary for proper spacing, supporting, and fastening reinforcing bars and wire fabric in place.

Provide wire bar type supports conforming to ACI/MCP-3, ACI/MCP-4 and CRSI 10MSP.

Legs of supports in contact with formwork must be hot-dip galvanized, or plastic coated after fabrication, or stainless-steel bar supports.

2.6 BONDING MATERIALS

2.6.1 Concrete Bonding Agent

Provide aqueous-phase, film-forming, nonoxidizing, freeze and thaw-resistant compound agent suitable for brush or spray application conforming to ASTM C932.

2.6.2 Epoxy-Resin Adhesive Binder

Provide two-component, epoxy-polysulfide polymer type binder with an amine-type curing-agent conforming to ASTM C881/C881M.

2.7 CLASSIFICATION AND QUALITY OF CONCRETE

2.7.1 Concrete Classes and Usage

Provide concrete classes, compressive strength, requirements for air entrainment, and usage as follows:

CONCRETE CLASS	MIN. 28-DAY COMPRESSIVE STRENGTH POUNDS PER SQ. IN.	REQUIREMENT FOR AIR ENTRAINMENT	USAGE
4A	4000	Air-entrained	For structural concrete work exposed to freezing and thawing, unless otherwise indicated or specified, such as exterior columns and spandrels
4N	4000	Nonair-entrained	For structural concrete work not exposed to freezing and thawing such as interior columns, beams, supported slabs and other structural members for interior slabs on ground subjected to foot traffic

2.7.2 Limits for Concrete Proportions

Provide limits for maximum water/cement ratio and minimum cement content for each concrete class as follows:

CONCRETE CLASS	MAX. WATER/CEMENT RATIO BY WEIGHT	MIN. CEMENT FOR 3- TO 4-INCH SLUMP, (NO. OF 94-POUND SACKS) PER CU. YD.
4A	0.46	6.0
4N	0.48	6.0
* Weight of water to weight of cement in pounds in one cubic yard of concrete.		

2.7.3 Maximum Size of Aggregate

Size of aggregate, designated by the sieve size on which maximum amount of retained coarse aggregate is 5 to 10 percent by weight, must be as follows:

MAXIMUM SIZE OF AGGREGATE	ASTM C33/C33M SIZE NUMBER	TYPE OF CONSTRUCTION
1-1/2 inches	467	Monolithic slabs on ground, concrete fill, and other flatwork having a depth of not less than 5 inches and a clear distance between reinforcing bars of not less than 2 inches

3/4 inch	67	Reinforced walls, columns, girders, beams, and other formed sections having a dimension between forms of not less than 6 inches and clear distance between reinforcing bars or reinforcing bar and face of form of not less than 1 inch
3/4 inch	67	Monolithic concrete slabs and other flatwork having a depth of not less than 2-1/2 inches and a clear distance between reinforcing bars of not less than 1 inch

Maximum size of aggregate may be that required for most critical type of construction using that concrete class.

2.7.4 Slump

Provide slump for concrete at time and in location of placement as follows:

TYPE OF CONSTRUCTION	SLUMP
Footings, unreinforced walls	Not less than 1 inch nor more than 3 inches
Columns, beams, reinforced walls, monolithic slabs	Not less than 1 inch nor more than 4 inches
Ramps and other sloping surfaces	0 nor more than 3 inches

2.7.5 Total Air Content

Air content of exposed concrete and interior concrete must be in accordance with ASTM C260/C260M and/or as follows:

LIMITS OF CONCRETE EXPOSURE	REQUIREMENT FOR AIR ENTRAINMENT	MAXIMUM SIZE OF AGGREGATE	TOTAL AIR CONTENT BY VOLUME
Exposed to freezing and thawing or subjected to hydraulic pressure	Air-entrained	1-1/2 or 2 inches	4 to 6 percent
		3/4 inch	5 to 7 percent
		1/2 or 3/8 inch	6 to 8.5 percent

Provide concrete exposed to freezing and thawing or subjected to hydraulic pressure that is air-entrained by addition of approved air-entraining admixture to concrete mix.

PART 3 EXECUTION

3.1 EXAMINATION

Do not begin installation until substrates have been properly constructed; verify that substrates are plumb and true.

If substrate preparation is the responsibility of another installer, notify Architect/Engineer of unsatisfactory preparation before processing.

Check field dimensions before beginning installation. If dimensions vary too much from design dimensions for proper installation, notify Architect/Engineer and wait for instructions before beginning installation.

3.2 PREPARATION

Determine quantity of concrete needed and minimize the production of excess concrete. Designate locations or uses for potential excess concrete before the concrete is poured.

3.2.1 General

Surfaces against which concrete is to be placed must be free of debris, loose material, standing water, snow, ice, and other deleterious substances before start of concrete placing.

Remove standing water without washing over freshly deposited concrete. Divert flow of water through side drains provided for such purpose.

3.2.2 Subgrade Under Foundations and Footings

When subgrade material is semiporous and dry, sprinkle subgrade surface with water as required to eliminate suction at the time concrete is deposited. When subgrade material is porous, seal subgrade surface by covering surface with specified vapor retarder; this may also be used over semiporous, dry subgrade material instead of water sprinkling.

3.2.3 Subgrade Under Slabs on Ground

Before construction of slabs on ground, have underground work on pipes and conduits completed and approved.

Previously constructed subgrade or fill must be cleaned of foreign materials and inspected by the Contractor for adequate compaction and surface tolerances as specified.

Actual density of top 12 inches of subgrade soil material-in-place must not be less than the following percentages of maximum density of same soil material compacted at optimum moisture content in accordance with ASTM D1557.

SOIL MATERIAL	PERCENT MAXIMUM DENSITY
Capillary water barrier Drainage Fill	100
Cohesionless soil material	100
Cohesive soil material	95

Finish surface of capillary water barrier under interior slabs on ground must not show deviation in excess of 1/4 inch when tested with a 10-foot straightedge parallel with and at right angles to building lines.

Finished surface of subgrade or fill under exterior slabs on ground must not be more than 0.02-foot above or 0.10-foot below elevation indicated.

Prepare subgrade or fill surface under exterior slabs on ground as specified for subgrade under foundations and footings.

3.2.4 Formwork

Complete and approve formwork. Remove debris and foreign material from interior of forms before start of concrete placing.

3.2.5 Edge Forms and Screed Strips for Slabs

Set edge forms or bulkheads and intermediate screed strips for slabs to obtain indicated elevations and contours in finished slab surface and must be strong enough to support vibrating bridge screeds or roller pipe screeds if nature of specified slab finish requires use of such equipment. Align concrete surface to elevation of screed strips by use of strike-off templates or approved compacting-type screeds.

3.2.6 Reinforcement and Other Embedded Items

Secure reinforcement, joint materials, and other embedded materials in position, inspected, and approved before start of concrete placing.

3.3 FORMS

ACI/MCP-2. Provide forms, shoring, and scaffolding for concrete placement. Set forms mortar-tight and true to line and grade. Chamfer above grade exposed joints, edges, and external corners of concrete 0.75 inch unless otherwise indicated. Provide formwork with clean-out openings

to permit inspection and removal of debris. Forms submerged in water must be watertight.

3.3.1 General

Construct forms to conform, within the tolerances specified, to shapes dimensions, lines, elevations, and positions of cast-in-place concrete members as indicated. Forms must be supported, braced, and maintained sufficiently rigid to prevent deformation under load.

3.3.2 Design and Construction of Formwork

Provide formwork design and construction that conforms to ACI/MCP-2, Chapter 4.

Provide forms that are tight to prevent leakage of cement paste during concrete placing.

Support form facing materials by structural members spaced close to prevent deflection of form facing material. Fit forms placed in successive units for continuous surfaces to accurate alignment to ensure a smooth completed surface within the tolerances specified. Where necessary to maintain the tolerances specified, such as long spans where immediate supports are not possible, camber formwork for anticipated deflections in formwork due to weight and pressure of fresh concrete and to construction loads.

Chamfer exposed joints, edges, and external corners a minimum of 3/4 inch by moldings placed in corners of column, beam, and wall forms.

Provide shores and struts with a positive means of adjustment capable of taking up formwork settlement during concrete placing operations. Obtain adjustment with wedges or jacks or a combination thereof. When adequate foundations for shores and struts cannot be secured, provide trussed supports.

Provide temporary openings in wall forms, column forms, and at other points where necessary to permit inspection and to facilitate cleaning.

Provide forms that are readily removable without impact, shock, or damage to concrete.

3.3.3 Coating

Before concrete placement, coat the contact surfaces of forms with a nonstaining mineral oil, nonstaining form coating compound, or two coats of nitrocellulose lacquer. Do not use mineral oil on forms for surfaces to which adhesive, paint, or other finish material is to be applied.

3.3.4 Reshoring

Reshore concrete elements where forms are removed prior to the specified time period. Do not permit elements to deflect or accept loads during form stripping or reshoring. Forms on columns, walls, or other load-bearing members may be stripped after 2 days if loads are not applied to the members. After forms are removed, reshore slabs and beams over 10 feet in span and cantilevers over 4 feet for the remainder of the specified time period in accordance with paragraph entitled "Removal of Forms." Perform reshoring operations to prevent subjecting concrete members to overloads, eccentric loading, or reverse bending. Provide reshoring elements with the

same load-carrying capabilities as original shoring and spaced similar to original shoring. Firmly secure and brace reshoring elements to provide solid bearing and support.

3.3.5 Reuse

Reuse forms providing the structural integrity of concrete and the aesthetics of exposed concrete are not compromised.

3.3.6 Forms for Standard Rough Form Finish

Give rough form finish concrete formed surfaces that are to be concealed by other construction, unless otherwise specified.

Form facing material for standard rough form finish must be the specified concrete form plywood or other approved form facing material that produces concrete surfaces equivalent in smoothness and appearance to that produced by new concrete form plywood panels.

For concrete surfaces exposed only to the ground, undressed, square-edge, 1-inch nominal thickness lumber may be used. Provide horizontal joints that are level and vertical joints that are plumb.

3.3.7 Forms for Standard Smooth Form Finish

Give smooth form finish concrete formed surfaces that are to be exposed to view or that are to be covered with coating material applied directly to concrete or with covering material bonded to concrete, such as waterproofing, dampproofing, painting, or other similar coating system.

Form facing material for standard smooth finish must be the specified overlaid concrete form plywood or other approved form facing material that is nonreactive with concrete and that produce concrete surfaces equivalent in smoothness and appearance to that produced by new overlaid concrete form plywood panels.

Maximum deflection of form facing material between supports and maximum deflection of form supports such as studs and wales must not exceed 0.0025 times the span.

Provide arrangement of form facing sheets that are orderly and symmetrical, and sheets that are in sizes as large as practical.

Arrange panels to make a symmetrical pattern of joints. Horizontal and vertical joints must be solidly backed and butted tight to prevent leakage and fins.

3.3.8 Form Ties

Provide ties that are factory fabricated metal, adjustable in length, removable or snap-off type that do allow form deflection or do not spall concrete upon removal. Portion of form ties remaining within concrete after removal of exterior parts must be at least 1-1/2 inches back from concrete surface. Provide form ties that are free of devices that leave a hole larger than 7/8 inch or less than 1/2 inch in diameter in concrete surface. Form ties fabricated at the project site or wire ties of any type are not acceptable.

3.3.9 Tolerances for Form Construction

Construct formwork to ensure that after removal of forms and prior to patching and finishing of formed surfaces, provide concrete surfaces in accordance with tolerances specified in ACI/MCP-1 and ACI/MCP-2.

3.3.10 Removal of Forms and Supports

After placing concrete, forms must remain in place for the time periods specified in ACI/MCP-4. Do not remove forms and shores (except those used for slabs on grade and slip forms) until the client determines that the concrete has gained sufficient strength to support its weight and superimposed loads. Base such determination on compliance with one of the following:

a. The plans and specifications stipulate conditions for removal of forms and shores, and such conditions have been followed, or

b. The concrete has been properly tested with an appropriate ASTM standard test method designed to indicate the concrete compressive strength, and the test results indicate that the concrete has gained sufficient strength to support its weight and superimposed loads.

Prevent concrete damage during form removal. Clean all forms immediately after removal.

3.3.10.1 Special Requirements for Reduced Time Period

Forms may be removed earlier than specified if ASTM C39/C39M test results of field-cured samples from a representative portion of the structure indicate that the concrete has reached a minimum of 85 percent of the design strength.

3.4 FORMED SURFACES

3.4.1 Preparation of Form Surfaces

Coat contact surfaces of forms with form-coating compound before reinforcement is placed. Provide a commercial formulation form-coating compound that does not bond with, stain, nor adversely affect concrete surfaces and impair subsequent treatment of concrete surfaces that entails bonding or adhesion nor impede wetting of surfaces to be cured with water or curing compounds. Do not allow excess form-coating compound to stand in puddles in the forms nor to come in contact with concrete against which fresh concrete is placed. Make thinning of form-coating compound with thinning agent of the type, in the amount, and under the conditions recommended by form-coating compound manufacturer's printed or written directions.

3.4.2 Tolerances

ACI/MCP-4 and as indicated.

3.4.3 As-Cast Form

Provide form facing material producing a smooth, hard, uniform texture on the concrete. Arrange facing material in an orderly and symmetrical manner and keep seams to a practical minimum. Support forms as necessary to meet required tolerances. Do not use material with raised grain, torn surfaces,

worn edges, patches, dents, or other defects which can impair the texture of the concrete surface.

3.5 PLACING REINFORCEMENT AND MISCELLANEOUS MATERIALS

ACI/MCP-2. Provide bars, wire fabric, wire ties, supports, and other devices necessary to install and secure reinforcement. Reinforcement must not have rust, scale, oil, grease, clay, or foreign substances that would reduce the bond. Rusting of reinforcement is a basis of rejection if the effective cross-sectional area or the nominal weight per unit length has been reduced. Remove loose rust prior to placing steel. Tack welding is prohibited.

3.5.1 General

Provide details of reinforcement that are in accordance with ACI/MCP-3 and ACI/MCP-4 and as specified.

3.5.2 Vapor Barrier

Provide beneath the on-grade concrete floor slab. Use the greatest widths and lengths practicable to eliminate joints wherever possible. Lap joints a minimum of 12 inches. Remove torn, punctured, or damaged vapor barrier material and provide with new vapor barrier prior to placing concrete. Concrete placement must not damage vapor barrier material.

3.5.3 Reinforcement Supports

Place reinforcement and secure with galvanized or non corrodible chairs, spacers, or metal hangers. For supporting reinforcement on the ground, use concrete or other non corrodible material, having a compressive strength equal to or greater than the concrete being placed.

3.5.4 Splicing

As indicated on contract drawings.

3.5.5 Cover

ACI/MCP-2 for minimum coverage, unless otherwise indicated.

3.5.6 Setting Miscellaneous Material

Place and secure anchors and bolts, pipe sleeves, conduits, and other such items in position before concrete placement. Plumb anchor bolts and check location and elevation. Temporarily fill voids in sleeves with readily removable material to prevent the entry of concrete.

3.5.7 Construction Joints

Locate joints to least impair strength. Continue reinforcement across joints unless otherwise indicated.

3.5.8 Expansion Joints and Contraction Joints

Provide expansion joint at edges of interior floor slabs on grade abutting vertical surfaces, and as indicated. Make expansion joints 1/2 inch wide unless indicated otherwise. Fill expansion joints not exposed to weather with preformed joint filler material. Completely fill joints exposed to

weather with joint filler material and joint sealant. Do not extend reinforcement or other embedded metal items bonded to the concrete through any expansion joint unless an expansion sleeve is used. Provide contraction joints, either formed or saw cut or cut with a jointing tool, to the indicated depth after the surface has been finished. Complete saw joints within 4 to 12 hours after concrete placement. Protect joints from intrusion of foreign matter.

3.5.9 Fabrication

Shop fabricate reinforcing bars to conform to shapes and dimensions indicated for reinforcement, and as follows:

Provide fabrication tolerances that are in accordance with ACI/MCP-1, ACI/MCP-2 and ACI/MCP-3.

Provide hooks and bends that are in accordance with ACI/MCP-3 and ACI/MCP-4.

Reinforcement must be bent cold to shapes as indicated. Bending must be done in the shop. Rebending of a reinforcing bar that has been bent incorrectly is not be permitted. Bending must be in accordance with standard approved practice and by approved machine methods.

Tolerance on nominally square-cut, reinforcing bar ends must be in accordance with ACI/MCP-3.

Deliver reinforcing bars bundled, tagged, and marked. Tags must be metal with bar size, length, mark, and other information pressed in by machine. Marks must correspond with those used on the placing drawings.

Do not use reinforcement that has any of the following defects:

a. Bar lengths, depths, and bends beyond specified fabrication tolerances

b. Bends or kinks not indicated on drawings or approved shop drawings

c. Bars with reduced cross-section due to rusting or other cause

Replace defective reinforcement with new reinforcement having required shape, form, and cross-section area.

3.5.10 Placing Reinforcement

Place reinforcement in accordance with ACI/MCP-3 and ACI/MCP-4.

For slabs on grade (over earth or over capillary water barrier) and for footing reinforcement, support bars or welded wire fabric on precast concrete blocks, spaced at intervals required by size of reinforcement, to keep reinforcement the minimum height specified above the underside of slab or footing.

For slabs other than on grade, supports for which any portion is less than 1 inch from concrete surfaces that are exposed to view or to be painted must be of precast concrete units, plastic-coated steel, or stainless steel protected bar supports. Precast concrete units must be wedge shaped, not larger than 3-1/2 by 3-1/2 inches, and of thickness equal to that indicated for concrete protection of reinforcement. Provide precast units that have

cast-in galvanized tie wire hooked for anchorage and blend with concrete surfaces after finishing is completed.

Contractor must cooperate with other trades in setting of anchor bolts, inserts, and other embedded items. Where conflicts occur between locating reinforcing and embedded items, the Contractor must notify the Contracting Officer so that conflicts may be reconciled before placing concrete. Anchors and embedded items must be positioned and supported with appropriate accessories.

Handle epoxy-coated reinforcing bars carefully to prevent damage to the coating. Use plastic-coated tie wire and supports of a type to prevent damage to the reinforcing bars.

Provide reinforcement that is supported and secured together to prevent displacement by construction loads or by placing of wet concrete, and as follows:

Provide supports for reinforcing bars that are sufficient in number and sufficiently heavy to carry the reinforcement they support, and in accordance with ACI/MCP-3, ACI/MCP-4 and CRSI 10MSP. Do not use supports to support runways for concrete conveying equipment and similar construction loads.

Equip supports on ground and similar surfaces with sand-plates.

Support welded wire fabric as required for reinforcing bars.

Secure reinforcements to supports by means of tie wire. Wire must be black, soft iron wire, not less than 16 gage.

With the exception of temperature reinforcement, tied to main steel approximately 24 inches on center, reinforcement must be accurately placed, securely tied at intersections with 18-gage annealed wire, and held in position during placing of concrete by spacers, chairs, or other approved supports. Point wire-tie ends away from the form. Unless otherwise indicated, numbers, type, and spacing of supports must conform to ACI/MCP-3.

Bending of reinforcing bars partially embedded in concrete is permitted only as specified in ACI/MCP-3 and ACI/MCP-4.

3.5.11 Spacing of Reinforcing Bars

Spacing must be as indicated. If not indicated, spacing must be in accordance with the ACI/MCP-3 and ACI/MCP-4.

Reinforcing bars may be relocated to avoid interference with other reinforcement, or with conduit, pipe, or other embedded items. If any reinforcing bar is moved a distance exceeding one bar diameter or specified placing tolerance, resulting rearrangement of reinforcement is subject to approval.

3.5.12 Concrete Protection for Reinforcement

Concrete protection must be in accordance with the ACI/MCP-3 and ACI/MCP-4.

3.5.13 Welding

Welding must be in accordance with AWS D1.4/D1.4M.

3.6 BATCHING, MEASURING, MIXING, AND TRANSPORTING CONCRETE

ASTM C94/C94M, and ACI/MCP-2, except as modified herein. Batching equipment must be such that the concrete ingredients are consistently measured within the following tolerances: 1 percent for cement and water, 2 percent for aggregate, and 3 percent for admixtures. Furnish mandatory batch ticket information for each load of ready mix concrete.

3.6.1 Measuring

Make measurements at intervals as specified in paragraphs entitled "Sampling" and "Testing."

3.6.2 Mixing

ASTM C94/C94M and ACI/MCP-2. Machine mix concrete. Begin mixing within 30 minutes after the cement has been added to the aggregates. Place concrete within 90 minutes of either addition of mixing water to cement and aggregates or addition of cement to aggregates if the air temperature is less than 84 degrees F. Reduce mixing time and place concrete within 60 minutes if the air temperature is greater than 84 degrees F except as follows: if set retarding admixture is used and slump requirements can be met, limit for placing concrete may remain at 90 minutes. Additional water may be added, provided that both the specified maximum slump and water-cement ratio are not exceeded. When additional water is added, an additional 30 revolutions of the mixer at mixing speed is required. Dissolve admixtures in the mixing water and mix in the drum to uniformly distribute the admixture throughout the batch.

3.6.3 Transporting

Transport concrete from the mixer to the forms as rapidly as practicable. Prevent segregation or loss of ingredients. Clean transporting equipment thoroughly before each batch. Do not use aluminum pipe or chutes. Remove concrete which has segregated in transporting and dispose of as directed.

3.7 PLACING CONCRETE

Place concrete as soon as practicable after the forms and the reinforcement have been inspected and approved. Do not place concrete when weather conditions prevent proper placement and consolidation; in uncovered areas during periods of precipitation; or in standing water. Prior to placing concrete, remove dirt, construction debris, water, snow, and ice from within the forms. Deposit concrete as close as practicable to the final position in the forms. Do not exceed a free vertical drop of 3 feet from the point of discharge. Place concrete in one continuous operation from one end of the structure towards the other. Position grade stakes on 10 foot centers maximum in each direction when pouring interior slabs and on 20 foot centers maximum for exterior slabs.

3.7.1 General Placing Requirements

Deposit concrete continuously or in layers of such thickness that no concrete is placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If a section

cannot be placed continuously, provide construction joints as specified. Perform concrete placing at such a rate that concrete which is being integrated with fresh concrete is still plastic. Deposit concrete as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation.

Concrete to receive other construction must be screeded to proper level to avoid excessive skimming or grouting.

Do not use concrete which becomes nonplastic and unworkable or does not meet quality control limits as specified or has been contaminated by foreign materials. Use of retempered concrete is permitted. Remove rejected concrete from the site.

3.7.2 Footing Placement

Concrete for footings may be placed in excavations without forms upon inspection and approval by the Contracting Officer. Excavation width must be a minimum of 4 inches greater than indicated.

3.7.3 Vibration

ACI/MCP-2. Furnish a spare, working, vibrator on the job site whenever concrete is placed. Consolidate concrete slabs greater than 4 inches in depth with high frequency mechanical vibrating equipment supplemented by hand spading and tamping. Consolidate concrete slabs 4 inches or less in depth by wood tampers, spading, and settling with a heavy leveling straightedge. Operate internal vibrators with vibratory element submerged in the concrete, with a minimum frequency of not less than 6000 impulses per minute when submerged. Do not use vibrators to transport the concrete in the forms. Penetrate the previously placed lift with the vibrator when more than one lift is required. Use external vibrators on the exterior surface of the forms when internal vibrators do not provide adequate consolidation of the concrete.

3.7.4 Application of Epoxy Bonding Compound

Apply a thin coat of compound to dry, clean surfaces. Scrub compound into the surface with a stiff-bristle brush. Place concrete while compound is stringy. Do not permit compound to harden prior to concrete placement. Follow manufacturer's instructions regarding safety and health precautions when working with epoxy resins.

3.7.5 Pumping

ACI/MCP-2. Pumping must not result in separation or loss of materials nor cause interruptions sufficient to permit loss of plasticity between successive increments. Loss of slump in pumping equipment must not exceed 2 inches. Do not convey concrete through pipe made of aluminum or aluminum alloy. Avoid rapid changes in pipe sizes. Limit maximum size of course aggregate to 33 percent of the diameter of the pipe. Limit maximum size of well rounded aggregate to 40 percent of the pipe diameter. Take samples for testing at both the point of delivery to the pump and at the discharge end.

3.7.6 Cold Weather

ACI/MCP-2. Do not allow concrete temperature to decrease below 50 degrees F.

Obtain approval prior to placing concrete when the ambient temperature is below 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. Cover concrete and provide sufficient heat to maintain 50 degrees F minimum adjacent to both the formwork and the structure while curing. Limit the rate of cooling to 37 degrees F in any 1 hour and 50 degrees F per 24 hours after heat application.

3.7.7 Hot Weather

Maintain required concrete temperature using Figure 2.1.5 in ACI/MCP-2 to prevent the evaporation rate from exceeding 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. Shade the fresh concrete as soon as possible after placing. Start curing when the surface of the fresh concrete is sufficiently hard to permit curing without damage. Provide water hoses, pipes, spraying equipment, and water hauling equipment, where job site is remote to water source, to maintain a moist concrete surface throughout the curing period. Provide burlap cover or other suitable, permeable material with fog spray or continuous wetting of the concrete when weather conditions prevent the use of either liquid membrane curing compound or impervious sheets. For vertical surfaces, protect forms from direct sunlight and add water to top of structure once concrete is set.

3.7.8 Follow-up

Check concrete within 24 hours of placement for flatness, levelness, and other specified tolerances. Adjust formwork and placement techniques on subsequent pours to achieve specified tolerances.

3.7.9 Placing Concrete in Forms

Deposit concrete placed in forms in horizontal layers not exceeding 24 inches.

Remove temporary spreaders in forms when concrete placing has reached elevation of spreaders.

Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Provide vibrating equipment adequate in number of units and power of each unit to properly consolidate concrete. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced points not farther apart than visible effectiveness of machine. Do not insert vibrator into lower courses of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of concrete mix.

Do not start placing of concrete in supporting elements until concrete previously placed in columns and walls is no longer plastic and has been in place a minimum of 2 hours.

3.7.10 Placing Concrete Slabs

Place and consolidate concrete for slabs in a continuous operation, within the limits of approved construction joints until placing of panel or section is completed.

During concrete placing operations, consolidate concrete by mechanical vibrating equipment so that concrete is worked around reinforcement and other embedded items and into corners. Consolidate concrete placed in beams and girders of supported slabs and against bulkheads of slabs on ground by mechanical vibrators as specified. Consolidate concrete in remainder of slabs by vibrating bridge screeds, roller pipe screeds, or other approved method. Limit consolidation operations to time necessary to obtain consolidation of concrete without bringing an excess of fine aggregate to the surface. Concrete to be consolidated must be as dry as practical and surfaces thereof must not be manipulated prior to finishing operations. Bring concrete correct level with a straightedge and struck-off. Use bull floats or darbies to smooth surface, leaving it free of humps or hollows. Sprinkling of water on plastic surface is not permitted.

Provide finish of slabs as specified.

3.7.11 Bonding

Surfaces of set concrete at joints, except where bonding is obtained by use of concrete bonding agent, must be roughened and cleaned of laitance, coatings, loose particles, and foreign matter. Roughen surfaces in a manner that exposes the aggregate uniformly and does not leave laitance, loosened particles of aggregate, nor damaged concrete at the surface.

Obtain bonding of fresh concrete that has set as follows:

At joints between footings and walls or columns, between walls or columns and the beams or slabs they support, and elsewhere unless otherwise specified; roughened and cleaned surface of set concrete must be dampened, but not saturated, immediately prior to placing of fresh concrete.

At joints in exposed-to-view work; at vertical joints in walls; at joints near midpoint of span in girders, beams, supported slabs, other structural members; in work designed to contain liquids; the roughened and cleaned surface of set concrete must be dampened but not saturated and covered with a cement grout coating.

Provide cement grout that consists of equal parts of portland cement and fine aggregate by weight with not more than 6 gallons of water per sack of cement. Apply cement grout with a stiff broom or brush to a minimum thickness of 1/16 inch. Deposit fresh concrete before cement grout has attained its initial set.

Bonding of fresh concrete to concrete that has set may be obtained by use of a concrete bonding agent. Apply such bonding material to cleaned concrete surface in accordance with approved printed instructions of bonding material manufacturer.

3.8 SURFACE FINISHES EXCEPT FLOOR, SLAB, AND PAVEMENT FINISHES

3.8.1 Defects

Repair formed surfaces by removing minor honeycombs, pits greater than 1 square inch surface area or 0.25 inch maximum depth, or otherwise defective areas. Provide edges perpendicular to the surface and patch with nonshrink grout. Patch tie holes and defects when the forms are removed. Concrete with extensive honeycomb including exposed steel reinforcement, cold

joints, entrapped debris, separated aggregate, or other defects which affect the serviceability or structural strength will be rejected, unless correction of defects is approved. Obtain approval of corrective action prior to repair. The surface of the concrete must not vary more than the allowable tolerances of ACI/MCP-4. Exposed surfaces must be uniform in appearance and finished to a smooth form finish unless otherwise specified.

3.8.2 Not Against Forms (Top of Walls)

Surfaces not otherwise specified must be finished with wood floats to even surfaces. Finish must match adjacent finishes.

3.8.3 Formed Surfaces

3.8.3.1 Tolerances

ACI/MCP-1 and as indicated.

3.8.3.2 Standard Smooth Finish

Finish must be as-cast concrete surface as obtained with form facing material for standard smooth finish. Repair and patch defective areas as specified; and all fins and remove other projections on surface.

3.9 FLOOR, SLAB, AND PAVEMENT FINISHES AND MISCELLANEOUS CONSTRUCTION

ACI/MCP-2, unless otherwise specified. Slope floors uniformly to drains where drains are provided.

3.9.1 Finish

Place, consolidate, and immediately strike off concrete to obtain proper contour, grade, and elevation before bleedwater appears. Permit concrete to attain a set sufficient for floating and supporting the weight of the finisher and equipment. If bleedwater is present prior to floating the surface, drag the excess water off or remove by absorption with porous materials. Do not use dry cement to absorb bleedwater.

3.9.1.1 Scratched

Use for surfaces intended to receive bonded applied cementitious applications. After the concrete has been placed, consolidated, struck off, and leveled to a Class C tolerance as defined below,roughen the surface with stiff brushes of rakes before final set.

3.9.1.2 Broomed

Use on surfaces of exterior walks, platforms, patios, and ramps, unless otherwise indicated. Perform a floated finish, then draw a broom or burlap belt across the surface to produce a coarse scored texture. Permit surface to harden sufficiently to retain the scoring or ridges. Broom transverse to traffic or at right angles to the slope of the slab.

3.9.1.3 Pavement

Screed the concrete with a template advanced with a combined longitudinal and crosswise motion. Maintain a slight surplus of concrete ahead of the template. After screeding, float the concrete longitudinally. Use a straightedge to check slope and flatness; correct and refloat as

necessary. Obtain final finish by a burlap drag. Drag a strip of clean, wet burlap from 3 to 10 feet wide and 2 feet longer than the pavement width across the slab. Produce a fine, granular, sandy textured surface without disfiguring marks. Round edges and joints with an edger having a radius of 1/8 inch.

3.10 CURING AND PROTECTION

ACI/MCP-2 unless otherwise specified. Begin curing immediately following form removal. Avoid damage to concrete from vibration created by blasting, pile driving, movement of equipment in the vicinity, disturbance of formwork or protruding reinforcement, and any other activity resulting in ground vibrations. Protect concrete from injurious action by sun, rain, flowing water, frost, mechanical injury, tire marks, and oil stains. Do not allow concrete to dry out from time of placement until the expiration of the specified curing period. Do not use membrane-forming compound on surfaces where appearance would be objectionable, on any surface to be painted, where coverings are to be bonded to the concrete, or on concrete to which other concrete is to be bonded. If forms are removed prior to the expiration of the curing period, provide another curing procedure specified herein for the remaining portion of the curing period. Provide moist curing for those areas receiving liquid chemical sealer-hardener or epoxy coating. Allow curing compound/sealer installations to cure prior to the installation of materials that adsorb VOCs.

3.10.1 General

Protect freshly placed concrete from premature drying and cold or hot temperature and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of cement and proper hardening of concrete.

Start initial curing as soon as free water has disappeared from surface of concrete after placing and finishing. Keep concrete moist for minimum 72 hours.

Final curing must immediately follow initial curing and before concrete has dried. Continue final curing until cumulative number of hours or fraction thereof (not necessarily consecutive) during which temperature of air in contact with the concrete is above 50 degrees F has totaled 168 hours. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, final curing may be terminated when the average compressive strength has reached 70 percent of the 28-day design compressive strength. Prevent rapid drying at end of final curing period.

3.10.2 Moist Curing

Remove water without erosion or damage to the structure. Prevent water run-off.

3.10.2.1 Ponding or Immersion

Continually immerse the concrete throughout the curing period. Water must not be more than 50 degrees F less than the temperature of the concrete. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.10.2.2 Fog Spraying or Sprinkling

Apply water uniformly and continuously throughout the curing period. For temperatures between 40 and 50 degrees F, increase the curing period by 50 percent.

3.10.2.3 Pervious Sheeting

Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 6 inches over adjacent sheeting. Provide sheeting that is at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.

3.10.2.4 Impervious Sheeting

Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12 inches minimum. Provide sheeting not less than 18 inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Cover or wrap columns, walls, and other vertical structural elements from the top down with impervious sheeting; overlap and continuously tape sheeting joints; and introduce sufficient water to soak the entire surface prior to completely enclosing.

3.10.3 Liquid Membrane-Forming Curing Compound

3.10.3.1 Protection of Treated Surfaces

Prohibit pedestrian and vehicular traffic and other sources of abrasion at least 72 hours after compound application. Maintain continuity of the coating for the entire curing period and immediately repair any damage.

3.10.4 Curing Periods

ACI/MCP-2 except 10 days for retaining walls, pavement or chimneys, 21 days for concrete that is in full-time or intermittent contact with seawater, salt spray, alkali soil or waters. Begin curing immediately after placement. Protect concrete from premature drying, excessively hot temperatures, and mechanical injury; and maintain minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing are subject to approval by the Contracting Officer.

3.10.5 Curing Methods

Accomplish curing by moist curing, by moisture-retaining cover curing, by membrane curing, and by combinations thereof, as specified.

Moist curing:

Accomplish moisture curing by any of the following methods:

Keeping surface of concrete wet by covering with water

Continuous water spraying

Covering concrete surface with specified absorptive cover for curing concrete saturated with water and keeping absorptive cover wet by water spraying or intermittent hosing. Place absorptive cover to provide coverage of concrete surfaces and edges with a slight overlap over adjacent absorptive covers.

Moisture-cover curing:

Accomplish moisture-retaining cover curing by covering concrete surfaces with specified moisture-retaining cover for curing concrete. Place cover directly on concrete in widest practical width, with sides and ends lapped at least 3 inches. Weight cover to prevent displacement; immediately repair tears or holes appearing during curing period by patching with pressure-sensitive, waterproof tape or other approved method.

Membrane curing:

Accomplish membrane curing by applying specified membrane-forming curing compound to damp concrete surfaces as soon as moisture film has disappeared. Apply curing compound uniformly in a two-coat operation by power-spraying equipment using a spray nozzle equipped with a wind guard. Apply second coat in a direction at right angles to direction of first coat. Total coverage for two coats must be not more than 200 square feet per gallon of curing compound. Respray concrete surfaces which are subjected to heavy rainfall within 3 hours after curing compound has been applied by method and at rate specified. Maintain continuity of coating for entire curing period and immediately repair damage to coating during this period.

Membrane-curing compounds must not be used on surfaces that are to be covered with coating material applied directly to concrete or with a covering material bonded to concrete, such as other concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, painting, and other coatings and finish materials.

3.10.6 Curing Formed Surfaces

Accomplish curing of formed surfaces, including undersurfaces of girders, beams, supported slabs, and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed before end of curing period, accomplish final curing of formed surfaces by any of the curing methods specified above, as applicable.

3.10.7 Curing Unformed Surfaces

Accomplish initial curing of unformed surfaces, such as monolithic slabs, floor topping, and other flat surfaces, by membrane curing.

Unless otherwise specified, accomplish final curing of unformed surfaces by any of curing methods specified above, as applicable.

Accomplish final curing of concrete surfaces to receive liquid floor hardener of finish flooring by moisture-retaining cover curing.

3.10.8 Temperature of Concrete During Curing

When temperature of atmosphere is 41 degrees F and below, maintain

temperature of concrete at not less than 55 degrees F throughout concrete curing period or 45 degrees F when the curing period is measured by maturity. When necessary, make arrangements before start of concrete placing for heating, covering, insulation, or housing as required to maintain specified temperature and moisture conditions for concrete during curing period.

When the temperature of atmosphere is 80 degrees F and above or during other climatic conditions which cause too rapid drying of concrete, make arrangements before start of concrete placing for installation of wind breaks, of shading, and for fog spraying, wet sprinkling, or moisture-retaining covering of light color as required to protect concrete during curing period.

Changes in temperature of concrete must be uniform and not exceed 37 degrees F in any 1 hour nor 80 degrees F in any 24-hour period.

3.10.9 Protection from Mechanical Injury

During curing period, protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration and from damage caused by rain or running water.

3.10.10 Protection After Curing

Protect finished concrete surfaces from damage by construction operations.

3.11 FIELD QUALITY CONTROL

3.11.1 Sampling

ASTM C172/C172M. Collect samples of fresh concrete to perform tests specified. ASTM C31/C31M for making test specimens.

3.11.2 Testing

3.11.2.1 Slump Tests

ASTM C143/C143M. Take concrete samples during concrete placement. The maximum slump may be increased as specified with the addition of an approved admixture provided that the water-cement ratio is not exceeded. Perform tests at commencement of concrete placement, when test cylinders are made, and for each batch (minimum) or every 20 cubic yards (maximum) of concrete.

3.11.2.2 Temperature Tests

Test the concrete delivered and the concrete in the forms. Perform tests in hot or cold weather conditions (below 50 degrees F and above 80 degrees F) for each batch (minimum) or every 20 cubic yards (maximum) of concrete, until the specified temperature is obtained, and whenever test cylinders and slump tests are made.

3.11.2.3 Compressive Strength Tests

ASTM C39/C39M. Make five test cylinders for each set of tests in accordance with ASTM C31/C31M. Take precautions to prevent evaporation and loss of water from the specimen. Test two cylinders at 7 days, two cylinders at 28 days, and hold one cylinder in reserve. Take samples for

strength tests of each mix design of concrete placed each day not less than once a day, nor less than once for each 160 cubic yards of concrete, nor less than once for each 5400 square feet of surface area for slabs or walls. For the entire project, take no less than five sets of samples and perform strength tests for each mix design of concrete placed. Each strength test result must be the average of two cylinders from the same concrete sample tested at 28 days. If the average of any three consecutive strength test results is less than f'c or if any strength test result falls below f'c by more than 450 psi, take a minimum of three ASTM C42/C42M core samples from the in-place work represented by the low test cylinder results and test. Concrete represented by core test is considered structurally adequate if the average of three cores is equal to at least 85 percent of f'c and if no single core is less than 75 percent of f'c. Retest locations represented by erratic core strengths. Remove concrete not meeting strength criteria and provide new acceptable concrete. Repair core holes with nonshrink grout. Match color and finish of adjacent concrete.

3.11.2.4 Air Content

ASTM C173/C173M or ASTM C231/C231M for normal weight concrete . Test air-entrained concrete for air content at the same frequency as specified for slump tests.

3.11.2.5 Strength of Concrete Structure

Compliance with the following is considered deficient if it fails to meet the requirements which control strength of structure in place, including following conditions:

Failure to meet compressive strength tests as evaluated

Reinforcement not conforming to requirements specified

Concrete which differs from required dimensions or location in such a manner as to reduce strength

Concrete curing and protection of concrete against extremes of temperature during curing, not conforming to requirements specified

Concrete subjected to damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration

Poor workmanship likely to result in deficient strength

3.11.2.6 Testing Concrete Structure for Strength

When there is evidence that strength of concrete structure in place does not meet specification requirements, make cores drilled from hardened concrete for compressive strength determination in accordance with ASTM C42/C42M, and as follows:

Take at least three representative cores from each member or area of concrete-in-place that is considered potentially deficient. Location of cores will be determined by the Contracting Officer.

Test cores after moisture conditioning in accordance with ASTM C42/C42M if concrete they represent is more than superficially wet under service.

Air dry cores, (60 to 80 degrees F with relative humidity less than 60

percent) for 7 days before test and test dry if concrete they represent is dry under service conditions.

Strength of cores from each member or area are considered satisfactory if their average is equal to or greater than 85 percent of the 28-day design compressive strength of the class of concrete.

Core specimens will be taken and tested by the Government. If the results of core-boring tests indicate that the concrete as placed does not conform to the drawings and specification, the cost of such tests and restoration required must be borne by the Contractor.

Fill core holes solid with patching mortar and finished to match adjacent concrete surfaces.

Correct concrete work that is found inadequate by core tests in a manner approved by the Contracting Officer.

3.12 WASTE MANAGEMENT

As specified in the Waste Management Plan and as follows.

3.13 JOINTS

3.13.1 Construction Joints

Make and locate joints not indicated so as not to impair strength and appearance of the structure, as approved. Locate construction joints as follows:

a. In walls at not more than 60 feet in any horizontal direction; at top of footing; at top of slabs on ground; at top and bottom of door and window openings or where required to conform to architectural details; and at underside of deepest beam or girder framing into wall

b. In columns or piers, at top of footing; at top of slabs on ground; and at underside of deepest beam or girder framing into column or pier

c. Near midpoint of spans for supported slabs, beams, and girders unless a beam intersects a girder at the center, in which case construction joints in girder must offset a distance equal to twice the width of the beam. Make transfer of shear through construction joint by use of inclined reinforcement.

d. In slabs on ground, so as to divide slab into areas not in excess of 1,200 square feet

Provide keyways at least 1-1/2-inches deep in construction joints in walls and slabs and between walls and footings; approved bulkheads may be used for slabs.

Joints must be perpendicular to main reinforcement. Reinforcement must be continued across construction joints.

3.13.2 Isolation Joints in Slabs on Ground

Provide joints at points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

Fill joints with premolded joint filler strips 1/2 inch thick, extending full slab depth. Install filler strips at proper level below finish floor elevation with a slightly tapered, dress-and-oiled wood strip temporarily secured to top of filler strip to form a groove not less than 3/4 inch in depth where joint is sealed with sealing compound and not less than 1/4 inch in depth where joint sealing is not required. Remove wood strip after concrete has set. Contractor must clean groove of foreign matter and loose particles after surface has dried.

3.13.3 Control Joints in Slabs on Ground

Provide joints to form panels as indicated.

Under and on exact line of each control joint, cut 50 percent of welded wire fabric reinforcement before placing concrete.

Joints must be 1/8-inch wide by 1/5 to 1/4 of slab depth and formed by inserting hand-pressed fiberboard strip into fresh concrete until top surface of strip is flush with slab surface or by cutting the concrete with a saw after the concrete has set. After concrete has cured for at least 7 days, the Contractor must remove inserts and clean groove of foreign matter and loose particles.

3.13.4 Sealing Joints in Slabs on Ground

Isolation and control joints which are to receive finish flooring material must be sealed with joint sealing compound after concrete curing period. Slightly underfill groove with joint sealing compound to prevent extrusion of compound. Remove excess material as soon after sealing as possible.

Sealing is not required for isolation and control joints to be covered with finish flooring material. Groove must be left ready to receive filling material that is provided as part of finish floor covering work.

3.14 INSTALLATION OF ANCHORAGE DEVICES

3.14.1 General

Anchorage devices and embedded items required for other work that is attached to, or supported by, set and build in cast-in-place concrete as part of the work of this section, using setting drawings, instructions, and directions for work to be attached thereto.

3.14.2 Placing Anchorage Devices

Anchorage devices and embedded items must be positioned accurately and supported against displacement. Fill openings in anchorage devices such as slots and threaded holes with an approved, removable material to prevent entry of concrete into openings.

3.15 CONCRETE CONVEYING

3.15.1 Transfer of Concrete At Project Site

Handle concrete from point of delivery and transfer to concrete conveying equipment and to locations of final deposit as rapidly as practical by methods which prevent segregation and loss of concrete mix materials.

3.15.2 Mechanical Equipment for Conveying Concrete

Equipment must ensure a continuous flow of concrete at delivery end, as approved. Provide runways for wheeled concrete-conveying equipment from concrete delivery point to locations of final deposit. Interior surfaces of concrete conveying equipment must be free of hardened concrete, debris, water, snow, ice, and other deleterious substances.

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DIVISION 04 - MASONRY

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SECTION 04 20 00

MASONRY

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 318	(2011; Errata 2011) Building Code Requirements for Structural Concrete and Commentary
ACI 530/530.1	(2011; Errata 2011) Building Code Requirements and Specification for Masonry Structures and Related Commentaries
ACI SP-66	(2004) ACI Detailing Manual

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A615/A615M	(2012) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A641/A641M	(2009a) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A706/A706M	(2009b) Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A82/A82M	(2007) Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM C1019	(2011) Standard Test Method for Sampling and Testing Grout
ASTM C1072	(2011) Standard Test Method for Measurement of Masonry Flexural Bond Strength
ASTM C140	(2012) Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units

ASTM C144	(2011) Standard Specification for Aggregate for Masonry Mortar
ASTM C150/C150M	(2011) Standard Specification for Portland Cement
ASTM C270	(2012) Standard Specification for Mortar for Unit Masonry
ASTM C476	(2010) Standard Specification for Grout for Masonry
ASTM C494/C494M	(2011) Standard Specification for Chemical Admixtures for Concrete
ASTM C593	(2006; R 2011) Fly Ash and Other Pozzolans for Use with Lime for Soil Stabilization
ASTM C641	(2009) Staining Materials in Lightweight Concrete Aggregates
ASTM C780	(2011) Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
ASTM C90	(2011b) Loadbearing Concrete Masonry Units
ASTM C91/C91M	(2012) Standard Specification for Masonry Cement
ASTM C94/C94M	(2012) Standard Specification for Ready-Mixed Concrete
ASTM C989/C989M	(2011) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D2000	(2012) Standard Classification System for Rubber Products in Automotive Applications
ASTM D2240	(2005; R 2010) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2287	(2011) Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
ASTM E119	(2012a) Standard Test Methods for Fire Tests of Building Construction and Materials

1.2 SYSTEM DESCRIPTION

1.2.1 Design Requirements

1.2.1.1 Unit Strength Method

Compute compressive strength of masonry system "Unit Strength Method", ACI 530/530.1. Submit calculations and certifications of unit and mortar strength.

1.2.1.2 Seismic Requirement

Wall Type	Vertical	Horizontal
Structural	24 inches	48 inches
Non-structural	48 inches	80 inches

Bond beams are required at the top of footings, at the bottom and top of openings at roof and floor levels, and at the top of parapet walls.

1.2.1.3 Masonry Strength

Determine masonry strength in accordance with ACI 530/530.1; submit test reports on three prisms as specified in ACI 530/530.1. The cost of testing shall be paid by the Contractor.

1.2.2 Additional Requirements

a. Maintain at least one spare vibrator on site at all times.

b. Provide bracing and scaffolding necessary for masonry work. Design bracing to resist 45 psi wind pressure of psf.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

Cold Weather Installation; G

SD-03 Product Data

Cement; G

Contamination Reports; G

SD-04 Samples

Concrete Masonry Units (CMU); G

Anchors, Ties, and Bar Positioners; G
Expansion-Joint Materials; G
Joint Reinforcement; G

SD-05 Design Data

Pre-mixed Mortar; G
Unit Strength Method; G

SD-06 Test Reports

Field Testing of Mortar; G
Field Testing of Grout; G
Masonry Cement; G
Fire-rated CMU; G
Masonry Inspector Qualifications; G

SD-07 Certificates

Concrete Masonry Units (CMU)
Anchors, Ties, and Bar Positioners
Expansion-Joint Materials
Joint Reinforcement
Masonry Cement

Precast Concrete Items
Admixtures for Masonry Mortar
Admixtures for Grout

SD-08 Manufacturer's Instructions

Masonry Cement

1.4 QUALITY ASSURANCE

1.4.1 Contamination Reports

When using bricks containing contaminated soil, supplier shall certify that the hazardous waste is neutralized by the manufacturing process and that no additional pollutants will be released, or that the product is free from hazardous contaminants.

1.4.2 Masonry Inspector Qualifications

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 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. Submit copies of masonry inspector reports.

1.4.3 Detail Drawings

Submit detail drawings showing bar splice locations. . 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. Submit 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.

1.5 DELIVERY, STORAGE, AND HANDLING

Materials shall be delivered, stored, handled, 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.

1.5.1 Masonry Units

Cover and protect moisture-controlled concrete masonry units and cementitious materials from precipitation. Conform to all handling and storage requirements of ASTM C90. Mark prefabricated lintels on top sides to show either the lintel schedule number or the number and size of top and bottom bars.

1.5.2 Reinforcement, Anchors, and Ties

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.

1.5.3 Cementitious Materials, Sand and Aggregates

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. Store sand and aggregates in a manner to prevent contamination or segregation.

1.6 PROJECT/SITE CONDITIONS

Conform to ACI 530/530.1 for hot and cold weather masonry erection.

1.6.1 Hot Weather Installation

Take the following precautions 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.

1.6.2 Cold Weather Installation

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, submit a written statement of proposed cold weather

construction procedures for approval.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

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. Submit sample of colored mortar with applicable masonry unit and 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 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. Submit certificates of compliance stating that the materials meet the specified requirements.

2.2 CONCRETE MASONRY UNITS (CMU)

Submit samples and certificates as specified. Cement shall have a low alkali content and be of one brand. Units shall be of modular dimensions and air, water, or steam cured.

a. Hollow Load-Bearing Units: ASTM C90, made with lightweight aggregate. Provide load-bearing units for exterior walls, foundation walls, load-bearing walls, and shear walls.

2.2.1 Aggregates

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 C641: 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 C989/C989M; Grade 100.

2.2.2 Kinds and Shapes

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. 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.

2.2.3 Fire-Rated CMU

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 E119.

TABLE I FIRE-RATED CONCRETE MASONRY UNITS See note (a) in Table III			
	Minimum equivalent thickness in 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

Minimum equivalent thickness shall equal net volume as determined in conformance with ASTM C140 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. Submit calculation results.

2.3 PRECAST CONCRETE ITEMS

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 3000 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. Submit specified factory certificates.

2.3.1 Lintels

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 3000 psi using 1/2 inch to No. 4 nominal-size coarse aggregate. Reinforcement shall conform to ASTM A615/A615M Grade 60,000 psi. Limit lintel deflection due to dead plus live load to L/600 or 0.3 inches whichever is less. Provide top and bottom bars for lintels over 36 inches in length.

2.3.2 Sills and Copings

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.

2.4 MORTAR FOR STRUCTURAL MASONRY

ASTM C270, Type S. Strength (f'm) as indicated. Test in accordance with ASTM C780. Use Type II portland cement. Use Masonry 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 C593.

2.5 MASONRY MORTAR AND PRE-MIXED MORTAR

Mortar Type S shall conform to the proportion specification of ASTM C270 except Type S cement-lime mortar proportions shall be 1 part cement, 1/2 part lime and 4-1/2 parts aggregate. Type N 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 C91/C91M 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 C780 and ASTM C1072. 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.

2.5.1 Admixtures for Masonry Mortar

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 C494/C494M, Type C. Submit the required certifications.

2.5.2 Cement

Portland cement shall conform to ASTM C150/C150M, Type I, II, or III. Masonry cement shall conform to ASTM C91/C91M, Type 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. 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. Additives shall conform to requirements in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.5.3 Sand and Water

Sand shall conform to ASTM C144. Water shall be clean, potable, and free from substances which could adversely affect the mortar.

2.6 GROUT AND READY-MIXED GROUT

Grout shall conform to ASTM C476, fine. 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 C1019. Use grout subject to the limitations of Table III. Do not change proportions and do not use materials with different physical or chemical characteristics in grout for the work unless additional evidence is furnished that the grout meets the specified requirements. Ready-Mixed grout shall conform to ASTM C94/C94M

2.6.1 Admixtures for Grout

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 C494/C494M, Type C. In general, air-entrainment, anti-freeze or chloride admixtures shall not be used except as approved by the Contracting Officer. Submit required certifications.

2.6.2 Grout Barriers

Grout barriers for vertical cores shall consist of fine mesh wire, fiberglass, or expanded metal.

2.7 ANCHORS, TIES, AND BAR POSITIONERS

Anchors and ties shall be fabricated without drips or crimps and shall be zinc-coated in accordance with ASTM A153/A153M, Class B-2. Steel wire used for anchors and ties shall be fabricated from steel wire conforming to ASTM A82/A82M. Wire ties or anchors in exterior walls shall conform to ASTM A641/A641M. Joint reinforcement in interior walls, and in exterior or interior walls exposed to moist environment shall conform to ASTM A641/A641M; 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. Submit two anchors, ties and bar positioners of each type used, as samples.

2.7.1 Wire Mesh Ties

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.

2.7.2 Wall Ties

Provide wall ties 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.

2.7.3 Dovetail Anchors

Provide dovetail anchors 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. Use these anchors for anchorage of veneer wythes or composite-wall facings extending over the face of concrete columns, beams, or walls. Fill cells within vertical planes of these anchors solid with grout for full height of walls or partitions, or solid units may be used. Dovetail slots are specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.7.4 Adjustable Anchors

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.

2.7.5 Bar Positioners

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.

2.8 JOINT REINFORCEMENT

Joint reinforcement shall be factory fabricated from steel wire conforming to ASTM A82/A82M, welded construction. Tack welding will not be acceptable in reinforcement used for wall ties. Wire shall have zinc coating conforming to ASTM A153/A153M, 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. Submit one piece of each type used, including corner and wall

intersection pieces, showing at least two cross wires.

2.9 REINFORCING STEEL BARS AND RODS

Reinforcing steel bars and rods shall conform to ASTM A706/A706M, Grade 60.

2.10 CONTROL JOINT KEYS

Control joint keys shall be a factory fabricated solid section of natural or synthetic rubber (or combination thereof) conforming to ASTM D2000or polyvinyl chloride conforming to ASTM D2287. 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 D2240.

2.11 EXPANSION-JOINT MATERIALS

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. Submit one piece of each type of material used.

PART 3 EXECUTION

3.1 PREPARATION

Prior to start of work, masonry inspector shall verify the applicable conditions as set forth in ACI 530/530.1, inspection. The Contracting Officer will serve as inspector or will select a masonry inspector.

3.1.1 Stains

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.

3.1.2 Loads

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.

3.1.3 Surfaces

Clean surfaces on which masonry is to be placed of laitance, dust, dirt, oil, organic matter, or other foreign materials and slightly roughen to provide a surface texture with a depth of at least 1/8 inch. Sandblast, if necessary, to remove laitance from pores and to expose the aggregate.

3.2 LAYING MASONRY UNITS

a. 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 running bond pattern. Facing courses shall be level with back-up courses, unless the use of adjustable ties has been approved in which case the tolerances shall be plus or minus 1/2 inch. Each unit shall be adjusted to its final position while mortar is still soft and plastic.

b. 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.

c. 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.

3.2.1 Forms and Shores

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.

3.2.2 Reinforced Concrete Masonry Units Walls

Fill all 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.

3.2.3 Concrete Masonry Units

Units in piers, pilasters, columns, starting courses on footings, solid foundation walls, 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. Foundation walls below grade shall be grouted solid. 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.

3.2.4 Tolerances

Lay masonry plumb, true to line, with courses level. Keep bond pattern plumb throughout. Square corners unless noted otherwise. Except for walls constructed of prefaced concrete masonry units, lay masonry within the following tolerances (plus or minus unless otherwise noted):

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

TABLE II TOLERANCES	
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

3.2.5 Cutting and Fitting

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.

3.2.6 Jointing

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:

3.2.6.1 Flush Joints

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.

3.2.6.2 Tooled Joints

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.

3.2.6.3 Door and Window Frame Joints

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.

3.2.7 Joint Widths

Joint widths shall be as follows:

3.2.7.1 Concrete Masonry Units

Concrete masonry units shall have 3/8 inch joints, except for prefaced concrete masonry units.

3.2.7.2 Prefaced Concrete Masonry Units

Prefaced concrete masonry units shall have a joint width of 3/8 inch wide on unfaced side and not less than 3/16 inch nor more than 1/4 inch wide on prefaced side.

3.2.8 Embedded Items

Fill spaces around built-in items with mortar. Point openings around flush-mount electrical outlet boxes in wet locations with mortar. Embed anchors, ties, wall plugs, accessories, flashing, pipe sleeves and other items required to be built-in as the masonry work progresses. Fully embed anchors, ties and joint reinforcement in the mortar. Fill cells receiving anchor bolts and cells of the first course below bearing plates with grout.

3.2.9 Unfinished Work

Step back unfinished work for joining with new work. Toothing may be resorted to only when specifically approved. Remove loose mortar and thoroughly clean the exposed joints before laying new work.

3.2.10 Masonry Wall Intersections

Masonry bond each course 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.

3.2.11 Partitions

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 as shown. 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 MORTAR MIX

Mix mortar in a mechanically operated mortar mixer for at least 3 minutes, but not more than 5 minutes. Measure ingredients for mortar by volume.

Ingredients not in containers, such as sand, shall be accurately measured by the use of measuring boxes. Mix water with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units. Retemper mortar that has stiffened because of loss of water through evaporation by adding water to restore the proper consistency and workability. Discard mortar that has reached its initial set or that has not been used within 2.5 hours after mixing.

3.4 REINFORCING STEEL

Clean reinforcement 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.

3.4.1 Positioning Bars

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.

3.4.2 Splices

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.

3.5 JOINT REINFORCEMENT INSTALLATION

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.

3.6 PLACING GROUT

Fill cells containing reinforcing bars 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.

3.6.1 Vertical Grout Barriers for Fully Grouted Walls

Provide grout barriers not more than 30 feet apart, or as required, to limit the horizontal flow of grout for each pour.

3.6.2 Horizontal Grout Barriers

Embed grout barriers in mortar below cells of hollow units receiving grout.

3.6.3 Grout Holes and Cleanouts

3.6.3.1 Grout Holes

Provide grouting holes in slabs, spandrel beams, and other in-place overhead construction. Locate holes over vertical reinforcing bars or as required to facilitate grout fill in bond beams. Provide additional openings spaced not more than 16 inches on centers 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, plug and finish grouting holes to match surrounding surfaces.

3.6.3.2 Cleanouts for Hollow Unit Masonry Construction

Provide cleanout holes 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, construct cleanout courses using bond beam units in an inverted position to permit cleaning of all cells. Provide cleanout holes at a maximum spacing of 32 inches where all cells are to be filled with grout. Establish a new series of cleanouts 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, close cleanout holes in an approved manner to match surrounding masonry.

3.6.4 Grouting Equipment

3.6.4.1 Grout Pumps

Pumping through aluminum tubes will not be permitted. Operate pumps to produce a continuous stream of grout without air pockets, segregation, or contamination. Upon completion of each day's pumping, remove waste materials and debris from the equipment, and dispose of outside the masonry.

3.6.4.2 Vibrators

Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout. Maintain at least one spare vibrator at the site at all times. Apply vibrators at uniformly spaced points not further apart than the visible effectiveness of the machine. Limit duration of vibration to time necessary to produce satisfactory consolidation without causing segregation.

3.6.5 Grout Placement

Lay masonry to the top of a pour before placing grout. Do no place grout

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.

3.6.5.1 Low-Lift Method

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.

3.6.5.2 High-Lift Method

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.

TABLE III
POUR HEIGHT AND TYPE OF GROUT FOR VARIOUS GROUT SPACE DIMENSIONS

			Minimum Dimensions of the Total Clear Areas Within Grout Spaces and Cells in inches (1,2)	
Maximum Grout Pour Height feet (4)	Grout Type	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 shall 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.

3.7 BOND BEAMS

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.

3.8 CONTROL JOINTS

Control joints shall be provided as indicated and shall be constructed by using mortar to fill the head joint in accordance with the details shown on the drawings. 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.

3.9 JOINTS SHOWN ON THE DRAWINGS

a. will be located, detailed, and constructed as shown on the drawings. Keep joints free of mortar and other debris.

3.10 SHELF ANGLES

Adjust shelf angles as required to keep the masonry level and at the proper elevation. Shelf angles shall be galvanized and 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.

3.11 LINTELS

3.11.1 Masonry Lintels

Construct masonry lintels 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.

3.11.2 Precast Concrete and Steel Lintels

Construct precast concrete and steel lintels 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.

3.12 SILLS AND COPINGS

Sills and copings shall be set in a full bed of mortar with faces plumb and true.

3.13 ANCHORAGE TO CONCRETE AND STRUCTURAL STEEL

3.13.1 Anchorage to Concrete

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.

3.13.2 Anchorage to Structural Steel

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.

3.14 POINTING AND CLEANING

After mortar joints have attained their initial set, but prior to hardening, completely remove mortar and grout daubs or splashings 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.

3.14.1 Dry-Brushing

a. Exposed concrete masonry unit

c. shall be dry-brushed at the end of each day's work and after any required pointing, using stiff-fiber bristled brushes.

3.15 BEARING PLATES

Set bearing plates for beams, joists, joist girders and similar structural members 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.

3.16 PROTECTION

Protect facing materials against staining. Cover top of walls 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.

3.17 WASTE MANAGEMENT

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.

3.17.1 Separate and Recycle Waste

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. Use leftover mixed mortar as where lower strength mortar meets the requirements for bulk fill. Separate masonry waste and place in designated area for use as structural fill. Separate selected masonry waste and excess for landscape uses, either whole or crushed as ground cover.

3.18 TEST REPORTS

3.18.1 Field Testing of Mortar

Take at least three specimens of mortar each day. Spread a layer of mortar 1/2 to 5/8 inch thick on the masonry units and allowed to stand for one minute. Prepare and test the specimens for compressive strength in accordance with ASTM C780. Submit test results.

3.18.2 Field Testing of Grout

Field sampling and testing of grout shall be in accordance with the applicable provisions of ASTM C1019. 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. Submit test results.

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METAL FASTENINGS

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.

ASME INTERNATIONAL (ASME)

ASME BPVC SEC IX	(2010) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT SNT-TC-1A	(2011) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A5.1/A5.1M	(2012) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS A5.17	(1980) Carbon Steel Electrodes and Fluxes for Submerged Arc Welding
AWS D1.1/D1.1M	(2012; Errata 2011) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2008) Structural Welding Code - Aluminum
AWS D1.6/D1.6M	(2007) Structural Welding Code - Stainless Steel

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA-SPEC-5004	Welding of Aerospace Ground Support Equipment and Related Nonconventional Facilities

1.2 WELD CRITERIA

Except as noted, all carbon steel welding shall be in accordance with AWS D1.1/D1.1M and NASA-SPEC-5004. All aluminum welding shall be in accordance with AWS D1.2/D1.2M and NASA-SPEC-5004 All stainless steel welding shall be in accordance with AWS D1.6/D1.6M and NASA-SPEC-5004 with one exception. The pre-qualified welding procedure specifications

presented in AWS D1.6/D1.6M do not need to be qualified by testing, as stipulated by NASA-SPEC-5004.

Classification: See NASA-SPEC-5004 for classification to establish levels of inspection for structural weldments. All welds require a Class B inspection except where weld is designated as a Class A weld.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Training data shall be submitted for welding inspectors in accordance with the paragraph entitled, "Certification of Welding Inspectors," of this section; G.

SD-02 Shop Drawings

Detail Drawings shall be submitted in accordance with the section entitled, "General" of this section; G.

SD-06 Test Reports

Test reports shall be submitted for the following items in accordance with AWS D1.1/D1.1M for carbon steel, AWS D1.2/D1.2M for aluminum, and AWS D1.6/D1.6M for stainless steel. Inspection reports of shop welds shall be submitted within 1 week of test date in accordance with the paragraph entitled "Quality Provisions", of this section.

Welder Qualifications; G
Inspector Qualification Tests; G
Inspection reports of shop welds; G

SD-07 Certificates

Welding Procedures and Welder Qualifications shall be submitted in accordance with the paragraph entitled, "Qualifications of Welding Procedures and Welders," of this section; G.

Certificates shall be submitted for qualifications of welding procedures and welders in accordance with the paragraph entitled, "Certification of Welding Inspectors," of this section; G.

Certificates for Electrodes; G

SD-09 Manufacturer's Field Reports

Inspection Reports of field welds shall be submitted within 1 week of test date in accordance with the paragraph entitled, "Quality Provisions," of this section; G.

1.4 QUALIFICATIONS OF WELDING PROCEDURES AND WELDERS

Prior to any production welding, the Contractor shall demonstrate the

satisfactory quality of representative welds by means of tests specified hereinafter under paragraph entitled, "Quality Provisions." Certificates of such qualification shall be current for welder qualifications and welding procedures and are subject to the Contracting Officer's approval. Certificates shall have the Government inspector's stamp affixed.

1.5 PROCEDURE AND PERFORMANCE QUALIFICATIONS

Contractor shall qualify welding procedures and welder performances.

Qualifications and certification shall be accomplished in accordance with the applicable portions of AWS D1.1/D1.1M for carbon steel, AWS D1.2/D1.2M for aluminum, and AWS D1.6/D1.6M for stainless steel. Additionally, carbon steel welders and welding operators shall be qualified in accordance with ASME BPVC SEC IX. Copies of certification shall be submitted to the Contracting Officer.

Retesting is not required for renewal of performance qualification if the welder has performed production welding meeting the requirements of this specification within the previous six months.

1.6 CERTIFICATION OF WELDING INSPECTORS

Welding inspectors shall be certified to meet the requirements of ASNT SNT-TC-1A. Contractor may have an in-house level III certified inspector as a designated representative to certify other inspectors at levels I and II. As an option, he may use the services of a private laboratory, approved by the Contracting Officer, to provide a certified level III inspector to conduct qualification training and examination of the Contractor's personnel at level II. In such instances, the responsibility of certification shall be retained by the Contractor. Inspector Qualification Tests shall meet referenced standards within this and referenced sections.

If a private laboratory is used to provide qualification training and examination of the Contractor's inspectors, the Contractor shall have at least level II nondestructive testing (NDT) inspectors of the applicable testing method on his staff for performance of the required inspections. These inspectors shall be certified to perform inspections of the type required by the specifications.

Contractor may certify a level II inspector in magnetic particle or liquid penetrant and waive the required trainee or level I documented work experience time if the Contractor specifically ascertains that the employee is qualified to properly perform the required inspection and so states in his certification to the Contracting Officer. Once an inspector has been certified, no further training will be required for the life of the contract.

Contractor also has the option of using the services of a private laboratory, approved by the Contracting Officer, to provide the required NDT inspections.

Training data shall be submitted for welding inspectors. Data shall include description of training, training aids to be used, samples of training materials to be used, and schedules of training.

Certificates shall be submitted for qualifications of welding procedures and welders including the type of welding and positions each operator is

qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests.

1.7 HANDLING AND STORAGE

All materials used in welding processes shall be stored so that no degradation will result during storage. Handling and storage methods shall be stated in the welding procedure.

PART 2 PRODUCTS

2.1 GENERAL

Base metal shall be as specified in AWS D1.1/D1.1M for carbon steel, AWS D1.2/D1.2M for aluminum, and AWS D1.6/D1.6M for stainless steel.

Welding rods, welding wire, and electrodes used in welding shall be capable of producing satisfactory welds when used by a certified welding operator with adequate welding apparatus and shall have a composition suitable for producing welds conforming to the requirements of NASA-SPEC-5004.

Fluxes for carbon steel shall be of such composition that the carbon content of the resulting weld metal will be within the limits for the applicable base metal. Fluxes for submerged-arc welding shall be compatible with the filler metal and the base metal and shall be of such a composition that the qualities of the resultant weldment shall be equivalent to or better than those obtained by the electric-arc-coated electrode process.

Anti-spatter compounds, when used, shall be of a consistency and uniformity that degradation of the weldment will not result. Anti-spatter compounds shall also be easy to apply and remove.

Detail Drawings shall include the following:

Class A welds shall be transposed by the Contractor to detail drawings by designating "A" in the tail of the weld symbol. Detail drawings shall include notes specifying radiographic inspection for Class A welds. These notes shall be detailed enough to ascertain that a satisfactory radiographic inspection can be accomplished considering technique, fabrication sequence, and joint configuration for each Class A weld.

2.2 ELECTRODES FOR MANUAL SHIELDED METAL-ARC WELDING

Electrodes for manual shielded metal-arc welding of carbon steel shall meet the requirements of AWS D1.1/D1.1M. Electrodes shall be, covered mild-steel electrodes, E70 series conforming to AWS A5.1/A5.1M.

2.3 ELECTRODES AND FLUX FOR SUBMERGED-ARC WELDING

The bare electrodes and flux used in combination for submerged-arc welding of carbon steel shall meet the requirements of AWS D1.1/D1.1M and shall be bare mild-steel electrodes and fluxes F70 series for submerged-arc welding conforming to AWS A5.17.

Shielded metal-arc electrodes having low-hydrogen coverings shall be purchased in hermetically sealed containers or dried for at least 2 hours between 450 and 500 degrees F before they are used. After opening,

hermetically sealed electrodes shall be stored at all times in an oven, supplied by the Contractor, capable of maintaining a temperature of at least 250 degrees F.

The flux used for submerged-arc welding shall be dry and free of contamination from dirt, mill scale, or other foreign material. Flux used in welding shall not be reused.

2.4 FILLER METAL FOR ALUMINUM WELDING

Filler metal shall conform to the requirements of AWS D1.2/D1.2M.

2.5 FILLER METAL FOR STAINLESS STEEL WELDING

Filler metal shall conform to the requirements of AWS D1.6/D1.6M.

PART 3 EXECUTION

3.1 JOINT PREPARATION

Interpretation of the weld symbols shall be made in accordance with AWS A2.4. Mismatch and misalignment of fit-up shall not exceed the allowable as shown in AWS D1.1/D1.1M for steel, AWS D1.2/D1.2M for aluminum, and AWS D1.6/D1.6M for stainless steel. Root opening of the joint shall be checked before tacking or depositing the first layer to ensure that it is correct. Oxide and protective coatings shall be removed. Surfaces to be welded shall be free of grease and other foreign matter. Any method of removal may be used which does not contaminate the surfaces. Edges to be fusion welded shall be essentially free of defects and finished to a surface roughness in accordance with AWS D1.1/D1.1M for carbon steel, AWS D1.2/D1.2M for aluminum, and AWS D1.6/D1.6M for stainless.

Thermal or mechanical cutting may be used to cut carbon steel. Mechanical cutting may be used to cut stainless steel piping and tubing. Anti-spatter compound, when used, shall be applied to all surfaces adjacent to the joints where it is necessary to control spatter from welding.

3.2 PROTECTION OF EQUIPMENT AND ADJACENT SURFACES

Contractor shall protect equipment and adjacent surfaces during welding operations. Damages resulting from failure to provide protection shall be repaired to the satisfaction of the Contracting Officer, at no additional cost to the Government.

3.3 PROCEDURES

3.3.1 Preheating and Interpass Heating

Temperatures shall be measured by a surface pyrometer or other suitable temperature-indicating means, accurate within plus or minus 25 degrees F. Heating and maintaining the proper temperature shall be accomplished, as applicable, by a furnace, by induction, by a gentle sootfree gas flame, by heat lamps, or by other suitable means capable of providing a reasonably uniform temperature throughout the part. When a gas flame is used for preheating, the area to be welded shall be brushed clean of any soot before tacking or welding.

3.3.2 Tacking

Tack welds shall be used as required. Wherever possible, the tack welds shall be spaced symmetrically along or around the joint. Tack welds shall be of sufficient size and length to permit ease of subsequent welding, yet ensure holding of the parts in place without cracking of the tack weld. Chipping or grinding shall be done to fair both ends of the tack welds in with base metal. Tack welds which have cracked shall be removed.

3.3.3 Weld Beads

Weld beads shall be terminated so as to avoid critical areas of the weld. Assemblies shall be welded in the flat position whenever practical. The back step and skip methods of welding shall be used to lessen warpage when necessary. Tabs on which the arc can be struck or extinguished may be used wherever practical to minimize porosity at the beginning and end of the weld bead. When manual welding multipass welds in circumferential joints in tubular sections or depositing continuous-circular-butt or fillet-type welds, the first layer, should be deposited by welds in opposite quadrants. All machine welding or circumferential or circular type joints shall be accomplished utilizing a continuous single pass or multiple stringer technique. All groove welded joints which are to be welded from both sides and which require 100 percent penetration shall be back gouged, as necessary, to ensure complete penetration of the joint.

3.3.4 Techniques

A maximum of two passes shall be deposited on the first side prior to the back gouging of the back side. The imbalance of passes between sides on double sided weld joints shall not exceed two. Back gouging to sound metal may be done by chisel, grinder, or air carbon-arc process. Gouged areas shall be smoothed to fair in with adjacent metal. Starts and stops of each weld bead shall be chipped or ground as necessary to remove cracks and visible porosity in the weld metal before depositing the subsequent weld bead. Ground areas shall fair in smoothly with the adjacent material. Weld beads shall not terminate in inside corners or in other critical areas such as changes in welding direction or sudden changes in section thickness. Return welds shall be continuously full size around the corner for a length equal to twice the weld size. End returns shall be indicated on design and detail drawings. Corner welds may be a fillet weld, a butt weld, or a combination thereof depending of forming or drawing requirements. Unless otherwise specified, there shall be complete penetration to the inside of the joint permitted for contouring and blending when an inside fillet weld is not specified. The outside of the joint shall blend smoothly with the adjacent metal and unless otherwise specified, sufficient metal shall be added to provide a suitable fillet or reinforcement.

3.3.5 Postweld Heat Treatment

Stress relief or heat treatment of welded assemblies is optional unless specifically called for on the drawing.

3.4 IN-PROCESS REPAIR OF WELDMENTS

Weld repair shall be performed in accordance with NASA-SPEC-5004. A weld repair is defined as any time defects in weld metal have been corrected.

3.5 QUALITY PROVISIONS

3.5.1 Inspection Requirements

Contractor shall perform all inspection requirements as specified. The Contractor shall use his independent inspection facilities and services acceptable to the Government. The provision in NASA-SPEC-5004 that permits use of the Contractor's own inspectors is not applicable for this project. Inspection and test records shall be kept complete and provided to the Contracting Officer or his designated representative. Contracting Officer, or his designated representative, reserves the right to perform (at Government expense and without any increase in contract price) any or all of the inspections set forth in this specification to ensure that the end item conforms to the prescribed requirements. Test records, inspection reports of shop welds, and inspection reports of field welds shall be kept complete and provided to the Contracting Officer or his designated representative within 1 week of the test being performed.

3.5.2 Inspection

Welds shall conform to AWS D1.1/D1.1M for carbon steel, AWS D1.2/D1.2M for aluminum, and AWS D1.6/D1.6M for stainless steel.

Weld inspection shall be performed in accordance with NASA-SPEC-5004A.

Certain Class B welds, whose quality cannot be satisfactorily determined by the testing procedures set forth in "Inspection Requirements" and "Examination of Weldments," as determined by the Contracting Officer, shall be subject to radiographic inspection at Government expense but without increase in contract price.

3.5.3 Examination of Weldments

Joint design tolerance shall be inspected prior to welding to verify compliance with AWS D1.1/D1.1M for steel, AWS D1.2/D1.2M for aluminum, and AWS D1.6/D1.6M for stainless steel. Weld joint fit shall be inspected for accurate alignment to ensure complete and sound penetration of the root pass. Inspector shall also inspect each root pass to ensure complete penetration and soundness.

Visual inspection of all welds shall be accomplished using AWS fillet and butt weld gages.

Magnetic particle inspection of Class B carbon steel weldments shall be performed in accordance with the requirements of AWS D1.1/D1.1M.

Radiographic inspection shall be conducted, when applicable, in accordance with AWS D1.1/D1.1M or AWS D1.6/D1.6M.

3.5.4 Acceptance Criteria

Defects shall not be in excess of those specified in AWS D1.1/D1.1M and NASA-SPEC-5004 for steel, AWS D1.2/D1.2M for aluminum, and AWS D1.6/D1.6M for stainless steel. In case of doubt, the Contracting Officer may require coupons to be cut from base or weld material for destructive tests. When the material of weld does not meet the applicable specifications for strength and soundness, the Contractor shall be liable for the cost of the investigation of the defective area. When coupons are removed from any part of the structure, the members shall be repaired in a neat and

workmanlike manner, with joints of proper type to develop the full strength of the members and joints cut, and with peening as necessary or as directed to relieve residual stress.

3.5.5 Inspection Record

An inspection record for each full penetration weld made in the field shall be prepared. Inspection records shall be made available to the Contracting Officer within 1 week of the test being performed.

3.6 POSTWELD CLEANING

All welded assemblies shall be cleaned free of oxides, flux, scale, weld splatter or other foreign matter prior to final inspection.

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STRUCTURAL STEEL

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 HB-17	(2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 201	(2006) AISC Certification Program for Structural Steel Fabricators
AISC 325	(2011) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 360	(2010) Specification for Structural Steel Buildings

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2012; Errata 2011) Structural Welding Code - Steel

ASME INTERNATIONAL (ASME)

ASME B46.1	(2009) Surface Texture, Surface Roughness, Waviness and Lay

ASTM INTERNATIONAL (ASTM)

ASTM A108	(2007) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143/A143M	(2007) Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and

	Procedure for Detecting Embrittlement
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A193/A193M	(2012) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A276	(2010) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2010) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A325	(2010) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A36/A36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A500/A500M	(2010a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A529/A529M	(2005; R 2009) Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A572/A572M	(2012) Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A6/A6M	(2012) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A668/A668M	(2004; R 2009) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A992/A992M	(2011) Standard Specification for Structural Steel Shapes
ASTM C1107/C1107M	(2011) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

ASTM C827/C827M	(2010) Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
ASTM F1554	(2007ae1) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F436	(2011) Hardened Steel Washers
ASTM F844	(2007a) Washers, Steel, Plain (Flat), Unhardened for General Use

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

29 CFR 1926.756	Steel Erection; Beams and Columns

1.2 SYSTEM DESCRIPTION

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 360 and AISC 325 except as modified in this contract.

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. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Erection Plan, including description of temporary supports; G

Fabrication drawings including description of connections; G

SD-03 Product Data

Shop primer

Welding electrodes and rods

Non-Shrink Grout

SD-06 Test Reports

Bolts, nuts, and washers

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.

SD-07 Certificates

Steel

Bolts, nuts, and washers

Galvanizing

Pins and rollers

AISC Quality Certification

Welding procedures and qualifications

1.4 AISC QUALITY CERTIFICATION

Work shall be fabricated in an AISC certified Category Std fabrication plant.

1.5 QUALITY ASSURANCE

1.5.1 Drawing Requirements

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. Sign and seal fabrication drawings by a professional engineer registered in the State of Florida. 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. Double connections that require an erection seat to comply with OSHA 29 CFR 1926.756(c)(1) shall be shown on the shop drawings, reviewed and approved by the structural engineer of record. Use AWS A2.4 standard welding symbols. Shoring and temporary bracing shall be designed and sealed by a Florida registered professional engineer and submitted for record purposes, with calculations, as part of the drawings. 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.

1.5.2 Certifications

1.5.2.1 Erection Plan

Indicate the sequence of erection, temporary shoring and bracing. The Plan shall be developed by a Florida registered professional engineer. The Contractor shall submit and receive written approval of the erection plan from the COTR prior to commencement of field erection.

1.5.2.2 Welding Procedures and Qualifications

See Specification section 05 05 23.00 98, METAL FASTENINGS.

Conform to all requirements specified in AWS D1.1/D1.1M.

PART 2 PRODUCTS

2.1 STEEL

2.1.1 Structural Steel

ASTM A36/A36M. ASTM A529/A529M, Grade 50

2.1.2 High-Strength Structural Steel

2.1.2.1 Low-Alloy Steel

ASTM A572/A572M, Grade 50. ASTM A992/A992M Grade 50.

2.1.3 Structural Shapes for Use in Building Framing

Wide flange shapes, ASTM A992/A992M.

2.1.4 Structural Steel Tubing

ASTM A500/A500M, Grade B.

2.1.5 Steel Pipe

ASTM A53/A53M, Type E or S, Grade B.

2.2 BOLTS, NUTS, AND WASHERS

Provide the following unless indicated otherwise.

2.2.1 Structural Steel, Steel Pipe

2.2.1.1 Bolts

ASTM A325, Type 1. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

2.2.1.2 Nuts

ASTM A563, Grade and Style for applicable ASTM bolt standard recommended.

2.2.1.3 Washers

ASTM F436 washers for ASTM A325 bolts.

2.2.2 High-Strength Structural Steel and Structural Steel Tubing

2.2.2.1 Bolts

ASTM A325, Type 1.

2.2.2.2 Nuts

ASTM A563, Grade and Style as specified in the applicable ASTM bolt standard.

2.2.2.3 Washers

ASTM F436, plain carbon steel.

2.2.3 Foundation Anchorage

2.2.3.1 Anchor Bolts

ASTM F1554 Gr 55, Class 1A. Stainless steel ASTM A193/A193M.

2.2.3.2 Anchor Nuts

ASTM A563, Grade A, hex style. Stainless steel ASTM A193/A193M.

2.2.3.3 Anchor Washers

ASTM F844. Stainless steel Type 316 conforming to ASTM A276.

2.2.3.4 Anchor Plate Washers

ASTM A36/A36M Stainless steel Type 316 conforming to ASTM A276.

2.3 STRUCTURAL STEEL ACCESSORIES

2.3.1 Welding Electrodes and Rods

AWS D1.1/D1.1M.

2.3.2 Non-Shrink Grout

ASTM C1107/C1107M, with no ASTM C827/C827M shrinkage. Grout shall be nonmetallic.

2.3.3 Welded Shear Stud Connectors

AWS D1.1/D1.1M.

2.3.4 Pins and Rollers

ASTM A668/A668M, Class C, D, F, or G; ASTM A108, 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

See Specification section 09 97 13.00 40.

2.5 GALVANIZING

ASTM A123/A123M or ASTM A153/A153M, as applicable, unless specified otherwise galvanize after fabrication where practicable.

2.6 FABRICATION

2.6.1 Markings

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. Do not locate match markings in areas that will decrease member strength or cause stress concentrations. Affix embossed tags to hot-dipped galvanized members.

2.6.2 Shop Primer

2.6.2.1 Cleaning and Primer

See Specfication section 09 97 13.00 40.

2.6.3 Surface Finishes

ASME B46.1 maximum surface roughness of 125 for pin, pinholes, and sliding bearings, unless indicated otherwise.

2.7 DRAINAGE HOLES

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

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. The fabricating plant shall be certified under the AISC 201 for Category STD.

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 A6/A6M.

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 in accordance with Specification Section 09 97 13.00 40, STEEL COATINGS.

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.

3.2 INSTALLATION

3.3 ERECTION

a. Erection of structural steel, shall be in accordance with the applicable provisions of AISC 325 . Erection plan shall be reviewed, stamped and sealed by a licensed structural engineer.

3.3.1 STORAGE

Material shall be stored out of contact with the ground in such manner and location as will minimize deterioration.

3.4 CONNECTIONS

Except as modified in this section, connections not detailed shall be designed in accordance with AISC 360. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque

wrenches. Punch, subpunch and ream, or drill bolt 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.

3.4.1 Common Grade Bolts

ASTM A307 bolts 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.

3.4.2 High-Strength Bolts

ASTM A325 bolts shall be fully tensioned to 70 percent of their minimum tensile strength. 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 GAS CUTTING

Use of gas-cutting torch in the field for correcting fabrication errors will not be permitted on any major member in the structural framing. Use of a gas cutting torch will be permitted on minor members not under stress only after approval has been obtained from the Contracting Officer.

3.6 WELDING

See Specfication section 05 05 23.00 98, METAL FASTENINGS.

3.7 GALVANIZING REPAIR

See Specfication section 09 97 13.00 40, STEEL COATINGS.

3.8 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing, except that electric power for field tests will be furnished as set forth in Division 1. 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.

3.8.1 Welds

See Specification section 05 05 23.00 98, METAL FASTENINGS.

3.8.2 High-Strength Bolts

3.8.2.1 Testing Bolt, Nut, and Washer Assemblies

Test a minimum of 3 bolt, nut, and washer assemblies from each mill certificate batch in a tension measuring device at the job site prior to the beginning of bolting start-up. Demonstrate that the bolts and nuts, when used together, can develop tension not less than the provisions specified in AISC 360, depending on bolt size and grade. The bolt tension shall be developed by tightening the nut. A representative of the

manufacturer or supplier shall be present to ensure that the fasteners are properly used, and to demonstrate that the fastener assemblies supplied satisfy the specified requirements.

3.8.2.2 Inspection

Inspection procedures shall be in accordance with AISC 360. 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.

The Contractor shall inspect bolted connections in accordance with AISC 360.

3.8.2.3 Testing

The Contractor shall have an independent testing agency perform nondestructive tests on 10 percent of the installed bolts to verify compliance with pre-load bolt tension requirements.

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 Contractor shall allow access for the Government to perform the tests. 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 at the Contractor's expense. Retest new bolts after installation at the Contractor's expense.

3.8.3 Testing for Embrittlement

ASTM A143/A143M for steel products hot-dip galvanized after fabrication.

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SECTION 05 40 00

COLD-FORMED METAL FRAMING

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 IRON AND STEEL INSTITUTE (AISI)

AISI S100	(2007; Supp 1: 2009; Supp 2: 2010) North American Specification for the Design of Cold-Formed Steel Structural Members
AISI S200	(2007) North American Standard for Cold-Formed Steel Framing - General Provision
AISI S201	(2007) North American Standard for Cold-Formed Steel Framing - Product Data
AISI S202	(2011) Code of Standard Practice for Cold-formed Steel Structural Framing
AISI S211	(2007) North American Standard for Cold-Formed Steel Framing - Wall Stud Design
AISI S212	(2007) North American Standard for Cold-Formed Steel Framing - Header Design
AISI S213	(2007; Suppl 1 2009) North American Standard for Cold-Formed Steel Framing - Lateral Design
AISI SG02-KIT	(2001; Supp 1 2004) North American Specification for the Design of Cold-Formed Steel Structural Members
AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2012; Errata 2011) Structural Welding Code - Steel
AWS D1.3/D1.3M	(2008; Errata 2008) Structural Welding Code - Sheet Steel

ASTM INTERNATIONAL (ASTM)

ASTM A1003/A1003M	(2012) Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members
ASTM A1011/A1011M	(2012) 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 A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A370	(2011a) Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C1007	(2011a) Standard Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories
ASTM C1513	(2012) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections
ASTM C955	(2011c) Load-Bearing (Transverse and Axial) Steel Studs, Runners (Tracks), and Bracing or Bridging for Screw Application of Gypsum Panel Products and Metal Plaster Bases
ASTM E119	(2012a) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E329	(2011c) Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction
ASTM F1941	(2010) Standard Specification for Electrodeposited Coatings on Threaded Fasteners (Unified Inch Screw Threads (UN/UNR))

ASTM F1941M	(2007) Standard Specification for Electrodeposited Coatings on Threaded Fasteners (Metric)

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. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Framing Components; G

a. 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.

b. Connection details showing fastener type, quantity, location, and other information to assure proper installation.

c. Drawings depicting panel configuration, dimensions, components, locations, and construction sequence if the Contractor elects to install prefabricated/prefinished frames.

SD-03 Product Data

Steel studs,joists, tracks, bracing, bridging and accessories

SD-05 Design Data

Metal framing calculations; G

SD-07 Certificates

Load-bearing cold-formed metal framing

Mill certificates or test reports from independent testing agency, qualified in accordance with ASTM E329, 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 A370.

Welds

Certified copies of welder qualifications test records showing qualification in accordance with AWS D1.3/D1.3M.

1.3 DELIVERY, STORAGE, AND HANDLING

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 an 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. Steel framing and related accessories shall be stored and handled in accordance with the AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing".

1.4 LOAD-BEARING COLD-FORMED METAL FRAMING

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 SG03-3.

1.5 MAXIMUM DEFLECTION

a. Studs:

Deflection Criteria	Exterior Finish
L/240 or L/360	Synthetic Plaster, Metal Panels
L/360	Cement Plaster, Wood Veneer
L/600	Brick Veneer, Stone Panels

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.

1.6 QUALITY ASSURANCE

a. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

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 installations of cold-formed metal framing that are similar to those indicated for this project in material, design, and extent.

c. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E329 for testing indicated.

d. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

e. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel".

2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel".

f. Fire-Test-Response Characteristics: Where indicated, provide cold-formed metal framing identical to that of assemblies tested for fire resistance per ASTM E119 by, and displaying a classification label from, a testing and inspecting agency acceptable to authorities having jurisdiction.

g. AISI Specifications and Standards: Comply with:

1. AISI S100, "North American Specification for the Design of Cold-Formed Steel Structural Members".

2. AISI S200, "North American Standard for Cold-Formed Steel Framing - General Provision".

3. AISI S201, "North American Standard for Cold-Formed Steel Framing - Product Data".

4. AISI S202, "Code of Standard Practice for Cold-Formed Steel Structural Framing".

5. AISI S211, "North American Standard for Cold-Formed Steel Framing - Wall Stud Design".

6. AISI S212, "North American Standard for Cold-Formed Steel Framing - Header Design".

7. AISI S213, "North American Standard for Cold-Formed Steel Framing - Lateral Design".

1.6.1 Drawing Requirements

Submit framing components to show sizes, thicknesses, layout, material designations, methods of installation, and accessories.

1.6.2 Design Data Required

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

Framing components shall comply with ASTM C955 and the following.

a. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

b. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: ST33H (ST230H) ST50H (ST340H) .

2. Coating: G60 (Z180).

c. Steel Sheet for Vertical Deflection Clips: ASTM A1003/A1003M, ASTM A653/A653M, structural steel, zinc coated, of grade and coating as

follows:

1. Grade: As required by structural performance.

2. Coating: G90 (Z275).

d. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0428 inch.

2. Flange Width: 1-5/8 inches.

e. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0538 inch.

2. Flange Width: 1-1/4 inches.

2.1.1 Studs and Joists of 16 Gage (0.0538 Inch) and Heavier

Galvanized steel, ASTM A653/A653M and ASTM A1003/A1003M, SS Grade 50,; or carbon steel, ASTM A1011/A1011M, Grade 50, painted.

2.1.2 Studs and Joists of 18 Gage (0.0478 Inch) and Lighter

Studs and Joists of 18 Gage (0.0428 Inch) and Lighter, Track, and Accessories (All Gages): Galvanized steel, ASTM A653/A653M and ASTM A1003/A1003M, Grade 50 33,000.

2.1.3 Sizes, Gages, Section Modulus, and Other Structural Properties

Size and gage as indicated.

2.2 MARKINGS

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:

a. An ICC number.

b. Manufacturer's identification.

c. Minimum delivered uncoated steel thickness.

d. Protective coating designator.

e. Minimum yield strength.

2.3 CONNECTIONS

Screws for steel-to-steel connections shall be self-drilling, tapping screws in compliance with ASTM C1513 of the type, size and location as shown on the drawings. Electroplated screws shall have a minimum 5 micron zinc coating in accordance with ASTM F1941. Screws, bolts, and anchors shall be hot-dipped galvanized in accordance with ASTM A123/A123M or

ASTM A153/A153M as appropriate. Screws bolts, and anchors shall be hot dipped galvanized in accordance with ASTM A123/A123M or ASTM A153/A153M as appropriate.

2.4 PLASTIC GROMMETS

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

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 in the design calculations.

3.1.1 Welds

All welding shall be performed in accordance with AWS D1.3/D1.3M, as modified by AISI SG02-KIT. All welders, welding operations, and welding procedures shall be qualified according to AWS D1.3/D1.3M. All welds shall be cleaned and coated with rust inhibitive galvanizing paint. Do not field weld materials lighter than 18 gage.

3.1.2 Screws

Screws shall be of the self-drilling self-tapping 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 SG02-KIT. Screws covered by sheathing materials shall have low profile heads.

3.1.3 Anchors

Anchors shall be of the type, size, and location shown on the drawings.

3.1.4 Powder-Actuated Fasteners

Powder-actuated fasteners shall be of the type, size, and location shown on the drawings.

3.2 INSTALLATION

Install cold-formed framing in accordance with ASTM C1007 and AISI S200.

Install cold-formed steel framing according to AISI S202 and to manufacturer's written instructions unless more stringent requirements are indicated.

3.2.1 Tracks

Provide accurately aligned runners 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

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 SG03-3, 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 Erection Tolerances

a. 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.

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SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS

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 ADM	(2010) Aluminum Design Manual
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 SAFETY ENGINEERS (ASSE/SAFE)

ASSE/SAFE A10.3	(2006) Operations - Safety Requirements for Powder Actuated Fastening Systems

ASME INTERNATIONAL (ASME)

ASME B18.2.1	(2010) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(2010) Standard for Square and Hex Nuts
ASME B18.21.1	(2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
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	(2010) Machine Screws, Tapping Screws, and Machine Drive Screws (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A283/A283M	(2003; R 2007) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	(2010) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A325	(2010) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A36/A36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A500/A500M	(2010a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A529/A529M	(2005; R 2009) Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A786/A786M	(2005; R 2009) Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates
ASTM A924/A924M	(2010a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM B108/B108M	(2011) Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2012) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

ASTM B26/B26M	(2011) Standard Specification for Aluminum-Alloy Sand Castings
ASTM C1513	(2012) Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections
ASTM D2047	(2011) Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(2009) Metal Bar Grating Manual

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Aluminum Platforms, fabrication drawings, including description of connections; G

Aluminum Platforms, installation drawings, including description of temporary supports; G

Access doors and panels, installation drawings; G

Cover plates and frames, installation drawings; G

Floor gratings, installation drawings; G

Embedded angles and plates, installation drawings; G

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; G

Cover plates and frames

Floor gratings

1.3 QUALIFICATION OF WELDERS

See Specification section 05 05 23.00 98.

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. ASTM A529/A529M, Grade 50.

2.1.2 Structural Tubing

ASTM A500/A500M.

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 Grating and Planking

a. Metal plank, non-slip requirement, aluminum ASTM B209, 6061-T6; steel ASTM A653/A653M, G90.

b. 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 14 gage.

2.1.7 Anchor Bolts

ASTM A325. 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 as indicated on contract drawings.

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 to 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 B18.21.1.

2.1.8 Aluminum Alloy Products

Conform to ASTM B209 for sheet plate, ASTM B221 for extrusions and ASTM B26/B26M or ASTM B108/B108M for castings, as applicable. Provide aluminum extrusions at least 1/8 inch thick and aluminum plate or sheet at least 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, 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 shop 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. Repair field damaged surfaces in accordance with Specification section 09 97 13.00 40.

2.2.4 Steel Coatings

See Specification section 09 97 13.00 40.

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 14 gage with welded joints and anchorage for securing into construction. Provide access doors with a minimum of 14 by 20 inches and of not lighter than 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 COVER PLATES AND FRAMES

Fabricate cover plates of 1/4 inch thick rolled steel weighing not more than 100 pounds per plate with a selected raised pattern nonslip top surface, 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 galvanized. 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 15 feet. Provide flush drop handles for removal formed from 1/4 inch round stock where indicated. 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 1/8 inch clearance at edges and between cover plates.

2.5 FLOOR GRATINGS

Design steel grating in accordance with NAAMM MBG 531 for bar type grating or manufacturer's charts for plank grating. Galvanize steel floor gratings.

a. NAAMM MBG 531, band ends of gratings with bars of the same or greater thickness than the metal used for grating. Weld banding bars to the bearing bars or channels at least every fourth bar or channel and in every corner. Tack weld intervening bars or channels. Band diagonal or round cuts by welding bars of the same or greater thickness metal used for grating in accordance with the manufacturer's standard for trim unless otherwise indicated.

b. Attach gratings to structural members by welding. Connect to structural members according to contract drawings.

c. Slip resistance requirements must exceed both wet and dry a static coefficient of friction of 0.5.

2.6 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 welds. Construct to have at least 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.

2.7 ALUMINUM PLATFORMS

Provide aluminum platforms as indicated. Conform to AA ADM for design, fabrication and installation of aluminum platforms.

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

See Specification Section 05 05 23.00 98.

3.6 FINISHES

3.6.1 Dissimilar Materials

Where dissimilar metals are in contact, protect surfaces with teflon isolator material to prevent galvanic or corrosive action.

3.7 COVER PLATES AND FRAMES

Install the tops of cover plates and frames flush with floor.

-- End of Section --

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DIVISION 05 - METALS

SECTION 05 51 00

METAL STAIRS

PART 1 GENERAL

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2.3 CONCRETE INSERTS
2.4 MASONRY ANCHORAGE DEVICES
2.5 FASTENERS
2.6 GENERAL FABRICATION
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2.8.2 Stair Framing
2.8.3 Steel Floor Plate Treads and Platforms
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3.1 STEEL STAIRS
3.2 FIELD WELDING
3.3 TOUCHUP PAINTING

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SECTION 05 51 00

METAL STAIRS

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 314	(1990; R 2008) Standard Specification for Steel Anchor Bolts

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2010) Specification for Structural Steel Buildings

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2012; Errata 2011) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A27/A27M	(2010) Standard Specification for Steel Castings, Carbon, for General Application
ASTM A283/A283M	(2003; R 2007) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A307	(2010) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A36/A36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A653/A653M	(2011) Standard Specification for Steel

	Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM C514	(2004; R 2009e1) Standard Specification for Nails for the Application of Gypsum Board
ASTM E488	(1996; R 2003) Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM MBG 531	(2009) Metal Bar Grating Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2012; Amendment 1 2012) Life Safety Code

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

29 CFR 1910.24	Fixed Industrial Stairs

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Iron and Steel Hardware; G

Steel Shapes, Plates, Bars and Strips; G

Metal Stair System; G

SD-03 Product Data

Structural Steel Plates, Shapes, and Bars; G

Protective Coating; G

Steel Stairs; G

Stairs; G

Concrete Inserts; G

Masonry Anchorage Devices; G

1.3 QUALIFICATIONS FOR WELDING WORK

Section 05 05 23.00 98 WELDING, STRUCTURAL applies to work specified in

this sectio:PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

Submit complete and detailed fabrication drawings for all iron and steel hardware, and for all steel shapes, plates, bars and strips used in accordance with the design specifications referenced in this section.

Pre-assemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

For the fabrication of work exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, prior to cleaning, treating, and application of surface finishes, including zinc coatings.

2.2 STRUCTURAL STEEL PLATES, SHAPES AND BARS

Structural-size shapes and plates, conforming to ASTM A36/A36M, unless otherwise noted, except bent or cold-formed plates.

Steel plates - bent or cold-formed, conforming to ASTM A283/A283M, Grade C.

Steel bars and bar-size shapes, conforming to ASTM A36/A36M, unless otherwise noted for steel bars and bar-size shapes.

2.3 CONCRETE INSERTS

Threaded-type concrete inserts consisting of galvanized ferrous castings, internally threaded to receive 3/4-inch diameter machine bolts; either malleable iron conforming to ASTM A47/A47M or cast steel conforming to ASTM A27/A27M, hot-dip galvanized in accordance with ASTM A153/A153M.

Carbon steel bolts having special wedge-shaped heads, nuts, washers, and shims and galvanized in accordance with ASTM A153/A153M. Provide slotted-type concrete inserts consisting of galvanized1/8-inch thick pressed steel plate conforming to ASTM A283/A283M; of box-type welded construction with slot designed to receive 3/4-inch diameter square-head bolt with knockout cover; and be hot-dip galvanized in accordance with ASTM A123/A123M.

2.4 MASONRY ANCHORAGE DEVICES

Provide masonry anchorage devices consisting of expansion shields complying with AASHTO M 314, ASTM E488 and ASTM C514 as follows:

c. Bolt anchor expansion shields for lag bolts; zinc-alloy, long shield anchors class, Group II, Type 1, Class 1.2.5 FASTENERS

Galvanized zinc-coated fasteners in accordance with ASTM A153/A153M and suitable for exterior applications. Select fasteners for the type, grade, and class required for the installation of steel stair items.

Standard/regular hexagon-head bolts and nuts be conforming to ASTM A307, Grade A.

2.6 GENERAL FABRICATION

Prepare and submit metal stair system shop drawings with detailed plans and elevations at not less than 1 inch to 1 foot with details of sections and connections at not less than 3 inches to 1 foot. Also detail placement drawings, diagrams, templates for installation of anchorage, including but not limited to, anchor bolts, and miscellaneous metal items having integral anchorage devices.

Use materials of size and thicknesses indicated or, if not indicated, of required size and thickness to produce adequate strength and durability in finished product for intended use. Work materials to dimensions indicated on approved detail drawings, using proven details of fabrication and support. Use type of materials indicated or specified for the various components of work.

Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32 inch, and bend metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

Continuously weld corners and seams in accordance with the recommendations of AWS D1.1/D1.1M. Grind smooth exposed welds and flush to match and blend with adjoining surfaces.

Form exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type indicated or, if not indicated, use Phillips flathead (countersunk) screws or bolts.

Provide and coordinate anchorage of the type indicated with the supporting structure. Fabricate anchoring devices, space as indicated and required to provide adequate support for the intended use of the work.

Use hot-rolled steel bars for work fabricated from bar stock unless work is indicated or specified as fabricated from cold-finished or cold-rolled stock.

2.7 PROTECTIVE COATING

Steel stairs are to be painted according to specification Section 09 97 13.00 98 STEEL COATINGS.

2.8 STAIRS

2.8.1 General

Fabricate stairs conforming to 29 CFR 1910.24 and NFPA 101.

2.8.2 Stair Framing

Fabricate stringers of structural steel channels, or plates, or a combination thereof as indicated. Provide closures for exposed ends of strings.

Construct platforms of structural steel channel headers and miscellaneous framing members as indicated. Bolt headers to stringers and newels and framing members to stringers and headers.

2.8.3 Steel Floor Plate Treads and Platforms

Provide raised pattern steel floor plate fabricated from steel complying with ASTM A36/A36M. Provide pattern as indicated or, if not indicated, as selected from manufacturer's standard patterns.

Form treads of 1/4-inch thick steel floor plate with integral nosing and back edge stiffener. Weld steel supporting brackets to strings and treads to brackets.

Fabricate platforms of steel floor plate to thickness indicated. Provide nosing that match treads at landings. Secure floor plates to platform framing members with welds.

2.8.4 Safety Treads

NAAMM MBG 531 steel, Type W ASTM A653/A653M.

2.8.5 Steel Stairs

Provide steel stairs complete with stringers, steel floor plate treads, landings, columns, handrails, and necessary bolts and other fastenings, and accessories.

2.8.5.1 Design Loads

Design stairs to sustain a live load of not less than 100 pounds per square foot, or a concentrated load of 320 pounds applied where it is most critical. Conform to AISC 360 with the design and fabrication of steel stairs, other than a commercial product. Design stairs to conform to NFPA 101.

2.8.5.2 Materials

Provide steel stairs of welded construction except that bolts may be used where welding is not practicable. Screw or screw-type connections are not permitted.

a. Structural Steel: ASTM A36/A36M.

b. Steel floor plate for treads and landings. Where shown on the drawings, provide gratings for Treads and Landings: NAAMM MBG 531 Provide gratings with nonslip nosings.

c. Support steel floor plate or steel grating, where indicated, on angle cleats welded to stringers or treads with integral cleats, welded or bolted to the stringer. Provide sheet-steel landings with angle stiffeners welded on. Close exposed ends. Form all exposed joints to exclude water. Provide bent plate for tread and 1/4" stiffened stub plate for landing supports.

d. Before fabrication, obtain necessary field measurements and verify drawing dimensions.

e. Clean metal surfaces free from mill scale, flake rust and rust pitting prior to shop finishing. Weld permanent connections. Finish welds flush and smooth on surfaces that will be exposed after installation.

PART 3 EXECUTION

3.1 STEEL STAIRS

Provide anchor bolts, grating fasteners, washers, and all parts or devices necessary for proper installation. Provide lock washers under nuts.

3.2 FIELD WELDING

Execute procedures of manual shielded metal arc welding, appearance and quality of welds made, and methods used in correcting welding work in compliance with Section 05 05 23.00 98 Metal Fastenings.

3.3 TOUCHUP PAINTING

Immediately after installation, clean all field welds, bolted connections, and abraded areas of the shop painted material, and repaint exposed areas in accordance with Section 09 97 13.00 98 STEEL COATINGS.

-- End of Section --

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SECTION 05 51 33

METAL LADDERS

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2.2 FABRICATION FINISHES
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2.2.2 Galvanize
2.2.3 Repair of Zinc-Coated Surfaces
2.2.4 Shop Cleaning and Painting
2.2.4.1 Surface Preparation
2.2.4.2 Pretreatment, Priming and Painting
2.3 LADDERS
2.3.1 Ladder Safety Ssytem

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS
3.2 WORKMANSHIP
3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS
3.4 WELDING
3.5 FINISHES
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3.6 LADDERS

-- End of Section Table of Contents --

SECTION 05 51 33

METAL LADDERS

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 A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A36/A36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A47/A47M	(1999; R 2009) Standard Specification for Ferritic Malleable Iron Castings
ASTM A500/A500M	(2010a) 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	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A924/A924M	(2010a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

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

29 CFR 1910.27 Fixed Ladders

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Ladders, installation drawings; G

1.3 QUALIFICATION OF WELDERS

Qualify welders in accordance with 05 05 23.00 98 METAL FASTENINGS. 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.

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.

2.2 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, G90, as applicable.

2.2.2 Galvanize

Anchor bolts, washers, and parts or devices necessary for proper installation, unless indicated otherwise.

2.2.3 Repair of Zinc-Coated Surfaces

Repair shop 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.

Repair field damaged surfaces in accordance with Section 09 97 13.00 98, STEEL COATINGS.

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. Wash cleaned surfaces which become contaminated with rust, dirt, oil, grease, or other contaminants with solvents until thoroughly clean.

2.2.4.2 Pretreatment, Priming and Painting

Paint ladders in accordance with Section 09 97 13.00 98 STEEL COATINGS.

2.3 LADDERS

Fabricate vertical ladders conforming to Section 7 of 29 CFR 1910.27. Use 2 1/2 by 3/8 inch steel flats for stringers and 3/4 inch diameter steel rods for rungs. Rungs to be not less than 16 inches wide, spaced one foot apart, plug welded or shouldered and headed into stringers. Install ladders so that the distance from the rungs to the finished wall surface will not be less than 7 inches. Provide heavy clip angles riveted or bolted to the stringer and drilled for not less than two 1/2 inch diameter expansion bolts as indicated. Provide intermediate clip angles not over 48 inches on centers.

2.3.1 Ladder Safety Ssytem

Conform to 29 CFR 1910.27. Provide 3/8-inch diameter wire rope for fastening to the side rungs of ladders or directly to the structure.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Install items at locations indicated. Verify all measurements and take all field measurements necessary before fabrication. Provide exposed fastenings of compatible materials, generally matching 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 will be cause for rejection. Conceal fastenings where practicable. Thickness of metal and details of assembly and supports must provide strength and stiffness. Items listed below require additional procedures.

3.2 WORKMANSHIP

Metalwork must be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching must produce clean true lines and surfaces. Continuously weld along the entire area of contact. Do not tack weld exposed connections of work in place. Grind smooth exposed welds. Provide smooth finish on exposed surfaces of work in place, unless otherwise approved. Where tight fits are required, mill joints. Cope or miter corner joints, well formed, and in true alignment. Install in accordance with approved drawings, cuts, and details.

3.3 ANCHORAGE, FASTENINGS, AND CONNECTIONS

Provide anchorage where necessary for fastening metal items securely in place. Make exposed fastenings of compatible materials, generally matching in color and finish, to which fastenings are applied. Conceal fastenings where practicable.

3.4 WELDING

Perform welding, welding inspection, and corrective welding, in accordance with Section 05 05 23.00 98 WELDING, STRUCTURAL. Use continuous welds on all exposed connections. Grind visible welds smooth in the finished installation.

3.5 FINISHES

3.5.1 Dissimilar Materials

Where dissimilar metals are in contact, protect surfaces with isolation material as shown on the drawings, to prevent galvanic or corrosive action.

3.6 LADDERS

Secure to the adjacent construction with the clip angles attached to the stringer. Install intermediate clip angles not over 48 inches on center. Install brackets as required for securing of ladders welded or bolted to structural steel. Ends of ladders must not rest upon floor.

-- End of Section --

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DIVISION 05 - METALS

SECTION 05 52 00

METAL RAILINGS

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SECTION 05 52 00

METAL RAILINGS

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 WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2012; Errata 2011) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2008) Structural Welding Code - Aluminum

ASME INTERNATIONAL (ASME)

ASME B18.2.1	(2010) Square and Hex Bolts and Screws (Inch Series)
ASME B18.21.1	(2009) Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)

ASTM INTERNATIONAL (ASTM)

ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A283/A283M	(2003; R 2007) Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A36/A36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A500/A500M	(2010a) 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 B429/B429M	(2010e1) Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 521	(2001) Pipe Railing Manual

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G

Iron and Steel Hardware; G

Steel Shapes, Plates, Bars and Strips

SD-03 Product Data

Structural Steel Plates, Shapes, and Bars; G

Structural Steel Tubing; G

Steel Railings and Handrails; G

Aluminum Railings and Handrails; G

Anchorage and Fastening Systems; G

SD-08 Manufacturer's Instructions

Installation Instructions; G

1.3 QUALITY ASSURANCE

1.3.1 Welding Procedures

Section 05 05 23.00 98 WELDING, STRUCTURAL applies to work specified in this section.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide complete, detailed fabrication and installation drawings for all iron and steel hardware, and for all steel shapes, plates, bars and strips used in accordance with the design specifications referenced in this section.

Pre-assemble items in the shop to the greatest extent possible. Disassemble units only to the extent necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

For the fabrication of work exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding, or by welding and grinding, prior to cleaning, treating, and application of surface finishes, including zinc coatings.

2.2 GENERAL FABRICATION

Provide fabrication drawings including railings and handrails detail plans and elevations at not less than 1 inch to 1 foot. Provide details of sections and connections at not less than 3 inches to 1 foot. Also detail setting drawings, diagrams, templates for installation of anchorages, including anchor bolts, and miscellaneous metal items having integral anchors.

Use materials of size and thicknesses indicated or, if not indicated, of required size and thickness to produce adequate strength and durability in finished product for intended use. Work materials to dimensions indicated on approved detail drawings, using proven details of fabrication and support. Use type of materials indicated or specified for the various components of work.

Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ensure all exposed edges are eased to a radius of approximately 1/32 inch. Bend metal corners to the smallest radius possible without causing grain separation or otherwise impairing the work.

Weld corners and seams continuously and in accordance with the recommendations of AWS D1.1/D1.1M or AWS D1.2/D1.2M. Grind exposed welds smooth and flush to match and blend with adjoining surfaces.

Form exposed connections with hairline joints that are flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of the type indicated or, if not indicated, use Phillips flathead (countersunk) screws or bolts.

Provide anchorage of the type indicated and coordinated with the supporting structure. Fabricate anchoring devices and space as indicated and as required to provide adequate support for the intended use of the work.

Use hot-rolled steel bars for work fabricated from bar stock unless work is indicated or specified to be fabricated from cold-finished or cold-rolled stock.

2.3 STRUCTURAL STEEL PLATES, SHAPES AND BARS

Provide structural-size shapes and plates, except plates to be bent or cold-formed, conforming to ASTM A36/A36M, unless otherwise noted.

Provide steel plates, to be bent or cold-formed,conforming to ASTM A283/A283M, Grade C.

Provide steel bars and bar-size shapes conforming to ASTM A36/A36M, unless otherwise noted.

2.4 STRUCTURAL STEEL TUBING

Provide structural steel tubing, hot-formed, welded or seamless, conforming to ASTM A500/A500M, Grade B, unless otherwise noted.

2.5 STEEL PIPE

Provide pipe conforming to ASTM A53/A53M, type as selected, Grade B; primed finish, unless galvanizing is required; standard weight (Schedule 40).

2.6 FASTENERS

Provide galvanized zinc-coated fasteners in accordance with ASTM A153/A153M suitable for exterior applications. Select fasteners for the type, grade, and class required for the installation of steel stair items.

Provide square-head lag bolts conforming to ASME B18.2.1.

Provide plain round, general-assembly-grade, carbon steel washers conforming to ASME B18.21.1.

Provide helical spring, carbon steel lockwashers conforming to ASME B18.2.1.

2.7 PROTECTIVE COATING

Prepare steelwork as indicated in accordance with Section 09 97 13.00 98 STEEL COATINGS.

2.8 STEEL RAILINGS AND HANDRAILS

Design guardrails and handrails to resist a concentrated load of 200 lbs in any direction at any point of the top of the rail or 20 lbs per foot applied horizontally to top of the rail, whichever is more severe. NAAMM AMP 521, provide the same size rail and post. Provide pipe collars of the same material and finish as the handrail and posts.

2.8.1 Steel Rails

Provide steel rails, including steel pipe conforming to ASTM A53/A53M or structural tubing conforming to ASTM A500/A500M, Grade A or B of equivalent strength. Provide steel railings of 1 1/2 or 2 inches nominal size, as shown on the drawings.

a. Fabrication: Joint posts, rail, and corners by the following method:

(1) Mitered and welded joints made by fitting post to top rail and intermediate rail to post, mitering corners, groove welding joints, and grinding smooth. Butt railing splices and reinforce them by a tight fitting interior sleeve not less than 6 inches long.

Provide toeboard between railing posts where indicated, and consist of 1/8-inch steel flat bars not less than 4 inches high. Secure toeboard as indicated.

2.9 ALUMINUM RAILINGS AND HANDRAILS

Provide railings and handrails consisting of 1 1/2 inch nominal schedule 40 pipe except where otherwise specified or loading conditions require 1-1/2" nominal schedule 80 pipe, per ASTM B429/B429M. Ensure all fasteners are type 316 stainless steel.

a. Fabrication: Provide jointing by the following method:

(1) Mitered and welded joints made by fitting post to top rail, intermediate rail to post, and corners, must be groove welded and

ground smooth. Provide butted splices, where allowed by the Contracting Officer, reinforced by a tight fitting dowel or sleeve not less than 6 inches in length. Tack weld or epoxy cement dowel or sleeve to one side of the splice.

b. Removable railing sections: Provide removable railing sections as indicated. Provide toeboards and brackets where indicated, using flange castings as appropriate.

PART 3 EXECUTION

3.1 INSTALLATION INSTRUCTIONS

Submit manufacturer's installation instructions for the following products to be used in the fabrication of hand rail work:

a. Anchorage and fastening systems

Provide complete, detailed fabrication and installation drawings for all iron and steel hardware, and for all steel shapes, plates, bars and strips used in accordance with the design specifications referenced in this section.

3.2 PREPARATION

Adjust stair railings and handrails prior to securing in place to ensure proper matching at butting joints and correct alignment throughout their length. Space posts not more than 5 feet on center. Plumb posts in each direction. Secure posts and rail ends as shown on the drawings.

Anchor posts in concrete by means of pipe sleeves set and anchored into concrete. Provide sleeves of galvanized, standard weight, steel pipe, not less than 6 inches long, and having an inside diameter not less than 1/2-inch greater than the outside diameter of the inserted pipe post. Provide steel plate closure secured to the bottom of the sleeve, with closure width and length not less than 1-inch greater than the outside diameter of the sleeve. After posts have been inserted into sleeves, fill the annular space between post and sleeve with molten lead, sulfur, or a quick-setting hydraulic cement. Cover anchorage joint with a round steel flange welded to the post.

Anchor posts to steel with steel oval flanges, angle type or floor type as required by conditions, welded to posts and bolted to the steel supporting members.

Anchor rail ends into concrete and masonry with steel round flanges welded to rail ends and anchored into the wall construction with lead expansion shields and bolts.

Anchor rail ends to steel with steel oval or round flanges welded to tail ends and bolted to the structural steel members.

Secure handrails to walls by means of wall brackets and wall return fitting at handrail ends. Provide brackets of malleable iron castings, with not less than 3-inch projection from the finish wall surface to the center of the pipe drilled to receive one 3/8-inch bolt. Locate brackets not more than 60 inches on center. Provide wall return fittings of cast iron castings, flush-type, with the same projection as that specified for wall brackets. Secure wall brackets and wall return fittings to building

construction as follows:

For concrete and solid masonry anchorage, use bolt anchor expansion shields and lag bolts.

Install toeboards and brackets where indicated. Make splices, where required, at expansion joints. Install removable sections as indicated.

3.3 STEEL RAIL

Install steel handrail by welding post to stringers or structural steel frame work with partial penetration welds. Weld toeboard to post.

3.4 ALUMINUM RAIL

Affix to base structure by base plates or flanges bolted to stringers or structural steel framework. Provide type 316 stainless steel bolts to anchor aluminum alloy flanges, of a size appropriate to the standard product of the manufacturer. Where aluminum or alloy fittings or extrusions are to be in contact with dissimilar metalsprovide isolation as noted on the drawings.

3.5 FIELD WELDING

Ensure procedures of manual shielded metal arc welding, appearance and quality of welds made, and methods used in correcting welding work comply with AWS D1.1/D1.1M.

3.6 TOUCHUP PAINTING

Immediately after installation, clean field welds, bolted connections, abraded areas and touch up finish in accordance with Sections 09 90 00.00 98 GENERAL COATINGS and 09 97 13.00 98 STEEL COATINGS as required..

-- End of Section --

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FABRICATED WALL PANEL ASSEMBLIES

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 ARCHITECTURAL MANUFACTURERS ASSOCIATION (AAMA)

AAMA 501.1	(2005) Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI S100	(2007; Supp 1: 2009; Supp 2: 2010) North American Specification for the Design of Cold-Formed Steel Structural Members
AISI SG03-3	(2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/UL 263	American National Standard Specification for Fire Resistance Ratings

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2010; Change 2010; Change 2011; Errata 2011; Change 2011) Minimum Design Loads for Buildings and Other Structures

AMERICAN WELDING SOCIETY (AWS)

AWS A5.1/A5.1M	(2012) Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding
AWS D1.1/D1.1M	(2012; Errata 2011) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2008) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM A1008/A1008M	(2012a) 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

ASTM A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A36/A36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A606/A606M	(2009a) Standard Specification for Steel Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM C273/C273M	(2011) Shear Properties of Sandwich Core Materials
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM D1056	(2007) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D1308	(2002; R 2007) Effect of Household Chemicals on Clear and Pigmented Organic Finishes
ASTM D1621	(2010) Compressive Properties of Rigid Cellular Plastics
ASTM D1622	(2008) Apparent Density of Rigid Cellular Plastics
ASTM D1667	(2005; R 2011) Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell)
ASTM D2244	(2011) Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates
ASTM D2247	(2011) Testing Water Resistance of Coatings in 100% Relative Humidity
ASTM D2794	(1993; R 2010) Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
ASTM D3363	(2005; E 2011; R 2011; E 2012) Film Hardness by Pencil Test
ASTM D4214	(2007) Standard Test Method for Evaluating the Degree of Chalking of Exterior Paint

	Films
ASTM D522	(1993a; R 2008) Mandrel Bend Test of Attached Organic Coatings
ASTM D523	(2008) Standard Test Method for Specular Gloss
ASTM D714	(2002; R 2009) Evaluating Degree of Blistering of Paints
ASTM D822	(2001; R 2006) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D968	(2005; R 2010) Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM E119	(2012a) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E136	(2012) Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C
ASTM E1592	(2005; R 2012) Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference
ASTM E283	(2004; R 2012) Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	(2000; R 2009) Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E662	(2012) Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
ASTM E84	(2012c) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM G152	(2006) Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	(2004; R 2010) Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

METAL BUILDING MANUFACTURERS ASSOCIATION (MBMA)

MBMA MBSM	(2002) Metal Building Systems Manual

NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (NAAMM)

NAAMM AMP 500 (2006) Metal Finishes Manual

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 701 (2010) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793 (2012) Architectural Sheet Metal Manual, 7th Edition

UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir (2012) Building Materials Directory

1.2 DEFINITIONS

Fabricated Wall Panel Assembly: Metal wall and liner panels, attachment system components, miscellaneous metal framing, thermal insulation, 2 Hr fire and accessories shop fabricated or field assembled for a complete weather-tight wall system.

1.3 DESCRIPTION OF FABRICATED WALL PANEL ASSEMBLY SYSTEM

Factory color finished, galvanized metal wall panel system with concealed fastening attachment. Panel profile must be embossed factory-formed and assembled from roll-formed exterior and interior steel facing sheets laminated to a structural mineral wool core, as shown on drawings.

1.3.1 Metal Wall Panel General Performance

Comply with performance requirements, conforming to AISI S100, without failure due to defective manufacture, fabrication, installation, or other defects in construction. Wall panels and accessory components must conform to the following standards:

ASTM A1008/A1008M
ASTM A123/A123M
ASTM A36/A36M
ASTM A653/A653M
ASTM A606/A606M
ASTM C273/C273M
ASTM D522 for applied coatings
UL Bld Mat Dir

1.3.2 Structural Performance

Maximum calculated fiber stress must not exceed the allowable value in the AISI or AA manuals. Midspan deflection under maximum design loads is limited to L/180. Contract drawings show 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.

Provide metal wall panel assemblies complying with the load and stress

requirements in accordance with ASTM E1592. Wind Load force due to wind action governs the design for panels.

Wall systems and attachments are to resist a 15 psf wind load.

1.3.3 Air Infiltration

Air leakage must conform to the limits through the wall assembly area when tested according to ASTM E283.

1.3.4 Water Penetration Under Static Pressure

No water penetration when tested according to ASTM E331.

1.3.5 Water Penetration Under Dynamic Pressure

No evidence of water leakage when tested according to AAMA 501.1.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification of Manufacturer; G
Qualification of Installer; G

SD-02 Shop Drawings

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.

Wall Panel Assemblies; G
Flashing and Accessories; G
Anchorage Systems; G
2HR Fire Fabric; G

Show fabrication and installation details for static smoke curtains (2HR fire fabric) as part of the 2HR rated flexible engineered fire assembly with mounting frame. Include plans, sections, details, attachments to other work, and the following:
-Requirement for supporting static smoke curtains (2HR fire fabric)
-Requirements for lapping joints.

SD-03 Product Data

Submit Manufacturer's catalog data for the following items:

Factory Color Finish; G
Sub-girts and Formed Shapes; G
Closure Materials; G
Insulation; G

Pressure Sensitive Tape; G
Sealants and Caulking; G
Rated Wall Assembly; G
Accessories; G

SD-04 Samples

Submit as required each of the following samples:

Wall Panel Assemblies; G, 12 inches long by actual panel width
Fasteners; G
Metal Closure Strips; G, 10 inches long of each type
Insulation; G, approximately 8 by 11 inches

Submit manufacturer's color charts and chips; G, approximately 4 by 4 inches, showing full range of colors, textures and patterns available for wall panels with factory applied finishes.

2HR Fire Fabric; G

For each type of fabric from dye lot to be used for the work, with specified treatments applied, and showing complete pattern and texture repeat, if any. Mark top and face of fabric. Prepare Samples of not less than 12 inches (305mm) square.

SD-05 Design Data

engineering calculations; G

SD-06 Test Reports

Submit test reports for the following in accordance with the referenced articles in this section.

Leakage Tests; G

Coatings and base metals of metal wall type of test as specified in paragraphs entitled, "Steel Sheet Materials," and in various referenced standards in this section.

Factory Color Finish Performance Requirements

SD-07 Certificates

Submit certificates for the following items showing conformance with referenced standards contained in this section:

Fasteners

Provide evidence that products used within this specification are manufactured in the United States.

Qualification of Manufacturer

Certify that the manufacturer of the metal wall panel system meets requirements specified under paragraph entitled "Qualification of Manufacturer."

Qualification of Installer

Certify that the applicator meets requirements specified under paragraph entitled "Qualification of Installation Contractor."

Submit the wall system assembly wind load and fire rating classification listings.; G

SD-08 Manufacturer's Instructions

Installation of Wall panels; G

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.

SD-11 Closeout Submittals

Warranty
Instructions To:
Government and/or Contractor Personnel
Include copies of Material Safety Data Sheets for maintenance/repair materials.

Submit warranty for labor and materials.

1.5 QUALITY ASSURANCE

1.5.1 Pre-Installation Conference

After submittals are received and approved but before wall panel and insulation work, including associated work, is performed, the Contracting Officer will hold a pre-siding 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:

flashing and accessories
anchorage systems
manufacturer's catalog data
Factory Color Finish

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.

Sub-girts and Formed Shapes
Closure Materials, including metal closure strips.
Insulation
Pressure Sensitive Tape
Rated Wall Assembly test data
Accessories
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. Include wall plan delineating dimensions and attachment patterns for each zone.

e. Flashing, 2 HR fire fabric, 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 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.

i. Sample Warranty.

1.5.2 Manufacturer's Technical Representative

The representative must have authorization from manufacturer to approve field changes and be thoroughly familiar with the products and installations in the geographical area where construction will take place.

1.5.3 Qualification of Manufacturer

Metal wall panel system manufacturer must have:

a. A minimum of five (5) years experience in manufacturing metal wall system and accessory products.

b. Provide engineering services by an authorized engineer; currently licensed in the geographical area where construction will take place, having a minimum of four (4) years experience as an engineer knowledgeable in wind load design analysis, protocols and procedures for the MBMA MBSM; ASCE 7, and ASTM E1592.

c. Provide certified engineering calculations using the products submitted for:

Wind load requirements in accordance with FM Wind Design Guide.

1.5.4 Qualification of Installer

The installation contractor must be approved and certified by the wall panel manufacturer prior to beginning the installation of the metal wall system.

1.5.4.1 Qualifications for Welding Work

Welding procedures must conform to AWS A5.1/A5.1M, AWS D1.1/D1.1M for steel

or AWS D1.2/D1.2M for aluminum.

1.5.5 Single Source

Obtain each type of metal wall and liner panels, clips, closures and other accessories from the standard products of the single source from a single manufacturer to operate as a complete system for the intended use.

1.5.6 Surface-Burning Characteristics

Provide metal wall panels having insulation core material with the following surface-burning characteristics as determined by testing identical products according to ASTM E84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 450 or less.

1.5.7 Fire-Resistance Ratings

Where indicated, provide metal wall panels identical to those of assemblies tested for fire resistance per ASTM E119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
Combustion Characteristics: ASTM E136.

1.5.8 Fabrication

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 and with dimensional and structural requirements.

Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

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.

1.5.8.1 Sheet Metal Accessories

Fabricate flashing and trim to comply with recommendations in SMACNA 1793 that apply to the design, dimensions, metal, and other characteristics of item indicated:

a. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

b. End Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

c. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

d. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

e. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA or by metal wall panel manufacturer for application, but not less than thickness of metal being secured.

1.5.9 Finishes

Comply with NAAMM AMP 500 for recommendations for applying and designating finishes.

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, HANDLING, AND STORAGE

Deliver and package components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed and protected during transportation and handling.

Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.

Stack and store metal wall panels horizontally on platforms or pallets, covered with suitable weather-tight and ventilated covering to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.

Retain strippable protective covering on metal wall panel for period of metal wall panel installation.

Protect foam-plastic insulation as follows:

a. Do not expose to sunlight, except to extent necessary for period of installation and concealment.

b. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.

Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.7 PROJECT CONDITIONS

Weather Limitations: Proceed with installation preparation only when existing and forecasted weather conditions permit Work to proceed without water entering into existing walling system or building.

Field Measurements: Verify locations of wall framing and opening dimensions by field measurements before metal wall panel fabrication and indicate measurements on Shop Drawings.

1.8 WARRANTY

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 of the defective workmanship is to be the responsibility of the metal wall panel system manufacturer.

PART 2 PRODUCTS

2.1 PANEL MATERIALS

2.1.1 Steel Sheet

Roll-form steel wall and liner panels to the specified profile, with fy = 24 gauge and depth as indicated. Material must be plumb and true, and within the tolerances listed:

a. Galvanized Steel Sheet conforming to ASTM A653/A653M and AISI SG03-3.

b. Individual panels to have continuous length to cover the entire length of any unbroken wall area with no joints or seams and formed without warping, waviness, or ripples that are not part of the panel profile and free of damage to the finish coating system.

c. Provide panels with thermal expansion and contraction consistent with the type of system specified.

1. Embossed surface texture.

2.1.2 Laminated Fire-Resistive Metal Panel

Provide factory-formed and assembled metal panels fabricated from roll-formed exterior and interior steel facing sheets laminated to a structural mineral wool core designed to form weather-tight seals. Include accessories required for weather-tight installation.

a. Fire Resistance Wall: 2 hour for non-load bearing when tested according to ANSI/UL 263 per UL Design U050.

b. Mineral Core Density: Nominal 8.5 lb/cu. ft. when tested according to ASTM D1622.

c. Compressive Strength: Minimum 20 psi when tested according to ASTM D1621.

d. Shear Strength: 26 psi when tested according to ASTM C273/C273M.

e. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects.

2.1.3 Finish

All panels are to receive a factory-applied Kynar 500/Hylar 5000 finish consisting of a baked-on top-coat with a manufacturer's recommended prime coat conforming to the following:

a. Metal Preparation: All metal is to have the surfaces carefully prepared for painting on a continuous process coil coating line by alkali cleaning, hot water rinsing, application of chemical conversion coating, cold water rinsing, sealing with acid rinse, and thorough drying.

b. Prime Coating: A base coat of epoxy paint, specifically formulated to interact with the top-coat, is to be applied to the prepared surfaces by roll coating to a dry film thickness of 0.20 plus 0.05 mils. This prime coat must be oven cured prior to application of finish coat.

c. Exterior Finish Coating: Apply the finish coating over the primer by roll coating to dry film thickness of 0.80 plus 5 mils (3.80 plus 0.50 mils for Vinyl Plastisol) for a total dry film thickness of 1.00 plus 0.10 mils (4.00 plus 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 0.30 plus 0.05 mils for a total dry film thickness of 0.50 plus 0.10 mils. The wash-coat must be oven-cured.

e. Color: The exterior finish chosen from the manufacturer's 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:

Chalking:	ASTM D4214
Color Change and Conformity:	ASTM D2244
Weatherometer:	ASTM G152, ASTM G153 and ASTM D822
Humidity:	ASTM D2247 and ASTM D714
Salt Spray:	ASTM B117
Chemical Pollution:	ASTM D1308
Gloss at 60:	ASTM D523
Pencil Hardness:	ASTM D3363
Reverse Impact:	ASTM D2794
Flexibility:	ASTM D522

Abrasion:	ASTM D968
Flame Spread:	ASTM E84

2.2 MISCELLANEOUS METAL FRAMING

2.2.1 General

Cold-formed metallic-coated steel sheet conforming to ASTM A653/A653M and specified in Division 05 Section 05 40 00 "Cold-Formed Metal Framing" unless other wise indicated.

2.2.2 Fasteners for Miscellaneous Metal Framing

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 7 requirements.

2.3 FASTENERS

2.3.1 General

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 7 requirements.

2.3.2 Exposed Fasteners

Fasteners for wall panels to be corrosion resistant coated steel, aluminum, stainless steel, or nylon capped steel compatible with the sheet panel or flashing and of a type and size recommended by the manufacturer to meet the performance requirements and design loads. Fasteners for accessories to be the manufacturer's standard. Provide an integral metal washer matching the color of attached material with compressible sealing EPDM gasket approximately 3/32 inches thick.

2.3.3 Screws

Screws to be corrosion resistant coated steel, aluminum and/or stainless steel being the type and size recommended by the manufacturer to meet the performance requirements.

2.3.4 Rivets

Rivets to be closed-end type, corrosion resistant coated steel, aluminum or stainless steel where watertight connections are required.

2.3.5 Attachment Clips

Fabricate clips from steel hot-dipped galvanized in accordance with ASTM A653/A653M steel. Size, shape, thickness and capacity as required meeting the insulation thickness and design load criteria specified.

2.4 ACCESSORIES

2.4.1 General

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.

2.4.2 Rubber Closure Strips

Closed-cell, expanded cellular rubber conforming to ASTM D1056 and ASTM D1667; extruded or molded to the configuration of the specified wall panel and in lengths supplied by the wall panel manufacturer.

2.4.3 Metal Closure Strips

Factory fabricated steel closure strips to be the same gauge, color, finish and profile of the specified wall panel.

2.4.4 Joint Sealants

2.4.4.1 Sealants and Caulking

Sealants are to be an approved gun type for use in hand- or air-pressure caulking guns at temperatures above 40 degrees F (or frost-free application at temperatures above 10 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.

Prime all joints to receive sealants with a compatible one-component or two-component primer as recommended by the wall panel manufacturer.

2.4.4.2 Shop-Applied

Sealant for shop-applied caulking must be an approved gun grade, non-sag one component polysulfide or silicone conforming to ASTM C920, Type II, and with a curing time to ensure the sealant's plasticity at the time of field erection.

2.4.4.3 Field-Applied

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 C920, Type II. Color to match panel colors.

2.4.4.4 Tape Sealant

Pressure sensitive, 100 percent solid with a release paper backing; permanently elastic, non-sagging, non-toxic and non-staining as approved by the wall panel manufacturer.

2.5 ROOF OPENING FOR ACCESS DOOR

Fabricated from same material, finish, and color as exterior facings of roof panels; with bottom of skirt profiled to match panel profiles and with welded top box and integral full-length cricket. Fabricate opening subframing of 0.060-inch (1.52-mm-) nominal thickness, angle-, C-, or Z-shaped steel sheet. Fabricate opening and subframing to withstand indicated loads of size and height indicated. Finish to match metal roof panels.

Refer to Section 07 72 33 Roof/Ceiling Hatches for access doors and panels.

2.6 SHEET METAL FLASHING AND TRIM

2.6.1 Fabrication

Shop fabricate sheet metal flashing and trim where practicable to comply with recommendations in SMACNA 1793 that apply to design, dimensions, metal, and other characteristics of item indicated. Obtain field measurements for accurate fit before shop fabrication.

Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.

2.7 REPAIR OF FINISH PROTECTION

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.

2.8 2HR FIRE FABRIC

Provide Static Fire Protective Smoke Curtains (2HR Fire Fabric), as available from manufacturers:

1. U.S. Smoke & Fire, 888-917-8777, 888-917-5612 - www.ussmokeandfire.com
2. Smoke Guard, 800-574-0330 - www.smokeguard.com

The fabric curtain shall be manufactured C41000WK fiber cloth incorporating a "Panama" weave for increased stability. The woven glass fiber fabric shall be UL listed for two hours.

2.8.1 Required Test Reports & Minimum Performance Standards

Underwriter Laboratory Label Requirement for Fire Protective Smoke Curtains (2HR Fire Fabric) Testing Report, Label Requirements, and the following Minimum Performance Standard:

a) UL Labeled, Listed, Classified, Certified and Marked -10D Fire Protective Curtains (2 hours).
b) UL Oversize Certificate Labeled, Listed, Classified, Certified and Marked
c) ASTM E84 - 10 test report with a calculated smoke developed (CSD) of 2 and a smoke developed index (SDI) of 0 and a calculated Flame spread (CFS) of 0.
d) ASTM E119, ANSI/UL 263- Time/temperature curves for 2 hours.
e) ASTM E662 - Smoke Density Test.

f) ASTM E136 Base Substrate
g) NFPA 701 Large Scale Test
h) NFPA 701 Small Scale Test
i) UL Follow up Service Report Required

Note: "Tested in Accordance to" standard not acceptable for Fire Protective Curtains. Intertek label is not acceptable.

PART 3 EXECUTION

3.1 EXAMINATION

A. 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.

B. 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 7 and as required for the geographical area where construction will take place.

C. 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.

D. 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.

E. Submit to the Contracting Officer a written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.

B. Miscellaneous Framing: Install sub-purlins, girts, angles, furring, and other miscellaneous wall panel support members and anchorage according to metal wall panel manufacturer's written instructions.

3.3 WALL PANEL INSTALLATION

Provide metal wall panels of full length from sill to eave as indicated, 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.

a. Steel Wall Panels: Use stainless-steel fasteners for exterior surfaces and galvanized steel fasteners for interior surfaces.

b. Anchor Clips: Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturer's written instructions.

c. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal wall panel manufacturer.

d. 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.

Erect wall panel system in accordance with the approved erection drawings, the printed instructions and safety precautions of the manufacturer.

Sheets are not to be subjected to overloading, abuse, or undue impact. Bent, chipped, or defective sheets shall not be applied.

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 eave, and sill.

Work is to allow for thermal movement of the wall panel, movement of the building structure, and to provide permanent freedom from noise due to wind pressure.

Field cutting metal wall panels by torch is not permitted.

3.4 ROOF OPENINGS

Install flashing around access doors and panels where they meet metal panels.

3.5 FASTENER INSTALLATION

Anchor metal wall panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturer's written instructions.

3.6 FLASHING, TRIM AND CLOSURE INSTALLATION

3.6.1 General Requirements

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.

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.

3.6.2 Metal Flashing

Exposed metal flashing is to be installed at building corners, sills and eaves, junctions between metal siding and walling.

Exposed metal flashing is to be the same material, color, and finish as the specified metal wall panel.

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.

Flashing is to be furnished in at least 8 foot lengths. Exposed flashing is to have 1 inch locked and blind-soldered end joints, and expansion joints at intervals of not more than 16 feet.

Exposed flashing and flashing subject to rain penetration to be bedded in the specified joint sealant.

Flashing which is in contact with dissimilar metals to be isolated by means of the specified asphalt mastic material to prevent electrolytic deterioration.

Drips to be formed to the profile indicated, with the edge folded back 1/2 inch to form a reinforced drip edge.

3.6.3 Closures

Install metal closure strips at 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.

Install mastic closure strips at intersection of the wall with metal walling; top and bottom of metal siding; heads of wall openings; and in other required locations.

3.7 WORKMANSHIP

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.

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.

3.8 ACCEPTANCE PROVISIONS

3.8.1 Erection Tolerances

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.

3.8.2 Leakage Tests

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.

Inspection and testing is to be made promptly after erection to permit correction of defects and the removal and replacement of defective materials.

3.8.3 Repairs to Finish

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.

Repaired metal surfaces that are not acceptable to the project requirements are to be immediately removed and replaced with new material.

3.8.4 Paint-Finish Metal Siding

Paint-finish metal siding will be tested for color stability by the Contracting Officer during the manufacturer's specified guarantee period.

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.

New panels will be subject to the specified tests for an additional year from the date of their installation.

3.9 CLEAN-UP AND DISPOSAL

Clean all exposed sheet metal work at completion of installation. Remove metal shavings, filings, nails, bolts, and wires from work area. Remove grease and oil films, excess sealants, handling marks, contamination from steel wool, fittings and drilling debris and scrub the work clean. Exposed metal surfaces to be free of dents, creases, waves, scratch marks, solder or weld marks, and damage to the finish coating.

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 --

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DIVISION 07 - THERMAL AND MOISTURE PROTECTION

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SECTION 07 60 00

FLASHING AND SHEET METAL

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 WELDING SOCIETY (AWS)

AWS D1.2/D1.2M	(2008) Structural Welding Code - Aluminum

ASTM INTERNATIONAL (ASTM)

ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B221	(2012) Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
ASTM B32	(2008) Standard Specification for Solder Metal
ASTM D1171	(1999; R 2007) Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
ASTM D2137	Standard Test Methods for Rubber Property - Brittleness Point of Flexible Polymers and Coated Fabrics
ASTM D2240	(2005; R 2010) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D395	(2003; R 2008) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2006a; E 2008; R 2008) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D573	(2004; R 2010) Standard Test Method for Rubber - Deterioration in an Air Oven
ASTM D624	(2000; R 2012) Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

UNDERWRITERS LABORATORIES (UL)

UL 94	(1996; Reprint Jan 2012) Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

1.2 GENERAL REQUIREMENTS

Finished sheet metalwork will form a weathertight construction without waves, warps, buckles, fastening stresses or distortion, which allows for expansion and contraction. Sheet metal mechanic is responsible for cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Flashing at wall penetrations; G

Flashing at pipe penetrations; G

Indicate thicknesses, dimensions, fastenings and anchoring methods, expansion joints, and other provisions necessary for thermal expansion and contraction. Scaled manufacturer's catalog data may be submitted for factory fabricated items.

SD-03 Product Data

Pipe Boot; G

SD-11 Closeout Submittals

Quality Control Plan

Submit for sheet metal work in accordance with paragraph entitled "Field Quality Control."

1.4 DELIVERY, HANDLING, AND STORAGE

Package and protect materials during shipment. Uncrate and inspect materials for damage, dampness, and wet-storage stains upon delivery to the job site. Remove from the site and replace damaged materials that cannot be restored to like-new condition. Handle sheet metal items to avoid damage to surfaces, edges, and ends. Store materials in dry, weather-tight, ventilated areas until immediately before installation.

PART 2 PRODUCTS

2.1 MATERIALS

Do not use lead, lead-coated metal, or galvanized steel. Use any metal listed by SMACNA Arch. Manual for a particular item, unless otherwise specified or indicated. Conform to the requirements specified and to the thicknesses and configurations established in SMACNA Arch. Manual for the materials.

Furnish sheet metal items in 8 to 10 foot lengths. Single pieces less than 8 feet long may be used to connect to factory-fabricated inside and outside corners, and at ends of runs. Factory fabricate corner pieces with minimum 12 inch legs. Provide accessories and other items essential to complete the sheet metal installation. Provide accessories made of the same or compatible materials as the items to which they are applied. Fabricate sheet metal items of the materials specified below and to the gage, thickness, or weight shown in Table I at the end of this section. Provide sheet metal items with mill finish unless specified otherwise. Where more than one material is listed for a particular item in Table I, each is acceptable and may be used except as follows:

2.1.1 Exposed Sheet Metal Items

Must be of the same material. Consider the following as exposed sheet metal: flashings and related accessories.

2.1.2 Aluminum Alloy Sheet and Plate

ASTM B209 form alloy, and temper appropriate for use.

2.1.2.1 Alclad

When fabricated of aluminum, fabricate the items Alclad 3003, Alclad 3004, Alclad 3005, clad on both sides unless otherwise indicated.

Flashing

2.1.2.2 Finish

Exposed exterior sheet metal items of aluminum must have a baked-on, factory-applied color coating of polyvinylidene fluoride (PVF2) or other equivalent fluorocarbon coating applied after metal substrates have been cleaned and pretreated. Provide finish coating dry-film thickness of 0.8 to 1.3 mils and color to match existing adjacent wall surfaces.

2.1.3 Aluminum Alloy, Extruded Bars, Rods, Shapes, and Tubes

ASTM B221.

2.1.4 Solder

ASTM B32, 95-5 tin-antimony.

2.1.5 Fasteners

Use the same metal or a metal compatible with the item fastened. Use stainless steel fasteners to fasten dissimilar materials.

2.2 PIPE BOOT

EPDM pipe boot meeting ASTM D2240, ASTM D412, ASTM D624, ASTM D573, ASTM D395, ASTM D1171, ASTM D2137 and passing UL 94 for Fire Resistance.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Workmanship

Make lines 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.

Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry, and free of defects and projections. For installation of items not shown in detail or not covered by specifications conform to the applicable requirements of SMACNA 1793, Architectural Sheet Metal Manual. Provide sheet metal flashing wherever indicated and necessary to make the work watertight. Join sheet metal items together as shown in Table II.

3.1.2 Bolts, Rivets, and Screws

Install bolts, rivets, and screws where indicated or required. Provide compatible washers where required to protect surface of sheet metal and to provide a watertight connection. Provide mechanically formed joints in aluminum sheets 0.040 inch or less in thickness.

3.1.3 Seams

Straight and uniform in width and height with no solder showing on the face.

3.1.3.1 Loose-Lock Expansion Seams

Not less than 3 inch wide; provide minimum one inch movement within the joint. Completely fill the joints with the specified sealant, applied at not less than 1/8 inch thick bed.

3.1.3.2 Flat Seams

Make seams in the direction of the flow.

3.1.4 Welding and Mechanical Fastening

Use welding for aluminum of thickness greater than 0.040 inch. Aluminum 0.040 inch or less in thickness must be butted and the space backed with formed flashing plate; or lock joined, mechanically fastened, and filled with sealant as recommended by the aluminum manufacturer.

3.1.4.1 Welding of Aluminum

Use welding of the inert gas, shield-arc type. For procedures, appearance and quality of welds, and the methods used in correcting welding work, conform to AWS D1.2/D1.2M.

3.1.4.2 Mechanical Fastening of Aluminum

Use No. 12, aluminum alloy, sheet metal screws or other suitable aluminum alloy or stainless steel fasteners. Drive fasteners in holes made with a No. 26 drill in securing side laps, end laps, and flashings. Space fasteners 12 inch maximum on center. Where end lap fasteners are required to improve closure, locate the end lap fasteners not more than 2 inch from the end of the overlapping sheet.

3.1.5 Protection from Contact with Dissimilar Materials

3.1.5.1 Aluminum

Do not allow aluminum surfaces in direct contact with other metals except stainless steel, zinc, or zinc coating. Where aluminum contacts another metal, provide 0.031 inch PTFE strip.

3.1.6 Flashing at Wall Penetrations

Provide metal for pipes projecting through vertical surface.

3.1.7 Flashing at Pipe Penetrations

Provide metal flashing for all pipes projecting through the wall surface.

3.1.8 Single Pipe

Set flange of EPDM pipe boot in compatible sealant and fasten with Type 316 stainless steel self-tapping screws with integral teflon insulated washer. Secure boot to pipe by a draw band. Seal the area of boot in contact with pipe with an approved sealant.

3.2 PAINTING

3.2.1 Aluminum Surfaces

Shall be solvent cleaned and given one coat of zinc-molybdate primer and one coat of aluminum paint.

3.3 CLEANING

Clean exposed sheet metal work at completion of installation. Remove grease and oil films, handling marks, contamination from steel wool, fittings and drilling debris, and scrub-clean. Free the exposed metal surfaces of dents, creases, waves and scratch marks.

3.4 REPAIRS TO FINISH

Scratches, abrasions, and minor surface defects of finish may be repaired in accordance with the manufacturer's printed instructions and as approved. Repair damaged surfaces caused by scratches, blemishes, and variations of color and surface texture. Replace items which cannot be repaired.

3.5 FIELD QUALITY CONTROL

Establish and maintain a Quality Control Plan for sheet metal used in conjunction with roofing to assure compliance of the installed sheet metalwork with the contract requirements. Remove work that is not in compliance with the contract and replace or correct. Include quality

control, but not be limited to, the following:

a. Observation of environmental conditions; number and skill level of sheet metal workers; condition of substrate.

b. Verification that specified material is provided and installed.

c. Inspection of sheet metalwork, for proper size(s) and thickness(es), fastening and joining, and proper installation.

3.5.1 Procedure

Submit for approval prior to start work. Include a checklist of points to be observed. Document the actual quality control observations and inspections. Furnish a copy of the documentation to the Contracting Officer at the end of each day.

TABLE I. SHEET METAL WEIGHTS, THICKNESSES, AND GAGES	
Sheet Metal Items	Aluminum mm
Flashings:	
Base	.040
Cap (Counter-flashing)	.032
Extrusions	.075
Sheets, smooth	.050
Edge strip	.050

TABLE II. SHEET METAL JOINTS		
TYPE OF JOINT		
Item Designation	Aluminum	Remarks
Flashings		
Base	One inch flat locked, soldered; sealed; 3 inch lap for expansion joint	Aluminum producer's recommended hard setting sealant for locked aluminum joints. Fill each metal expansion joint with a joint sealing compound compound.
Edge strip	Butt	--

TABLE II. SHEET METAL JOINTS		
TYPE OF JOINT		
Item Designation	Aluminum	Remarks
Extrusions	Butt with 1/2 inch space	Use sheet flashing beneath and a cover plate
Sheet, smooth	Butt with 1/4 inch space	Use sheet flashing backup plate.

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SECTION 07 72 33

ROOF/CEILING HATCHES

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 A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM E152	(1981ae1) Fire Tests of Door Assemblies

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 252	(2012) Standard Methods of Fire Tests of Door Assemblies

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1793	(2012) Architectural Sheet Metal Manual, 7th Edition

UNDERWRITERS LABORATORIES (UL)

UL	(2012) Fire Resistance Directory

1.2 DESIGN REQUIREMENTS

Design fire-rated access panel for use with the 2 hour accessway. Ceiling access panel design shall provide a minimum 1-1/2 hour "B" label protection in accordance with UL Directory and shall be provided with a continuous weep along the bottom of both sides of wind band. Units shall be self-cleaning by the action of the elements, and shall have provisions for carrying water and normal wind-transported soil matter to the outside of the 2 hour accessway. Access panel shall be free of internal obstructions or moving parts which will require maintenance, and shall be complete with type of mounting indicated on drawings.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fire-rated Access Panels; G

1.4 QUALITY ASSURANCE

Manufacturer shall specialize in design and manufacture of the type of access panel specified in this section, and shall have a minimum of 10 years of documented successful experience. Provide a an access panel installer experienced in the installation of panel types specified.

1.5 DELIVERY, STORAGE, AND HANDLING

Access panels shall be cartoned or crated prior to shipment. Protect panels from moisture and damage. Remove damaged items from the site.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Galvanized Steel Sheets

Steel sheets shall be commercial quality, zinc-coated steel (hot-dip galvanized) of quality established by ASTM A653/A653M, minimum G90 coating thickness.

2.2 FIRE-RATED ACCESS PANELS

Provide ceiling access panels fabricated of galvanized steel, and assembled to any desired length. Provide access panels with UL labeled fire-rated system complete with accessories to meet building code requirements. Door and frame assembly shall be tested in accordance with ASTM E152 and NFPA 252 and UL listed for 1-1/2 hours.

Assembly shall be UL listed "B" label for 1-1/2 hours in walls (maximum temperature rise to 250 degrees F in 30 min.), listed for 3 hours in fire-rated non-combustible floor and ceiling assembly in accordance with Warnock-Hersey, Report #WHI-495-PSH-0192.

2.2.1 Door

Door shall be fabricated from minimum 20 gauge cold rolled steel, insulated sandwich type construction. Door shall be insulated with 2-inch thick fire rated mineral fiber, minimum R value of 8.

2.2.2 Frame

Frame shall be fabricated from minimum 16 gauge cold rolled steel with 1 inch flange.

2.2.3 Hardware

Door shall be self-latching with automatic closer and interior release mechanism. Hinge shall be a flush continuous piano hinge. Latch(es) shallbe knurled knob/key operated latch bolt. Mortise cylinder to receive Best lock, 1.125-inch cyclinder.

2.2.4 Basis of Design

Product basis of design: WB FR 800 Series Standard Fire-Rated Access Door, available from The Williams Bros. Corporation of America, 1330 Progress Drive, Front Royal, VA 22630, 800-255-5515, www.wbdoors.com.

2.3 FABRICATION

Access panels shall be fabricated in accordance with approved shop drawings. Welds, soldered seams, rivets and fasteners shall be clean, secure, watertight, and smooth. Edges shall be wired or beaded, where necessary, to ensure rigidity.

2.4 FINISH

2.4.1 Galvanized Steel Finish

Galvanized steel access panels shall be factory-coated with rust-resistant primer and baked-on finish coats of acrylic.

2.4.2 Color

Color shall be gray, as selected from manufacturer's standard color palette.

PART 3 EXECUTION

3.1 PREPARATION

Prepare rough openings and other ceiling conditions in accordance with approved shop drawings and manufacturer's recommendations. Rough openings shall be field-measured and recorded on shop drawings prior to fabrication of access panels. Before starting the work, protect surrounding surfaces from damage. Coordinate fabrication with construction schedule. Submit dimensioned drawings indicating location of each type of access panel including details of construction, gauges of metal, and methods of operation.

3.2 INSTALLATION

Coordinate access panel installation with 2 hour accessway work, and in accordance with approved shop drawings, manufacturer's published instructions, and chapter 8 of SMACNA 1793. The access panel installation shall be watertight and free of vibration noise. Clean access panels in accordance with access panel manufacturer's recommendations.

3.3 PROTECTION

Protect exposed access panel finish surfaces against the accumulation of paint, grime, mastic, disfigurement, discoloration and damage for duration of construction activities.

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SECTION 07 84 00

FIRESTOPPING

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 E119	(2012a) Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E1399	(1997; R 2009) Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems
ASTM E1966	(2007; R 2011) Fire-Resistive Joint Systems
ASTM E2174	(2010ae1) Standard Practice for On-Site Inspection of Installed Fire Stops
ASTM E2393	(2010a) Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers
ASTM E814	(2011a) Standard Test Method for Fire Tests of Through-Penetration Fire Stops
ASTM E84	(2012c) Standard Test Method for Surface Burning Characteristics of Building Materials

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/
FM AS 4991	(2001) Approval of Firestop Contractors

UNDERWRITERS LABORATORIES (UL)

UL 1479	(2003; Reprint Mar 2010) Fire Tests of Through-Penetration Firestops
UL 2079	(2004; Reprint Jun 2008) Tests for Fire Resistance of Building Joint Systems
UL 723	(2008; Reprint Sep 2010) Test for Surface Burning Characteristics of Building

Materials

UL Fire Resistance	(2012) Fire Resistance Directory

1.2 SYSTEM DESCRIPTION

1.2.1 General

Furnish and install tested and listed firestopping systems, combination of materials, or devices 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 and gaps.

a. Through-penetrations include the annular space around pipes, tubes, conduit, wires, cables and vents.

b. Construction joints include those used to accommodate expansion, contraction, wind, or seismic movement; firestopping material shall not interfere with the required movement of the joint.

Gaps requiring firestopping include gaps betweenthe top of the fire-rated walls and the floor deck above and at the intersection of shaft assemblies and adjoining fire resistance rated assemblies.

1.2.2 Sequencing

Coordinate the specified work with other trades. Apply firestopping materials, at penetrations of pipes and ducts, prior to insulating, unless insulation meets requirements specified for firestopping. Apply firestopping materials. at building joints and construction gaps, prior to completion of enclosing walls or assemblies. Cast-in-place firestop devices shall be located and installed in place before concrete placement. Pipe, conduit or cable bundles shall be installed through cast-in-place device after concrete placement but before area is concealed or made inaccessible. Firestop material shall be inspected and approved prior to final completion and enclosing of any assemblies that may conceal installed firestop.

1.2.3 Submittals Requirements

a. Submit detail drawings including manufacturer's descriptive data, typical details conforming to UL Fire Resistance or other details certified by another nationally recognized testing laboratory, installation instructions or UL listing details for a firestopping assembly in lieu of fire-test data or report. For those firestop applications for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgment, derived from similar UL system designs or other tests, shall be submitted for review and approval prior to installation. Submittal shall indicate the firestopping material to be provided for each type of application. When more than a total of 5 penetrations and/or construction joints are to receive firestopping, provide drawings that indicate location, "F" "T" and "L" ratings, and type of application.

b. Submit certificates attesting that firestopping material complies with the specified requirements. For all intumescent firestop materials used in through penetration systems, manufacturer shall provide certification from UL of passing the "Aging and Environmental

Exposure Testing " portion of UL 1479.

c. Submit documentation of training and experience for Installer.

d. Submit manufacturer's representative certification stating that firestopping work has been inspected and found to be applied according to the manufacturer's recommendations and the specified requirements.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Firestopping Materials; G.

SD-07 Certificates

Manufacturer's Technical Representative
Firestopping Materials.
Installer Qualifications; G.
Inspection; G.

1.4 QUALITY ASSURANCE

1.4.1 Installer

Engage an experienced Installer who is:

a. FM Research approved in accordance with FM AS 4991, operating as a UL Certified Firestop Contractor, or

b. Certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary staff, training, and a minimum of 3 years experience in the installation of manufacturer's products in accordance with specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an installer engaged by the Contractor does not in itself confer installer qualifications on the buyer. The Installer shall have been trained by a direct representative of the manufacturer (not distributor or agent) in the proper selection and installation procedures. The installer shall obtain from the manufacturer written certification of training, and retain proof of certification for duration of firestop installation.

1.4.2 Manufacturer's Technical Representative

The manufacturer's technical representative shall be a direct representative of the manufacturer (not a distributor or an agent). Provide current documentation from the manufacturer that he or she is a direct representative of the manufacturer and is qualified to perform the specified inspections and certify the firestopping installation.

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver materials in the original unopened packages or containers showing name of the manufacturer and the brand name. Store materials off the

ground, protected from damage and exposure to elements. Remove damaged or deteriorated materials from the site.

PART 2 PRODUCTS

2.1 FIRESTOPPING MATERIALS

Provide firestopping materials, supplied from a single domestic manufacturer, consisting of commercially manufactured, asbestos-free, nontoxic, water-based, noncombustible products FM APP GUIDE approved, or UL listed, for use with applicable construction and penetrating items, complying with the following minimum requirements:

2.1.1 Fire Hazard Classification

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 E84 or UL 723. Material shall be an approved firestopping material as listed in UL Fire Resistance or by a nationally recognized testing laboratory.

2.1.2 Toxicity

Material shall be nontoxic and carcinogen free to humans at all stages of application or during fire conditions and shall not contain hazardous chemicals or require harmful chemicals to clean material or equipment. Firestop material must be free from Ethylene Glycol, PCB, MEK, or other types of hazardous chemicals.

2.1.3 Fire Resistance Rating

Firestop systems shall be UL Fire Resistance listed or FM APP GUIDE approved with "F" rating at least equal to fire-rating of fire wall or floor in which penetrated openings are to be protected. Where required, firestop systems shall also have "T" rating at least equal to the fire-rated floor in which the openings are to be protected.

2.1.3.1 Through-Penetrations

Firestopping materials for through-penetrations, as described in paragraph SYSTEM DESCRIPTION, shall provide "F", "T" and "L" fire resistance ratings in accordance with ASTM E814 or UL 1479.

2.1.3.2 Construction Joints and Gaps

Fire resistance ratings of construction joints, as described in paragraph SYSTEM DESCRIPTION, and gaps such as those between floor slabs walls shall be the same as the construction in which they occur. Construction joints and gaps shall be provided with firestopping materials and systems that have been tested in accordance with ASTM E119, ASTM E1966 or UL 2079 to meet the required fire resistance rating. Systems installed at construction joints shall meet the cycling requirements of ASTM E1399 or UL 2079. All joints at the intersection of the top of a fire resistance rated wall and the underside of a fire-rated floor or floor ceiling assembly shall provide a minimum class II movement capability.

2.1.4 Material Performance

All firestop materials are subject to these minimum standards of performance.

a. Firestop material shall be capable of installation at temperatures of 35 to 120 degrees F.

b. Material must be able to be frozen, thawed and still maintain manufacturer approval for installation.

c. Firestop material must convey a manufacturer's written warranty guaranteeing the performance of the material for the sustainable lifetime of the structure.

d. Material must maintain a shelf life of no less than two years from date of manufacturing.

e. Acceptable firestop cast-in-place devices are factory assembled intumescent lined round or oval plastic cylinders capable of protecting plastic, metallic, cable, and blank openings through the cast-in-place device equal to the fire-resistance rating of the floor.

PART 3 EXECUTION

3.1 PREPARATION

Areas to receive firestopping shall be free of dirt, grease, oil, or loose materials which may affect the fitting or fire resistance of the firestopping system. For cast-in-place firestop devices, formwork or metal deck to receive device prior to concrete placement shall be sound and capable of supporting device. Prepare surfaces as recommended by the manufacturer.

3.2 INSTALLATION

Completely fill void spaces with firestopping material regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping systems for filling floor voids 4 inches or more in any direction shall be capable of supporting the same load as the floor is designed to support or shall be protected by a permanent barrier to prevent loading or traffic in the firestopped area. Install firestopping in accordance with manufacturer's written instructions. Provide tested and listed firestop systems 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 walls.

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

3.2.1 Insulated Pipes and Ducts

Thermal insulation shall be cut and removed where pipes or ducts pass through firestopping, unless insulation meets requirements specified for firestopping. Replace thermal insulation with a material having equal thermal insulating and firestopping characteristics.

3.2.2 Fire Dampers

Install and firestop fire dampers in accordance with Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEM. Firestop installed with fire damper must be tested and approved for use in fire damper system. Firestop installed with fire damper must be tested and approved for use in fire damper system.

3.2.3 Data and Communication Cabling

Cabling for data and communication applications shall be sealed with re-enterable firestopping products. Firestopping devices shall be pre-manufactured modular devices, containing built-in self-sealing intumescent inserts. Firestopping devices shall allow for cable moves, additions or changes without the need to remove or replace any firestop materials. Devices must be capable of maintaining the fire resistance rating of the penetrated membrane at 0% to 100% visual fill of penetrants; while maintaining "L" rating of <5 cfm/sf measured at ambient temperature and 400* F at 0% to 100% visual fill. Each device must be capable of retrofit applications and be available in square and round configurations, with single, double, triple and six-plex bracket systems provided. Firestop devices must also allow for plastic pipe, metallic pipe, and mixed multiple penetrations through a single device.

3.3 INSPECTION

3.3.1 General Requirements

Install one of each type of penetration and have it inspected and accepted by the Contracting Officer prior to the installation of the remainder of the penetrations. At this inspection, the manufacturer's technical representative of the firestopping material shall be present. The remainder of the firestopped areas shall not be covered or enclosed until inspection is complete and approved by the manufacturer's technical representative. The 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. Submit written reports indicating locations of and types of penetrations and types of firestopping used at each location; type shall be recorded by UL listed printed numbers.

3.3.2 Inspection Standards

Inspect all firestopping in accordance to ASTM standards for firestop inspection, and document inspection results.

a. ASTM E2393

b. ASTM E2174

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SECTION 07 92 00

JOINT SEALANTS

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 C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM D1056	(2007) Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber
ASTM D2240	(2005; R 2010) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D412	(2006a; E 2008; R 2008) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Sealants; G

Primers; G

Bond breakers; G

Backstops; G

Manufacturer's descriptive data including storage requirements, shelf life, curing time, instructions for mixing and application, and primer data (if required). Provide a copy of the Material Safety Data Sheet for each solvent, primer or sealant material.

1.3 ENVIRONMENTAL CONDITIONS

Apply sealant when the ambient temperature is between 40 and 90 degrees F.

1.4 DELIVERY AND STORAGE

Deliver materials to the job site in unopened manufacturers' external shipping containers, with brand names, date of manufacture, color, and material designation clearly marked thereon. Label elastomeric sealant containers to identify type, class, grade, and use. Carefully handle and store materials to prevent inclusion of foreign materials or subjection to sustained temperatures exceeding 90 degrees F or less than 0 degrees F.

1.5 QUALITY ASSURANCE

1.5.1 Compatibility with Substrate

Verify that each of the sealants are compatible for use with joint substrates.

1.5.2 Joint Tolerance

Provide joint tolerances in accordance with manufacturer's printed instructions.

1.6 SPECIAL WARRANTY

Guarantee sealant joint against failure of sealant and against water penetration through each sealed joint for five years.

PART 2 PRODUCTS

2.1 SEALANTS

Provide sealant that has been tested and found suitable for the substrates to which it will be applied.

2.1.1 Interior Sealant

Provide ASTM C920, Type S or M, Grade NS, Class 12.5, Use NT. Location(s) and color(s) of sealant for the following:

LOCATION	COLOR
a. Small voids between walls or partitions and door frames, built-in or surface-mounted equipment and fixtures, and similar items.	Gray
b. Perimeter of frames at doors, in metal wall panel and interior masonry walls.	Gray
c. Perpendicular wall intersections.	Gray
d. Pipe penetration in walls: in pipe sleeves around pipe.	Gray

LOCATION	COLOR
e. Metal floor panels to metal.	Gray
f. Metal to metal joints where sealant is indicated.	Gray
g. Behind escutcheon plates at valve pipe penetrations .	Gray

2.1.2 Floor Joint Sealant

ASTM C920, Type S or M, Grade P, Class 25, Use T. Provide location(s) and color(s) of sealant as follows:

LOCATION	COLOR
a. Control and expansion joints in floors, slabs, and walkways.	Gray

2.1.3 Preformed Sealant

Provide preformed sealant of polybutylene or isoprene-butylene based pressure sensitive weather resistant tape or bead sealant capable of sealing out moisture, air and dust when installed as recommended by the manufacturer. At temperatures from minus 30 to plus 160 degrees F, the sealant must be non-bleeding and no loss of adhesion.

2.1.4 Extruded Elastomeric Seal

Provide an extruded elastomeric seal that is capable of movement in two horizontal directions and vertical (sheer) direction, +/- 1 inch (1/2 movement) when installed as recommended by the manufacturer. Extruded elastomeric seal shall be tested in accordance with ASTM D412 and ASTM D2240.

2.2 PRIMERS

Provide a nonstaining, quick-drying type and consistency recommended by the sealant manufacturer for the particular application.

2.3 BACKSTOPS

Provide neoprene, foams free from oil or other staining elements as recommended by sealant manufacturer. Provide 25 to 33 percent oversized backing for closed cell material, unless otherwise indicated. Make backstop material compatible with sealant. Do not use oakum and other types of absorptive materials as backstops.

2.3.1 Neoprene

Conform to ASTM D1056, closed cell expanded neoprene cord Type 2, Class C, Grade 2C2 Neoprene backing.

2.4 CLEANING SOLVENTS

Provide type(s) recommended by the sealant manufacturer.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

Clean surfaces from dirt frost, moisture, grease, oil, wax, lacquer, paint, or other foreign matter that would tend to destroy or impair adhesion. Remove oil and grease with solvent. Surfaces must be wiped dry with clean cloths. When resealing an existing joint, remove existing caulk or sealant prior to applying new sealant. For surface types not listed below, contact sealant manufacturer for specific recommendations.

3.1.1 Steel Surfaces

Remove loose mill scale by sandblasting or, if sandblasting is impractical or would damage finish work, scraping and wire brushing. Remove protective coatings by sandblasting or using a residue-free solvent.

3.1.2 Aluminum

Remove temporary protective coatings from surfaces that will be in contact with sealant. When masking tape is used as a protective coating, remove tape and any residual adhesive just prior to sealant application. For removing protective coatings and final cleaning, use nonstaining solvents recommended by the manufacturer of the item(s) containing aluminum surfaces.

3.1.3 Concrete and Masonry Surfaces

Where surfaces have been treated with curing compounds, oil, or other such materials, remove materials by sandblasting or wire brushing. Remove laitance, efflorescence and loose mortar from the joint cavity.

3.2 SEALANT PREPARATION

Do not add liquids, solvents, or powders to the sealant. Mix multicomponent elastomeric sealants in accordance with manufacturer's instructions.

3.3 APPLICATION

3.3.1 Joint Width-To-Depth Ratios

a. Acceptable Ratios:

JOINT WIDTH	JOINT DEPTH	
	Minimum	Maximum
For metal, glass, or other nonporous surfaces:		

JOINT WIDTH	JOINT DEPTH	
	Minimum	Maximum
1/4 inch (minimum)	1/4 inch	1/4 inch
over 1/4 inch	1/2 of width	Equal to width
For concrete or masonry:		
1/4 inch (minimum)	1/4 inch	1/4 inch
over 1/4 inch to 1/2 inch	1/4 inch	Equal to width
over 1/2 inch to 2 inch	1/2 inch	5/8 inch
Over 2 inch	As recommended by sealant manufacturer	

b. Unacceptable Ratios: Where joints of acceptable width-to-depth ratios have not been provided, clean out joints to acceptable depths and grind or cut to acceptable widths without damage to the adjoining work. Grinding is not required on metal surfaces.

3.3.2 Masking Tape

Place masking tape on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Remove masking tape within 10 minutes after joint has been filled and tooled.

3.3.3 Backstops

Install backstops dry and free of tears or holes. Tightly pack the back or bottom of joint cavities with backstop material to provide a joint of the depth specified. Install backstops in the following locations:

a. Where indicated.

b. Where backstop is not indicated but joint cavities exceed the acceptable maximum depths specified in paragraph entitled, "Joint Width-to-Depth Ratios".

3.3.4 Primer

Immediately prior to application of the sealant, clean out loose particles from joints. Where recommended by sealant manufacturer, apply primer to joints in concrete masonry units, and other porous surfaces in accordance with sealant manufacturer's instructions. Do not apply primer to exposed finish surfaces.

3.3.5 Bond Breaker

Provide bond breakers to the back or bottom of joint cavities, as recommended by the sealant manufacturer for each type of joint and sealant used, to prevent sealant from adhering to these surfaces. Carefully apply the bond breaker to avoid contamination of adjoining surfaces or breaking bond with surfaces other than those covered by the bond breaker.

3.3.6 Sealants

Provide a sealant compatible with the material(s) to which it is applied. Do not use a sealant that has exceeded shelf life or has jelled and can not be discharged in a continuous flow from the gun. Apply the sealant in accordance with the manufacturer's printed instructions with a gun having a nozzle that fits the joint width. Force sealant into joints to fill the joints solidly without air pockets. Tool sealant after application to ensure adhesion. Make sealant uniformly smooth and free of wrinkles. Upon completion of sealant application, roughen partially filled or unfilled joints, apply sealant, and tool smooth as specified. Apply sealer over the sealant when and as specified by the sealant manufacturer.

3.4 PROTECTION AND CLEANING

3.4.1 Protection

Protect areas adjacent to joints from sealant smears. Masking tape may be used for this purpose if removed 5 to 10 minutes after the joint is filled.

3.4.2 Final Cleaning

Upon completion of sealant application, remove remaining smears and stains and leave the work in a clean and neat condition.

a. Masonry and Other Porous Surfaces: Immediately scrape off fresh sealant that has been smeared on masonry and rub clean with a solvent as recommended by the sealant manufacturer. Allow excess sealant to cure for 24 hour then remove by wire brushing or sanding.

b. Metal and Other Non-Porous Surfaces: Remove excess sealant with a solvent-moistened cloth.

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STEEL DOORS AND FRAMES

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 WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2012; Errata 2011) Structural Welding Code - Steel

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924/A924M	(2010a) Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM E1300	(2009a) Determining Load Resistance of Glass in Buildings
ASTM F2248	(2009) Standard Practice for Specifying an Equivalent 3-Second Duration Design Loading for Blast Resistant Glazing Fabricated with Laminated Glass

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.115	(2006) Hardware Preparation in Steel Doors and Steel Frames

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 252	(2012) Standard Methods of Fire Tests of Door Assemblies
NFPA 80	(2010; TIA 10-2) Standard for Fire Doors and Other Opening Protectives

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR 111	(2009) Recommended Selection and Usage Guide for Standard Steel Doors, Frames and Accessories
SDI/DOOR A250.11	(2001) Recommended Erection Instructions

	for Steel Frames
SDI/DOOR A250.6	(2003; R2009) Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames
SDI/DOOR A250.8	(2003; R2008) Recommended Specifications for Standard Steel Doors and Frames

UNDERWRITERS LABORATORIES (UL)

UL 10C	(2009) Standard for Positive Pressure Fire Tests of Door Assemblies

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. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Doors; G

Frames; G

Accessories

Show elevations, construction details, metal gages, hardware provisions, method of glazing, and installation details.

Schedule of doors; G

Schedule of frames; G

Submit door and frame locations.

SD-03 Product Data

Doors; G

Frames; G

Accessories

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 DELIVERY, STORAGE, AND HANDLING

Deliver doors, frames, and accessories undamaged and with protective wrappings or packaging. Strap knock-down frames in bundles. 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

SDI/DOOR A250.8, except as specified otherwise. Prepare doors to receive door hardware as specified in Section 08 71 00. Undercut where indicated. Doors shall be 1-3/4 inch thick, unless otherwise indicated. Provide glazing in accordance with ASTM F2248 and ASTM E1300.

2.1.1 Classification - Level, Performance, Model

2.1.1.1 Extra Heavy Duty Doors

SDI/DOOR A250.8, Level 3, physical performance Level A, Model 2 with core construction as required by the manufacturer for interior doors . Where vertical stiffener cores are required, the space between the stiffeners shall be filled with mineral board insulation.

2.2 ACCESSORIES

2.2.1 Astragals

For interior pairs of fire rated doors, provide stainless steel astragals complying with NFPA 80 for fire rated assemblies.

2.3 STANDARD STEEL FRAMES

SDI/DOOR A250.8, Level 3, except as otherwise specified. Form frames to sizes and shapes indicated, with welded corners. Provide steel frames for doors, unless otherwise indicated.

2.3.1 Welded Frames

Continuously weld frame faces at corner joints. Mechanically interlock or continuously weld stops and rabbets. Grind welds smooth.

Weld frames in accordance with the recommended practice of the Structural Welding Code Sections 1 through 6, AWS D1.1/D1.1M and in accordance with the practice specified by the producer of the metal being welded.

2.3.2 Stops and Beads

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.

2.3.3 Anchors

Provide anchors to secure the frame to adjoining construction. Provide steel anchors, zinc-coated or painted with rust-inhibitive paint, not

lighter than 18 gage.

2.3.3.1 Wall Anchors

Provide at least three anchors for each jamb.

a. Masonry: Provide anchors of corrugated or perforated steel straps or 3/16 inch diameter steel wire, adjustable or T-shaped;

b. Stud partitions: Weld or otherwise securely fasten anchors to backs of frames. Design anchors to be fastened to closed steel studs with sheet metal screws, and to open steel studs by wiring or welding;

c. Completed openings: Secure frames to previously placed concrete or masonry with expansion bolts in accordance with SDI/DOOR 111; and

2.3.3.2 Floor Anchors

Provide floor anchors drilled for 3/8 inch anchor bolts at bottom of each jamb member.

2.4 FIRE DOORS AND FRAMES

The requirements of NFPA 80 shall take precedence over details indicated or specified.

2.4.1 Labels

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 10C. 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.

2.4.2 Astragal on Fire Doors

On pairs of labeled fire doors, conform to NFPA 80 and UL requirements.

2.5 HARDWARE PREPARATION

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 ANSI/BHMA A156.115. 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 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.

2.6 FINISHES

2.6.1 Factory-Primed Finish

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, or paintable A25 galvannealed steel without primer. Where coating is removed by welding, apply touchup of factory primer.

2.6.2 Hot-Dip Zinc-Coated and Factory-Primed Finish

Fabricate interior scheduled doors and frames from hot dipped zinc coated steel, alloyed type, that complies with ASTM A924/A924Mand ASTM A653/A653M. 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. 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.

2.7 FABRICATION AND WORKMANSHIP

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 frames in exposed masonry walls or partitions to allow sufficient space between the inside back of trim and masonry to receive caulking compound.

2.8 PROVISIONS FOR GLAZING

Materials are specified in Section 08 81 00, GLAZING.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Frames

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. Where frames require ceiling struts or overhead bracing, anchor frames to the struts or bracing.

3.1.2 Doors

Hang doors in accordance with clearances specified in SDI/DOOR A250.8. After erection and glazing, clean and adjust hardware.

3.1.3 Fire Doors and Frames

Install fire doors and frames, including hardware, in accordance with NFPA 80. Install fire rated doors and frames in accordance with NFPA 80.

3.2 PROTECTION

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, in accordance with Section 09 97 13.00 98 Steel Coatings.

3.3 CLEANING

Upon completion, clean exposed surfaces of doors and frames thoroughly. Remove mastic smears and other unsightly marks.

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SECTION 08 71 00

DOOR HARDWARE

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.

BUILDERS HARDWARE MANUFACTURERS ASSOCIATION (BHMA)

ANSI/BHMA A156.1	(2006) Butts and Hinges
ANSI/BHMA A156.13	(2005) Mortise Locks & Latches Series 1000
ANSI/BHMA A156.16	(2008) Auxiliary Hardware
ANSI/BHMA A156.18	(2006) Materials and Finishes
ANSI/BHMA A156.3	(2008) Exit Devices
ANSI/BHMA A156.4	(2008) Door Controls - Closers
ANSI/BHMA A156.5	(2010) Auxiliary Locks and Associated Products
ANSI/BHMA A156.6	(2010) Architectural Door Trim
ANSI/BHMA A156.7	(2003; R 2009) Template Hinge Dimensions
ANSI/BHMA A156.8	(2010) Door Controls - Overhead Stops and Holders
BHMA A156.15	(2011) Release Devices Closer Holder, Electromagnetic and Electromechanical

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2012; Amendment 1 2012) Life Safety Code
NFPA 80	(2010; TIA 10-2) Standard for Fire Doors and Other Opening Protectives

STEEL DOOR INSTITUTE (SDI/DOOR)

SDI/DOOR A250.8	(2003; R2008) Recommended Specifications for Standard Steel Doors and Frames

UNDERWRITERS LABORATORIES (UL)

UL Bld Mat Dir	(2012) Building Materials Directory

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

SD-02 Shop Drawings

Hardware schedule; G

SD-03 Product Data

Hardware items; G

SD-08 Manufacturer's Instructions

Installation

1.3 HARDWARE SCHEDULE

Prepare and submit hardware schedule in the following form:

Hardware Item	Quantity	Size	Reference Publi-cation Type No.	Finish	Mfr Name and Catalog No.	Key Control Symbols	UL Mark (If fire rated and listed	BHMA Finish Desig-nation

1.4 QUALITY ASSURANCE

1.4.1 Hardware Manufacturers and Modifications

Provide, as far as feasible, locks, hinges, and closers of one lock, hinge, or closer manufacturer's make. Modify hardware as necessary to provide features indicated or specified.

1.5 DELIVERY, STORAGE, AND HANDLING

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.

PART 2 PRODUCTS

2.1 TEMPLATE HARDWARE

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 ANSI/BHMA A156.7 for template hinges. Coordinate hardware items to prevent interference with other hardware.

2.2 HARDWARE FOR FIRE DOORS AND EXIT DOORS

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." 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

Clearly and permanently mark with the manufacturer's name or trademark, hinges, ocks, 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 Hinges

ANSI/BHMA A156.1, 4-1/2 by 4-1/2 inch unless otherwise indicated. Construct reverse-bevel hinges for interior doors so that pins will be nonremovable when door is closed. Other antifriction bearing hinges may be provided in lieu of ball-bearing hinges.

2.3.2 Locks and Latches

2.3.2.1 Mortise Locks and Latches

ANSI/BHMA A156.13, Series 1000, Operational Grade 1, Security Grade 2. Provide mortise locks with escutcheons not less than 7 by 2-1/4 inch with a bushing at least 1/4 inch long. Cut escutcheons to suit cylinders and provide trim items with straight, beveled, or smoothly rounded sides, corners, and edges. Install levers and roses of mortise locks with screwless shanks and no exposed screws.

2.3.3 Exit Devices

ANSI/BHMA A156.3, Grade 1. Provide adjustable strikes for rim type and vertical rod devices. Provide open back strikes for pairs of doors with mortise and vertical rod devices. Provide touch bars in lieu of conventional crossbars and arms.

2.3.4 Exit Locks With Alarm

ANSI/BHMA A156.5, Type E0431 (with full-width horizontal actuating bar) for single doors; Type E0431 (with actuating bar) or E0471 (with actuating bar and top and bottom bolts, both leaves active) for pairs of doors, unless otherwise specified. Provide terminals for connection to remote indicating panel.

2.3.5 Cylinders and Cores

Provide cylinders for new locks, including locks provided under other sections of this specification. Provide fully compatible cylinders with products of the Best Lock Corporation with interchangeable cores which are removable by a special control key. Factory set the cores with seven pin tumblers using the A4 system and F keyway. Provide construction interchangeable cores.

2.3.6 Keying System

The Government will provide permanent cores and keys for mortise locksets, and exit devices. Furnish cylinders as manufactured by Best Lock Corp.

Provide temporary cores and keys for the Contractor's use during construction, and for testing the locksets.

2.3.7 Lock Trim

Cast, forged, or heavy wrought construction and commercial plain design.

2.3.7.1 Lever Handles

Provide lever handles in lieu of knobs. Conform to the minimum requirements of ANSI/BHMA A156.13 for mortise locks of lever handles for exit devices. Provide lever handle locks with a breakaway feature (such as a weakened spindle or a shear key) to prevent irreparable damage to the lock when force in excess of that specified in ANSI/BHMA A156.13 is applied to the lever handle. Provide lever handles return to within 1/2 inch of the door face.

2.3.8 Door Bolts

ANSI/BHMA A156.16. Provide dustproof strikes for bottom bolts, except for doors having metal thresholds. Automatic latching flush bolts: ANSI/BHMA A156.3, Type 25.

2.3.9 Closers

ANSI/BHMA A156.4, Series C02000, Grade 1, with PT 4C. Provide with brackets, arms, mounting devices, fasteners, full size covers, and other features necessary for the particular application. Size closers in accordance with manufacturer's recommendations, or provide multi-size closers, Sizes 1 through 6. Provide manufacturer's 10 year warranty.

2.3.9.1 Identification Marking

Engrave each closer with manufacturer's name or trademark, date of manufacture, and manufacturer's size designation located to be visible after installation.

2.3.10 Overhead Holders

ANSI/BHMA A156.8.

2.3.11 Closer Holder-Release Devices

BHMA A156.15.

2.3.12 Door Protection Plates

ANSI/BHMA A156.6.

2-inch less than door width for single door; 1-inch less than door width for pairs of doors. Provide 10-inch kick plates for flush doors.

2.3.13 Door Stops and Silencers

ANSI/BHMA A156.16. Silencers Type L03011. Provide three silencers for each single door, two for each pair.

2.3.14 Special Tools

Provide special tools, such as spanner and socket wrenches and dogging keys, required to service and adjust hardware items.

2.4 FASTENERS

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

ANSI/BHMA A156.18. Provide hardware in BHMA 630 finish (satin stainless steel), unless specified otherwise. Provide items not manufactured in stainless steel in BHMA 626 finish (satin chromium plated) over brass or bronze, except prime coat finish for surface door closers, and except BHMA 652 finish (satin chromium plated) BHMA 600 finish (primed for painting) for steel hinges. Furnish exit devices in BHMA 626 finish in lieu of BHMA 630 finish except where BHMA 630 is specified under paragraph entitled "Hardware Sets". Match exposed parts of concealed closers to lock and door trim.

PART 3 EXECUTION

3.1 FIRE DOORS AND EXIT DOORS

Install hardware in accordance with NFPA 80 for fire doors, NFPA 101 for exit doors.

3.2 HARDWARE LOCATIONS

SDI/DOOR A250.8, unless indicated or specified otherwise.

a. Kick Plates: Push side of single-acting doors. Both sides of double-acting doors.

3.3 FIELD QUALITY CONTROL

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. Correct, repair, and finish, as directed, errors in cutting and fitting and damage to adjoining work.

3.4 HARDWARE SETS

Provide hardware for steel doors under this section. Deliver steel Hardware templates and hardware, except field-applied hardware to the door and frame manufacturer for use in fabricating the doors and frames.

FINISH HARDWARE

ACCEPTABLE PRODUCTS

A. The following is a list of acceptable products:

Products:	Specified Manufacturers:	Acceptable Manufacturers:

HINGES	MCKINNEY	HAGER, LAWERENCE
FLUSH BOLTS	ROCKWOOD	HAGER, McKINNEY
EXIT DEVICES	CORBIN-RUSSWIN	YALE, SARGENT
CYLINDERS	BEST	NO SUBSTITUTE
LOCKS	CORBIN-RUSSWIN	BEST, SARGENT
DOOR CLOSERS	SARGENT	YALE, CORBIN-RUSSWIN
KICK PLATES	ROCKWOOD	HAGER, McKINNEY
WALL BUMPERS	ROCKWOOD	
SILENCERS	ROCKWOOD	
COORDINATOR	ROCKWOOD	
REMOVABLE MULLION	CORBIN-RUSSWIN	

HW-01			STAIR WELL/CORRIDOR (HM)		
QTY	ITEM	MODEL	SIZE/TRIM	OPTION	FINISH
3 ea	HINGES	T4A3386	4.5 X 4.5	NRP	630
1 ea	EXIT DEVICE	ED 5200 A*			630
1 ea	CLOSER	351 P3		SR	EN
1 ea	KICK PLATE	J102			630
2 ea	SILENCERS	608			
1 ea	WALL BUMPERS	409			

*Important Note: Provide no hardware on pull side of door at elevator lobby to 2 HR Accessway

HW-02			CORRIDOR EGRESS (PAIR HM)		
QTY	ITEM	MODEL	SIZE/TRIM	OPTION	FINISH
6 ea	HINGES	T4A3386	4.5 X 4.5	NRP	630
1 ea	FLUSHBOLT	1845			630
1 ea	EXIT DEVICE	ED 5200 A	PR910	PASSAGE	630
2 ea	CLOSER	351 P3		SR	EN
1 ea	COORDINATOR	576			
4 ea	SILENCERS	608			
2 ea	WALL BUMPERS	409			
2 ea	KICK PLATE	J102			630

HW-03			TOILET ROOMS (HM)		
QTY	ITEM	MODEL	SIZE/TRIM	OPTION	FINISH
3 ea	HINGES	T4A3386	4.5 X 4.5	NRP	630
1 ea	LOCKSET	ML2048	LC PSA		630
1 ea	CYLINDER	IE	LAR		630
1 ea	CLOSER	351 P3		SR	EN
1 ea	KICK PLATE	J102			630
1 ea	WALL BUMPERS	409			630
2 ea	SILENCERS	608			

HW-04			MECHANICAL/ ELECTRICAL (HM)		
QTY	ITEM	MODEL	SIZE/TRIM	OPTION	FINISH
3 ea	HINGES	T4A3386	4.5 X 4.5	NRP	630
1 ea	EXIT DEVICE	ED5200A	PR910	PASSAGE	630
1 ea	CYLINDER	IE	LAR		630
1 ea	CLOSER	351 P3		SR	EN
1 ea	KICK PLATE	J102			630
2 ea	SILENCERS	608			
1 ea	WALL BUMPER	409			630

HW-05			COMM./MECH./ELEC. PAIR HM)		
QTY	ITEM	MODEL	SIZE/TRIM	OPTION	FINISH
6 ea	HINGES	T4A3386	4.5 X 4.5	NRP	630

HW-05			COMM./MECH./ELEC. PAIR HM)		
1 ea	FLUSHBOLT	1845			630
2 ea	EXIT DEVICES	ED5200A	PR910	PASSAGE	630
1 ea	CYLINDER	IE	LAR		630
2 ea	CLOSER	351 P3		SR	EN
2 ea	KICK PLATE	J102			630
4 ea	SILENCERS	608			
2 ea	WALL BUMPERS	409			=
1 ea	REMOVAL MULLION	ED5000		907A	

HW-06			STORAGE/MISC. (HM)		
QTY	ITEM	MODEL	SIZE/TRIM	OPTION	FINISH
3 ea	HINGES	T4A3386	4.5 X 4.5	NRP	630
1 ea	LOCKSET	ML2057	LC PSA		630
1 ea	CYLINDER	IE	LAR		630
1 ea	CLOSER	351 P3		SR	EN
1 ea	KICK PLATE	J102			630
2 ea	SILENCERS	608			
1 ea	WALL BUMPERS	409			

HW-07			CLOSET / JANITOR (HM)		
QTY	ITEM	MODEL	SIZE/TRIM	OPTION	FINISH
3 ea	HINGES	T4A3386	4.5 X 4.5	NRP	630
1 ea	LOCKSET	ML2057	LC PSA		630
1 ea	CYLINDER	IE	LAR		630
2 ea	SILENCERS	608			

HW-07			CLOSET / JANITOR (HM)		
1 ea	WALL BUMPERS	409			

HW-08			CORRIDOR (HM)		
QTY	ITEM	MODEL	SIZE/TRIM	OPTION	FINISH
3 ea	HINGES	T4A3386	4.5 X 4.5	NRP	630
1 ea	CYLINDER	IE	LAR		630
1 ea	LOCKSET	ML2048	LC PSA		630
1 ea	CLOSER	351 P3		SR	EN
1 ea	WALL BUMPER	409			
2 ea	SILENCERS	608			

HW-09			CORRIDOR PAIR (HM)		
QTY	ITEM	MODEL	SIZE/TRIM	OPTION	FINISH
6 ea	HINGES	T4A3386	4.5 X 4.5	NRP	630
1 ea	FLUSHBOLT	1845			630
1 ea	CYLINDER	IE	LAR		630
1 ea	LOCKSET	ML2048	LC PSA		630
2 ea	CLOSER	351 P3		SR	EN
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GLAZING

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 Z97.1	(2009; Errata 2010) Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test

ASTM INTERNATIONAL (ASTM)

ASTM C1036	(2010e1) Standard Specification for Flat Glass
ASTM C1172	(2009e1) Standard Specification for Laminated Architectural Flat Glass
ASTM C509	(2006; R 2011) Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM C864	(2005; R 2011) Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM E119	(2012a) Standard Test Methods for Fire Tests of Building Construction and Materials

GLASS ASSOCIATION OF NORTH AMERICA (GANA)

GANA Glazing Manual	(2004) Glazing Manual
GANA Sealant Manual	(2008) Sealant Manual

INSULATING GLASS MANUFACTURERS ALLIANCE (IGMA)

IGMA TB-3001	(1990) Guidelines for Sloped Glazing
IGMA TM-3000	(1997) Glazing Guidelines for Sealed Insulating Glass Units

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

16 CFR 1201 Safety Standard for Architectural Glazing Materials

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. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Glass; G

Manufacturer's product data showing compliance with specififed standards and fire rating.

1.3 SYSTEM DESCRIPTION

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.

1.4 DELIVERY, STORAGE, AND HANDLING

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.

1.5 ENVIRONMENTAL REQUIREMENTS

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.

PART 2 PRODUCTS

2.1 GLASS

ASTM C1036, unless specified otherwise. In doors, provide safety glazing material conforming to 16 CFR 1201.

2.1.1 Laminated Glass

ASTM C1172, Kind LA fabricated from two nominal 1/8 inch pieces of Type I, Class 1, Quality q3, flat annealed transparent glass conforming to ASTM C1036. Flat glass shall be laminated together with a minimum of 0.030 inchthick, clear polyvinyl butyral interlayer. The total thickness shall be nominally 1/4 inch.

2.1.2 Fire/Safety Rated Glass

Fire/safety rated glass shall be laminated Type I transparent flat type, Class 1-clear. Glass shall have a 90 minute rating when tested in accordance with ASTM E119. Glass shall be permanently labeled with appropriate markings.

2.2 SETTING AND SEALING MATERIALS

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.

2.2.1 Sealants

Provide elastomeric sealants.

2.2.1.1 Elastomeric Sealant

ASTM C920, Type S, Grade NS, Class 12.5, Use G. Use for channel or stop glazing metal sash. Sealant shall be chemically compatible with setting blocks, edge blocks, and sealing tapes. Color of sealant shall be gray.

2.2.2 Joint Backer

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.

2.2.3 Glazing Gaskets

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 recommended by the manufacturer for the intended application.

2.2.3.1 Fixed Glazing Gaskets

Fixed glazing gaskets shall be closed-cell (sponge) smooth extruded compression gaskets of cured elastomeric virgin neoprene compounds conforming to ASTM C509, Type 2, Option 1.

2.2.3.2 Wedge Glazing Gaskets

Wedge glazing gaskets shall be high-quality extrusions of cured elastomeric virgin neoprene compounds, ozone resistant, conforming to ASTM C864, Option 1, Shore A durometer between 65 and 75.

2.2.4 Accessories

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.

PART 3 EXECUTION

3.1 PREPARATION

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.

3.2 GLASS SETTING

Shop glaze oitems 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. 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 Sheet Glass

Cut and set with the visible lines or waves horizontal.

3.3 CLEANING

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.

3.4 PROTECTION

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. Glass units which are broken, chipped, cracked, abraded, or otherwise damaged during construction activities shall be removed and replaced with new units.

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SECTION 09 29 00

GYPSUM BOARD

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 C1002	(2007) 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
ASTM C1047	(2010a) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM C1396/C1396M	(2011) Standard Specification for Gypsum Board
ASTM C1629/C1629M	(2006; R 2011) Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels
ASTM C475/C475M	(2002; R 2007) Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C840	(2011) Application and Finishing of Gypsum Board
ASTM C954	(2011) Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness
ASTM D1037	(2006a) Evaluating Properties of Wood-Base Fiber and Particle Panel Materials
ASTM D2394	(2005; R 2011) Simulated Service Testing of Wood and Wood-Base Finish Flooring
ASTM D5420	(2010) Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Strike Impacted by a Falling Weight (Gardner Impact)
ASTM E695	(2003; R 2009) Measuring Relative

	Resistance of Wall, Floor, and Roof Construction to Impact Loading

GYPSUM ASSOCIATION (GA)

GA 214	(2010) Recommended Levels of Gypsum Board Finish
GA 216	(2010) Application and Finishing of Gypsum Panel Products

UNDERWRITERS LABORATORIES (UL)

UL Fire Resistance	(2012) Fire Resistance Directory

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Gypsum Board; G

Impact Resistant Gypsum Board; G

Shaftwall Liner Panel; G

Accessories; G

Submit for each type of gypsum board.

SD-07 Certificates

Asbestos Free Materials; G

Certify that gypsum board types, gypsum backing board types, cementitious backer units, and joint treating materials do not contain asbestos.

SD-08 Manufacturer's Instructions

Material Safety Data Sheets

1.3 DELIVERY, STORAGE, AND HANDLING

1.3.1 Delivery

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

Keep materials dry by storing inside a sheltered building. Where necessary to store gypsum board 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 offgas or emit harmful fumes, such as kerosene heaters, fresh paint, or adhesives.

1.3.3 Handling

Neatly stack gypsum board flat to prevent sagging or damage to the edges, ends, and surfaces.

1.4 ENVIRONMENTAL CONDITIONS

1.4.1 Temperature

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, and joint treatment materials, or the bonding of adhesives.

1.4.2 Exposure to Weather

Protect gypsum board products from direct exposure to rain, snow, sunlight, and other extreme weather conditions.

1.4.3 Temporary Ventilation

Provide temporary ventilation for work of this section.

1.5 QUALIFICATIONS

Furnish type of gypsum board work specialized by the installer with a minimum of 3 years of documented successful experience.

PART 2 PRODUCTS

2.1 MATERIALS

Conform to specifications, standards and requirements specified. Provide gypsum board types, and joint treating materials manufactured from asbestos free materials only. Submit Material Safety Data Sheets for gypsum materials.

2.1.1 Gypsum Board

2.1.1.1 Regular

48 inch wide, 5/8 inch thick, tapered edges..

2.1.1.2 Type X (Special Fire-Resistant)

48 inch wide, 5/8 inch thick tapered.

2.1.2 Impact Resistant Gypsum Board

48 inchwide, 5/8 inch thick, tapered edges.
Reinforced gypsum panel with imbedded fiber mesh or lexan backing testing

in accordance with the following tests. Hard body impact test must attain a Level 2 performance in accordance with ASTM C1629/C1629M. Provide fasteners that meet manufacturer requirements and specifications stated within this section.

2.1.2.1 Structural Failure Test

ASTM E695 or ASTM D2394 for structural failure (drop penetration). ASTM E695 using a 60 lb sand filled leather bag, resisting no less than 300 ft. lb. cumulative impact energy before failure or ASTM D2394 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.

2.1.2.2 Indentation Test

ASTM D5420 or ASTM D1037 for indentation resistance. ASTM D5420 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 D1037 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.

2.1.3 Joint Treatment Materials

ASTM C475/C475M. 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.

2.1.3.1 Embedding Compound

Specifically formulated and manufactured for use in embedding tape at gypsum board joints and compatible with tape, substrate and fasteners.

2.1.3.2 Finishing or Topping Compound

Specifically formulated and manufactured for use as a finishing compound.

2.1.3.3 All-Purpose Compound

Specifically formulated and manufactured to serve as both a taping and a finishing compound and compatible with tape, substrate and fasteners.

2.1.3.4 Setting or Hardening Type Compound

Specifically formulated and manufactured for use with fiber glass mesh tape.

2.1.3.5 Joint Tape

Use cross-laminated, tapered edge, reinforced paper, or fiber glass mesh tape recommended by the manufacturer.

2.1.4 Fasteners

2.1.4.1 Screws

ASTM C1002, Type "G", Type "S" or Type "W" steel drill screws for fastening gypsum board to gypsum board, and steel framing members less than 0.033 inch thick. ASTM C954 steel drill screws for fastening gypsum board to steel framing members 0.033 to 0.112 inch thick.

2.1.5 Shaftwall Liner Panel

ASTM C1396/C1396M. 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.

2.1.6 Accessories

ASTM C1047. 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.

PART 3 EXECUTION

3.1 EXAMINATION

3.1.1 Framing and Furring

Verify that framing and furring are securely attached and of sizes and spacing to provide a suitable substrate to receive gypsum board. Verify that all blocking, headers and supports are in place. Do not proceed with work until framing and furring are acceptable for application of gypsum board.

3.1.2 Gypsum Board and Framing

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 Walls

Verify that surfaces of masonry 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

Apply gypsum board to framing and furring members in accordance with ASTM C840 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 not 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 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 Application of Gypsum Board to Steel Framing and Furring

Apply in accordance with ASTM C840, System VIII or GA 216.

3.2.2 Control Joints

Install expansion and contraction joints in ceilings and walls in accordance with ASTM C840, System XIII or GA 216. Fill control joints between studs in fire-rated construction with firesafing insulation to match the fire-rating of construction.

3.3 FINISHING OF GYPSUM BOARD

Tape and finish gypsum board in accordance with ASTM C840, GA 214 and GA 216. Finish plenum areas above ceilings to Level 1 in accordance with GA 214. Finish walls and ceilings to receive fiberglass reinforced coating finish before painting to Level 3 in accordance with GA 214. Finish walls and ceilings without critical lighting to receive flat paints, light textures, or wall coverings to Level 4 in accordance with GA 214. Unless otherwise specified, finish all 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. Protect workers, building occupants, and HVAC systems from gypsum dust.

3.4 SEALING

Seal openings around pipes, fixtures, and other items projecting through gypsum board units as specified in Section 07 92 00 JOINT SEALANTS. Apply material with exposed surface flush with gypsum board.

3.5 FIRE-RESISTANT ASSEMBLIES

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. 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.

3.6 PATCHING

Patch surface defects in gypsum board to a smooth, uniform appearance, ready to receive finishes.

3.7 SHAFTWALL FRAMING

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.

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SECTION 09 65 00

RESILIENT FLOORING

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 E648	(2010e1) Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM F1861	(2008) Resilient Wall Base
ASTM F710	(2011) Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring

1.2 SYSTEM DESCRIPTION

1.2.1 Fire Resistance Requirements

Provide a minimum average critical radiant flux of 0.22 watts per square centimeter for flooring in corridors and exits when tested in accordance with ASTM E648.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Adhesives; G

Wall Base; G

SD-04 Samples

Resilient Flooring and Accessories; G

SD-08 Manufacturer's Instructions

Surface Preparation; G
Installation; G

SD-10 Operation and Maintenance Data

Resilient Flooring and Accessories; G

1.4 DELIVERY, STORAGE, AND HANDLING

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 adsorb 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.

1.5 ENVIRONMENTAL REQUIREMENTS

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.

1.6 SCHEDULING

Schedule resilient flooring application after the completion of other work which would damage the finished surface of the flooring.

1.7 WARRANTY

Provide manufacturer's standard performance guarantees or warranties that extend beyond a one year period.

1.8 EXTRA MATERIALS

Provide 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 WALL BASE

Conform to ASTM F1861, Type TV (thermoplastic vinyl), Style B (coved - installed with resilient flooring). Provide 4 inch high and a minimum 1/8 inch thick wall base. Provide preformed corners in matching height, shape, and color.

2.2 ADHESIVES

Provide adhesives for base as recommended by the manufacturer and comply with local indoor air quality standards. VOC content shall be less than 50 grams/. Submit 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.

2.3 CAULKING AND SEALANTS

Provide caulking and sealants in accordance with Section 07 92 00 JOINT SEALANTS.

2.4 MANUFACTURER'S COLOR, PATTERN AND TEXTURE

Provide color, pattern and texture for resilient flooring and accessories selected from manufacturer's standard colors. Color listed is not intended to limit the selection of equal colors from other manufacturers Provide flooring in any one continuous area or replacement of damaged flooring in continuous area from same production run with same shade and pattern. Submit manufacturer's descriptive data and three samples of each indicated color and type of base, sized a minimum 2-1/2 by 4 inch.

PART 3 EXECUTION

3.1 EXAMINATION

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. Submit manufacturer's printed installation instructions for all flooring materials and accessories, including preparation of substrate, and recommended adhesives.

3.2 SURFACE PREPARATION

Provide a smooth, true, level plane for surface preparation of the flooring, except where indicated as sloped. Floor to be flat to within 3/16 inch in 10 feet. Prepare subfloor in accordance with flooring manufacturer's recommended instructions. Comply with ASTM F710 for concrete subfloor preparation. 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 concrete curing and sealer compounds from the slabs, other than the type that does not adversely affect adhesion. Remove paint, varnish, oils, release agents, sealers, waxes, and adhesives, as required by the flooring product in accordance with manufacturer's printed installation instructions.

3.3 PLACING WALL BASE

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 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.

3.4 CLEANING

Immediately upon completion of installation of base in an area, dry/clean the base and adjacent surfaces to remove all surplus adhesive. Clean base as recommended in accordance with manufacturer's printed maintenance instructions. No sooner than 5 days after installation, wash base with a nonalkaline cleaning solution, rinse thoroughly with clear cold water. Clean and maintain base as recommended by the manufacturer.

3.5 PROTECTION

From the time of installation until acceptance, protect base from damage as recommended by the flooring manufacturer. Remove and replace base which becomes damaged, loose, torn, or curled and wall base which is not tight to wall or securely adhered.

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PAINTING AND COATING

PART 1 GENERAL

This specification section includes painting requirements for architectural surfaces such as aluminum guardrails. For additional coating requirements refer to Section 09 97 13.00 98 STEEL COATINGS

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 C 920	(2011) Standard Specification for Elastomeric Joint Sealants

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev C; Notice 1) Colors Used in Government Procurement

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material Safety Data Sheets shall be submitted to the Contracting Officer.; G

Manufacturer's Standard Color Charts shall be submitted for architectural painting materials in accordance with the paragraph entitled, "General," of this section.; G

A Safety Plan; G shall be submitted to the Contracting Officer.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items including designated name, formula or specification number, manufacturer's instructions and name of manufacturer. Data shall include detailed analysis of each coating material required, with constituents measured as percentages of the total weight of coating; and details of application, thinning, and average coverage per gallon.

Abrasive Blasting Material; G
Sealant Compound; G

Inhibitive Polyamide Epoxy; G
Aliphatic Polyurethane; G
Material, Equipment and Fixture Lists; G
Mix Designs; G

SD-08 Manufacturer's Instructions

Manufacturer's Instructions; G shall be submitted for architectural coatings in accordance with paragraph entitled, "General," of this section.

1.3 DELIVERY, HANDLING AND STORAGE

Materials shall be delivered in their original, unbroken containers bearing the manufacturer's name and product identification.

All paint materials, thinners, and cleaners shall be stored in tightly closed containers in a covered, well-ventilated area where they will not be exposed to excessive heat, sparks, flame, or direct sunlight. Water-based materials shall be protected against freezing.

Material Safety Data Sheets shall be submitted by the contracting officer.

1.4 GENERAL

A Safety Plan shall be submitted for protective coating systems in accordance with OSHA regulations. See paragraph 3.1.1 for requirements.

Material, Equipment and Fixture Lists shall be submitted for manufacturer's style or catalog numbers, specification and drawing reference numbers and warranty information for the Protective Coatings Systems fabrication site.

Manufacturer's Standard Color Charts shall be submitted showing manufacturer's standard finish colors.Three color chips of each coloir shall also be submitted.

Mix Designs shall be submitted for each type of protective coating including a complete list of ingredients and admixtures. Applicable test report shall verify that the mix has been successfully tested and meets design requirements.

1.5 CONTRACTOR PERSONNEL QUALIFICATION

Personnel assigned to the work shall be certified by the Contractor to have had adequate previous experience in the successful application of paints and coatings similar to those specified.

1.6 WARRANTY

Contractor shall guarantee all work against defects in labor and material for a period of one year.

PART 2 PRODUCTS

2.1 GENERAL

The following are suggested paint manufacturers and their products that have been tested and approved by the government. Substitute paints are not acceptable. All thinners and cleaners shall be products of the coating

manufacturer. Primer and finish coats of the paint system shall be products of the same manufacturer.

Manufacturer's Instructions shall be submitted for architectural coatings showing printed instructions covering thinning, mixing, handling, and applying.

2.2 ABRASIVE BLASTING MATERIAL

Abrasive Blasting Material for aluminum surfaces shall be walnut shells, plastic media or approved equivalent.

2.3 SEALANT COMPOUND

Sealant Compound shall be a self-curing, single component, polysulfide-rubber type conforming to ASTM C 920 Type S, Grade NS, Class 25, use NT, A and O. Sealant shall be gray in color and capable of being applied into the joint with a caulking gun.

2.4 EPOXY

An Inhibitive Polyamide Epoxy shall be selected from the following listing.

All coatings thinners, and cleaners shall be the product of the same manufacturer.

Section I. Materials with Greater than 420 Grams/Liter (3.5 Pounds/Gallon) VOC (SB is Solvent-Based and WB is Water-Based):

Epoxy	Manufacturer
Devran 201 (SB)	International Paint LLC/Devoe Coatings 6001 Antoine Drive Houston, TX 77091 (713) 682-1711 (800) 654-2616 www.international-pc.com
PittGuard 95-245 (SB)	PPG Industries, Inc. One PPG Place Pittsburgh, PA 15272 (800) 722-4509 www.ppg.com

For marking frp grating, provide polyamide epoxy primer, basis of design: 66 (SB)

Section II. Materials with Less than 340 Grams/Liter (2.8 Pounds/Gallon) VOC (SB is Solvent-Based and WB is Water-Based):

Epoxy	Manufacturer
Amerlock 400 (SB) Amerlock 2/400 (SB)*	PPG Industries, Inc. One PPG Place Pittsburgh, PA 15272 800) 722-4509

Epoxy	Manufacturer www.ppgamercoatus.ppgpmc.com
Carboguard 893 (SB) Carbomastic 15 (SB) St. Louis, MO 63146	Carboline Company 2150 Schuetz Road (314) 644-1000 www.carboline.com
Devran201H (SB)	International Paint LLC/Devoe Coatings 6001 Antoine Drive Houston, TX 77091 (713) 682-1711 (800) 654-2616 www.international-pc.com
Macropoxy 646-100	Sherwin-Williams 101 Prospect Avenuet Cleveland, OH 44115 (800) 336-1110 www.sherwin-williams.com
Interseal 670HS (SB)	International Paint LLC 6001 Antoine Drive Houston, TX 77091 (713) 682-1711 (800) 654-2616 www.international-pc.com

2.5 POLYURETHANE

An Aliphatic Polyurethane finish coat shall be selected from the following listing and all coatings, thinners, and cleaners shall be the product of the same manufacturer. Each successive coating shall be of a contrasting color to provide a visual assurance of complete coverage.

Section I. Materials with Greater than 420 Grams/Liter (3.5 Pounds/Gallon) VOC (SB is Solvent-Based and WB is Water-Based):

Topcoat (Type)	Manufacturer
Devthane 359 (SB) Devthane 369 (SB) Devthanw 379 UVA (SB)	International Paint LLC/Devoe Coatings 6001 Antoine Drive Houston, TX 77091 (713) 682-1711 (800) 654-2616 www.international-pc.com
PittThane 95-812 (SB)	PPG Industries, Inc. One PPG Place Pittsburgh, PA 15272 (800) 722-4509 www.ppg.com

Section II. Materials with Less than 340 Grams/Liter (2.8 Pounds/Gallon) VOC (SB is Solvent-Based and WB is Water-Based):

Topcoat (Type)	Manufacturer
Amercoat 450HS (SB) PSX1001 (SB) Americoat 450H (SB) Amercoat 335 (SB)	PPG Industries, Inc. One PPG Place Pittsburgh, PA 15272 (800) 722-4509 www.ppg.com
Carbothane 134HS (SB) Carboacrylic 3359 (WB) Carboxane 2000 (SB)	Carboline Company 2150 Schuetz Road St. Louis, MO 63146 (314) 664-1000 www.carboline.com
Devthane 379 (SB)	International Paint LLC/Devoe Coatings 6001 Antoine Drive Houston, TX 77091 (713) 682-1711 (800) 654-2616 www.international-pc.com
Hydrogloss WB (WB) Hi-Solids Poly-CA (SB)	Sherwin-Williams 101 Prospect Avenue Cleveland, OH 44115 (800) 336-1110
Interfine 979 (SB) Interfine 878 (SB)	International Paint LLC 6001 Antoine Drive Houston, TX 77091 (713) 682-1711 www.international-pc.com

2.6 APPROVED SYSTEMS

All coatings, thinners, and cleaners shall be the product of the same manufacturer. Each successive coating shall be of a contrasting color to provide a visual assurance of complete coverage.

Primer (Type)	Base Coat (Type)	Topcoat (Type)	Manufacturer
N/A	Devran 201(SB)	Devthane 359(SB)	ICI Devoe Coatings 4000 Dupont Circle Louisville, KY 40207 (800) 654-2616 www.devoecoatings.com
N/A	Devran 201(SB)	Devthane 369(SB)	
N/A	Devran 201(SB)	Devthane 379UVA(SB)	
N/A	PittGuard 95-245(SB)	PittThane 95-812(SB)	PPG Industries, Inc. One PPG Place Pittsburgh, PA 15272 (800) 722-4509 www.ppg.com
N/A	Amerlock 400(SB)	Amercoat 450(SB)	PPG Industries, Inc. One PPG Place Pittsburgh, PA 15272 (800) 722-4509 www.ppgamercoatus.ppgpmc.com
N/A	Amerlock 2/400 (SB)	Amercoat 450H(SB)	
	Amerlock 2/400 (SB)	Amercoat 335(SB)	
N/A	Carboguard 893(SB)	Carbothane 134HS(SB)	Carboline Co. 2150 Schuetz Road St. Louis, MO 63146 (314) 644-1000 www.carboline.com
N/A	Carbomastic 15(SB)	Carboacrylic 3359(WB)	
	Carboguard 893(SB)	Carboacrylic 3359(WB)	
N/A	Devran 201H(SB)	Devthane 379(SB)	ICI Devoe Coatings 4000 Dupont Circle Louisville, KY 40207 (800) 654-2616 www.devoecoatings.com
N/A	Macropoxy 646-100(SB)	Hydrogloss WB(WB)	Sherwin-Williams 101 Prospect Ave. Cleveland, OH 44115 (800)336-1110 www.sherwin-williams.com
N/A	Macropoxy 646-100(SB)	Hi-Solids Poly-CA(SB)	
N/A	Interseal 670HS(SB)	Interfine 979(SB)	International Paint 6001 Antoine Drive Houston, TX 77091 (713) 682-1711 www.international-pc.com
N/A	Interseal 670HS(SB)	Interfine 878(SB)	

PART 3 EXECUTION

3.1 GENERAL

Manufacturer's recommendations for surface preparation, thinning, mixing, handling, and applying his product shall be considered a part of this specification. In case of conflict between the manufacturer's recommendations and the requirements of this specification, the latter shall take precedence.

3.2 PROTECTION

Contractor shall remove and reinstall, or provide acceptable protection for, all hardware, accessories, lighting and electrical components, factory-finished materials, plumbing fixtures and fittings, and any other materials that may become splattered or damaged by the painting work. "WET PAINT" signs shall be posted to indicate newly painted surfaces.

Every precaution shall be taken to prevent damage to adjacent surfaces. Roping, barricading or covering to preclude damage to personal and real property during surface preparation and painting shall be the Contractor's responsibility. When spray painting, the Contractor must give 24 hours advance warning, coordinated with the Contracting Officer or his representative, and post signs to ensure appropriate warning.

3.3 SURFACE PREPARATION

3.3.1 General Surface Preparation

All surfaces shall be clean, dry, and free from contaminants and foreign matter. All chipped, peeling, or blistered paint shall be removed and the surface spot-primed. Hard, glossy surfaces shall be dulled and roughened to ensure proper adhesion.

All aluminum surfaces shall be brush blasted and coated per paragraph 3.7.1 of this specfication.

3.3.1.1 Coating Instructions

Manufacturer's recommendation for thinning, mixing, handling and applying his product shall be considered a part of this specification. In the event of conflict between the requirements of this specification and the manufacturer's recommendations, this specification shall take precedence.

Compressed air used for spraying coatings shall be free of moisture and oil.

Each coat of material applied shall be free from runs, sags, blisters, and bubbles; variations in color, gloss, and texture; holidays (missed areas); excessive film build; foreign contaminants; dry overspray. Masking shall be complete and each coat applied shall form a film of uniform thickness.

All coatings shall be thoroughly worked into all joints, crevices and open spaces.

All coatings shall be applied by airless or conventional spray.

3.3.1.2 Weather Conditions

No coatings shall be applied when contamination from rainfall is imminent or when the temperature or humidity is outside limits recommended by the coating manufacturer. To prevent moisture condensation during application, surface temperature must be at least 3 degrees Celsius (5 degrees Fahrenheit) above the dewpoint. Wind speed shall not exceed 25 kilometers per hour (15 miles per hour) in the immediate coating area when using spray application methods.

3.3.2 Masonry Surfaces

All surfaces shall be free from form-release compounds, laitance, and other contaminants.

Large cracks, voids and other major surface imperfections shall be repaired before painting. All repairs to cracks and openings in cement block or masonry surfaces shall require preparation of a "V" type opening with the top of the "V" one-half the depth of the crack or opening. All non-tenacious material shall be removed, then the "V" shall be filled using Portland cement grout.

3.3.3 Sealing

All cracks, crevices, and joints such as those along the perimeter of doors and mounted fixtures shall be sealed with a paintable polysulfide type caulking.

Sealant shall be a self-curing, single component, polysulfide-rubber type conforming to ASTM C 920 Type S, Grade NS, Class 25, use NT, A and O. Sealant shall be gray in color and capable of being applied into the joint with a caulking gun.

3.4 MIXING AND APPLICATION

3.4.1 General

All painting shall be accomplished in accordance with the painting schedule.

No paints or coatings shall be applied when the temperature or humidity is outside the limits recommended by the manufacturer, per 3.3.1.2.

Paints and coatings shall be applied by brush, roller, or airless spray.

Each coat of material applied shall be free from runs, sags, bubbles, and foreign contaminants; variations in color, gloss and texture; dry overspray, brush, and roller marks; holidays (missed areas); or other evidence of poor application.

All paints and coatings shall be thoroughly worked into corners and crevices.

Paints and coatings shall be neatly "cut-in" around doors, windows, ceilings, etc.

All newly painted surfaces shall be adequately protected from damage.

3.4.2 Procedures

Coatings shall be applied as follows:

a. Material shall be thoroughly stirred to produce a uniform mixture.

b. Material shall be thinned for workability and improved spray characteristics, but only according to the manufacturer's instructions.

c. Each coat shall be applied uniformly at the minimum wet-film thickness specified by the manufacturer.

d. Special attention shall be given when coating sharp edges, corners, and crevices to ensure complete coverage.

e. Finish coats shall show good hiding characteristics and uniform appearance.

3.5 SPOT-PAINTING

Spot-painting to correct damaged surfaces will be allowed only when touchup area blends into the surrounding finish. Otherwise, the entire area shall be recoated. Touchup shall be accomplished using the same method of application as was used to apply the original material.

3.6 ACCEPTANCE PROVISIONS

3.6.1 Inspection

Work as described herein shall be inspected for compliance with this specification by an independent NACE (National Association of Corrosion Engineers) Certified Coating Inspector Level 3 provided by the Contractor. See Section 09 97 13.0098, paragraph 3.5

3.6.2 Cleanup

Contractor shall be responsible for removal of all paint or coating splatter and spills from floors, adjacent walls, hardware, and all other finished surfaces.

Contractor shall leave the work area clean and free from all rubbish and accumulated material left from his work.

3.7 PAINT SCHEDULE

3.7.1 Paint Schedule

Colors shall be in accordance with FED-STD-595.

SURFACE DESCRIPTION	SURFACE PREPARATION	COATING	FINISH COLOR	DRY-FILM THICKNESS
Aluminum surfaces except cable trays and cable tray covers	SP-7	Epoxy Urethane	Gray 16473*	Per Mfg's instructions Per Mfg's instructions

Copper Pipe	SP-1	Epoxy Urethane	Gray 16473*	Per Mfg's instructions Per Mfg's instructions
Gypsum Board partitions		Waterborne light industrial coating (semigloss)	Gray 16473*	4 mils
Shaftwall ceilings, partitions		Waterborne light industrail coating (semigloss)	Gray 16473*	4 mils
Concrete Masonry Unit Walls	ICRI 03732	Block Surfacer Acrylic epoxy	Gray 16473*	Per Mfg's instructions
Concrete floor slab	ICRI 03732	Urethane Sealer	Clear Satin	Per Mfg's instrucitons

* FED-STD-595 Color Identification Number

-- End of Section --

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-- End of Section Table of Contents --

SECTION 09 97 13.00 98

STEEL COATINGS

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 A 123	(2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM C 920	(2011) Standard Specification for Elastomeric Joint Sealants

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD 595	(Rev C; 2008) Colors Used in Government Procurement

U.S. Department of Defense (DOD)

MIL-A-22262	(1959) Abrasive Blast Ship Hull Blast Cleaning
MIL-PRF-24667	(1987) Coating System Non-Skid Roll or Spray

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

KSC-STD-SF-0004	(Rev B) Safety Standard for Ground Piping Systems Color Coding and Identification

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC AB-1	(2000) Mineral and Slag Abrasives
SSPC SP 1	(2000e1) Solvent Cleaning
SSPC SP 7	(2007) Brush-Off Blast Cleaning
SSPC SP 10	(2000) Joint Surface Preparation, Standard Near-White Metal Blast Cleaning (NACE No. 2)
SSPC SP 11	(1987; E 2004) Power Tool Cleaning to Bare Metal
SSPC SP 3	(2004; E 2004) Power Tool Cleaning

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material Safety Data Sheets; G shall be submitted in accordance with the paragraph entitled, "delivery, handling and storage", of this section.

Material, Equipment, and Fixture Lists; G shall be submitted in accordance with the paragraph entitled, "General," of this section.

Manufacturer's Color Samples; G shall be submitted for painting materials in accordance with the paragraph entitled, "General", of this section.

A Safety Plan; G shall be submitted in accordance with paragraph entitled, "General," of this section.

Mix Designs; G shall be submitted in accordance with paragraph entitled, "General", of this section.

Coating Inspector Plan; G shall be submitted in accordance with paragraph entitled, "Inspection" of this section.

Waste Management Plan; G shall be submitted in accordance with Section 01 57 20.00 10 ENVIRONMENTAL PROTECTION.

SD-02 Shop Drawings

Coating Repair Plan; G shall be submitted for each piece of GFE in accordance with the paragraph entitled, "Touch-up" of this section.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items, including designated name, formula or specification numbers, manufacturer's instructions and name of manufacturer. Data shall include detailed analysis of each coating material required, with constituents measured as percentages of the total weight of coating; and details of application, thinning, and average coverage per liter gallon:

Abrasive Blasting Material; G
Sealant Compound; G
Inorganic Zinc; G
Aliphatic Polyurethane; G
Non-Skid Coatings; G

SD-06 Test Reports

Inspection reports; G shall be submitted for protective coating systems in accordance with paragraph entitled, "Inspection," of this section.

Daily Inspection Reports; G shall be submitted for protective

coating systems in accordance with paragraph entitled, "Inspection," of this section.

SD-08 Manufacturer's Instructions

Manufacturer's instructions shall be submitted for Protective Coatings; G including details of thinning, mixing, handling, and application.

1.3 SCOPE

This section covers materials, surface preparation and the application of protective coatings on all new structure and equipment installed under this contract as well as any existing coating damaged by construction activities. This specification does not apply to existing equipment, systems and structure, except as indicated.

1.4 DELIVERY, HANDLING AND STORAGE

Materials shall be delivered in their original, unbroken containers bearing the manufacturer's name, product identification, and batch number. Coatings, thinners, and cleaners shall be stored in tightly closed containers in a covered, well-ventilated area where they will be protected from exposure to extreme cold or heat, sparks, flame, direct sunlight, or rainfall. Manufacturer's instructions for storage limitations shall be followed.

Material Safety Data Sheets shall be submitted by the Contractor.

1.5 PROTECTION OF EQUIPMENT AND ADJACENT SURFACES

All equipment and adjacent surfaces that may be damaged as a result of any phase of this work shall be protected.

1.6 GENERAL

A Safety Plan shall be submitted for protective coating systems in accordance with OSHA regulations. See paragraph 3.1.1 for requirements.

Material, Equipment, and Fixture Lists shall be submitted for manufacturer's style or catalog numbers, specification and drawing reference numbers and warranty information for the Protective Coatings Systems fabrication site.

Manufacturer's Color Samples shall be submitted showing the manufacturer's match of the FED standard finish colors specified.

Mix Designs shall be submitted for each type of protective coating including a complete list of ingredients and admixtures. Applicable test report shall verify that the mix has been successfully tested and meets design requirements.

PART 2 PRODUCTS

2.1 ABRASIVE BLASTING MATERIAL

Blasting aggregates for use on carbon steel shall be approved materials in accordance with MIL-A-22262 or SSPC AB-1, Type I or II, Class A, or steel grit. Only materials approved in the QPL attached to MIL-A-22262 shall be

used. The abrasive grade selected must produce the required surfaces profile and possess physical properties that are compatible with the requirements of this standard. The steel grit shall be neutral (6.0 to 8.0 pH), rust and oil free, dry, commercial-grade blasting grit with a hardness to 40 to 50 Rockwell C. The size shall be selected to produce the required anchor profile. All abrasive blasting material shall be silica free.

Steel grit shall not be used as the blasting aggregate for stainless steel. Abrasive blasting material for stainless steel surfaces shall be walnut shells, plastic media, or approved equivalent.

2.2 SEALANT COMPOUND

Sealant shall be a self-curing, single component, polysulfide-rubber type conforming to ASTM C 920 Type S, Grade NS, Class 25, use NT, A and O. Sealant shall be gray in color and capable of being applied into the joint with a calking gun.

2.3 PROTECTIVE COATINGS

2.3.1 Coating Systems

All carbon steel surfaces shall be abrasive blasted per SSPC SP 10 and coated with inorganic zinc unless otherwise noted specifically on the drawings or paragraph 3.7 Coating Schedule of this specification.

All stainless steel surfaces shall be degreased and brush blasted per SSPC SP 7 and coated with coating system No. 6 unless specifically noted in the drawings or paragraph 3.7 COATING SCHEDULE of this specification.

Special care must be taken to avoid damaging surfaces when blasting, especially thin-walled items.

The following are suggested paint manufacturers and their products which have been tested and approved by the government. Substitute paints are not acceptable. All thinners and cleaners shall be products of the coating manufacturer. Primer and finish coats of the paint system shall be products of the same manufacturer.

All products have been approved for use by NASA. However, not all products are appropriate for all weather/environmental conditions. It is the responsiblity of the Cotnractor to select the products for use on the project.

The following coating systems definitions are to be specified for use on the surfaces listed in the Coating Schedules, of this section, and as directed.

COATING SYSTEM NO. 1

Coating System No. 1 shall consist of inorganic zinc only. Inorganic zinc shall be selected from the following listing. Coatings, thinners, and cleaners shall be the product of one manufacturer.

Section I. Materials with Greater than 400 Grams/Liter (3.3 Pounds/Gallon) VOC (SB is Solvent-Based and WB is Water-Based):

Coating Designation	Type	Manufacturer
Dimetcote 9	SB	PPG Industries, Inc. One PPG Place Pittsburgh, PA 15272 (800) 722-4509 www.ppgamercoatus.ppgpmc.com
Carbo-Zinc 11	SB	Carboline Company 2150 Schuetz Road St. Louis, MO 63146 (314) 644-1000 www.carboline.com
Cathacoat 304L Cathacoat 304K	SB SB	ICI Devoe Coatings 4000 Dupont Circle Louisville, KY 40207 (800) 654-2616 www.devoecoatings.com
Metalhide 1001	SB	PPG Industries, Inc. One PPG Place Pittsburgh, PA 15272 (800) 722-4509 www.ppg.com
Zinc-Clad II	SB	Sherwin-Williams Company 101 Prospect Avenue N.W. Cleveland, OH 44115 (800) 336-1110 www.sherwin-williams.com

Section II. Materials with Less than 400 Grams/Liter (3.3 Pounds/Gallon) VOC (SB is Solvent-Based and WB is Water-Based):

Coating Designation	Type	Manufacturer
Dimetcote D-9H Dimetcote D-9HS	SB SB	PPG Industries, Inc. One PPG Place Pittsburgh, PA 15272 (800) 722-4509 www.ppgamercoatus.ppgpmc.com
Carbo-Zinc 11HS Carbo-Zinc 11 VOC Carbo-Zinc 11 WB	SB SB WB	Carboline Company 2150 Schuetz Road St. Louis, MO 63146 (314) 644-1000 www.carboline.com
Cathacoat 305 Cathacoat 304V	WB SB	ICI Devoe Coatings 4000 Dupont Circle Louisville, KY 40207 (800) 654-2616 www.devoecoatings.com
InterZinc 22HS	SB	International Paint 6001 Antoine Drive

Coating Designation	Type	Manufacturer
		Houston, TX 77091 (713) 682-1711 www.international-pc.com
Zinc-Clad XI Zinc-Clad II Plus	WB SB	Sherwin-Williams Company 101 Prospect Avenue N.W. Cleveland, OH 44115 (800) 336-1110 www.sherwin-williams.com
Kolor-Zinc 2.8 VOC	SB	Keeler & Long/PPG 856 Echo Lake Road Watertown, CT 06795 (800) 238-8596 www.ppg.com/coatings/pmc/brands/keelerlong

COATING SYSTEM NO. 2

Coating System No. 2 shall consist of an inhibitive metal primer and two (2) coats polyurethane.

COATING SYSTEM NO. 3

Coating System No. 3 shall consist of inorganic zinc first coat and inhibitive polyamide epoxy tie coat and polyurethane Topcoat. Coatings shall be selected from the following listing and all coatings, thinners, and cleaners shall be the product of the same manufacturer. Each successive coating shall be of a contrasting color to provide a visual assurance of complete coverage.

Primer (Type)	Midcoat (Type)	Topcoat (Type)	Manufacturer
Cathacoat 304L(SB) Cathacoat 304L(SB) Cathacoat 304L(SB) Cathacoat 304K	Devran 201(SB) Devran 230(SB) Devran 201(SB) Devran 201(SB)	Devthane 359(SB) Devthane 369(SB) Devthane 369(SB) Devthane 379UVA(SB)	ICI Devoe Coatings 4000 Dupont Circle Louisville, KY 40207 (800) 654-2616 www.devoecoatings.com
MetalHide 1001(SB)	PittGuard 95-245(SB)	PittThane 95-812(SB)	PPG Industries, Inc. One PPG Place Pittsburgh, PA 15272 (800) 722-4509 www.ppg.com
Kolor-Zinc 2.8 VOC (SB)	N/A	Coraflon ADS (SB)	Keeler & Long/PPG 856 Echo Lake Road Watertown, CT 06795 (800) 238-8596 www.ppg.com/coatings/pmc/brands/keelerlong
Carbozinc 11 (SB)	N/A	Carbothane 133 LH(SB)	Carboline Company 2150 Schuetz Road

Primer	Midcoat (Type)	Topcoat (Type)	Manufacturer
			St. Louis, MO 63146 (314) 644-1000 www.carboline.com
D-9HS(SB)	Amerlock 400(SB)	Amercoat 450(SB)	PPG Industries, Inc.
D-9HS(SB)	N/A	PSX700(SB)	One PPG Place
D-9H(SB)	Amercoat 383(SB)	PSX1001(SB)	Pittsburgh, PA 15272
D-9H(SB)	Amerlock 2/400 (SB)	Amercoat 450H(SB)	(800) 722-4509 www.ppgamercoatus.ppgpmc.com
D-9H(SB)	Amerlock 2/400 (SB)	Amercoat 335(SB)	
CZ-11HS(SB)	Carboguard 893(SB)	Carbothane 134HS(SB)	Carboline Co.
CZ-11HS(SB)	Carbomastic 15(SB) Car 893(SB)	Carboacrylic 3359(WB)	2150 Schuetz Road St. Louis, MO 63146 (314) 644-1000 www.carboline.com
CZ-11HS(SB)	N/A	Carboxane 2000(SB)	
CZ-11WB(WB)	Carboguard 893(SB)	Carboacrylic 3359(WB)	
CZ-11WB(WB)	Carboacrylic 3358(WB)	Carboacrylic 3359(WB)	
Cathacoat 304V(SB)	Devran 201H(SB)	Devthane 379(SB)	ICI Devoe Coatings 4000 Dupont Circle Louisville, KY 40207 (800) 654-2616 www.devoecoatings.com
Zinc Clad XI(WB)	N/A	Polysiloxane XLE	Sherwin-Williams 101 Prospect Ave. Cleveland, OH 44115 (800)336-1110 www.sherwin-williams.com
Zinc Clad II Plus(SB)	Macropoxy 646-100(SB)	Hydrogloss WB(WB)	
Zinc Clad II Plus(SB)	Macropoxy 646-100(SB)	Hi-Solids Poly-CA(SB)	
InterZinc 22HS(SB)	Interseal 670HS(SB)	Interfine 979(SB)	International Paint 6001 Antoine Drive Houston, TX 77091 (713) 682-1711 www.international-pc.com
InterZinc 22HS(SB)	Interseal 670HS(SB)	Interfine 878(SB)	

COATING SYSTEM NO. 4

Coating System No. 4 applies to hot dipped galvanized items.

Galvanized surfaces to be top coated shall be prepared by solvent cleaning per SSPC SP 1 and brush blasted per SSPC SP 7 using Star Blast X-11 with compressed air pressure 40 to 60 psi.

Rigid steel conduit shall be coated with coating System No.4.

COATING SYSTEM NO. 5

Coating System No. 5 shall consist of a non-skid coating system applied to steel floor surface subject to personnel traffic and equipment carts. Approved Non-skid coatings shall meet MIL-PRF-24667, Type 1, as available from American Safety Technologies, Inc., 565 Eagle Rock Ave, Roseland, NJ

07068, telephone (800) 631-7841, www.astantislip.com, or approved equal (Primer MS 7C, Topcoat MS 400C, Color Topping MS 200.

Primer	Non-skid	Manufacturer
MS-7C7	AS-2300 SCILTC	American Safety Technologies, Inc.

- Type 1 - High durability, rollable deck coating
- Composition G - General use abrasive deck system
- Non-skid coating shall conform to MIL-PRF-24667

COATING SYSTEM NO. 6

Coating System No. 6 shall consist of an inhibitive polyamide epoxy tie coat, and Aliphatic Polyurethane finish coat. Coatings shall be selected from the following listing and all coatings, thinners, and cleaners shall be the product of the same manufacturer. Each successive coating shall be of a contrasting color to provide a visual assurance of complete coverage.

Section I. Materials with Greater than 400 Grams/Liter (3.3 Pounds/Gallon) VOC (SB is Solvent-Based and WB is Water-Based):

Tiecoat (Type)	Topcoat (Type)	Manufacturer
Devran 201 (SB)	Devthane 359 (SB)	ICI Devoe Coatings Co.
Devran 230 (SB)	Devthane 369 (SB)	4000 Dupont Circle
Devran 201 (SB)	Devthane 369 (SB)	Louisville, KY 40207
Devran 201(SB)	Devthane 379 (SB)	(800) 654-2616
		www.devoecoatings.com

Section II. Materials with Less than 400 Grams/Liter (3.3 Pounds/Gallon) VOC (SB is Solvent-Based and WB is Water-Based):

Tiecoat (Type)	Topcoat (Type)	Manufacturer
Amerlock 400 (SB)	Amercoat 450S (SB)	Ameron P.C.F.G.
N/A	PSX700 (SB)	210 North Berry St.
Amercoat 383(SB)	PSX101 (SB)	Brea, CA 92821
Amerlock 2/400(SB)	Americoat 450H(SB)	(800) 926-3766
Amerlock 2/400(SB)	Americoat 335(SB)	www.ameron.intl.com
Carboguard 893 (SB)	Carbothane 134HS (SB)	Carboline Company
Carbomastic 15 (SB)	Carboacrylic 3359 (WB)	350 HanleyIndustrialCt.
Cargoguard 893 (SB)	Carboxane 2000(SB)	St. Louis, MO 63114
N/A	Carboxane 2000(SB)	(800) 677-0753
Carboguard 893 (SB	Carboacrylic 3359(WB)	www.carboline.com
Carboacrylic 3359(WB)	Carboacrylic 3359(WB)	
Devran 201H (SB)	Devthane 379 (SB)	ICI Devoe Coatings Co.
		4000 Dupont Circle
		Louisville, KY 40207
		(800) 654-2616
		www.devoecoatings.com

Tiecoat (Type)	Topcoat (Type)	Manufacturer
Macropoxy 646-100 HiSolids	Polyurethane 250	Sherwin Williams 101 Prospect Ave Cleveland, OH 44115 (800) 336-1110 www.sherwin-william.com
Interseal 670HS(SB)	Interfine 979(SB)	International Paint 6001 Antoine Dr. Houston, TX 77091 (713) 682-1711 www.international-pc.com
Interseal 670HS(SB)	Interfine 878(SB)	

PART 3 EXECUTION

3.1 SURFACE PREPARATION

3.1.1 General

The on-site abrasive blasting and painting work shall require complete containment, collection and disposal of waste material in accordance with OSHA and local government and KSC environmental and safety regulations for handling hazardous materials and personnel protection.

The Contractor shall submit a plan and procedure for approval by the Contracting Officer for the protection of personnel and the environment during abrasive blasting and painting. The submittal shall describe materials, equipment and instrumentation used for compliance to contain, collect and dispose of waste materials in accordance with OSHA and the local authority.

Faying surfaces that will become inaccessible after installation shall be abrasive blasted and coated with inorganic zinc only, prior to installation.

Surfaces that are part of slip-critical joints shall be abrasive blasted and coated with inorganic zinc only prior to installation.

Surfaces to be welded shall be masked off and left uncoated. After installation by completion of field welding, all uncoated surfaces shall be cleaned and painted in accordance with paragraph 3.3.

Surfaces shall be inspected and degreased as required prior to subsequent surface preparation and the application of protective coatings. Degreasing shall be by solvent cleaning, detergent washing, or steam cleaning. SSPC SP 1 shall apply for solvent cleaning.

Immediately after the surface to be coated has been prepared, it will be inspected by the NACE Inspector to determine compliance with the specification for surface preparation. Any areas not meeting the surface preparation requirements shall be re-cleaned until approved. No coatings shall be applied until the surface preparation has been approved.

Prepared surfaces shall be coated within 6 hours after completion of surface preparation and before rusting or recontamination occurs. Surfaces not coated within 6 hours or which show rusting or contamination, regardless of the length of time after preparation, shall be reprepared.

Fastener holes shall be treated as uncoated surfaces and shall be coated in accordance with this specification.

Surface preparation and coating operations shall be sequenced so that freshly applied coatings will not be contaminated by dust or foreign matter.

3.1.2 Colors

Inorganic zinc coatings shall be pigmented so that there is a definite contrast between the coating and the dull gray appearance of the blasted steel surface during the coating application. Color coding for fluid system piping shall be in accordance with KSC-STD-SF-0004. Finish coat colors specified in paragraph 3.6 shall be in accordance with FED-STD 595 color numbers using pigments free of lead, chromium and cadmium.

3.1.3 Abrasive Blasting (AB)

Abrasive blasting shall conform to SSPC SP 10.

Compressed air used for abrasive blasting shall be free of moisture and oil.

Surfaces not to be blasted are:

Prefinished surfaces except when specified to be blast-cleaned in the coating schedule

Piston rods and bearing surfaces

A minimum nozzle pressure of 90 pounds per square inch shall be maintained.

Weld slag, weld spatter, and foreign matter shall be removed from surfaces to be coated prior to abrasive blasting using mechanical methods as specified.

Blast cleaning shall achieve a 1.5-to 3.0-mil anchor profile as indicated by a surface profile comparator, replica tape, or similar device.

Rust and corrosion shall be removed from pits and depressions.

Abrasive blast aggregate shall not be reused.

All traces of abrasive residue and dust shall be removed from the surface, leaving it clean and dry.

3.1.4 Mechanical Cleaning (MC)

Where mechanical cleaning is specified required, needle scalers or abrasive disks or wheels shall be used in accordance with SSPC SP 3 and SSPC SP 11, leaving the surface anchor profile of the surface cleaned with the power tool equal to 1.5 mil to 3.0 mil. All rust shall be completely removed from its and depressions.

3.2 INSPECTION OF SURFACE PREPARATION

Immediately after the surface has been prepared, it will be inspected by the NACE inspector to determine compliance with the specification for surface preparation. Any areas not meeting the surface preparation requirements shall be recleaned until approved. No coatings shall be applied until the surface preparation has been approved.

3.3 COATING APPLICATION

Application and handling characteristics of all coatings will vary. To obtain optimum performance, adequate instructions from the manufacturer are essential and must be closely followed, in conjunction with the requirements of this specification.

Manufacturer's recommendations for thinning, mixing, handling, and applying his product shall be considered a part of this specification. In the event of conflict between the requirements of this specification and the manufacturer's recommendations, this specification shall take precedence.

Compressed air used for spraying coatings shall be free of moisture and oil.

Each coat of material applied shall be free from runs, sags, blisters, bubbles, variations in color, gloss and texture, holidays (missed areas), excessive film build, foreign contaminants, dry overspray, etc.

All coatings shall be thoroughly worked into all joints, crevices, and open spaces. Special attention shall be paid to welds, cutouts, sharp edges, rivets, crevices and bolts to ensure proper coverage and thickness.

All newly coated surfaces shall be adequately protected from damage. Special attention shall be paid to potential damage resulting from nearby operations such as grinding, welding, cutting, etc. Metal fittings that result form such activity shall not remain on coated surfaces. Any damage to coatings resulting from such operations shall be cleaned and touched-up per paragraph 3.3 of this section.

Apply all coatings by airless spray, conventional spray, or by brush. Airless spray shall be used for large surface areas. Conventional spray and brushes may be used for small areas of intricate configuration and touchup. During application of inorganic zinc coating, maintain uniform suspension.

3.3.1 Weather Conditions

The ambient weather conditions at the actual location of the work shall be determined before and during the surface preparation and coating application operations to ensure they are correct for the work being conducted.

No coatings shall be applied when contamination from rainfall is imminent or when the temperature or humidity is outside limits recommended by the coating manufacturer. To prevent moisture condensation during application, surface temperature must be at least 3 degrees Celsius (5 degrees Fahrenheit) above the dewpoint. Wind speed shall not exceed 25 kilometers per hour (15 miles per hour) in the immediate coating area when using spray application methods.

Proper instrumentation shall be used to measure air temperature, relative humidity, dewpoint, surface temperature, and wind speed and direction.

All ambient weather conditions shall be recorded in the daily inspection reports.

Solvent-based inorganic zinc coatings, polysiloxane topcoats, and IOTs shall not be applied in conditions with <40 percent RH.

Water-based inorganic zinc coatings shall not be applied in conditions with <40 percent or >80 percent RH.

3.3.2 Mixing and Application Procedures

Material shall be stirred thoroughly using a instrument that will not induce air into coating.

Strain the mixed material through a 30 to 60 mesh screen.

Provide continuous slow agitation during application to maintain uniform suspension. Avoid continuous rapid agitation.

Thin for workability and improved spray characteristics only. Use only the manufacturers' recommended thinner and amount.

Adjust spray equipment to produce an even wet coat with minimum overspray.

Apply in even parallel passes, overlapping 50 percent to provide complete and uniform coverage. Pay special attention to welds, cut-outs, sharp edges, rivets, crevices, and bolts to ensure proper coverage.

Pressure pot, when used, shall be kept at the same level or above the spray gun for proper material delivery.

3.3.3 Dry-Film Thickness (DFT)

Coatings shall be applied to the following dry-film thicknesses:

Coating System No. 1:	
Inorganic zinc	4.0 to 6.0 mils
Coating System No. 3:	
Inorganic zinc	4.0 to 6.0 mils
Water Based	Per Mfg's recommendations
Inhibitive Polyamide Epoxy	
Aliphatic Polyurethane	Per Mfg's recommendations
Coating System No. 4:	
Hot Dipped Galvanized	ASTM A 123
Coating System No. 5:	
Heavy Duty Metal Primer	Per Mfg's recommendations
2-part epoxy with premixed aggregate	
Coating System No. 6	
Inhibitive Polymide Epoxy	Per Mfg's recommendation
Aliphatic Polyurethane	Per Mfg's recommendation

When dry through (dry to handle), the film thickness shall be checked with a calibrated nondestructive dry-film thickness gage. If less than specified thickness, additional material shall be applied as required. Proper DFT for the inorganic zinc coating shall be obtained in a single application which may consist of multiple passes, while coating is still wet.

3.4 TOUCH-UP AND REPAIR

Touch-up shall be required of all damaged coatings that occur during shipment and field handling. During the construction work, touch-up shall be an on-going process to repair coatings that are damaged and expose steel surfaces to the elements. Field welds shall be cleaned, painted and inspected promptly to avoid rust formation.

Repair surfaces shall be prepared for coatings by water washing and by mechanical methods to SSPC SP 11 to a roughness profile of 1.5 mils to remove corrosion and weld slag to bare metal. All chipped, peeling, or blistered paint shall be removed prior to touch-up. Repair coatings shall be "feathered in" to adjacent existing coating edges. Touched-up areas shall blend in with the surrounding area.

The following general touch-up requirements shall apply:

COATING SYSTEM	TOUCH UP COATING
Coating System No. 1:	
Inorganic zinc	Inorganic zinc
Coating System No. 3:	
Inorganic zinc	Inorganic zinc
Epoxy	Epoxy
Aliphatic Polyurethane	Aliphatic Polyurethane
Coating System No. 4:	
Hot Dipped Galvanized	Inorganic zinc
Coating System No. 5:	
Non-Skid Coating System	as recommended by mfg.
Coating System No. 6:	
Inhibitive Polymide Epoxy	Inhibitive Epoxy
Aliphatic Polyurethane	Aliphatic Polyurethane

Touch-up of damaged coatings shall be to the quality of the original finish coat. Contractor is responsible to protect the finish of all factory finishes and G.F.E. Should damage to these coating(s) be identified, the Contractor shall provide reasonable protection to prevent further damage. The Contractor shall submit a Coating Repair Plan for each damaged item. The plan shall include a proposed coating system, the location(s) of coating damage and proposed method of repair.

Final appearance and distribution of aggregate texture shall be uniform across the entire surface.

3.5 SEALANT COMPOUND APPLICATION

Caulking shall be accomplished after application and cure of inorganic zinc coating and prior to application of topcoats.

Exterior joints shall be calked to seal all crevices against intrusion of water, including, but not limited to, the following:

a. Perimeter of faying and bearing surfaces of structural members

b. Joints in members between intermittent welds

c. Perimeter of bearing surfaces between floor plates and supporting members (inside, outside, top, and bottom)

d. Stair treads, where joined to channel stringers

e. Openings of 1/2 inch or smaller (Foam filler backup shall be used as required.)

f. Hot-dipped galvanized vent holes

3.6 INSPECTION

On-site and off-site work as described herein shall be inspected for compliance with this specification by an independent third party NACE (National Association of Corrosion Engineers) Certified Coating Inspector Level 3 provided by the Contractor.

The NACE Certified Coating Inspector shall be present at the pre-work conference and shall submit a Coating Inspector Plan (CIP) specifically applicable to this project. The program shall include both off-site and on-site work.

The Coating Inspector Plan shall include, as a minimum, the following:

1. Basic inspection plan for determining compliance with the coating requirements in this section.
2. Inspection Forms which shall identify the key inspection intervals, activities and steps witnessed, inspected, tested and certified for this project.
3. The inspection plan for identifying areas and surfaces damaged during handling, erection and construction activities. Non-conformance reports are required to be signed and submitted to the Contracting Officer within 1 workday from the time that it is written. Once nonconformations have been corrected, complete a conformance verification report for the specific item or area.
4. Inspection and certifying repairs to damaged areas and surfaces.
5. Submittal schedule for issuing inspection reports. Signed, daily Inspection reports shall be submitted on a weekly basis as a minimum.
6. Non-conformance plan detailing expected coating failures and repairs, as well as sample reports.

Structural assemblies painted offsite and delivered onsite shall require the following:

1. Submittal of the certified daily inspection reports for each item.
2. Spot check a minimum of 10% of surface areas on each item delivered for compliance with the specifications. The government reserves the right to select the areas.
3. 10% of the surface areas shall be divided into 3 separate locations for spot checks.
4. Deficiencies greater than 10% shall require that the assembly be returned to the offsite facility for rework to comply with the specifications.

3.7 COATING SCHEDULE

SURFACE DESCRIPTION	SURFACE PREPARATION SSPC	COATING SYSTEM	FINISH COLOR	DRY-FILM THICKNESS
Structural Steel, including new floor framing	SP-10	1	Gray	IZ 4.0 to 6.0 mils
Selected Steel, as shown on the drawings	SP-10	3	Yellow 13951*	Per Mfg's instructions
Steel ladder rails	SP-10	3	Gray (lighter) 16473*	Per Mfg's instructions
Steel ladder rungs	SP-10	5	Gray (lighter) 16473*	Per Mfg's instructions
Walking Surfaces	SP-1,SP-7	5	Gray 16473*	Per Mfg's instructions
Steel Doors and Frames	SP-7	2	Gray (darker) 16187*	6.0 to 10.0 mils
Fixed Guardrails	SP-10	1	Gray	IZ 4.0 to 6.0 mils
Steel Posts, for removable aluminum rails		SP-7	2 Yellow 13951*	6.0 to 10.0 mils
Steel Stringers Stairs & Handrails	SP-10	3	Gray 16473*	Per Mfg's instructions
HDG Grating	SP-1, SP-7	4	Gray	HDG per ASTM A 123
Galvanized Conduit & Pipe	SP-1, SP-7	4	Gray	HDG per ASTM A 123
Non-Fire Protection Carbon Steel Piping	SP-10	1/6	Gray(lighter) 16473*	IOZ 3.0 to 5.0 mils Per Mfg's recommendations
Fire Protection Carbon Steel Piping	SP-10	1/6	Red 11105*	IOZ 3.0 to 5.0 mils Per Mfg's recommendations

*FED STD-595 Color Identification Number

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INTERIOR SIGNAGE

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 basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D635	(2010) Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position

INTERNATIONAL CODE COUNCIL (ICC)

ICC/ANSI A117.1	(2009) Accessible and Usable Buildings and Facilities

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2012; Amendment 1 2012) Life Safety Code

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

36 CFR 1191	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

SD-03 Product Data

Installation; G
Warranty; G

SD-04 Samples

Interior Signage; G

1.3 QUALITY ASSURANCE

1.3.1 Samples

Submit interior signage samples of each of the following sign types showing typical quality, workmanship and color: Directional sign. The samples may be installed in the work, provided each sample is identified and location recorded.

1.3.2 Detail Drawings

Submit detail drawings showing elevations of each type of sign, dimensions, details and methods of mounting or anchoring, mounting height, shape and thickness of materials, and details of construction. Include a schedule showing the location, each sign type, and message.

1.4 DELIVERY, STORAGE, AND HANDLING

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.

1.5 WARRANTY

Warrant the interior signage for a period of 2 years against defective workmanship and material. Warranties shall be signed by the authorized representative of the manufacturer. Submit warranty accompanied by the document authenticating the signer as an authorized representative of the guarantor. Guarantee that the signage products and the installation are free from any defects in material and workmanship from the date of delivery.

PART 2 PRODUCTS

2.1 STANDARD PRODUCTS

Signs shall be the standard product of a manufacturer regularly engaged in the manufacture of such products that essentially duplicate signs that have been in satisfactory use at least 2 years prior to bid opening. Obtain signage from a single manufacturer with edges and corners of finished letterforms and graphics true and clean.

2.2 SIGNAGE

2.2.1 Instructional Signs

Signs shall consist of laminated thermosetting Type MP plastic (three-ply melamine plastic laminate with phenolic core) and shall conform to the following:

Units shall be frameless. Corners of signs shall be rounded to 3/8 inch radius.

2.2.2 Evacuation and Load Rating Signs

Painted aluminum .063" gauge, with 1 inch radius corners. Lettering in 3M Scotchlite Hi Intensity vinyl sheeting, or approved equal, white reflective.

2.2.3 Type of Mounting For Signs

Provide extruded aluminum brackets 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 closed cell vinyl foam with adhesive backing. Adhesive shall be transparent, long aging, high tech formulation on two sides of the vinyl foam, fabricated from materials that are not corrosive to sign material and mounting surface.

2.2.4 Graphics

Signage graphics for modular signs shall conform to the following:

Engraved Copy: Machine engrave letters, numbers, symbols, and othergraphics 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 D635.

2.2.5 Character Proportions and Heights

Letters and numbers on signs conform to 36 CFR 1191.

2.2.6 Tactile Letters, Symbols and Braille

Raised letters and numbers on signs shall conform to 36 CFR 1191.

2.3 STAIR SIGNAGE

Provide signs on stairs serving three or more stories with special signage within the enclosure at each floor landing conforming to NFPA 101. Indicate the floor level, the terminus of the top and bottom of the stair enclosure, and the identification of the stair enclosure. Also, state the floor level of, and the direction to, exit discharge. Locate the signage inside the enclosure in a position that is visible when the door is in the open or closed position and install in conformance with 36 CFR 1191. The floor level designation shall also be tactile in accordance with ICC/ANSI A117.1.

2.4 PRESSURE SENSITIVE LETTERS

2.4.1 Fabrication

Ensure that vinyl letter edges and corners of finished letterforms and graphics are true and clean. Do not use letterforms and graphics with rounded positive or negative corners, nicked, cut, or ragged edges.

2.4.2 Size

Letter size: as indicated.

2.5 FABRICATION AND MANUFACTURE

2.5.1 Factory Workmanship

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.

2.5.2 Dissimilar Materials

Where dissimilar metals are in contact, the surfaces will be protected to prevent galvanic or corrosive action.

2.6 COLOR, FINISH, AND CONTRAST

Color shall be as indicated. Finish of all signs shall be eggshell, matte, or other non-glare finish as required in handicapped-accessible buildings.

2.7 TYPEFACE

Helvetica Regular.

PART 3 EXECUTION

3.1 INSTALLATION

Signs shall be installed plumb and true and in accordance with approved manufacturer's instructions at locations shown on the detail drawings . Mounting height and mounting location shall conform to 36 CFR 1191. Required blocking shall be installed. Signs on doors or other surfaces shall not be installed until finishes on such surfaces have been installed.

3.1.1 Anchorage

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. Exposed anchor and fastener materials shall be compatible with metal to which applied and shall have matching color and finish.

a. Signs mounted to painted gypsum board surfaces shall be removable for painting maintenance.

b. Install signs mounted on metal surfaces with magnetic tape.

3.1.2 Protection and Cleaning

Protect the work against damage during construction.

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WIRE MESH PARTITIONS

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 IRON AND STEEL INSTITUTE (AISI)

AISI SG03-3 (2002; Suppl 2001-2004; R 2008) Cold-Formed Steel Design Manual Set

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M (2008) Standard Specification for Carbon Structural Steel

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. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Wire mesh partitions

Show layout, details, materials, dimensions, finishes, and all information necessary for fabrication and installation.

SD-03 Product Data

Wire mesh partitions

Submit for each type of partition, door, and window.

1.3 DELIVERY, STORAGE, AND HANDLING

Deliver materials in manufacturer's original, unopened containers or packaging with labels intact and legible. Deliver, store, and handle materials so as to prevent damage. Replace damaged or defective materials with new.

1.4 DESCRIPTION OF WORK

Wire mesh partitions shall be all wire type, and shall be provided complete with fasteners, capping bars, adjustable floor sockets, bracing, doors, hardware, and other items necessary for a complete, useable, and rigid installation.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Steel Shapes, Plates, and Bars

ASTM A36/A36M.

2.1.2 Cold-Formed Steel

AISI SG03-3.

2.1.3 Wire Mesh

Carbon steel wire, woven diamond mesh, intermediate crimped.

2.1.4 Floor Sockets

Cast or forged steel or ductile iron, adjustable, approximately 2-1/2 inches high.

2.2 NORMAL DUTY PARTITIONS

2.2.1 Wire Mesh

10 gage wire, 1-1/2 inch mesh.

2.2.2 Vertical Frames

1-1/4 by 5/8 inch cold-rolled C section channels or 1-1/4 by 5/8 by 1/8 inch channels. Provide only C channels where frames are installed toe to toe without posts.

2.2.3 Horizontal Frames

1 by 5/8 inch channels.

2.2.4 Center Reinforcing Bar

One 1 by 1/2 by 1/8 inch channel with all wires woven through, or two 1 by 3/8 by 1/8 inch channels bolted together with mesh in between.

2.2.5 Capping Bar

2-1/4 by one by 1/8 inch channel or 2 by 1/4 inch flat bar.

2.2.6 Corner Posts

Structural steel angles, 1-1/4 by 1-1/4 by 1/8 inch.

2.2.7 Line Posts

Unless otherwise indicated, provide partitions more than 12 feet high with flat bar line posts bolted between vertical frame channels. Sizes of posts shall be as follows:

Partition Height	Size of Posts
12 feet to 14 feet 8 inches	1-3/4 by 5/16 inch or 2 by 1/4 inch
14 feet 8 inches to 19 feet 8 inches	2-1/2 by 5/16 inch
19 feet 8 inches to 23 feet 8 inches	3 by 5/16 inch

2.2.8 Hinged Doors

Frames shall be 1-1/4 by 1/2 by 1/8 inch channels with 1-1/4 by 1/8 inch flat bar cover on top and bottom rails and on hinge stile and a 1-3/8 by 3/4 by 1/8 inch angle riveted to the lock stile. Provide 1 1/2 pairs of regular weight, wrought steel, non-removable pin, butt hinges riveted or welded to the door and the door opening frame for each door.

2.2.9 Sheet Metal Base

Hot- or cold-rolled sheet steel, not lighter than 16 gage.

2.3 HEAVY DUTY PARTITIONS

2.3.1 Wire Mesh

6 gage wire, 2 inch mesh.

2.3.2 Panel Frames

1-1/2 by 3/4 by 1/8 inch steel channels.

2.3.3 Center Reinforcing Bar

One 1-1/2 by 3/4 by 1/8 inch channel with all wires woven through, or two 1-1/4 by 3/8 by 1/8 inch channels bolted together with mesh in between.

2.3.4 Capping Bar

Structural steel channel, 3 inch by 4.1 pounds.

2.3.5 Corner Posts

Structural steel angles, 1-3/4 by 1-3/4 by 1/8 inch.

2.3.6 Line Posts

Unless otherwise indicated, provide partitions with flat bar line posts bolted between vertical frame channels. Sizes of posts shall be as follows:

Partition Height	Size of Posts
7 feet to 12 feet	2-1/2 by 5/16 inch
12 feet to 16 feet	3 by 5/16 inch or 2-1/2 by 3/8 inch
16 feet to 20 feet	3-1/2 by 5/16 inch

2.3.7 Hinged Doors

Frames shall be 1-1/2 by 3/4 by 1/8 inch channels with 1-1/2 by 1/8 inch flat bar cover on top and bottom rails and on hinge stile and a 1-5/8 by 7/8 by 1/8 inch angle riveted to the lock stile. Provide 1-1/2 pairs of heavyweight, wrought steel, non-removable pin, butt hinges riveted or welded to the door and the door opening frame for each door.

2.4 DOOR OPENING FRAMES

Provide frames the same size and shape as the vertical frames for the mesh panels.

2.5 LOCKS

Provide each door with a mortise type lock with a six-pin tumbler lock cylinder on the outside and a recessed knob on the inside.

2.6 FABRICATION

2.6.1 Standard Panels

Wire shall be woven into diamond mesh, intermediate crimped, and securely clinched to frames. Joints shall be mortised and tenoned. Wire shall be continuous at center reinforcing bars, either woven through a single channel or bolted between two channels. Panel vertical frames shall have 1/4 inch bolt holes 12 inches o.c. for normal duty partitions 3/8 inch bolt holes 18 inches o.c. for heavy duty partitions.

2.6.2 Sheet Metal Base Panels

Upper portion shall be as specified for standard panels, except that the wire shall be clinched into the center reinforcing bar. Form sheet steel to fit between the panel frames and securely bolt to the frames.

2.6.3 Doors

Construction shall be similar to that specified for panels. Wire mesh shall be the same as that used in the adjacent partition panels.

2.6.4 Finish

Thoroughly clean ferrous metal, treat with phosphate, and paint with black enamel in the shop.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Wire Mesh Partitions

Install plumb, level, and true to line, within a tolerance of 1/8 inch in 10 feet or the height or run of the partition, if less than 10 feet. Anchor floor sockets to the floor with expansion bolts. Vertical frames and posts shall be bolted together with 1/4 inch bolts 12 inches o.c. for normal duty partitions 3/8 inch bolts 18 inches o.c. for heavy duty partitions. Secure top frames to a continuous capping bar with 1/4 inch diameter U bolts not more than 28 inches o.c.

3.1.2 Bracing

Brace free standing partitions more than 20 feet in length, at intervals not greater than 20 feet with a steel channel brace connected to the capping bar and anchored to the building wall or framing member with a structural steel I section or tube post welded to a 9 by 9 inch steel base plate anchored to the floor with 4 expansion bolts or as indicated.

3.1.3 Touch-Up

Clean and paint scratches, abrasions, and other damage to shop painted surfaces to match the shop-applied finish.

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FIRE SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 REQUIREMENTS

Provide design and installation in accordance with NFPA Standards. The interpretation of NFPA Standards rests with the Kennedy Space Center Fire Protection Engineer who is the Authority Having Jurisdiction (AHJ), and whose opinion is final.

This is a performance based specification with the Contractor responsible for providing engineering design, installation and testing associated with the work to be performed. As defined under Florida Statutes, Chapter 471, all design work will be performed by a "delegated engineer", who is a Professional Engineer, licensed to practice in Florida and competent in fire protection engineering.

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 IRON AND STEEL INSTITUTE (AISI)

AISC/AISI 121	(2004) Standard Definitions for Use in the Design of Steel Structures

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(2011) Grooved and Shouldered Joints

ASME INTERNATIONAL (ASME)

ASME A112.18.1/CSA B125.1	(2011) Plumbing Supply Fittings
ASME B16.34	(2009; Supp 2010) Valves - Flanged, Threaded and Welding End
ASME B16.39	(2009) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.4	(2011) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2009) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ASME B16.9	(2012) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.1	(2010) Power Piping

ASTM INTERNATIONAL (ASTM)

ASTM A126	(2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A135/A135M	(2009) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A183	(2003; R 2009) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A234/A234M	(2011a) Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
ASTM A307	(2010) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A563	(2007a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A795/A795M	(2008) Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use
ASTM C592	(2010) Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
ASTM D2000	(2012) Standard Classification System for Rubber Products in Automotive Applications

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/
FM AS 4991	(2001) Approval of Firestop Contractors

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(2013) Standard for the Installation of

	Sprinkler Systems
NFPA 14	(2010) Standard for the Installation of Standpipes and Hose Systems
NFPA 24	(2013) Standard for the Installation of Private Fire Service Mains and Their Appurtenances
NFPA 251	(2006) Standard Methods of Tests of Fire Resistance of Building Construction and Materials
NFPA 70	(2011; Errata 2 2012) National Electrical Code
NFPA 72	(2013) National Fire Alarm and Signaling Code

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2003; 4th Ed) 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)

MIL-STD-101	(1970; Rev B) Color Code for Pipelines & for Compressed Gas Cylinders

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev C; Notice 1) Colors Used in Government Procurement
CID A-A-1922	(Rev A; Notice 2) Shield, Expansion (Caulking Anchors, Single Lead)
CID A-A-1923	(Rev A; Notice 2) Shield, Expansion (Lag, Machine and Externally Threaded Wedge Bolt Anchors)
CID A-A-1924	(Rev A; Notice 2) Shield, Expansion (Self Drilling Tubular Expansion Shell Bolt Anchors
CID A-A-1925	(Rev A; Notice 2) Shield Expansion (Nail Anchors)
CID A-A-55614	(Basic; Notice 2) Shield, Expansion (Non-Drilling Expansion Anchors)
CID A-A-55615	(Basic; Notice 2) Shield, Expansion (Wood Screw and Lag Bolt Self-Threading Anchors

UNDERWRITERS LABORATORIES (UL)

UL 6	(2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Meeting

No later than 15 calendar days after Contract Award, mandatory attendance is required at a pre-installation meeting. Submit the following to the Contracting Officer for review:

a. Contractor's State Certification

b. Factory test data, including fully verified and dated copies of all results with a copy of the approved test procedure and any other related information.

c. Quality Assurance Plan

d. Test procedures and recording forms for the preliminary tests

Provide one (1) copy of the test procedures and recording forms for the preliminary tests. For the final acceptance tests, provide ten (10) copies of the test procedures and recording forms. In each test procedure, identify each sprinkler and standpipe component to be tested, describe the initial condition, each step or function in the test, required test results, and equipment to be employed. Provide test forms with suitable spaces for recording test results on all equipment, devices, and wiring to be tested. Provide test record forms that also have identified spaces for verification signatures of official witnesses and dates of the test.

1.3.1.1 Shop Drawings

Submit shop drawings for the following items in sufficient detail and scope to verify compliance with the requirements of the contract documents:

a. Records of Existing Conditions

Submit Records of existing conditions showing the results of Contractor's survey of work area conditions and features of existing structures and facilities within and adjacent to the job site. Commencement of work constitutes acceptance of existing conditions.

b. Schematics and Fabrication Drawings

Submit Schematics and Fabrication Drawings for automatic sprinkler and standpipe systems, consisting of fabrication and assembly drawings to be performed in the shop, prior to installation and at the actual job site. Meet all requirements in NFPA 13 for fabrication drawings, stipulated for "working plans", to include a building cross-section. Provide working plans signed and sealed by a Professional Engineer, licensed to practice in the State of Florida.

Indicate on working plans all sprinkler and standpipe piping (size and length), pipe hangers, sprinkler head type and locations, valves, riser

trim and associated components, etc. to comply with NFPA 13, "Working Plans."

c. Fire Service Floor Plans

Provide .DWG format computer generated floor plan layouts indicating all automatic sprinkler and standpipe systems components.

Locate sprinkler heads in a consistent pattern with ceiling grid, lights, and supply and return air diffusers. In the design, give full consideration to blind spaces, other system piping, electrical equipment, HVAC ductwork, and all other types of obstructions which could prevent the proper installation and operation of the sprinkler and standpipe systems.

Indicate in the Fire Service Floor Plans, the location of the wet-pipe automatic sprinkler systems, risers, standpipes, isolation valves, and initiating devices. Coordinate with the requirements of the Fire Alarm System Fire Service Floor Plan such that all fire alarm and suppression system devices are combined on a single fire service floor plan. Provide a symbol legend, which clearly identifies each device shown on the fire service floor plan. Install a copy of the fire service floor plan minimum size 18 by 24 inches in a painted metal frame with a Plexiglas cover. Submit the floor plan and it's location for approval to the Contracting Officer prior to installation.

1.3.1.2 Manufacturer's Product Data

Submit Manufacturer's Catalog Data in sufficient detail and scope to verify compliance with the requirements of the contract documents.

1.3.1.3 Fire-Protection System Performance Data

Submit Fire-Protection System Performance Data consisting of information on useful life, system functional flows, safety features, and mechanical automated details. As a minimum, include the following:

a. Design Analysis and Hydraulic Calculations

Provide hydraulic calculations for the hydraulic remote area of each riser and each occupancy classification. Provide hydraulic calculations signed and sealed by a Professional Engineer, licensed to practice in Florida.

Include in the design data design density, hydraulically most remote area, occupancy classification, sprinkler head orifice size, and pipe velocities. Specify the design density in gpm per sq ft of floor area. Provide discharge from individual heads in the hydraulically most remote area to be between 100 percent and 120 percent of the specified density. Design systems such that required pressure is at least 10% but not less than 10 psi below the supply curve and pipe velocities do not exceed 20 feet per second.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Contractor's State Certification; G

Factory Test Data; G

Quality Assurance Plan; G

Test Procedures and Recording Forms for the Preliminary Tests; G

SD-02 Shop Drawings

Schematics and Fabrication Drawings; G

As-Built Drawings; G

Fire Service Floor Plans; G

SD-03 Product Data

Piping Materials; G

Supporting Elements; G

Sprinkler Riser Equipment; G

Riser Alarm Equipment; G

Standpipe Equipment; G

Sprinkler Heads; G

Valves; G

Miscellaneous Materials; G

Identification Tags; G

Inspector's Test Valve; G

Fire Stopping; G

Fire-Protection System Performance Data; G

SD-05 Design Data

Design Analysis and Hydraulic Calculations; G

SD-06 Test Reports

Pressure Tests; G

Inspector's Test; G

SD-07 Certificates

Test Gauge Accuracy; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

1.5 QUALITY ASSURANCE PLAN

Ensure all equipment provided under this sprinkler system specification is manufactured to meet the requirements of this paragraph. Provide system(s) that is (are) the latest standard design, that is listed by Underwriters' Laboratories or approved by Factory Mutual FM APP GUIDE, and is suitable for the intended use.

Components installed under this contract cannot be more than one (1) year older than the date of installation. Submit proof that all components are Underwriter Laboratory UL Fire Prot Dir listed or Factory Mutual FM APP GUIDE and FM AS 4991 approved for their intended use and function, and are installed per manufacturer instructions. Provide materials and equipment furnished that are compatible with the existing system.

Number all fittings and coupling that require a specific torque range and ensure the corresponding torque value is documented. Submit verification that all grooved clamp type couplings and fittings were installed in accordance with the manufacturer installation manual.

1.5.1 Services Of A Certified Automatic Sprinkler Specialist

Provide services of a Certified Specialist thoroughly experienced in automatic sprinkler system installations on site to perform or directly supervise the installation, make all necessary adjustments and perform all tests on the automatic sprinkler system at the site.

Sprinkler System Specialist is certified when the specialist holds a valid Sprinkler System Layout, Level III Certification from the National Institute for Certification in Engineering Technologies NICET 1014-7 or is licensed by the State of Florida as a Contractor Class I in accordance with Florida State Statute, Chapter 633, Section 633.521 and holds a current Certificate of Competency.

Also consider certification of other recognized agencies with equivalent requirements. Provide evidence of the Contractors State Certification and the basis of certification to the Contracting Officer and approve by the Contracting Officer prior to any work being performed at Kennedy Space Center.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide fire-protection system materials and equipment conforming to the requirements of Underwriters Laboratories UL Fire Prot Dir or the Factory Mutual FM APP GUIDE. Provide materials and equipment compatible with the existing system.

2.1.1 Design Requirements

The work includes designing and providing new automatic wet pipe sprinkler systems consisting of but not limited to an easy riser type swing check valve, with all associated trim, including gauges, 2 inch main drain connection, floor drains, flow switches, and sprinkler heads for the wet-pipe sprinkler systems. Hydraulically design the automatic sprinkler system(s) to meet density and area of coverage requirements using a UL

listed or FM approved hydraulic design program. Provide the design, equipment, materials, installation, workmanship, examination, inspection, and testing in strict accordance with the required and advisory provisions of NFPA 13, NFPA 72, and NFPA 14, except as modified herein. Include in each system all materials, accessories, and equipment inside and outside the building to provide an operationally compliant system. In the system design give full consideration to blind spaces, piping, electrical equipment, ductwork, and other construction and equipment in accordance with working plans to be submitted for approval prior to installation. Locate sprinkler heads in a consistent pattern with ceiling grids, lights, speakers, supply diffusers and return diffusers.

Provide all additional equipment, junction boxes, conduit, and labor to meet the requirements and intent of this specification.

2.2 PIPING MATERIALS

2.2.1 Type BCS - Black Carbon Steel

Pipe 1/8 through 2 inches: Schedule 40 furnace butt welded or electric-resistance welded black-carbon steel conforming to ASTM A53/A53M, ASTM A135/A135M, ASTM A795/A795M, Type F (furnace butt welded) or Type E (electric-resistance welded), Grade B. Threaded piping in this size range shall be Schedule 80 conforming to the same above requirements.

Pipe 2-1/2 through 8 inches: Schedule 40 seamless or electric-resistance welded black carbon steel, conforming to ASTM A53/A53M, ASTM A135/A135M, ASTM A795/A795M, Type E (electric-resistance welded), Grade B, or Type S (seamless), Grade B.

Unions 2 inches and under: 300-pounds per square inch gage (psig) working steam pressure (wsp) female, screwed, black malleable iron, with ground joint and brass-to-iron seat conforming to ASME B16.39

Standard Pipe Couplings: Extra-heavy screwed black steel.

Fittings 2 inches and under: 175 psi working pressure, cast iron, screwed conforming to ASTM A126, Class A, and ASME B16.4.

Fittings 2-1/2 inches and larger: 175 psi working pressure, wrought steel, buttweld fittings, wall thickness to match piping system, complying with ASME B16.9 and 150 pound steel flanges complying with ASME B16.5.

Provide elbows that are of the long radius type.

Provide grooved pipe couplings 2-1/2 inch and larger: 175 psig minimum working pressure with a housing fabricated in two or more parts of black malleable-iron castings. Ensure grooved couplings do not require a specific torque setting for housing bolt installation. Provide piping that is grooved in accordance with AWWA C606, or the manufacturer's specifications, for proper installation of the grooved couplings used. Provide couplings of the same part number for use on a single system.

Provide coupling gaskets of molded synthetic rubber conforming to requirements of ASTM D2000. Provide coupling bolts that are oval-neck, track-head type with heavy hexagonal nuts, conforming to ASTM A183.

Grooved fittings 2-1/2 inch and larger: 175 psig working pressure fittings used with grooved couplings that are fabricated of black malleable-iron

castings, and are of the same manufacture as the pipe couplings. If a manufacturer's standard-size malleable-iron fitting pattern is not available, use fabricated fittings; fabricate fittings from Grade B seamless-steel pipe and long-radius seamless welding fittings, with wall thickness to match pipe, conforming to ASTM A234/A234M and ASME B16.9.

Do not use bushings; only pre-manufactured concentric or eccentric reducing fittings or reducing tees/elbows can be used to reduce pipe size.

Pre-manufactured shaped welded outlets (weld-o-lets) can be used in lieu of "tee" fittings where the branch pipe outlet is at least one pipe diameter smaller than the main.

Do not use non-grooved products which rely in any way upon gasketing, clamps, straps, or setscrews for maintaining system integrity.

Do not use adjustable "drop nipples" which utilize an O-ring type seal arrangement.

2.3 SUPPORTING ELEMENTS

Provide piping system components and miscellaneous supporting elements, including, but not limited to, building-structure attachments; standpipe equipment; supplementary steel; hanger rods, stanchions, and fixtures; vertical-pipe attachments; horizontal-pipe attachments; restraining anchors; and guides. Provide supporting elements suitable for stresses imposed by systems pressures and temperatures, natural, and other external forces. Include an additional 250 pound load at each anchor per NFPA 13.

Provide FM approved or UL listed supporting elements conforming to ASME B31.1, MSS SP-58, and ASME B16.34.

2.3.1 Building-Structure Attachments

2.3.1.1 Anchor Devices, Concrete and Masonry

Conform anchor devices to CID A-A-1922, CID A-A-1923, CID A-A-1924A, CID A-A-1925, CID A-A-55614 and CID A-A-55615:

Group I:	Shield, expansion (lead, bolt, and stud anchors)
Group II:	Shield, expansion (bolt anchors), Type 2, Class 2, Style 1 or 2
Group III:	Shield, expansion (self drilling tubular expansion shell bolt anchors

Do not use powder-actuated anchoring devices to support mechanical-systems components.

2.3.1.2 Beam Clamps

Provide beam clamps that are center-loading Types 21, 28, 29, and 30, UL listed, cataloged, and load-rated commercially manufactured products.

Type 20 beam clamps can be used for pipe 2 inch and under.

Where Type 25 beam clamps are used, use two per point of pipe support.

2.3.1.3 C-Clamps

Do not use C-clamps.

2.3.2 Horizontal-Pipe Attachments

2.3.2.1 Single Pipes

Support piping in sizes up to and including 2-inch ips by Type 1, 5, 6, 7, 9, 10, 11, or 12 solid, split-ring, or band type attachments.

Support piping in sizes 2-1/2 inches and larger by Type 1, 2, 3, or 4 attachments or with Type 41 or Type 49 pipe rolls.

2.3.2.2 Parallel Fire-Protection Pipes

Use trapeze hangers fabricated from approved structural steel shapes, with U-bolts, when so specified. Provide structural-steel shapes that conform to supplementary steel requirements or provide supports that are commercially available, approved proprietary-design rolled steel.

2.3.3 Vertical-Pipe Attachments

Provide single Type 8 vertical-pipe attachments.

2.3.4 Hanger Rods and Fixtures

Use only circular solid cross section rod hangers to connect building structure attachments to pipe-support devices. Use pipe, straps, or bars of equivalent strength for hangers.

Provide turnbuckles, swing eyes, and clevises as required by support system to accommodate temperature changes, pipe accessibility, and adjustment for load and pitch.

2.3.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, design and fabricate such supplementary steel in accordance with AISC/AISI 121.

Provide supplementary steel that is hot dipped galvanized or otherwise protected from corrosion as acceptable to the Contracting Officer.

2.4 SPRINKLER RISER EQUIPMENT

Provide UL listed or FM approved Riser alarm equipment for fire-protection use.

2.4.1 Standard Check Valve

Provide check valve that is UL listed or FM approved standard swing-check type with elastomer-disc seat. Provide check valve that has a ductile iron body with flanged or grooved ends and is of the clear opening type with flanged inspection and access cover plate for sizes 4 inches and larger. Provide check valve that is able to be installed vertically or horizontally, and that is rated for 300 psi working pressure. Provide

clapper that is type 304 stainless steel, Teflon-coated hot-rolled steel, ductile iron, coated ductile iron, or bronze with field replaceable EDPM or Nitrite seal, with nickel or bronze seat. Provide a valve with springs, hinge shafts and retaining rings that are stainless steel. Provide a valve that has a valve body manufacturer painted with a corrosion resistant non-lead coating.

2.4.2 Wet Pipe Valve

Wet-pipe sprinkler systems require a UL listed or FM approved OS&Y isolation valve with tamper switch and flow switch for each floor, as indicated on the contract drawings, complete with standard accessories and trim necessary to give alarm, supervisory, and trouble signals. Provide provisions for testing and draining the systems, including all necessary piping, fittings, and valves for proper operation of the systems.

2.5 WATER FLOW ALARM DEVICE

Provide water flow alarm devices that are UL listed for the particular type of system. Wire water flow switch to make or break a circuit on rise of water pressure. Provide water flow switch that has an integral field adjustable 0-90 second retard feature, and activates within 60 seconds, plus or minus ten (10) seconds upon opening of the inspectors test station.

Provide water flow alarm device that has a design working pressure of 300 psi, include two (2) sets of single pole, double throw contacts rated for not less than 2.0 amps at 30 VC. Provide housing that is die cast, suitable for both indoor and outdoor use and includes knockouts for conduit connections.

2.6 PRESSURE GAUGE

Provide pressure gauge with a minimum 3.5 inch diameter, brass or stainless steel case with chrome finish, glass or polycarbonate window, brass dial with white background, black markings, dual units (English and Metric), phosphor bronze bourdon tube, brass precision geared movement, plus or minus 3 percent accuracy, 300 psi working pressure, and three-way globe style gauge isolation valve with plugged end.

2.7 INSPECTOR'S TEST

Provide an inspector's test valve that is a three-position (OFF-TEST-DRAIN) combination test, drain, and pressure relief device with bronze body, bronze ball valve, one quarter turn handle, integral sight glass (on discharge side), and internal corrosion resistant orifice, sized to match the sprinkler head orifice size. Ensure pressure relief device is factory set to relieve pressure at 175 psi.

2.8 CLASS 1 STANDPIPE

Provide an automatic Class 1 standpipe system as established by NFPA 14, with 2-1/2 inch, 175-psi hose connections in the stairwells, at the locations indicated on the contract drawings. Hydraulically design the standpipe systems to provide a minimum water flow rate of 500 gpm, with a minimum residual pressure of 100 psig at the outlet of the two (2) hydraulically most remote 2-1/2 inch hose connections. Base hydraulic calculations and pipe sizes for the standpipe system on providing 500 gpm for the first standpipe and 250 gpm from the most remote valve on each additional standpipe, with the total not to exceed 1250 gpm.

2.9 SPRINKLER HEADS

2.9.1 Head Types

Use standard 1/2-inch orifice sprinkler heads, except that 17/32-inch heads can be used where required by hydraulic calculation.

Provide upright or pendant type heads in unfinished areas or above suspended ceilings.

Provide semi-recessed pendent type heads in finished areas with suspended ceilings. Provide heads and escutcheon plates that are chrome-plated brass.

2.9.2 Temperature Rating

Provide fusible links that have ordinary temperature classification, except where otherwise indicated or in locations defined in NFPA 13 as requiring intermediate or high temperature heads.

2.9.3 Spares

Furnish spares for each type of sprinkler head, complete with appropriate metal storage cabinet and wrench. Provide quantity of spare heads in accordance with NFPA 13. Mount cabinet next to riser or other location as directed by the Contracting Officer.

2.9.4 Head Protection

Protect heads with paper or plastic bags during painting operations. Immediately remove protection upon finishing painting operations.

Provide steel wire head guards wherever mechanical damage could occur. Provide head guards UL listed or FM approved for use with the sprinkler heads installed. Provide head guards with a manufacturer applied red finish, except where head guards UL listed or FM approved for use with the sprinkler heads installed do not come in a manufacturer applied red finish.

Provide water shields of cold rolled galvanized steel, and install on all heads located beneath other heads within their spray areas. Provide shields with red finish.

2.10 VALVES

2.10.1 Aboveground

Provide FM approved or UL listed gate, globe, and check valves (all sizes).

Provide FM approved ball valves, 2 inches and under, rated to 300 psi, with provisions to wire or lock handle in place where a critical alarm function is isolated.

Provide gate valves that are of the outside screw and yoke configuration with cast iron body and wedge and bronze yoke bushing, seat ring and face ring. Provide gate valves with a solid wedge, constructed of cast iron or bronze. Provide valves that have flanged or grooved ends and are rated for 175 psi non-shock cold water.

Provide angle valves (for main drain) of the screwed or union bonnet type that have bodies constructed of bronze with a bronze disk. Provide angle valves having rubber disk seats and screwed ends rated for 175 psi non-shock cold water.

Supervise all control and isolation valves using a tamper switch.

2.11 MISCELLANEOUS MATERIALS

2.11.1 Bolting

Provide flange and general-purpose bolting that is hex-head and conforms to ASTM A307, Grade B. Provide heavy hex-nuts that conform to ASTM A563. Square-head bolts and nuts are not acceptable.

2.11.2 Escutcheons

Provide escutcheons manufactured from ferrous metals. Provide only chrome-plated escutcheons, except when AISI 300 series corrosion-resistant steel is provided. Provide metals and finishes conforming to ASME A112.18.1/CSA B125.1.

Provide escutcheons that are one-piece type where mounted on chrome-plated pipe or tubing and one-piece or split-pattern type elsewhere. Provide escutcheons that have internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.11.3 Flange Gaskets

Provide gaskets that are suitable for the intended use and contain no asbestos.

2.11.4 Pipe-Thread Compounds

Use tetrafluoroethylene tape or other suitable compounds.

2.12 FIRE-PROTECTION SYSTEM IDENTIFICATION

Provide a coordinated system of piping and equipment identification which includes the following:

Framed and plastic-protected diagrammatic layout of all piping systems, identifying and locating piping, equipment, and valves. Where existing systems are being modified, bring existing layouts up to date.

Metal-tag-identified major valves, piping-system components, and equipment

Metal identification plate at controlling alarm valve identifying system and area protected

Service-labeled piping

2.12.1 Diagrams

Provide chart listing of equipment by designation number and show pertinent data. Provide diagrams that are neat, mechanical drawings mounted in extruded aluminum frames, with 1/8-inch thick acrylic plastic protection. Provide at a location directed by the Contracting Officer. Provide minimum

of one mounted chart and diagram, plus one extra copy of each, for each fire-protection system.

2.12.2 Metal Tags

Install Identification tags made of brass or aluminum and indicating function of valve or similar component on each system device. Provide tags that are not less than 2 inches in diameter and that have stamped markings.

Provide equipment with metal identification tags bearing an equipment designation number matching the drawing or diagram designations.

Secure tags to valve or equipment items with 12-gage galvanized wire.

Provide risers with a stamped metal tag containing the hydraulic design data. Also identify main drain and inspectors test stations using metal nameplates with minimum 2 inch high lettering chained to the valve.

2.12.3 Service Labeling

Label piping, including that concealed in accessible spaces, to designate service. Provide labels with an arrow or arrows to indicate flow direction. Provide labels or tag designations as follows:

SERVICE	LABEL OR TAG DESIGNATION
Main sprinkler supply	MAIN SPRINKLER SUPPLY
Sprinkler riser number	SPRINKLER RISER NO.
Sprinkler branch	SPRINKLER BRANCH
Standpipe equipment	STANDPIPE

Provide labels and arrows in accordance with the following:

Each point of entry and exit through walls

Each change in direction

In congested or hidden areas, at each point required to clarify service or indicate hazard

In long straight runs, locate labels at a distance visible to each other, but in no case can the distance between labels exceed 40 feet.

Provide label lettering to be 2 inches high. Where the size of pipes is 2-1/2-inch outside diameter and smaller, attach labels to 16-gage aluminum sheet that is attached to the pipe with 12-gage galvanized wire. Provide labels that are legible from the primary service and operating area.

Provide labels that are made of self-sticking plastic film designed for permanent installation. Provide labels that have red letters on white background.

Do not construe label and valve tag schedule above as defining or limiting the work. Label all piping systems.

2.13 PAINTING

Furnish equipment of the manufacturer's standard product with the manufacturer's standard finish coat.

Furnish other mechanical equipment with a shop-applied prime paint.

Paint all piping and appurtenances red in accordance with Section 09 97 13.00 98, STEEL COATINGS.

2.14 MAIN DRAINS

Provide dedicated drain piping at riser to discharge to sight cones attached to drains of adequate size to readily accept the full flow from each drain under maximum pressure. Pipe drains to existing drain riser.

PART 3 EXECUTION

3.1 GENERAL

Install system materials and equipment in accordance with the recommendations and provisions of NFPA 13, NFPA 14, and NFPA 24, and related Codes and Standards contained herein. Perform work in the presence of the Contracting Officer who will be notified by the Contractor 48 hours in advance of the start of work.

Provide licensed fire protection sprinkler contractors, licensed for such work in the state where the work is to be performed, to perform all installation work.

Riser locations, pipe sizes, and the number of risers shown on the drawings is approximate in nature. Coordinate final riser quantity and location with the building construction, system design, Code requirements, and water supply limitations and maintenance requirements. The number of risers shown on the documents are the minimum to be provided. Indicate on Contractor's shop drawing submittal the exact location and number of risers approved by the Contracting Officer.

For heads which could be damaged, provide wire head guards. For heads located beneath other heads where the spray from the upper head could cool the lower head, provide water shields. For locations where existing building elements could disrupt sprinkler or nozzle spray patterns, provide multiple levels of protection.

Provide return bends for systems with non-potable water sources.

3.2 ABOVEGROUND PIPING-SYSTEMS INSTALLATION

Run piping parallel with the lines of the building. Space and install piping and components so that a threaded pipe fitting can be removed between adjacent pipes and so that there is not less than 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Arrange hangers on different adjacent service lines running parallel to be in line with each other and parallel to the lines of the building.

Base load rating for pipe-hanger supports on all lines filled with water. Do not exceed slope gradient of pipe for deflection per span. Install schedule 40 and heavier ferrous pipe supports in accordance with the

following minimum rod size and maximum allowable hanger spacing. For concentrated loads such as valves, reduce allowable span proportionately.

PIPE SIZE (INCHES)	ROD SIZE (INCHES)	HANGER SPACING FOR STEEL PIPE (FEET)
1	3/8	8
1-1/4	3/8	12
1-1/2	3/8	15
2-1/2 to 3-1/2	3/8	15
5	1/2	15
6	1/2	15
8	1/2	15

Support vertical risers at the base where possible and at intervals specified. Guide piping for lateral stability as necessary. Place clamps under fittings wherever possible. Support carbon-steel at each floor at not more than 15 feet intervals for pipe 2 inches and smaller, and at not more than 20 feet intervals for pipe 2-1/2 inches and larger.

Securely support piping with allowance for thrust forces and thermal expansion and contraction and do not subject to mechanical, chemical, irrational, or other damage, in conformance with ASME B31.1.

Extend riser main drain piping full size to nearest common drain riser.

Install 2-1/2 inch fire hose connection valves for the Class I standpipe at 4'-6" above the finished floor, measured from the top of the valve discharge outlet.

Install piping sloped back towards the riser or the auxiliary drains to allow for drainage. Where trapped piping is unavoidable, provide auxiliary drains.

Install grooved couplings in accordance with manufacturer's instructions and provide means for the government inspector to access and verify proper installation. Provide access to piping materials prior to installation for the government inspector to verify proper grooves exist on all piping with grooved ends.

Locate inspector's test valve approximately 5 feet above finished floor. Provide inspector's test valve for each sprinkler system, or portion thereof equipped with an alarm device, for testing purposes. Locate inspector's test valve at the hydraulically most remote portion of the sprinkler system. Extend inspector's test piping to nearest common drain riser.

Size inspector's test lines to be capable of development of the design flow from one sprinkler without creating excessive back pressure.

3.3 FIRE STOPPING

Seal through-penetrations in fire walls, partitions, or any floors to allow passage of cables, ducts, pipes and conduits with a "fire stopping assembly" that is UL listed or FM approved, with a fire-resistance rating equal to the fire resistance rating of the walls, partitions, or floors, in accordance with NFPA 251. For sealing purposes, consider all floors to have a fire-resistance rating of 2 hours. Seal openings no longer required with a material of equal or greater fire resistance to that of the walls, partitions, or floors.

3.4 SLEEVES

Provide sleeves where piping passes through roofs, masonry or concrete walls, or floors.

Continuously weld or braze sleeves passing through steel decks to the deck.

Provide sleeves extending through floors, roofs, or load-bearing walls, and sleeves through fire barriers that are continuous and fabricated from Schedule 40 steel pipe with welded anchor lugs. Form other sleeves by molded linear polyethylene liners or similar materials that are removable. Provide sleeves with diameters that are large enough to accommodate pipe, insulation, and jacketing without touching the sleeve, and additionally provide a minimum 3/8-inch clearance. Provide sleeve that accommodates mechanical and thermal motion of pipe to preclude transmission of vibration to walls and generation of noise.

Pack solid the space between a pipe and the inside of a pipe sleeve or a construction surface penetration with mineral fiber conforming to ASTM C592 wherever the piping passes through firewalls, equipment-room walls, floors, and ceilings connected to occupied spaces, and other locations where sleeves or construction-surface penetrations occur between occupied spaces. Where sleeves or construction-surface penetrations occur between conditioned and unconditioned spaces, fill the space between a pipe, bare or insulated, and the inside of a pipe sleeve or construction-surface penetration with an elastomer caulk to a depth of 1/2 inch. Provide oil and grease free surfaces to be caulked.

3.5 ESCUTCHEONS

Provide escutcheons at penetrations of piping into finished areas. Where finished areas are separated by partitions through which piping passes, provide escutcheons on both sides of the partition. Where suspended ceilings are installed, provide plates at the underside only of such ceilings. Provide escutcheons that are chrome plated in occupied spaces and that conceal openings in building construction. Firmly attach escutcheons.

3.6 PAINTING

Bring manufacturer's standard-finish equipment surfaces damaged during construction to as-new condition by touchup or repainting to the satisfaction of the Contracting Officer, or replace with new undamaged equipment at no additional cost to the Government.

Thoroughly clean and paint with one coat of primer paint pipe hangers, supports, and other iron work in concealed spaces.

Give all automatic sprinkler and standpipe system piping, valves, and appurtenances, two coats of enamel, color No. 11105 (red) in accordance with MIL-STD-101 and FED-STD-595.

3.7 ELECTRICAL WORK

Provide electrical work that is specified in DIVISION 26 ELECTRICAL for control system wiring under Section 28 31 00.00 98 FIRE DETECTION AND ALARM and this section in accordance with UL 6 and NFPA 70. Use rigid metal conduit or intermediate metal conduit, except that electrical metallic tubing can be used in dry locations not enclosed in concrete or where not subject to mechanical damage.

3.8 SYSTEM TESTING

Prior to acceptance of the work, test completed systems in the presence of the Contracting Officer. Upon approval, provide certificates of testing.

Provide hydrostatic Pressure tests, unless otherwise specified. Use only potable water for testing.

Full opening of the inspector's test connection has to activate the riser water flow alarm device indicator and deliver a steady stream of water at the test outlet through a calibrated orifice equivalent in diameter to a single system sprinkler head.

Prepare and maintain test records of piping-system tests. Provide records that show personnel responsibilities, dates, test-gage identification numbers, ambient and test-water temperatures, pressure ranges, rates of pressure drops, and leakage rates. Each test acceptance requires the signature of the Contracting Officer.

3.8.1 Test Gages

Provide test gauges that have 4-1/2-inch dials or larger with accuracy of plus or minus 1/2 of 1 percent of full-scale range and dial graduations and pointer width compatible with readability to within one-half of the accuracy extremes. Include maximum permissible scale range for a given test to be such that the pointer during a test can only have a starting position at midpoint of the dial or within the middle third of the scale range. For each test gage, include a table indicating test gauge accuracy certification and corrections made within 90 days prior to the test, the test gage number, and the project number.

3.8.2 Test and Acceptable Criteria

Hydrostatically test above ground systems at 200 psi or where the maximum normal working pressure exceeds 150 psi, test the system at the maximum normal working pressure plus 50 psi. Maintain the applied pressure without further addition of test media for not less than 2 hours. Maximum allowable pressure drop is 0 psi.

Repair dripping or weeping joints.

3.9 DISINFECTION

Disinfect water piping, including valves, fittings, and other devices, with a solution of chlorine and water. Solution cannot contain less than 50 parts per million (ppm) of available chlorine. Hold solution for a period

of not less than 8 hours, at which time the solution has to contain a minimum residue of 2 ppm of available chlorine or the system will be re-disinfected. After successful disinfections, thoroughly flush the piping before placing into service. Water for disinfecting, and flushing will be furnished by the Government.

3.10 CLEANING AND ADJUSTING

At the completion of the work, thoroughly clean all parts of the installation. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that accumulated from the installation and testing of the system. Adjust automatic control devices for proper operation.

3.11 AS-BUILT DRAWINGS

Submit As-Built drawings for approval 21 days prior to the acceptance testing phase of the project as described in the paragraph entitled, "System Testing," of this section. Provide two (2) sets of magnetic media as-built drawings in .DWG or .DGN electronic format, and hard copies of all new and revised software and drawings with the submittal. Document on as-Built drawings the final system configuration including deviations from and amendments to the drawings, and field installation changes, concealed and visible.

3.12 OPERATION AND MAINTENANCE

Submit Operation and Maintenance Manuals, grouped by technical sections consisting of manufacturer's standard brochures, schematics, procedures, recommended spare parts, recommended test equipment, and safety precautions. Submit this information prior to performing acceptance tests.

-- End of Section --

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SECTION 21 13 29.00

WATER SPRAY FIXED SYSTEMS

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.

ASME INTERNATIONAL (ASME)

ASME B16.39	(2009) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.4	(2011) Standard for Gray Iron Threaded Fittings; Classes 125 and 250
ASME B16.5	(2009) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ASME B16.9	(2012) Standard for Factory-Made Wrought Steel Buttwelding Fittings

ASTM INTERNATIONAL (ASTM)

ASTM A 126/A 126M	(2004; R 2009) Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 135/A 135M	(2009) Standard Specification for Electric-Resistance-Welded Steel Pipe
ASTM A 53/A 53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A 795/A 795M	(2008) Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use

AMERICAN WELDING SOCIETY (AWS)

AWS B2.1	(2009) Welding Procedure and Performance Qualification

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 13	(2013) Standard for the Installation of Sprinkler Systems
NFPA 15	(2012) Standard for Water Spray Fixed Systems for Fire Protection
NFPA 70	(2011; Errata 2 2012) National Electrical Code
NFPA 72	(2013) National Fire Alarm and Signaling Code

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1014-7	(2003; 4th Ed) Program Detail Manual for Certification in the Field of Fire Protection Engineering Technology (Field Code 003) Subfield of Automatic Sprinkler System Layout

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA-SPEC-5004A	(2004; Rev A) Welding of Aerospace Ground Support Equipment and Related Nonconventional Facilities

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-58092	Tape, Antiseize, Polytetrafluoroethylene
FS WW-S-2739	Strainers, Sediment: Pipeline, Water, Air, Gas, Oil, or Steam

UNDERWRITERS LABORATORIES (UL)

UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

1.2 RELATED REQUIREMENTS

Installation shall be in accordance with NFPA Standards. The interpretation of NFPA Standards rests with the Kennedy Space Center Fire Protection Engineer who is the Authority Having Jurisdiction (AHJ), and whose opinion shall be final.

1.3 SYSTEM DESCRIPTION

1.3.1 Requirements

Provide new fixed water spray systems for the new VAB platforms. System shall provide uniform distribution of water to provide complete coverage over the platforms. The equipment, materials, installation, and workmanship shall be in strict accordance with the required and advisory provisions of NFPA 15, NFPA 70 and NFPA 72, except as modified herein. Each system shall include all materials, accessories and equipment necessary to provide each system complete and ready for use. Install each system to give full consideration to blind spaces, piping, electrical

equipment, and all other construction and equipment to provide complete coverage in accordance with the drawings to be submitted for approval. Devices and equipment for fire protection service shall be of a make and type listed by the Underwriter's Laboratories Inc. in the UL Fire Prot Dir, or approved by the Factory Mutual System and listed in FM APP GUIDE (to the extent possible/available). In the publications referred to herein, the advisory provisions shall be considered to be mandatory, as though the word "shall" had been substituted for "should" wherever it appears; reference to the "authority having jurisdiction" shall be interpreted to mean the Kennedy Space Center Fire Protection Engineer.

1.3.1.1 Shop Drawings

Prepare shop drawings for Fixed Water Spray Systems in accordance with the requirements of NFPA 15 and NFPA 13 for "Working Plans". Shop drawings ("Working Plans") shall be submitted for approval within 120 days after notice to proceed and prior to installation of the Fixed Water Spray Systems. Do not commence work until the various components have been approved. Show:

a. Space or area layout and include data essential to the proper installation of each system

b. Activation valve assemblies, controls, pneumatic tubing

c. Discharge nozzles and system piping layout

d. Supports

1.3.1.2 As-Built Drawings for the Fixed Water Spray Systems

Upon completion, and before final acceptance of the work, submit a complete set of as-built drawings for the fire extinguishing system, including complete as-built circuit diagrams. Submit as-built drawings in addition to the record drawings required by the contract "Special Conditions".

1.3.2 System Operation

Flow of water shall be controlled by actuated butterfly valves. Actuated butterfly valves shall be actuated by local push buttons as well as through a signal received from the LCC. Once activated, system(s) shall operate until signal is sent to close valves.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fixed Water Spray Systems; G
First Article Demonstration Test Plan; G

SD-03 Product Data

Pipe and Fittings; G
Actuated Butterfly Valves; G

Valves; Gate, and Solenoid; G
Spray Nozzles; G
Strainers; G
Pipe Hangers and Supports; G
Manual Activation Stations; G
Flexible metal hoses; G

SD-06 Test Reports

Preliminary Tests; G
Acceptance Tests; G

Submit for all inspections and tests specified under paragraph entitled "Field Quality Control."

SD-07 Certificates

Qualifications of Installer; G

Submit installers qualifications as required under paragraph entitled Qualifications of Installer."

Qualification of the welding procedure to be used and the performance of all welders and welding operators shall be submitted for approval and shall meet or exceed the requirements of AWS B2.1, Specification for Welding Procedure and Performance Qualification, ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications, or other applicable qualification standards as required by the authority having jurisdiction.

SD-10 Operation and Maintenance Data

Actuated Butterfly Valves; G
Gate Valves; G
Solenoid Valves; G

SD-11 Closeout Submittals

As-Built Drawings for the Fixed Water Spray Systems; G

1.5 QUALITY ASSURANCE

1.5.1 Qualifications of Installer

Qualifications of System Technician: Installation drawings, shop drawings and as-built drawings shall be prepared, by or under the supervision of, an individual who is experienced with the types of works specified herein, and is currently certified by the National Institute for Certification in Engineering Technologies NICET 1014-7 as an engineering technician with minimum Level-III certification in Special Hazard System program. Contractor shall submit data for approval showing the name and certification of all involved individuals with such qualifications at or prior to submittal of drawings.

1.5.2 Components

Components used in the installation shall be new, unused and not be greater than two years old from the date of manufacture.

PART 2 PRODUCTS

2.1 SYSTEM ACTIVATION

2.1.1 Water Spray System Activation

Each zone shall encompass the area as defined. Upon activation of the water spray system manual activation stations, the corresponding system(s) protecting that area shall activate.

2.2 ABOVEGROUND PIPING SYSTEMS

2.2.1 Pipe and Fittings

Comply with NFPA 15 requirements and the following:

Elbows shall be of the long radius type.

Bushings shall not be used, only pre-manufactured concentric or eccentric reducing fittings or reducing tees/elbows shall be used to reduce pipe size.

Pre-manufactured shaped welded outlets (weld-o-lets, thredolets, or flexolets) may be used in lieu of "tee" fittings, where the branch pipe outlet is at least one pipe diameter smaller than the main. Welded outlets shall be material to match pipe.

2.2.1.1 Black Steel Pipe

Pipe 1/8 through 2 inches: Schedule 80 furnace butt welded or electric-resistance welded black-carbon steel conforming to ASTM A 53/A 53M, ASTM A 135/A 135M, ASTM A 795/A 795M, Type F (furnace butt welded) or Type E (electric-resistance welded), Grade B. Threaded piping in this size range shall be Schedule 80 conforming to the same above requirements.

Pipe 2-1/2 through 8 inches Schedule 40, flanged or welded, seamless or electric-resistance welded black carbon steel, conforming to ASTM A 53/A 53M, ASTM A 135/A 135M or ASTM A 795/A 795M Type E (electric resistance welded), Grade B or Type S (seamless), Grade B.

Unions (2 inches and under): 300-psi pounds per square inch gage (psig) working steam pressure (wsp) female, screwed, black malleable iron, with ground joint and brass-to-iron seat conforming to ASME B16.39.

Standard Pipe Couplings: Extra-heavy screwed black steel.

Fittings (2 inches and under): 300 psi working pressure, cast iron, screwed conforming to ASTM A 126/A 126M, Class A, and ASME B16.4.

Fittings (1-1/2 inches and larger): 300 psi working pressure, wrought steel, buttweld fittings, wall thickness to match piping system, complying with ASME B16.9 and 150 pound steel flanges complying with ASME B16.5.

Grooved pipe couplings (all sizes): 300-psi minimum working pressure with housing fabricated in two parts of ductile iron castings. Coupling bolts shall be type 316 stainless steel oval-neck, track head type with type 316 stainless steel heavy hexagonal nuts. Coupling gasket shall be molded EPDM elastomer.

Grooved fittings (all sizes): 300-psi minimum working pressure, cast malleable or ductile iron, specifically designed and manufactured for use in grooved piping systems. Provide long radius elbows.

All grooved piping system components shall be of the same manufacturer, equal to Victaulic or engineering approved equal, and listed for use in fire protection systems.

2.2.2 Jointing Material for Threaded Connections

CID A-A-58092, Polytetrafluoroethylene (PTFE) tape. Pipe joint compound (pipe dope) is not acceptable.

2.2.3 Pipe Hangers and Supports

Pipe Hangers and supports shall be in accordance with NFPA 15 and as indicated on the drawings.

Piping in sizes up to and including 2-inch ips must be supported by Type 1, 5, 6, 7, 9, 10, 11 or 12 solid, split-ring, or band type attachments.

Piping in sizes 2-1/2 inches and larger must be supported by Type 1, 2, 3 or 4 clevis type attachments or with Type 41 or Type 49 pipe rolls.

"C" clamps shall not be used.

2.2.4 Valves

2.2.4.1 Gate Valves

Gate valves shall be UL listed or FM approved, outside screw and yoke configuration, cast or ductile iron body and wedge, resilient wedge, flanged or grooved joint, rated for 275 psi non-shock cold water.

2.2.4.2 Actuated Butterfly Valves

Actuated Butterfly Valves shall be Carbon steel body, flanged clear opening type, 6" diameter, equal to Jamesbury Fire-Tite, Class 150 single-flanged lugged, PTFE/stainless steel seat, 316 stainless steel disc, and graphite seal.

Valves shall be provided complete with pneumatic actuator properly matched for required torque and mounted to the valve by the manufacturer. Actuator shall be double-acting such that pneumatic pressure is required to actuate valve in either direction. Actuators shall be selected for operation with a water supply pressure of 250 psi and pneumatic supply pressure of 125 psi. Actuator body shall be aluminum, anodized and polyester coated, mounted to butterfly valve with type 304 or 316 stainless steel bracket.

Actuator body shall have provisions for rigid mounting of housing for protection and actuation of limit switches. The limit switch assembly shall employ two sets of contacts to indicate valve position. Conduit and conductors shall be provided to route these indications to the proper associated solenoid panel as indicated in the drawings and/or specifications. One set of valve limit switch normally open contacts shall close when the valve is completely closed, and another set of contacts shall close when the valve is completely open. The limit switch assembly shall be Neles Quartz or approved equal.

2.2.4.3 Solenoid Valves

Solenoid valves shall be as specified on the drawings (FP-801).

2.2.5 Identification Signs

Attach properly lettered approved stickers or valve tags conforming to NFPA 15 to each valve.

2.3 STRAINERS

FS WW-S-2739, Style Y (Y Pattern) strainers with removable screens having standard perforations, minimum 0.125 inch in diameter, in all spray system lines, as indicated on the drawings.

2.4 SPRAY NOZZLES

Nozzles for fixed spray systems shall be constructed of corrosion resistant (stainless) steel. Nozzles shall be of the open type. Nozzles characteristics shall be as determined by the Engineer of Record to provide the water spray pattern required over the shape and size of the area to be protected. Nozzles shall be applied within their listing or approval limitations.

2.5 Flexible Metal Hoses

Flexible metal hoses shall be corrugated Type 316L stainless steel interior with a single series 300 stainless steel wire braid exterior. Ends shall be welded on Type 316 stainless steel, configuration as indicated on the drawings (groove joint for 5-inch hoses and female locking cam style for 2-1/2-inch hoses). Hose shall be rated for maximum working pressure of 340 psi for 5-inch hoses and 500 psi for 2-1/2-inch hoses. Minimum bend radius shall be no greater than 28 inches for 5-inch hoses and 16 inches for 2-1/2-inch hoses. Hoses shall be US Hose Corporation Style 881, or approved equal.

PART 3 EXECUTION

3.1 PIPING LABELS

Provide approved permanent labels, spaced at 20 feet maximum intervals along pipe, indicating "FIRE PROTECTION" on corresponding piping.

3.2 FIELD QUALITY CONTROL

Prior to initial operation, inspect equipment and piping systems for compliance with drawings, specifications, and manufacturer's submittals. Perform tests in the presence of the Contracting Officer to determine conformance with the specified requirements.

3.2.1 Welding

Welding shall be in accordance with NASA-SPEC-5004A requirements for category D fluid service.

3.2.2 Preliminary Tests

Each piping system shall be hydrostatically tested at 250 psig in accordance with NFPA 13 and shall show no leakage or reduction in gage

pressure after 2 hours. The Contractor shall conduct complete preliminary tests, which shall encompass all aspects of system operation. Individually test all manual actuation stations, control panels, and all other components and accessories to demonstrate proper functioning. When tests have been completed and all necessary corrections made, submit to the Contracting Officer a signed and dated certificate, similar to that specified in NFPA 13, attesting to the satisfactory completion of all testing and stating that the system is in operating condition. Also include a written request for a formal inspection and test.

Contractor shall prepare and maintain test records of all piping-system tests. Records shall show personnel responsibilities, dates test conducted, test gage identification numbers, calibration date, ambient and test-water temperature, pressure ranges, rates of pressure drops and leakage rates.
Each test acceptance shall require the signature of the Contracting Officer or appointed designee.

3.2.3 Formal Inspection and Tests (Acceptance Tests)

The Contracting Officer's technical representative for the AHJ's designated representative will witness formal tests and approve all systems before they are accepted. The system shall be considered ready for such testing only after all necessary preliminary tests have been made and all deficiencies found have been corrected to the satisfaction of the equipment manufacturer's technical representative and written certification to this effect is received by the Contracting Officer. Submit the request for formal inspection at least 15 working days prior to the date the inspection is to take place. The control panel(s) shall be in continuous service for a "break-in" period of at least 15 consecutive days prior to the formal inspection. Experienced technicians regularly employed by the Contractor in the installation of both the mechanical and electrical portions of such systems shall be present during the inspection and shall conduct the testing. All necessary tests encompassing all aspects of system operation shall be made including the following, and any deficiency found shall be corrected and the system retested at no cost to the Government.

3.2.3.1 Systems and Device Testing

The entire initiating and actuation systems shall be operated. As a minimum, operation and supervision of the following functions and devices shall be demonstrated:

a. All operational and supervisory functions of the control panels.

b. Each manual actuation station and associated circuit(s).

c. All actuator circuits and system control valve(s).

3.2.3.2 Valve Actuation Testing

When all of the initiating, alarm, actuation, and supervisory functions of the system operate to the satisfaction of the Contracting Officer an operational test of each system shall be performed to demonstrate satisfactory performance, mechanical operation and operation of valves, release devices, and interlocks which control the protected areas. These tests shall be conducted by experienced personnel according to the equipment manufacturers' recommendations.

a. Demonstrate operation of each water control valve by activation of its respective solenoid valve.
b. For initial testing, the water supply may be temporarily shut off for the Valve Actuation Testing.
c. A full operational flow test for each quad valve assembly shall be performed. Water supply to platforms shall be shut off and the test leg valve opened. Flow shall continue until a steady state is observed at the test leg drain outlet, or until approved by a representative of the AHJ, and then the quad valves shall be commanded to close to test shut-off operation.

3.2.4 Additional Tests

When deficiencies, defects or malfunctions develop during the tests required, all further testing of the system shall be suspended until proper adjustments, corrections or revisions have been made to assure proper performance of the system. If these revisions require more than a nominal delay, the Contracting Officer shall be notified when the additional work has been completed, to arrange a new inspection and test of the system. All tests required shall be repeated prior to final acceptance, unless directed otherwise.

3.2.5 First Article Demonstration Test

A fully operational fire protection water spray system shall be constructed and tested on a full size mockup platform and egress ramp (wood construction is suggested). It is expected that the fire protection system components will be installed on the actual platform after successful completion of testing.

The platform system shall be as designed and shown on the drawings for Platform A North (sheet FP-411). The system mockup shall include all hard piping, fittings, flex hoses and nozzles installed in the configuration of the actual platform. The mockup will not be required to move/translate. The longer flex hose shall be installed on the lower maintenance platform without a hose carrier. Restraint shall be provided for this horizontal flex hose to simulate constraint in the hose carrier. The shorter draped flex hose shall be installed in the draped configuration without restraints to simulate the actual installed condition. Additional components required to be installed immediately before the inlet to the draped flex hose for testing include a flow meter, two 6" ball valves (one for shutoff and one for throttling) and certified test pressure gage.

First Article Demonstration fabrication and testing shall occur at the contractor's facility. All components including water for testing shall be provided by the contractor. The contractor shall make arrangements with the controlling municipality as required. Calculations by the delegated fire protection engineer shall be submitted to show that the required pressure and flow will be available to the test mockup from the water supply source.

Water supply shall be from a fire hydrant or other adequate source providing clean potable water. A booster pump shall be provided as required. Maximum flow and pressure, measured at the inlet to the draped flex hose shall be 1000 GPM at 52.1 PSI. The minimum water supply requirement, measured at the inlet to the draped flex hose shall be 830 GPM at 39.4 PSI.

Submit a First Article Demonstration Test Plan and details for approval to

include platform mockup construction, fire protection system components installation, test components and instrumentation data and installation, water supply information, test procedures and test report form. Initial testing shall flow water through the fire protection system at the above listed maximum pressure. This pressure and the resulting flow rate shall be recorded on the test report form. Observations shall be made and recorded of performance and any anomalies, including range of movement of flex hoses and nozzle spray masts. Flow shall continue onto the platform deck area while the throttling valve is adjusted to achieve the required (above specified) minimum flow and residual pressure. The specified minimum flow rate shall be maintained and the actual residual pressure recorded.

Subsequent testing shall measure water flow density at the design (minimum) flow rate by locating no less than 6 (six) catch pans randomly around the platform deck area, operating the system for 60 seconds and then measuring the water captured in the pans. The size and configuration of proposed catch pans to verify the minimum design density of 0.25 GPM per square foot shall be submitted as part of the First Article Demonstration Test Plan.

The First Article Demonstration Test shall also include one egress ramp. Water supply, instrumentation and procedures shall be similar to the platform test specified above. The egress ramp to be tested shall be for Platform A South, as designed and shown on drawing sheet FP-420 and with nozzles as scheduled on sheet FP-601. The egress ramp system mockup shall include all hard piping, fittings, flex hoses and nozzles installed in the configuration of the actual ramp. Maximum water supply requirement is 133 GPM at 46.1 PSI. Minimum water supply requirement is 112 GPM at 34.7 PSI.

Completely drain and dry system components before final installation on installed platform and egress ramp.

3.3 OPERATING INSTRUCTIONS

Provide operating instructions at control equipment and at each remote control station. Instructions shall clearly indicate all necessary steps for the operation of the system. Submit the proposed legend for operating instructions for approval prior to installation. Instructions shall be in engraved white letters on red rigid plastic or red enameled steel backgrounds and shall be of adequate size to permit them to be easily read.

3.4 PAINTING

All water spray systems piping, flanges and fittings shall be painted red in accordance with Section 09 97 13.00 98, STEEL COATINGS, using coating system number 6.

-- End of Section --

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GENERAL SERVICE COMPRESSED-AIR SYSTEMS, LOW PRESSURE

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 INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 360	(2010) Specification for Structural Steel Buildings

ASME INTERNATIONAL (ASME)

ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B18.2.2	(2010) Standard for Square and Hex Nuts
ASME B31.3	(2010) Process Piping
ASME B40.100	(2005; R 2010) Pressure Gauges and Gauge Attachments
ASME BPVC	(2010) Boiler and Pressure Vessels Code

ASTM INTERNATIONAL (ASTM)

ASTM A197/A197M	(2000; R 2011) Standard Specification for Cupola Malleable Iron
ASTM A307	(2010) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM B62	(2009) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58	(2009) 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-72	(2010a) Ball Valves with Flanged or Butt-Welding Ends for General Service

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FS FF-S-325	(Basic; Int Amd 3; Notices 3, 4) Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry)

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit Installation Drawings for low-pressure compressed air systems in accordance with paragraphs entitled, "Drawings," and "Aboveground Piping Materials," of this section.

SD-03 Product Data

Submit Equipment and Performance Data for piping systems.

Submit manufacturer's catalog data for the following items:

Aboveground Piping Materials

Piping Specialties

Supporting Elements

Valves

Accessories

Miscellaneous Materials

SD-06 Test Reports

Submit test reports for the following items in accordance with paragraph entitled, "Compressed Air Systems Testing," of this section.

Compressed Air Systems Testing

Valve-Operating Tests

Drainage Tests

Pneumatic Testing

Each acceptance test shall require the signature of the Contracting Officer and two record copies shall be delivered to the Contracting Officer after acceptance.

SD-07 Certificates

Submit certificates for the following items showing conformance with the referenced standards contained in this section.

Aboveground Piping Materials

Supporting Elements

Valves

Miscellaneous Materials

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with paragraph entitled, "Operation and Maintenance," of this section.

1.3 GENERAL REQUIREMENTS

Equipment and performance data submitted for piping systems shall show conformance with ASME Code.

1.4 OPERATION AND MAINTENANCE

Contractor shall submit 6 copies of the operation and maintenance manuals 30 calendar days prior to testing the low-pressure compressed air System. Update and resubmit data for final approval no later than 30 calendar days prior to contract completion.

1.5 DRAWINGS

Submit installation drawings for low-pressure compressed air systems in accordance with paragraphs entitled, "Aboveground Piping Materials" of this section.

Submit complete shop drawing data for pipe attachments for approval.

PART 2 PRODUCTS

2.1 ABOVEGROUND PIPING MATERIALS

2.1.1 Compressed Air Systems 125 Psig and Less

2.1.1.1 Type GCS Galvanized Carbon Steel

Pipe 1/2 through 2 inches shall be Schedule 40, seamless or electric resistance welded, galvanized steel, conforming to ASTM A53/A53M, Grade B, Type E or S. Type F is acceptable for sizes less than 2 inches.

Fittings 2 inches and under shall be 150-psig wsp, banded, galvanized, malleable iron, screwed, conforming to ASTM A197/A197M, ASME B16.3 .

Unions 2 inches and under shall be 300-psig wsp, female, screwed, galvanized, malleable iron with brass-to-iron seat and ground joint.

2.2 PIPING SPECIALTIES

2.2.1 Air Line Lubricators

Air line lubricators shall be of the pulse-type with pickup tube, polycarbonate resin bowl, large fill opening, metering rod flow adjuster, sight ball, and drain cock.

Lubricators shall be suitable for 200 psig at 165 degrees F.

2.2.2 Pressure Gages

Pressure gages shall conform to ASME B40.100. Pressure gages shall be Type I, Class 1, (pressure) for pressures indicated. Pressure gage size shall be 3-1/2 inches nominal diameter. Case shall be corrosion-resistant steel conforming to the AISI 300 series with an ASM No. 4 standard commercial polish or better. Equip gages with damper screw adjustment in inlet connection.

2.2.3 Line Strainers

Strainers shall be Y-type with removable basket. Strainers in sizes 2 inch ips and smaller shall have screwed ends. Body working pressure rating shall exceed maximum service pressure of system in which installed by at least 50 percent. Body shall have cast-in arrows to indicate direction of flow. Strainer bodies fitted with screwed screen retainers shall have straight threads and gasketed with nonferrous metal. Strainer bodies fitted with bolted-on screen retainers shall have offset blowdown holes. Fit strainers larger than 2-1/2-inches with manufacturer's standard blowdown valve. Body material shall be cast bronze conforming to ASTM B62. Where system material is nonferrous, strainer body material shall be nonferrous.

Minimum free-hole area of strainer element shall be equal to not less than 3.4 times the internal area of connecting piping. Strainer screens for air service shall have mesh cloth not to exceed 0.006 inch . Strainer screens shall have finished ends fitted to machined screen chamber surfaces to preclude bypass flow. Strainer element material shall be AISI Type 316 corrosion-resistant steel.

2.3 VALVES

2.3.1 Ball Valves (BAV)

Ball valves shall conform to MSS SP-72. Valves shall be Style 1 or 3.

Rate valves for service at not less than 175 psi at 200 degrees F.

Valve bodies in sizes 2 inch ips and smaller shall be screwed end connection type constructed of Class A copper alloy.

Balls and stems of valves 2 inch ips and smaller shall be manufacturer's standard Class A copper alloy with 900 Brinell hard chrome plating finish . Electroless nickel plating is acceptable.

Design valves for flow from either direction and seal equally tight in either direction.

Valves shall have full pipe size flow areas.

Valves with ball seals kept in place by spring washers are not acceptable. All valves shall have adjustable packing glands. Seats and seals shall be tetrafluoroethylene.

Valve body construction shall be such that torque from a pipe with valve in installed condition shall not tend to disassemble the valve by stripping setscrews or by loosening body end inserts or coupling nuts. Torque from a pipe shall be resisted by a one-piece body between end connections or by bolts in shear where body is of mating flange or surface-bolted construction.

2.4 MISCELLANEOUS MATERIALS

2.4.1 Bolting

Flange and general-purpose bolting shall be hex-head and shall conform to ASTM A307, Grade B. Heavy hex-nuts shall conform to ASME B18.2.2. Square-head bolts shall not be acceptable.

2.4.2 Elastomer Caulk

Polysulfide or polyurethane base elastomer caulking material shall be a two-component type conforming to ASTM C920.

2.4.3 Pipe Thread Compounds

Use tetrafluorethylene tape not less than 2 mils thick in compressed air systems for pipe sizes to and including 1 inch ips. Tetrafluoroethylene dispersions and other suitable compounds may be used for other applications upon approval by the Contracting Officer.

2.5 SUPPORTING ELEMENTS

Contractor shall provide all necessary piping system components and miscellaneous required supporting elements. Supporting elements shall be suitable for stresses imposed by system pressures and temperatures, and natural and other external forces.

Supporting elements shall be UL-listed and conform to requirements of ASME B31.3, MSS SP-58, and MSS SP-69, except as otherwise noted. Type devices specified herein are defined in MSS standards unless otherwise noted.

2.5.1 Building Structure Attachments

Concrete and masonry anchor devices shall conform to requirements of FS FF-S-325 Group I or II, Type 2, Class 2, Style 1 or 2; Group III or VIII. Do not use power actuated anchoring devices to support mechanical systems components.

Beam clamps shall be center loading Type 21, 28, 29 or 30, UL listed, cataloged, and load rated, and commercially manufactured.

Do not use C-clamps.

2.5.2 Horizontal Pipe Attachments

Piping in sizes to and including 2 inch ips shall be supported by Type 6

solid malleable-iron pipe rings except that split-band-type rings may be used in sizes up to 1 inch ips.

Piping in sizes through 8 inch ips inclusive shall be supported by Types 1, 3, or 4 attachments.

Trapeze hangers fabricated from approved structural steel shapes, with U-bolts, shall be used in congested areas and where multiple pipe runs occur. Structural steel shapes shall conform to supplementary steel requirements or be a commercially available, proprietary-design, rolled steel.

2.5.3 Vertical Pipe Attachments

Vertical pipe attachments shall be Type 8.

2.5.4 Hanger Rods and Fixtures

Use only circular cross-section rod hangers to connect building structure attachments to pipe support devices. Pipe, straps, or bars of equivalent strength may be used for hangers only where approved by the Contracting Officer.

Provide turnbuckles, swing eyes, and clevises as required by support system to accommodate pipe accessibility and adjustment for load and pitch.

2.5.5 Supplementary Steel

Where it is necessary to frame structural members between existing members or where structural members are used in lieu of commercially rated supports, such supplementary steel shall be designed and fabricated in accordance with AISC 360.

PART 3 EXECUTION

3.1 ABOVE GROUND PIPING SYSTEM INSTALLATION

3.1.1 Piping Systems

Fabricate and install piping systems in accordance with ASME B31.3, MSS SP-69, ASME BPVC, and applicable AWS requirements.

Fabricate pipe to measurements established on the job and carefully work into place without springing or forcing.

Pipe, tubing, fittings, valves, equipment, and accessories shall be clean and free of all foreign material before being installed in their respective systems. Clean pipe by a method approved by the Contracting Officer. Purge lines with dry, oil-free compressed air after erection, but purging shall not be relied upon for removing all foreign matter. Purge lines at a velocity equal to 1-1/2 times maximum normal flow velocity. During the progress of construction, protect open ends of pipe, fittings, and valves at all times to prevent the admission of foreign matter. Except when connections are actually underway, install plugs or caps on all pipe and component openings. Plugs or caps shall be commercially manufactured products.

Install piping straight and true, with approved offsets around obstructions and with necessary expansion bends or fitting offsets essential to a

satisfactory installation and as may be necessary to increase headroom or to avoid interference with the building construction, electric conduit, or facilities equipment.

Use standard long sweep pipe fittings for changes in direction. No mitered joints or pipe bends shall be permitted.

Tee connections shall be made with screwed tee fittings or grooved tee fittings, or, where pipe is being welded, branch connections shall be made with either welding tees or forged branch outlet fittings, either being acceptable without size limitations. Branch outlet fittings shall be forged, flared for improved flow where attached to the run, reinforced against external strains, and designed to withstand full burst-pressure strength requirements. Provide tool space between parallel piping runs whenever threaded unions or couplings are installed.

Horizontal piping shall have a grade of 1 inch per 100 feet.

Use eccentric reducers where required to permit proper drainage of pipe lines. Do not permit bushings for this purpose. Provide drain valves in piping systems at low points. Pipe drains shall consist of 1/2 inch globe valves with renewable disks and 3/4 inch hose adapter.

Perform installation of piping in a manner that will prevent stresses and strains from being imposed on connected equipment.

Make expansion bends in steel pipe from pipe sections and long-radius welding elbows in sizes 1 inch and larger. Expansion U-bends shall be cold sprung and welded into the line. Anchor line before removing the spreader from the expansion U-bend.

3.1.2 Joints

Ream pipe ends before joint connections are made.

Make up screwed joints with joint compound.

Apply joint compounds to the male thread only, and exercise care to prevent compound from reaching the interior of the pipe.

Provide screwed unions, welded unions, or bolted flanges wherever required to permit convenient removal of equipment, valves, and piping accessories from the piping system.

Assemble flanged joints with appropriate flanges, gaskets, and bolting. Clearance between flange faces shall be such that the connections can be gasketed and bolted tight without imposing undue strain on the piping system. Flange faces shall be parallel and the bores concentric. Center gaskets on the flange faces without projecting into the bore. Lubricate bolting with oil and graphite before assembly to ensure uniform bolt stressing. Draw up and tighten flange bolts in staggered sequence to prevent unequal gasket compression and deformation of the flanges. Wherever a flange with a raised face is joined to a companion flange with a flat face, the raised face shall be machined to a smooth matching surface, and a full facegasket shall be used. After the piping system has been tested and is in service at its maximum temperature, bolting shall be retightened. Only use hex-head nuts and bolts. Gasket material shall be fresh stock, 1/16 inch thick.

3.1.3 General Service Valve Locations

Provide valves in piping mains and branches as indicated on the drawings.

3.1.4 Supporting Elements Installation

Provide support elements in accordance with the requirements of ASME B31.3, MSS SP-58, MSS SP-69. Hang piping from building construction. No piping shall be hung from roof deck or from other pipe.

Attachment to building construction concrete shall be by approved cast-in concrete inserts wherever possible. Attachment to building construction solid masonry shall be by built-in anchors. Where attachment by either of above methods is not possible, specified masonry anchor devices may be used upon receipt of written approval from the Contracting Officer.

Construct masonry anchors selected for overhead applications of ferrous materials only.

Install masonry anchors conforming to FS FF-S-325 Group I or Group II, Type 2, Class 2, Style 1 or 2; Group VIII in rotary, nonpercussion, electric drilled holes. Group III self-drilling anchors may be used provided masonry drilling is done with electric hammers selected and applied in a manner that will preclude concrete spalling or cracking both visible or invisible. Pneumatic tool use is not allowed.

Percussive action, electric hammers, and combination rotary-electric hammers used for the installation of self-drilling anchors shall be selected in accordance with the following guide:

For nominal anchor device sizes 1/4- through 1/2 inch, the tool shall be hammer type only or combination rotary-hammer type and shall be rated at load to draw not more than 5.0 amperes when operating on 120-volt, 60-hertz power.

For nominal anchor device sizes 5/8 inch and larger, the hammer type only tool shall be rated at load to draw not more than 8.0 amperes when operating on 120-volt, 60-hertz power. Combination rotary hammer tools on the same power supply shall have a full-load current rating not to exceed 10 amperes.

Size inserts and anchors for the total stress to be applied with a safety factor as required by applicable codes but in no case less than 4.

Insert anchor devices into concrete sections not less than twice the overall length of the device and locate them not less than the following applicable distance from any side or end edge or centerline of adjacent anchor service:

Anchor Bolt Length (Inches)	Minimum Edge Space (Inches)
1/4	3-1/2
5/16	3-3/4
3/8	4
1/2	5
5/8	6
3/4	7
7/8	8

Anchor Bolt Length (Inches)	Minimum Edge Space (Inches)

In special circumstances, upon prior written approval of the Contracting Officer, center-to-center distance may be reduced to 50 percent of given distance provided the load on the device is reduced in direct proportion to reduced distance.

Piping shall run parallel with the lines of the building. Space and install piping and components so that a threaded pipe fitting may be removed between adjacent pipes and so that there will be not less than 1/2 inch of clear space between the finished surface and other work and between the finished surface and parallel adjacent piping. Hangers on different adjacent service lines running parallel with each other shall be arranged to be in line with each other and parallel to the lines of the building.

Place identical service systems piping, where practical, at same elevation and hung on trapeze hangers adjusted for proper pitch.

Spacing of trapeze hangers where piping is grouped in parallel runs shall be the closest interval required for any size pipe supported.

Where it is necessary to avoid any transfer of load from support to support or onto connecting equipment, pipe hangers shall be constant support type.

Provide approved pipe alignment guides, attached in an approved manner to the building structure, to control pipe movement in true alignment in the piping adjacent to and on each side of all pipe expansion loops.

Anchors incorporated in piping systems for the purpose of maintaining permanent pipe positions shall be welded to the piping and attached to the building structure in a manner approved by the Contracting Officer.

Suitably brace piping against sway and vibration. Bracing shall consist of brackets, anchor chairs, rods, and structural steel for vibration isolation.

Install hangers and supports for piping at intervals specified herein at locations not more than 3 feet from the ends of each runout and not over 25 percent of the specified interval from each change in direction of piping.

Load rating for all pipe hanger supports shall be based on weight and forces imposed on all lines. Deflection per span shall not exceed slope gradient of pipe. Schedule 40 and heavier pipe supports shall be in accordance with the following minimum rod size. Maximum allowable hanger spacing and concentrated loads will reduce allowable span proportionately:

PIPE SIZE INCHES	ROD SIZE INCHES	STEEL PIPE FEET
Up to 1	3/8	8
1-1/4 to 1-1/2	3/8	10
2	3/8	12

Where possible, support vertical risers at the base at intervals specified

and guide for lateral stability. Place clamps under fittings wherever possible. Support carbon steel pipe at each floor at not more than 15-foot intervals for pipe 2 inches and smaller.

After the piping systems have been installed, tested, and placed in satisfactory operation, the Contractor shall firmly tighten hanger rod nuts and jam nuts to prevent any movement.

3.2 COMPRESSED AIR SYSTEMS TESTING

Prior to acceptance of the work, pressure-test completed systems in the presence of the Contracting Officer.

Testing shall be done in two stages: preliminary stage and acceptance stage, including gage tests.

Perform no testing until personnel not directly involved in the test have been evacuated from the area.

Contractor may conduct tests for his own purposes, but preliminary testing and the acceptance test shall be conducted as specified.

3.2.1 Preliminary Stage Tests

Tests shall be pneumatic and shall use dry, oil-free compressed air.

Testing of any system for any purpose shall include preliminary testing by swabbing joints under test with standard high-strength film soap solution and observing for bubbles at internal pressures not in excess of 5 psi.

When testing reveals that leakage exceeds specified limits, isolate and repair the leaks, replace defective materials where necessary, and retest the system until specified limits are met. Remake leaking gaskets with new gaskets and new flange bolting, and discard used bolting and gaskets.

Other than standard piping flanges, plugs, caps and valves, only use commercially manufactured expandable elastomer plugs for sealing off piping for test purposes. Published safe test pressure rating of any plug used shall be not less than three times the actual test pressure being applied. During pneumatic testing, evacuate personnel from areas where plugs are used.

Remove components that could be damaged by test pressure from piping systems to be tested.

Perform valve-operating tests and drainage tests according to referenced standards.

Check piping system components, such as valves, for proper operation under system test pressure.

No test media shall be added to a system during a test for a period specified or determined by the Contracting Officer.

Duration of a test will be determined by the Contracting Officer and will be for a minimum of 15 minutes with a maximum of 24 hours. Test may be terminated by direction of the Contracting Officer at any point after it has been determined that the leakage rate is within limits.

Prepare and maintain test records of all piping systems tests. Records shall show Governmental and Contractor test personnel responsibilities, dates, test gage identification numbers, ambient temperatures, pressure ranges, rates of pressure drop, and leakage rates.

3.2.2 Test Gages

Contractor's test gages shall conform to ASME B40.100 and have a dial size of 8 inches or larger. Maximum permissible scale range for a given test shall be such that the pointer during a test shall have a starting position at midpoint of the dial or within the middle third of the scale range. Certification of accuracy and correction table shall bear a date within 90 calendar days prior to test use, test gage number, and the project number, unless otherwise approved by the Contracting Officer.

3.2.3 Acceptance Pressure Testing

Testing shall take place during steady-state ambient temperature conditions.

Test ferrous piping systems at 1-1/2 times maximum operating pressure. Maintain test pressure for a period of not less than 2 hours with an allowable pressure drop of 2 psi during that time unless otherwise approved by the Contracting Officer.

3.3 COMPRESSED AIR SYSTEM CLEANING

Remove rust and dirt from the bore and exterior surface of all piping and equipment. Clean pipeline strainers, temporary and permanent, during purging operations, after startup, and immediately prior to final acceptance by the Government.

Flush and clean new steel piping with a suitable degreasing agent until visible, grease, dirt, and other contaminants have been removed. Degreased waste material including the degreaser itself shall be disposed of in accordance with written instructions received from the Environmental authority having jurisdiction through the Contracting Officer and in accordance with all Local, State and Federal Regulations.

3.4 COMPRESSED AIR SYSTEMS IDENTIFICATION

Identification plates shall be protected and kept clean. Replace damaged and illegible identification plates at no additional expense.

Label and arrow piping at each point of entry and exit of piping passing through walls; at each change in direction, such as at elbows and tees; and in congested or hidden areas, at each point required to clarify service or indicate a hazard. Also label each riser.

In long straight runs, locate labels at distances visible to each other, but in no case shall the distance between labels exceed 75 feet. Labels shall be legible from the primary service and operating area.

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SECTION 23 00 00

AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS

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	(2008) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2006; INT 2007; Errata 2008) 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	(2011) 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	(1990; R 2008) Load Ratings and Fatigue Life for Roller Bearings
ABMA 9	(1990; R 2008) Load Ratings and Fatigue Life for Ball Bearings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2007; Addenda B 2008; Errata 2009, Errata

	2010; INT 2010; Errata 2011) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62.1	(2010; Errata 2011; INT 21 2012) 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; INT 1 2011; Errata 2011, Errata 2011; Errata 2011, INT 2-12 2011, Errata 2011; INT 13 2012; INT 14 2012) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASME INTERNATIONAL (ASME)

ASME A13.1	(2007) Scheme for the Identification of Piping Systems

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2012) 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 B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B766	(1986; R 2008) 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	(2011) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM E2016	(2011) Standard Specification for Industrial Woven Wire Cloth

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2011) Motors and Generators
NEMA MG 10	(2001; R 2007) 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 701	(2010) Standard Methods of Fire Tests for Flame Propagation of Textiles and Films
NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION (SMACNA)

SMACNA 1819	(2002) Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems, 5th Edition
SMACNA 1966	(2005) HVAC Duct Construction Standards Metal and Flexible, 3rd Edition
SMACNA 1981	(2008) Seismic Restraint Manual Guidelines for Mechanical Systems, 3rd Edition

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

40 CFR 82	Protection of Stratospheric Ozone

UNDERWRITERS LABORATORIES (UL)

UL 181	(2005; Reprint Oct 2008) Factory-Made Air Ducts and Air Connectors
UL 555	(2006; Reprint May 2012) Standard for Fire Dampers
UL 586	(2009) Standard for High-Efficiency Particulate, Air Filter Units
UL 6	(2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel
UL 705	(2004; Reprint Mar 2012) Standard for Power Ventilators
UL 900	(2004; Reprint Feb 2012) 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.

1.2.2 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
Air handling unit Number	AC
Control and instrument air	CONTROL AND INSTR.
Fan Number	V

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
1/2 thru 1-3/8 inch	1/2 inch
1-1/2 thru 2-3/8 inch	3/4 inch
2-1/2 inch and larger	1-1/4 inch

1.2.3 Color Coding

Color coding of all piping systems shall be in accordance with ASME A13.1.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings; G

SD-03 Product Data

Metallic Flexible Duct
Insulated Nonmetallic Flexible Duct Runouts
Duct Connectors
Duct Access Doors; G
Fire Dampers
Manual Balancing Dampers; G
Diffusers
Louvers
Centrifugal Fans
In-Line Centrifugal Fans
Air Handling Units; G

SD-06 Test Reports

Performance Tests; G
Damper Acceptance Test; G

SD-08 Manufacturer's Instructions

Manufacturer's Installation Instructions
Operation and Maintenance Training

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals
Fire Dampers; G
Manual Balancing Dampers; G
Centrifugal Fans; G
In-Line Centrifugal Fans; G
Air Handling Units; G

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.

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.

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 appliances owned by NASA shall 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.

1.5 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 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. Where applicable, provide equipment that is an ENERGY STAR Qualified product or a Federal Energy Management Program (FEMP) designated product.

2.2 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.

2.3 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.

2.4 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 DIVISION 26 - ELECTRICAL Applicable Sections. 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.

e. Provide variable frequency drives for motors as specified in DIVISION 26 - ELECTRICAL Applicable Sections.

2.5 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.

2.6 SEISMIC ANCHORAGE

Anchor equipment in accordance with applicable seismic criteria for the area and as defined in SMACNA 1981

2.7 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.

2.8 INDOOR AIR QUALITY

Provide equipment and components that comply with the requirements of ASHRAE 62.1 unless more stringent requirements are specified herein.

2.9 DUCT SYSTEMS

2.9.1 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.

b. Provide radius type elbows with a centerline radius of 1.5 times the width or diameter of the duct where space permits. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes are allowed.

c. Provide ductwork that meets the requirements of Seal Class A.

d. Provide sealants that conform to fire hazard classification specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS and are suitable for the range of air distribution and ambient temperatures to which it is exposed. Do not use pressure sensitive tape as a sealant.

e. Make spiral lock seam duct, and flat oval with duct sealant and lock with not less than 3 equally spaced drive screws or other approved methods indicated in SMACNA 1966. Apply the sealant to the exposed male part of the fitting collar so that the sealer is on the inside of the joint and fully protected by the metal of the duct fitting. Apply one brush coat of the sealant over the outside of the joint to at least 2 inch band width covering all screw heads and joint gap. Dents in the male portion of the slip fitting collar are not acceptable. Fabricate outdoor air intake ducts and plenums with watertight soldered or brazed joints and seams.

2.9.1.1 Metallic Flexible Duct

a. Provide duct that conforms to UL 181 and NFPA 90A with factory-applied insulation, vapor barrier, and end connections. Provide duct assembly that does not exceed 25 for flame spread and 50 for smoke developed. Provide ducts designed for working pressures of 2 inches water gauge positive and 1.5 inches water gauge negative. Provide flexible round duct length that does not exceed 5 feet. Secure connections by applying adhesive for 2 inches over rigid duct, apply flexible duct 2 inches over rigid duct, apply metal clamp, and provide minimum of three No. 8 sheet metal screws through clamp and rigid duct.

b. Inner duct core: Provide interlocking spiral or helically corrugated flexible core constructed of zinc-coated steel, aluminum, or stainless steel; or constructed of inner liner of continuous galvanized spring steel wire helix fused to continuous, fire-retardant, flexible vapor barrier film, inner duct core.

c. Insulation: Provide inner duct core that is insulated with mineral fiber blanket type flexible insulation, minimum of 1 inch thick. Provide insulation covered on exterior with manufacturer's standard fire retardant vapor barrier jacket for flexible round duct.

2.9.1.2 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 preinsulated, 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. Where coil induction or high velocity units are supplied with vertical air inlets, use a streamlined, vaned and mitered elbow transition piece for connection to the flexible duct or hose. Provide a die-stamped

elbow and not a flexible connector as the last elbow to these units other than the vertical air inlet type. 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.

2.9.1.3 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 round/oval ducts, secure the flexible material by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, install the flexible material locked to metal collars using normal duct construction methods. Provide a composite connector system that complies with NFPA 701 and is classified as "flame-retardent fabrics" in UL Bld Mat Dir.

2.9.1.4 Aluminum Ducts

ASTM B209, alloy 3003-H14 for aluminum sheet and alloy 6061-T6 or equivalent strength for aluminum connectors and bar stock.

2.9.2 Duct Access Doors

Provide hinged access doors conforming to SMACNA 1966 in ductwork and plenums where indicated and at all air flow measuring primaries, automatic dampers, fire dampers, coils, thermostats, and other apparatus requiring service and inspection in the duct system. Provide access doors upstream and downstream of air flow measuring primaries and heating and cooling coils. Provide doors that are a minimum 15 by 18 inches, unless otherwise shown. Where duct size does not accommodate this size door, make the doors as large as practicable. Equip doors 24 by 24 inches or larger with fasteners operable from inside and outside the duct. Use insulated type doors in insulated ducts.

2.9.3 Fire Dampers

Use multiple blade type, 180 degrees F fusible fire damper link, 3.0 hour rated fire dampers unless otherwise indicated. Provide fire dampers that conform to the requirements of NFPA 90A and UL 555. Perform the fire damper test as outlined in NFPA 90A. Provide a pressure relief door upstream of the fire damper. If the ductwork connected to the fire damper is to be insulated then provide a factory installed pressure relief damper. Provide automatic operating fire dampers with a dynamic rating suitable for the maximum air velocity and pressure differential to which it is subjected. Provide fire dampers approved for the specific application, and install according to their listing. Equip fire dampers with a steel sleeve or adequately sized frame installed in such a manner that disruption of the attached ductwork, if any, does not impair the operation of the damper. Equip sleeves or frames with perimeter mounting angles attached on both sides of the wall multi-blade type fire dampers. Install dampers that do not reduce the duct or the air transfer opening cross-sectional area. Install dampers so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness. Unless otherwise indicated, comply with the installation details given in SMACNA 1819 and in manufacturer's instructions for fire dampers. Perform acceptance testing of fire dampers according to paragraph Fire Damper Acceptance Test and NFPA 90A.

2.9.4 Manual Balancing Dampers

Furnish manual balancing dampers with accessible operating mechanisms. Use chromium plated operators (with all exposed edges rounded) in finished portions of the building. Provide manual volume control dampers that are operated by locking-type quadrant operators. Install dampers that are 2 gauges heavier than the duct in which installed. Unless otherwise indicated, provide opposed blade type multileaf dampers with maximum blade width of 12 inches. Provide access doors or panels for all concealed damper operators and locking setscrews. Provide stand-off mounting brackets, bases, or adapters not less than the thickness of the insulation when the locking-type quadrant operators for dampers are installed on ducts to be thermally insulated, to provide clearance between the duct surface and the operator. Stand-off mounting items shall be integral with the operator or standard accessory of the damper manufacturer.

2.9.5 Automatic Balancing Dampers

Provide dampers as specified in paragraph SUPPLEMENTAL COMPONENTS/SERVICES, subparagraph CONTROLS.

2.9.6 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 Zone 2 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.

Dampers smaller than 24 inches in either direction may have leakage of 40 cfm per square foot.

2.9.7 Plenums and Casings for Field-Fabricated Units

2.9.7.1 Plenum and Casings

Fabricate and erect plenums and casings as shown in SMACNA 1966, as applicable. Construct system casing of not less than 16 gauge galvanized sheet steel. Furnish cooling coil drain pans with 1 inch threaded outlet to collect condensation from the cooling coils. Fabricate drain pans from not lighter than 16 gauge steel, galvanized after fabrication or of 18 gauge corrosion-resisting sheet steel conforming to ASTM A167, Type 304, welded and stiffened. Thermally insulate drain pans exposed to the atmosphere to prevent condensation. Coat insulation with a flame resistant waterproofing material. Provide separate drain pans for each vertical coil section, and a separate drain line for each pan. Size pans to ensure capture of entrained moisture on the downstream-air side of the coil. Seal openings in the casing, such as for piping connections, to prevent air leakage. Size the water seal for the drain to maintain a pressure of at least 2 inch water gauge greater than the maximum negative pressure in the coil space.

2.9.7.2 Casing

Terminate casings at the curb line and bolt each to the curb using galvanized angle, as indicated in SMACNA 1966.

2.9.7.3 Access Doors

Provide access doors in each section of the casing. Weld doorframes in place, gasket each door with neoprene, hinge with minimum of two brass hinges, and fasten with a minimum of two brass tension fasteners operable from inside and outside of the casing. Where possible, make doors 36 by 18 inches and locate them 18 inches above the floor. Where the space available does not accommodate doors of this size, use doors as large as the space accommodates. Swing doors so that fan suction or pressure holds doors in closed position, airtight. Provide a push-button station, located inside the casing, to stop the supply.

2.9.7.4 Factory-Fabricated Insulated Sheet Metal Panels

Factory-fabricated components are allowed for field-assembled units, provided all requirements specified for field-fabricated plenums and casings are met. Provide panels of modular design, pretested for structural strength, thermal control, condensation control, and acoustical control. Seal and insulate panel joints. Provide and gasket access doors to prevent air leakage. Provide panel construction that is not less than 20 gauge galvanized sheet steel, assembled with fasteners treated against corrosion. Provide standard length panels that deflect not more than 1/2 inch under operation. Construct details, including joint sealing, not specifically covered, as indicated in SMACNA 1966. Construct the plenums and casings to withstand the specified internal pressure of the air systems.

2.9.7.5 Duct Liner

Unless otherwise specified, duct liner is not permitted.

2.9.7.6 Diffusers, Registers, and Grilles

Provide factory-fabricated units of corrosion-resistant steel 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. Where the inlet and outlet openings are located less than 7 feet above the floor, protect them by a grille or screen according to NFPA 90A.

2.9.7.7 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.

2.9.7.8 Louvers

Provide louvers for installation in exterior walls as per construction

plans and schedules.

2.9.7.9 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.

2.10 AIR SYSTEMS EQUIPMENT

2.10.1 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.

2.10.1.1 Centrifugal Fans

Provide fully enclosed, single-width single-inlet, or double-width double-inlet centrifugal fans, with AMCA Pressure Class I, II, or III as required or indicated for the design system pressure. Provide impeller wheels that are rigidly constructed and accurately balanced both statically and dynamically. Provide forward curved or backward-inclined airfoil design fan blades in wheel sizes up to 30 inches. Provide backward-inclined airfoil design fan blades for wheels over 30 inches in diameter. Provide fan wheels over 36 inches in diameter with overhung pulleys and a bearing on each side of the wheel. Provide fan wheels 36 inches or less in diameter that have one or more extra long bearings between the fan wheel and the drive. Provide sleeve type, self-aligning and self-oiling bearings with oil reservoirs, or precision self-aligning roller or ball-type with accessible grease fittings or permanently

lubricated type. Connect grease fittings to tubing for serviceability from a single accessible point. Provide L50 rated bearing life at not less than 200,000 hours as defined by ABMA 9 and ABMA 11. Provide steel, accurately finished fan shafts, with key seats and keys for impeller hubs and fan pulleys. Provide fan outlets of ample proportions, designed for the attachment of angles and bolts for attaching flexible connections. Provide manually operated inlet vanes on suction inlets. Provide manually operated outlet dampers. Unless otherwise indicated, provide motors that do not exceed 1800 rpm and have totally enclosed enclosures. Provide magnetic type motor starters with general-purpose enclosure.

2.10.2 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 weather-resistant enclosures.

2.10.3 Coils

Provide fin-and-tube type coils constructed of seamless copper tubes and aluminum or copper fins mechanically bonded or soldered to the tubes. 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.

2.10.3.1 Water Coils

Install water coils with a pitch of not less than 1/8 inch/foot of the tube length toward the drain end. Use headers constructed of copper. Furnish each coil with a plugged vent and drain connection extending through the unit casing. Provide removable water coils with drain pans.

2.10.4 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.

2.10.4.1 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.

2.10.4.2 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.

2.10.4.3 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 aluminum tubing, and all hardware and accessories for gauge mounting.

2.11 AIR HANDLING UNITS

2.11.1 Field-Fabricated Air Handling Units

Provide built-up units as specified in paragraph DUCT SYSTEMS. Provide fans, coils, and air filters as specified in paragraph AIR SYSTEMS EQUIPMENT for types indicated.

2.11.2 Factory-Fabricated Air Handling Units

Provide single-zone draw-through type units as indicated. Units shall include fans, coils, airtight insulated casing, prefilters, secondary filter sections, adjustable V-belt drives, sections where indicated, 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.

2.11.2.1 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. 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 galvanized steel, conforming to ASHRAE 62.1. Construct drain pans water tight, treated to prevent corrosion, and designed for positive condensate drainage. When 2 or more cooling coils are used, with one stacked above the other, condensate from the upper coils shall not flow across the face of lower coils. Provide intermediate drain pans or condensate collection channels and downspouts, as required to carry condensate to the unit drain pan out of the air stream and without moisture carryover. 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. Single-wall casing sections handling conditioned air shall be insulated with not less than 1 inch thick, 1-1/2 pound density coated fibrous glass material having a thermal conductivity not greater than 0.23 Btu/hr-sf-F. Double-wall casing sections handling conditioned air shall be insulated with not less than 2 inches of the same insulation specified for single-wall casings. 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.

2.11.2.2 Cooling Coils

Provide coils as specified in paragraph AIR SYSTEMS EQUIPMENT.

2.11.2.3 Air Filters

Provide air filters as specified in paragraph AIR SYSTEMS EQUIPMENT for types and thickness indicated.

2.11.2.4 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. 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 magnetic 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.

2.11.2.5 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.

2.12 SUPPLEMENTAL COMPONENTS/SERVICES

2.12.1 Chilled, Water Piping

The requirements for chilled, water piping and accessories are specified in Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS

2.12.2 Condensate Drain Lines

Provide and install condensate drainage for each item of equipment that

generates condensate in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS except as modified herein.

2.12.3 Insulation

The requirements for shop and field applied insulation are specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.12.4 Controls

The requirements for controls are specified in Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS; 23 09 33.00 40 ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC.

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 before performing the work.

3.2 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.

3.2.1 Condensate Drain Lines

Provide water seals in the condensate drain from all units. Provide a depth of each seal of 2 inches plus the number of inches, measured in water gauge, of the total static pressure rating of the unit to which the drain is connected. Provide water seals that are constructed of 2 tees and an appropriate U-bend with the open end of each tee plugged. Provide pipe cap or plug cleanouts where indicated. Connect drains indicated to connect to the sanitary waste system using an indirect waste fitting. Insulate air conditioner drain lines as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

3.2.2 Equipment and Installation

Provide frames and supports for tanks, compressors, pumps, valves, air handling units, fans, coils, dampers, and other similar items requiring supports. Floor mount or ceiling hang air handling units as indicated.

Anchor and fasten as detailed. Set floor-mounted equipment on not less than 6 inch concrete pads or curbs doweled in place unless otherwise indicated. Make concrete foundations heavy enough to minimize the intensity of the vibrations transmitted to the piping, duct work and the surrounding structure, as recommended in writing by the equipment manufacturer. In lieu of a concrete pad foundation, build a concrete pedestal block with isolators placed between the pedestal block and the floor. Make the concrete foundation or concrete pedestal block a mass not less than three times the weight of the components to be supported. Provide the lines connected to the pump mounted on pedestal blocks with flexible connectors. Submit foundation drawings as specified in paragraph DETAIL DRAWINGS. Provide concrete for foundations as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.2.3 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.

3.2.4 Flexible Duct

Install 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.

3.2.5 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.

3.2.6 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.

3.2.7 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.

3.2.8 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.

3.2.9 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.

3.3 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 3-inch margin around the equipment and supports. Allow equipment bases and foundations, when constructed of concrete or grout, to cure a minimum of 28 calendar days before being loaded.

3.4 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.

3.5 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. Incorporate housekeeping for field construction work which leaves all furniture and equipment in the affected area free of construction generated dust and debris; and, all floor surfaces vacuum-swept clean.

3.6 PENETRATIONS

Provide sleeves and prepared openings for duct mains, branches, and other penetrating items, and install during the construction of the surface to be penetrated. Cut sleeves flush with each surface. Place sleeves for round duct 15 inches and smaller. Build framed, prepared openings for round duct larger than 15 inches and square, rectangular or oval ducts. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Provide one inch clearance between penetrating and penetrated surfaces except at grilles, registers, and diffusers. Pack spaces between sleeve or opening and duct or duct insulation with mineral fiber conforming with ASTM C553, Type 1, Class B-2.

a. 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.

b. Framed Prepared Openings: Fabricate framed prepared openings from 20 gauge galvanized steel, unless otherwise indicated.

c. 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.

d. 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 round ducts 15 inches in diameter or less from 20 gauge galvanized steel. Fabricate collars for square and rectangular ducts, or round ducts with minimum dimension over 15 inches from 18 gauge galvanized steel. Fabricate collars for square and rectangular ducts with a maximum side of 15 inches or less from 20 gauge galvanized steel. Install collars with fasteners a maximum of 6 inches on center. Attach to collars a minimum of 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.

e. 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.

3.7 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.

a. 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.

b. Temperatures between 120 and 400 degrees F: Apply two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of two mils to metal surfaces subject to temperatures between 120 and 400 degrees F.

c. Temperatures greater than 400 degrees F: Apply two coats of 315

degrees C 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of two mils to metal surfaces subject to temperatures greater than 400 degrees F.

3.8 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.

3.9 DAMPER ACCEPTANCE TEST

Submit the proposed schedule, at least 2 weeks prior to the start of test. Operate all fire dampers and smoke dampers under normal operating conditions, prior to the occupancy of a building to determine that they function properly. Test each fire damper equipped with fusible link by having the fusible link cut in place. Test dynamic fire dampers with the air handling and distribution system running. Reset all fire dampers with the fusible links replaced after acceptance testing. To ensure optimum operation and performance, install the damper so it is square and free from racking.

3.10 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.

3.11 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 7 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 7 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.

3.12 CLEANING AND ADJUSTING

Provide a temporary bypass for water coils to prevent flushing water from passing through coils. Inside of Air Handling Unit 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.

3.13 OPERATION AND MAINTENANCE

3.13.1 Operation and Maintenance Manuals

Submit 6 manuals at least 2 weeks prior to field training. Submit Data Package 3 for the items/units listed under SD-10 Operation and Maintenance Data

3.13.2 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 8 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 --

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SECTION 23 05 48.00 40

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

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 S2.71	(1983; R 2006) Guide to the Evaluation of Human Exposure to Vibration in Buildings

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE HVAC APP IP HDBK	(2011) HVAC Applications Handbook, I-P Edition

NATIONAL ENVIRONMENTAL BALANCING BUREAU (NEBB)

NEBB PROCEDURAL STANDARDS	(2005) Procedural Standards for TAB (Testing, Adjusting and Balancing) Environmental Systems

1.2 ADMINISTRATIVE REQUIREMENTS

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section to the extent applicable.

Ensure all vibration-control apparatus is the product of a single manufacturing source, where possible. Human exposure levels should be considered using ASA S2.71 and NEBB PROCEDURAL STANDARDS.

Scheduled isolation mounting is in inches and is a minimum static deflection.

Spans referred to in Part 2, "Vibration-Isolation Systems Application," means longest bay dimension.

Determine exact mounting sizes and number of isolators by the isolator manufacturer based on equipment that will be installed. Check equipment revolutions per minute (rpm) and spring deflections to verify that resonance cannot occur.

Fiveworking days prior to commencement of installation, submit installation drawings for vibration isolator systems including equipment and performance requirements.

Indicate within outline drawings for vibration isolator systems, overall physical features, dimensions, ratings, service requirements, and weights

of equipment.

Within ten working days of Contract Award, submit equipment and performance data for vibration isolator systems including equipment base design; inertia-block mass relative to support equipment weight; spring loads and free, operating, and solid heights of spring; spring diameters; nonmetallic isolator loading and deflection; disturbing frequency; natural frequency of mounts; deflection of working member; and anticipated amount of physical movement at the reference points.

Ensure data includes the following:

a. Mountings
b. Bases
c. Isolators

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G
Outline Drawings; G

SD-03 Product Data

Equipment and Performance Data; G

SD-06 Test Reports

Type of Isolator; G
Type of Base; G
Allowable Deflection; G
Measured Deflection; G

PART 2 PRODUCTS

2.1 TYPE OF VIBRATION-ISOLATION PROVISIONS

Design for vibration isolation using ASHRAE HVAC APP IP HDBK, Chapter 48, as applicable to the following sections.

Submit test reports for testing vibration isolation for each type of isolator and each type of base, and meet referenced standards contained within this section. Include in test reports allowable deflection and measured deflection also meeting referenced standards within this section.

2.1.1 Materials

Ensure rubber is natural rubber and elastomer is chloroprene. Shore A durometer measurement of both materials and range between 40 and 60.

Inorganic materials such as precompressed, high-density, fibrous glass encased in a resilient moisture-impervious membrane may be used in lieu of

specified natural rubber and elastomers. Where this substitution is made, ensure specified deflections are modified by the manufacturing source to accommodate physical characteristics of inorganic materials and to provide equal or better vibration isolation.

Ensure weather-exposed metal vibration-isolator parts are corrosion protected. Chloroprene coat springs.

2.1.2 Mountings

Provide the following mountings:

Type A: Composite pad, with 0.25-inch thick elastomer top and bottom layers, molded to contain a pattern with nonslip characteristics in all horizontal directions. Elastomer loading is not to exceed 40 pounds per square inch (psi). Ensure minimum overall thickness is 1 inch. Maximum deflections up to 0.25-inch are allowed.

Type B: Double rubber-in-shear with molded-in steel reinforcement in top and bottom. Maximum deflections up to 0.50 inch are allowed.

Type C: Free-standing laterally stable open-spring type for deflections over 0.50 inch, with built-in bearing and leveling provisions, 0.25-inch thick Type A base elastomer pads, and accessories. Ensure outside diameter of each spring is equal to or greater than 0.9 times the operating height of the spring under rated load.

Type D: Partially housed type, containing one or more vertically restrained springs with at least 0.50 inch clearance maintained around springs, with adjustable limit stops, 0.25-inch thick Type A base elastomer pads, and accessories.

2.1.3 Bases

Provide the following bases:

Type R: Rails, connected mill-rolled structural steel, of sufficient dimension to preclude deflection at midpoint of unsupported span in excess of 1/1,440th of the span between isolators, power transmission, component misalignment, and any overhung weight. Where Type R bases are specified and the equipment proposed requires additional base support, use a Type S base.

Type S: Structural-steel bases common to a supported assembly, made from welded-joint mill-rolled structural steel with closed-perimeter configuration, isolators attached to outrigger supports.

Ensure height of steel members is sufficient to provide stiffness required to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components. Ensure height of steel member does not result in member deflection at midpoint of unsupported span of more than 1/1,440th of the span between isolators. Minimum height is 5 inches.

Type CIB: Provide concrete inertia blocks common to the entire assembly, with welded-joint construction, mill-rolled structural-steel perimeters, welded-in No. 4 reinforcing bars 8 inches on center each way near the bottom of the block, outrigger-isolator mounting

provisions, anchor bolts, and be filled with 3,000 psi cured-strength concrete.

Configure rectangular inertia bases to accommodate equipment supported.

Ensure minimum thickness of inertia base, in addition to providing suitable mass, is sufficient to provide stiffness to maintain equipment manufacturer's recommended alignment and duty efficiency of power-transmission components, and is sufficient to result in base deflection at midpoint of unsupported span of not more than 1/1,440th of the span between isolators. Verify minimum thickness, the preceding requirements not withstanding, is 8 percent of the longest base dimension.

Ensure pumps with flexible couplings does not have inertia bases less than 8 inches thick, and the minimum mass of concrete inertia block is equal in weight to supported equipment.

2.2 VIBRATION-ISOLATION SYSTEMS APPLICATION

Vibration isolation design per ASHRAE HVAC APP IP HDBK, Chapter 37.

2.2.1 Centrifugal Pump Locations

TYPE EQUIPMENT	BASEMENT BELOW-GRADE PROVISIONS*	ON\ABOVE GRADE 20-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 30-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 40-FOOT FLOOR-SPAN PROVISIONS*
Close-couple through 5 hp	None	-R-0.35	C-S-1.0	C-S-1.0
Bedplate-mounted through 5 hp	None	C-CIB-1.0	C-CIB-1.5	C-CIB-1.75
7-1/2 hp	None	C-CIB-1.0	C-CIB-1.75	C-CIB-2.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.2 Low-Pressure AHU Locations

Vibration-isolation provisions apply to floor-mounted Air Moving and Conditioning Association Class A packaged central-station units.

TYPE EQUIPMENT	BASEMENT BELOW-GRADE PROVISIONS*	ON\ABOVE GRADE 20-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 30-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 40-FOOT FLOOR-SPAN PROVISIONS*
Through 5 hp	B-U-0.35	C-U-1.0	C-U-1.0	C-U-1.0
7-1/2 hp				

TYPE EQUIPMENT	BASEMENT BELOW-GRADE PROVISIONS*	ON\ABOVE GRADE 20-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 30-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 40-FOOT FLOOR-SPAN PROVISIONS*
and over 250 to 500 rpm	B-U-0.35	C-U-1.75	C-U-1.75	C-U-1.75
500 rpm	B-U-0.35	C-U-1.0	C-U-1.5	

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.3 Medium- And High-Pressure AHU Locations

Vibration-isolation provisions apply to floor-mounted Air Moving and Conditioning Association Classes B and C packaged central-station units.

TYPE EQUIPMENT	BASEMENT BELOW-GRADE PROVISIONS*	ON\ABOVE GRADE 20-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 30-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 40-FOOT FLOOR-SPAN PROVISIONS*
Through 20 hp 250 to 300 rpm	B-U-0.35	C-U-2.5	C-U-2.5	C-U-3.5
300 to 500 rpm	B-U-0.35	C-U-1.75	C-U-1.75	C-U-2.5
500 rpm and over	B-U-0.35	C-U-1.0	C-U-1.0	C-U-1.75
Over 20 hp 250 to 300 rpm	B-U-0.35	C-U-2.5	C-CIB-3.5	C-CIB-3.5
300 to 500 rpm	B-U-0.35	C-U-2.5	C-CIB-2.5	C-CIB-3.5
500 rpm and over	B-U-0.35	C-U-1.0	C-CIB-1.75	C-CIB-2.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

2.2.4 Air-Moving Device Locations

Vibration-isolation provisions apply to housed free-standing fans of any pressure rating, located in field- fabricated central-station unit.

TYPE EQUIPMENT	BASEMENT BELOW-GRADE PROVISIONS*	ON\ABOVE GRADE 20-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 30-FOOT FLOOR-SPAN PROVISIONS*	ON\ABOVE GRADE 40-FOOT FLOOR-SPAN PROVISIONS*
Through 20 hp 200 to 300 rpm	B-U-0.35	C-S-2.5	C-S-2.5	C-S-3.5
300 to 500 rpm	B-U-0.35	C-S-1.75	C-S-1.75	C-S-2.5
500 rpm and over	B-U-0.35	C-S-1.0	C-S-1.5	C-S-1.75
Over 20 hp 250 to 300 rpm	B-U-0.35	C-S-2.75	C-CIB-3.5	C-CIB-5.0
300 to 500 rpm	B-U-0.35	C-S-1.75	C-CIB-2.5	C-CIB-3.5
500 rpm and over	B-U-0.35	C-S-1.0	C-CIB-1.75	C-CIB-2.5

*TYPE OF MOUNTING, BASE, AND MINIMUM DEFLECTION IN INCHES

PART 3 EXECUTION

3.1 INSTALLATION

Install equipment in accordance with manufacturer's recommendations.

Ensure rails, structural steel bases, and concrete inertia blocks are raised not less than 1 inch above the floor and are level when equipment supported is under operating load.

Ensure vibration-isolation installation and deflection testing after equipment start-up is directed by a competent representative of the manufacturer.

3.2 TESTS AND REPORTS

Ensure vibration-isolation devices are deflection tested. Submit test reports in accordance with paragraph entitled, "Submittals," substantiating that all equipment has been isolated as specified and that minimum specified deflections have been met. Make all measurements in the presence of the Contracting Officer.

-- End of Section --

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SECTION 23 05 93

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SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

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 HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 62.1	(2010; Errata 2011; INT 21 2012) Ventilation for Acceptable Indoor Air Quality

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

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.
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	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 testing, adjusting, and balancing (TAB) of new heating, ventilating, and cooling (HVAC) air and water 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.

1.3.1 Air Distribution Systems

Test, adjust, and balance systems (TAB) in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to exterior of air distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

1.3.2 Water Distribution Systems

TAB system in compliance with this section. Obtain Contracting Officer's written approval before applying insulation to water distribution systems as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS. At Contractor's option and with Contracting Officer's written approval, the piping systems may be insulated before systems are TAB'd.

Terminate piping insulation immediately adjacent to each flow control valve, automatic control valve, or device. Seal the ends of pipe insulation and the space between ends of pipe insulation and piping, with waterproof vapor barrier coating.

After completion of work under this section, insulate the flow control valves and devices as specified under Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

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. Water quantities and temperatures in thermal energy transfer equipment schedules.
5. Water quantities and heads in pump schedules.
6. Water flow measurement fittings and balancing fittings.

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 6 copies of the TAB Schematic Drawings and Report Forms to the Contracting Officer, no later than 21 days prior to the start of TAB field measurements.

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 titled "Sustainability" for detailed requirements.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Records of Existing Conditions; 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

SD-02 Shop Drawings

TAB Schematic Drawings and Report Forms; G

SD-03 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

SD-06 Test Reports

TAB Work Execution Schedule; G
TAB Procedures Summary; G
Design review report; G
TAB report; G

SD-07 Certificates

Independent TAB agency and personnel qualifications; G
Completed Pre-TAB Work Checklist
TAB Firm; G
Independent TAB Agency and Personnel Qualifications; G
TAB Submittal and Work Schedule; G
Design review report; G
Pre-field TAB engineering report; G
Advanced notice for TAB field work; G
Prerequisite HVAC Work Check Out List; 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.

1.5.2 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.

1.5.3 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

Fans:
a. Vibration Analysis
b. Balance Test and Measurement
c. Alignment (laser preferred)
d. Thermodynamic Performance Test

Heat Exchangers (General):
a. Hydrostatic Test
b. Thermodynamic Performance Test

Piping Systems:
a. Vibration Analysis

Valves:
a. Hydrostatic Test

1.5.4 Qualifications

1.5.4.1 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.

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.

1.5.4.2 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.

1.5.4.3 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.

1.5.4.4 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.

1.5.5 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 paragraph entitled "TAB Submittal and Work Schedule."

1.5.5.1 Contractor

a. TAB personnel: Ensure that the TAB work is accomplished by a group meeting the requirements specified in paragraph entitled "TAB Personnel Qualification Requirements."

b. TAB meeting: Attend the meeting with the TAB Supervisor, and ensure that a representative is present for the sheetmetal contractor, mechanical contractor, electrical contractor, and automatic temperature controls contractor.

c. HVAC documentation: Furnish one complete set of the following HVAC-related documentation to the TAB agency:

(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 paragraph entitled "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 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 TAB field measurement work. Ensure these support personnel are present at the times required by the TAB team, and cause no delay in 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) 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 TAB field work.

j. Insulation work: Ensure that openings in duct and machinery insulation coverings for TAB test ports are marked, closed and sealed.

1.5.5.2 TAB Agency

Provide the services of a TAB team which complies with the requirements of paragraph entitled "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.

1.5.5.3 TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical TAB procedures and TAB team field work.

b. 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 TAB field work.

e. 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.

f. 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.

(1) 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 TAB field check.

1.5.5.4 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 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.

1.5.6 Test Reports

1.5.6.1 Certified TAB Reports

Submit: TAB Report in the following manner:

a. Report format: Submit the completed pre-field data forms approved in the pre-field TAB Engineering Report completed by TAB field team, reviewed and certified by the TAB supervisor. Bind the report with a waterproof front and back cover. Include a table of contents identifying by page number the location of each report. Report forms and report data must be typewritten. Handwritten report forms or report data are not acceptable.

b. Temperatures: On each TAB report form reporting TAB work accomplished on HVAC thermal energy transfer equipment, include the indoor and outdoor dry bulb temperature range and indoor and outdoor wet bulb temperature range within which the TAB data was recorded.

(1) 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.

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. Report static pressure data for all supply, 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, and supply air automatic control dampers, both proportional and two-position, installed in unit cabinetry.

(4) Report static pressure drop across air filters, 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 louvers.

e. 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.

f. Certification: Include the typed name of the TAB supervisor and the dated signature of the TAB supervisor.

g. 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.

h. Calibration Curves: The TAB Supervisor must include, in the TAB Reports, a factory calibration curve for installed flow control balancing valves, flow venturi's and flow orifices TAB'd on the job.

1.6 PROJECT/SITE CONDITIONS

1.6.1 TAB Services to Obtain Existing Conditions

Conduct TAB of the indicated existing systems and equipment and submit the specified TAB reports for approval. Conduct this TAB work in accordance with the requirements of this section.

1.7 SEQUENCING AND SCHEDULING

1.7.1 TAB Submittal and Work Schedule

Comply with additional requirements specified in Appendix C: TAB SUBMITTAL AND WORK SCHEDULE included at the end of this section

1.7.2 TAB Submittal and Work Schedule

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 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.

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 TAB Engineering Report: Within 14 calendar days after approval of the TAB agency Personnel Qualifications, submit the Pre-Field TAB Engineering Report.

Prerequisite HVAC Work Check Out List and Advanced Notice For TAB Field Work: At a minimum of 115 calendar days prior to CCD, submit prerequisite HVAC work check out list certified as complete, and submit advance notice of commencement of TAB field work.

TAB Field Work: At a minimum of 90 calendar days prior to CCD, accomplish TAB field work; submit TAB report; and conduct field check.

Complete TAB Work: Prior to CCD, complete all TAB work.

1.7.2.1 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 TAB 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 SUBCONTRACTOR SPECIAL REQUIREMENTS

Perform all work in this section in accordance with 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.

1.9 WARRANTY

Furnish workmanship and performance warranty for the TAB system work performed for a period not less than 1 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 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 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 TAB MEETING

Meet with the Contracting Officer's technical representative (COTR) to develop a mutual understanding relative to the details of the 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 TAB PROCEDURES

3.3.1 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 the requirements of AABC MN-1 NEBB PROCEDURAL STANDARDS, NEBB MASV, 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, 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.

3.3.2 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.

3.3.3 TAB Air Distribution Systems

3.3.3.1 Units With Coils

Report heating and cooling performance capacity tests for hot water, chilled water, coils for the purpose of verifying that the coils meet the indicated design capacity. Submit the following data and calculations with the coil test reports:

a. For air handlers with capacities greater than 7.5 tons (90,000 Btu) cooling, such as factory manufactured units, central built-up units and rooftop units, conduct capacity tests in accordance with AABC MN-4, procedure 3.5, "Coil Capacity Testing."

   Do not determine entering and leaving wet and dry bulb temperatures by single point measurement, but by the average of multiple readings in compliance with paragraph 3.5-5, "Procedures", (in subparagraph d.) of AABC MN-4, Procedure 3.5, "Coil Capacity Testing."

   Submit part-load coil performance data from the coil manufacturer converting test conditions to design conditions; use the data for the purpose of verifying that the coils meet the indicated design capacity in compliance with AABC MN-4, Procedure 3.5, "Coil Capacity Testing," paragraph 3.5.7, "Actual Capacity Vs. Design Capacity" (in subparagraph c.).

b. For units with capacities of 7.5 tons (90,000 Btu) or less, such as fan coil units, duct mounted reheat coils associated with VAV terminal units, and unitary units, such as through-the-wall heat pumps:

   Determine the apparent coil capacity by calculations using single point measurement of entering and leaving wet and dry bulb temperatures; submit the calculations with the coil reports.

3.3.3.2 Air Handling Units

Air handling unit systems including fans (air handling unit fans, exhaust fans and winter ventilation fans), coils, ducts, plenums, mixing boxes, and air distribution devices for supply air, return air, outside air, mixed air relief air, and makeup air.

3.3.3.3 Heating and Ventilating Units

Heating and ventilating unit systems including fans, coils, ducts, plenums, roof vents, registers, diffusers, grilles, and louvers for supply air, return air, outside air, and mixed air.

3.3.3.4 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.

3.3.4 TAB Water Distribution Systems

3.3.4.1 Chilled Water

Chilled water systems including chillers, condensers, cooling towers, pumps, coils, system balance valves and flow measuring devices.

For water chillers, report data as required by AABC, NEBB and TABB standard procedures, including refrigeration operational data.

3.3.4.2 Heating Hot Water

Heating hot water systems including boilers, hot water converters (e.g., heat exchangers), pumps, coils, system balancing valves and flow measuring devices.

3.3.5 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 valves, balancing dampers, and sheaves. Further, this TAB work includes changing out fan sheaves and pump impellers if required to obtain air and water flow rates specified or indicated. If, with these adjustments and equipment changes, the specified or indicated design flow rates cannot be attained, contact the Contracting Officer for direction.

3.3.6 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 entitled "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.

3.3.7 TAB Reports

Additional requirements for TAB Reports are specified in Appendix B REPORTS - 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 entitled "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.

3.3.8 Quality Assurance - COTR TAB Field Acceptance Testing

3.3.8.1 TAB Field Acceptance Testing

During the field acceptance testing, verify, in the presence of the COTR, random selections of data (water, air quantities, air motion) 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: Air handling units (central stations).

Group 5: Supply fans, exhaust fans, and pumps.

Further, if any data on the TAB Report for Groups 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.

3.3.8.2 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 to be found. This additional field testing is up and above the original 25 percent of the of reported data entries to be field tested.

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.

3.3.8.3 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.

3.4 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.

3.5 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.

3.6 APPENDICES

Appendix A WORK DESCRIPTIONS OF PARTICIPANTS
Appendix B REPORTS - TAB
Appendix C TAB SUBMITTAL AND WORK SCHEDULE

Appendix A

WORK DESCRIPTIONS OF PARTICIPANTS

The Contractor is responsible for ensuring compliance with all requirements of this specification section. However, the following delineation of specific work items is provided to facilitate and co-ordinate execution of the various work efforts by personnel from separate organizations.

1. 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 "TAB Schedule" are met.

c. TAB meeting: Arrange and conduct the 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 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 entitled "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 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 TAB field work accompanied by completed prerequisite HVAC Work List

h. Insulation work: Ensure the duct and piping systems are properly insulated and vapor sealed upon the successful completion and

acceptance of the TAB work.

2. TAB Team Supervisor

a. Overall management: Supervise and manage the overall TAB team work effort, including preliminary and technical TAB procedures and TAB team field work.

b. Schedule: Ensure the requirements specified under the paragraph "TAB Schedule" are met.

c. Submittals: Provide the submittals specified herein.

d. 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 TAB Procedures Summary, the during the 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-TAB Checklists are completely and successfully conducted before TAB field work is performed.

g. Technical Assistance: Provide technical assistance to TAB field work.

h. Deficiencies Notification: Ensure the notifications of Construction Deficiencies are provided as specified herein. Comply with requirements of the paragraph entitled "Construction Deficiencies." Resolve each deficiency as soon as practical and submit revised schedules and other required documentation.

i. 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 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 -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. 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. TAB Procedures Summary

Submit a detailed narrative describing all aspects of the TAB field work to be performed. Clearly distinguish between TAB information. Include the following:

a. A list of the intended procedural steps for the 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 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 the TAB field work can be performed. The Contractor must complete, submit, and receive approval of the Completed Pre-TAB Work Checklist before the TAB field work can be accomplished.

g. 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 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. TAB Reports: Submit TAB Report following manner:

a. Procedure Summary: Submit a copy of the approved 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.

(1) 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.

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 data for all supply, 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, inlet and discharge static pressures.

(2) Report static pressure drop across chilled water coils, hot water coils, devices installed in unit cabinetry.

(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, 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 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. 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.

g. 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.

h. 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.

i. 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 entitled "Workmanship."

Appendix C

TAB SUBMITTAL AND WORK SCHEDULE

Perform the following items of work in the order listed adhering to the dates schedule specified below.

Submit TAB Agency and TAB Personnel Qualifications: Within 42 calendar days after date of contract award.

Submit the TAB Work Execution Schedule: within 14 days after receipt of the TAB agency and TAB personnel qualifications approval.

Submit the TAB Work Procedures Summary: within 14 days after receipt of the initial approved TAB Work Execution Schedule.

Meet with the COTR at the TAB Meeting: Within 28 calendar days after receipt of the approved initial TAB Execution Schedule.

Submit Design Review Report: Within 56 calendar days after the receipt of the approved initial DALT and TAB Work Execution Schedule.

TAB Field Work: At a minimum of 84 calendar days prior to CCD, 4and when the ambient temperature is within Season 1 limits, 4 accomplish TAB field work.

Submit TAB Report: Within 14 calendar days after completion of TAB field work, submit initial TAB report.

Quality Assurance - COTR TAB Field Check: 30 calendar days after initial TAB report is approved by the Contracting Officer, conduct field check.

Complete 4TAB Work: Prior to CCD, complete all TAB work 4 and submit final.

Receive the approved TAB report: Within 21 calendar days, receive the report from Contracting Officer approved TAB report.

-- End of Section --

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 23 07 00

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SECTION 23 07 00

THERMAL INSULATION FOR MECHANICAL SYSTEMS

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; INT 1 2011; Errata 2011, Errata 2011; Errata 2011, INT 2-12 2011, Errata 2011; INT 13 2012; INT 14 2012) 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	(2012) Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A580/A580M	(2012a) Standard Specification for Stainless Steel Wire
ASTM B209	(2010) Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
ASTM C1126	(2012) Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
ASTM C1136	(2010) Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C1290	(2011) Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts

ASTM C1427	(2007e1) Specification for Preformed Flexible Cellular Polyolefin Thermal Insulation in Sheet and Tubular Form
ASTM C195	(2007) Standard Specification for Mineral Fiber Thermal Insulating Cement
ASTM C449	(2007) Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement
ASTM C534/C534M	(2011) Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C547	(2012) Standard Specification for Mineral Fiber Pipe Insulation
ASTM C552	(2012) Standard Specification for Cellular Glass Thermal Insulation
ASTM C553	(2011) Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
ASTM C610	(2011) Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation
ASTM C795	(2008) Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel
ASTM C916	(1985; R 2007) Standard Specification for Adhesives for Duct Thermal Insulation
ASTM C920	(2011) Standard Specification for Elastomeric Joint Sealants
ASTM C921	(2010) Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
ASTM E2231	(2009) Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics
ASTM E84	(2012c) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2010) 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

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

UNDERWRITERS LABORATORIES (UL)

UL 723	(2008; Reprint Sep 2010) Test for Surface Burning Characteristics of Building Materials
UL 94	(1996; Reprint Jan 2012) 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. Field applied insulation materials required for use on Government-furnished items as listed in the SPECIAL CONTRACT REQUIREMENTS shall be furnished and installed by the Contractor.

1.2.2 Surface Burning Characteristics

Unless otherwise specified, insulation shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84. Flame spread, and smoke developed indexes, shall be determined by ASTM E84 or UL 723. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Test specimens shall be prepared and mounted according to ASTM E2231. Insulation materials located exterior to the building perimeter are not required to be fire rated.

1.2.3 Recycled Materials

Provide thermal insulation containing recycled materials to the extent practicable, provided that the materials meets all other requirements of this section. The minimum recycled material content of the following

insulation are:

Rock Wool	75 percent slag of weight
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 Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Submit the three SD types, SD-02 Shop Drawings, SD-03 Product Data, and SD-08 Manufacturer's Instructions at the same time for each system.

SD-02 Shop Drawings

MICA Plates; G
Pipe Insulation Systems and Associated Accessories
Duct Insulation Systems and Associated Accessories
Equipment Insulation Systems and Associated Accessories

SD-03 Product Data

Pipe Insulation Systems; G
Duct Insulation Systems; G
Equipment Insulation Systems; G

SD-04 Samples

Thermal Insulation; G

SD-08 Manufacturer's Instructions

Pipe Insulation Systems; G
Duct Insulation Systems; G
Equipment Insulation Systems; G

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. Insulation packages and containers shall be asbestos free.

PART 2 PRODUCTS

2.1 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. 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 which are located within, on, under, and adjacent to buildings; and for plumbing systems. Insulation shall be CFC and HCFC free.

2.2 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 and conform to the following:Flexible Elastomeric: Closed-cell, foam- or expanded-rubber materials containing anti-microbial additive. Comply with ASTM C534/C534M, Type I, Grade 1, for tubular materials and Type II, Grade 1, for sheet materials. Provide product recognized under UL 94 and listed in FM APP GUIDE.

2.2.1 Adhesives

2.2.1.1 Acoustical Lining Insulation Adhesive

Adhesive shall be a nonflammable, fire-resistant adhesive conforming to ASTM C916, Type I.

2.2.1.2 Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C195.

2.2.1.3 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. 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. 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.

a. 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.

b. Duct Insulation Display Sections: Display sample sections for rigid and flexible duct insulation used on the job. A temporary covering shall be used to enclose and protect display sections for duct insulation exposed to weather.

2.2.2 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. Natural cross-ventilation, local (mechanical) pickup, and/or general area (mechanical) ventilation shall be used to prevent an accumulation of solvent vapors, keeping in mind the ventilation pattern must remove any heavier-than-air solvent vapors from lower levels of the workspaces. Gloves and spectacle-type safety glasses are recommended in accordance with safe installation practices. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179, Type II, Class I. Provide product recognized under UL 94 and listed in FM APP GUIDE.

2.2.3 Caulking

ASTM C920, Type S, Grade NS, Class 25, Use A.

2.2.4 Corner Angles

2.2.4.1 General

Nominal 0.016 inch aluminum 1 by 1 inch with factory applied kraft backing. Aluminum shall be ASTM B209, Alloy 3003, 3105, or 5005.

2.2.4.2 Fittings

Fabricated Fittings are the prefabricated fittings for flexible elastomeric pipe insulation systems. Together with the flexible elastomeric tubes, they provide complete system integrity for retarding heat gain and controlling condensation drip from chilled-water and refrigeration systems. Flexible elastomeric, fabricated fittings provide thermal protection (0.25 k) and condensation resistance (0.05 Water Vapor Transmission factor).

2.2.5 Finishing Cement

ASTM C449: 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.

2.2.6 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.

2.2.7 Staples

Outward clinching type monel.

2.2.8 Jackets

2.2.8.1 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 (minimum 2.9 mils adhesive); with 0.0000 permeability when tested in accordance with ASTM E96/E96M; 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 WVT.

2.2.9 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 factory applied jackets are mineral fiber, cellular glass, and phenolic foam. Insulation materials that do not require jacketing are flexible elastomerics. All non-metallic jackets shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.2.9.1 White Vapor Retarder All Service Jacket (ASJ)

Standard reinforced fire retardant jacket for use on hot/cold pipes, ducts, or equipment. Vapor retarder jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

2.2.10 Wire

Soft annealed ASTM A580/A580M Type 302, 304 or 316 stainless steel, 16 or 18 gauge.

2.2.11 Insulation Bands

Insulation bands shall be 1/2 inch wide; 26 gauge stainless steel.

2.2.12 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 moisture vapor transmission of 0.02 perms, and a maximum flame spread index of 25 and a maximum smoke developed index of 50 when tested in accordance with ASTM E84.

2.3 PIPE INSULATION SYSTEMS

Insulation materials shall conform to Table 1. Insulation thickness shall be as listed in Table 2 and meet or exceed the requirements of ASHRAE 90.1 - IP. Insulation thickness shall be 1 inch. Pipe insulation materials shall be limited to those listed herein and shall meet the following requirements:

2.3.1 Aboveground Cold Pipeline (-30 to 60 deg.F)

Insulation for outdoor, indoor, exposed or concealed applications, shall be as follows:

a. Cellular Glass: ASTM C552, Type II, and Type III. Supply the insulation with manufacturer's recommended factory-applied jacket/vapor barrier.

b. Flexible Elastomeric Cellular Insulation: ASTM C534/C534M, Grade 1, Type I or II. Type II shall have vapor retarder/vapor barrier skin on one or both sides of the insulation.

c. Flexible Polyolefin Cellular Insulation: ASTM C1427, Grade 1 Type I or II.

d. Mineral Fiber Insulation with Integral Wicking Material (MFIWM): ASTM C547. Install in accordance with manufacturer's instructions.

2.4 DUCT INSULATION SYSTEMS

2.4.1 Duct Insulation

Provide factory-applied elastomeric insulation. Provide factory applied elastomeric closed cell or phenolic foam insulation according to manufacturer's recommendations for insulation with insulation manufacturer's standard reinforced fire-retardant vapor barrier, with identification of installed thermal resistance (R) value and out-of-package R value.

2.4.1.1 Blanket Insulation

Blanket flexible mineral fiber insulation conforming to ASTM C553, Type 1, Class B-3, 3/4 pcf nominal, 2.0 inches thick or Type II up to 250 degrees F. Also ASTM C1290 Type III may be used. ASHRAE 90.1 - IP.

2.4.2 Duct Insulation Jackets

2.4.2.1 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.

2.4.2.2 Metal Jackets

a. Aluminum Jackets: 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.

b. 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 EQUIPMENT INSULATION SYSTEMS

Insulate equipment and accessories as specified in Tables 4 and 5. All equipment is considered to be working in an outdoor environment. In outside locations, provide insulation 1/2 inch thicker than specified. Increase the specified insulation thickness for equipment where necessary to equal the thickness of angles or other structural members to make a smooth, exterior surface. Submit a booklet containing manufacturer's published installation instructions for the insulation systems in coordination with the submitted MICA Insulation Stds plates booklet. Annotate their installation instructions to indicate which product data and which MICA plate are applicable. The instructions must be copyrighted, have an identifying or publication number, and shall have been published prior to the issuance date of this solicitation. A booklet is also required by paragraphs titled: Pipe Insulation Systems and Duct Insulation Systems.

PART 3 EXECUTION

3.1 APPLICATION - GENERAL

Insulation shall only be applied to unheated and uncooled piping and equipment. All equipment and associated ductwork and piping is considered to be in an outdoor environment. 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 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.

3.1.2 Painting and Finishing

Painting shall be as specified in Section 09 90 00.00 98 PAINTING AND COATING.

3.1.3 Installation of Flexible Elastomeric Cellular Insulation

Flexible elastomeric cellular insulation shall be installed with seams and joints sealed with rubberized contact adhesive. Flexible elastomeric cellular insulation shall not be used on surfaces greater than 220 degrees F. Seams shall be staggered when applying multiple layers of insulation. Insulation exposed to weather and not shown to have jacketing shall be protected with two coats of UV resistant finish or PVC or metal jacketing as recommended by the manufacturer after the adhesive is dry and cured. A brush coating of adhesive shall be applied to both butt ends to be joined and to both slit surfaces to be sealed. The adhesive shall be allowed to set until dry to touch but tacky under slight pressure before joining the surfaces. Insulation seals at seams and joints shall not be capable of being pulled apart one hour after application. Insulation that can be pulled apart one hour after installation shall be replaced.

3.1.4 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.

3.1.5 Pipes/Ducts/Equipment which 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

a. Pipe insulation shall be continuous through the sleeve.

b. An aluminum jacket or vapor barrier/weatherproofing - self adhesive jacket (minimum 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 shall be provided over the insulation wherever penetrations require sealing.

c. Where pipes penetrate interior walls, the aluminum jacket or vapor barrier/weatherproofing - self adhesive jacket (minimum 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.

d. Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.

e. Where penetrating waterproofed floors, the aluminum jacket shall extend from below the backup material to a point 2 inches above the flashing with a band 1 inch from the end of the aluminum jacket.

3.2.1.3 Pipes Passing Through Hangers

a. Insulation, whether hot or cold application, shall be continuous through hangers. All horizontal pipes 2 inches and smaller shall be supported on hangers with the addition of a Type 40 protection shield to protect the insulation in accordance with MSS SP-69. Whenever insulation shows signs of being compressed, or when the insulation or jacket shows visible signs of distortion at or near the support shield, insulation inserts as specified below for piping larger than 2 inches shall be installed, or factory insulated hangers (designed with a load bearing core) can be used.

b. Horizontal pipes larger than 2 inches at 60 degrees F and above shall be supported on hangers in accordance with MSS SP-69.

c. Horizontal pipes larger than 2 inches and below 60 degrees F shall be supported on hangers with the addition of a Type 40 protection shield in accordance with MSS SP-69. An insulation insert of cellular glass, prefabricated insulation pipe hangers, 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.

d. Vertical pipes shall be supported with either Type 8 or Type 42 riser clamps with the addition of two Type 40 protection shields in accordance with MSS SP-69 covering the 360-degree arc of the insulation. An insulation insert of cellular glass or calcium silicate shall be installed between each shield and the pipe. The insert shall cover the 360-degree arc of the pipe. Inserts shall be the same thickness as the insulation, and shall extend 2 inches on each end beyond the protection shield. When insulation inserts are required in accordance with the above, and the insulation thickness is less than 1 inch, wooden or cork dowels or blocks may be installed between the pipe and the shield to prevent the hanger from crushing the insulation, as an option instead of installing insulation inserts. The insulation jacket shall be continuous over the wooden dowel, wooden block, or insulation insert. The vertical weight of the pipe shall be supported with hangers located in a horizontal section of the pipe. When the pipe riser is longer than 30 feet, the weight of the pipe shall be additionally supported with hangers in the vertical run of the pipe that are directly clamped to the pipe, penetrating the pipe insulation. These hangers shall be insulated and the insulation jacket sealed as indicated herein for anchors in a similar service.

e. Inserts shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket. The jacket material used to cover inserts in flexible elastomeric cellular insulation shall conform to ASTM C1136, Type 1, and is allowed to be of a different material than the adjoining insulation material.

3.2.1.4 Flexible Elastomeric Cellular Pipe Insulation

Flexible elastomeric cellular pipe insulation shall be tubular form for pipe sizes 6 inches and less. Grade 1, Type II sheet insulation used on pipes larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, the insulation shall be adhered directly to the pipe on the lower 1/3 of the pipe. Seams shall be staggered when applying multiple layers of insulation. Sweat fittings shall be insulated with miter-cut pieces the same size as on adjacent piping. Screwed fittings shall be insulated with sleeved fitting covers fabricated from miter-cut pieces and shall be overlapped and sealed to the adjacent pipe insulation.

3.2.1.5 Pipe Insulation Material and Thickness

TABLE 1					
Insulation Material for Piping					
Service					
	Material	Specification	Type	Class	VR/VB Req'd
Chilled Water (Supply & Return, Dual Temperature Piping, 40 F nominal)					
	Cellular Glass	ASTM C552	II	2	Yes
	Flexible Elastomeric Cellular	ASTM C534/C534M	I		No
	Faced Phenolic Foam	ASTM C1126	III		Yes
	Mineral Fiber with Wicking Material	ASTM C547	I		Yes
Service					
	Material	Specification			
	Perlite	ASTM C610			No
Condensate Drain Located Building					
	Cellurar Glass	ASTM C552	II	2	No
	Flexible Elastometric Cellular	ASTM C534/C534M	I		No
	Faced Phenolic Foam	ASTM C1126	II		No
Note: VR/VB + Vapor Retarder/Vapor Barrier					

TABLE 2		
Service		
	Material	Tube and Pipe Size (inch)

		<1	1-<1.5	1.5-<4	4-<8	< or =>8
Chilled Water (Supply & Return, 40 Degrees F nominal)						
	Cellular Glass	1.5	2	2	2.5	3
	Faced Phenolic Foam	1	1	1	1.5	2
	Mineral Fiber with Wicking Material	1	1.5	1.5	2	3
	Flexible Elastometric Cellular	1	1	1	N/A	N/A
Condensate Drain Located Inside Building						
	Cellular Glass	1.5	1.5	1.5	1.5	1.5
	Flexible Elastometric Cellular	1	1	1	N/A	N/A
	Faced Phenolic Foam	1	1	1	1	1

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. Chilled water.
b. Air conditioner condensate drains.

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 (minimum 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 (minimum 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 (minimum 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, kitchens, and mechanical rooms, aluminum jackets or greater than 3ply vapor barrier/weatherproofing self-adhesive (minimum 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 Cold Pipe

a. Insulation shall be applied to the pipe with joints tightly butted. All butted joints and ends shall be sealed with joint sealant and sealed with a vapor retarder coating, greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or PVDC adhesive tape.

b. Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches. Butt strips 3 inches wide shall be provided for circumferential joints.

c. Laps and butt strips shall be secured with adhesive and stapled on 4 inch centers if not factory self-sealing. If staples are used, they shall be sealed in accordance with item "e." below. Note that staples are not required with cellular glass systems.

d. Factory self-sealing lap systems may be used when the ambient temperature is between 40 and 120 degrees F during installation. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where gaps occur, the section shall be replaced or the gap repaired by applying adhesive under the lap and then stapling.

e. All Staples, including those used to repair factory self-seal lap systems, shall be coated with a vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape. All seams, except those on factory self-seal systems shall be coated with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

f. Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape. The patch shall extend not less than 1-1/2 inches past the break.

g. At penetrations such as thermometers, the voids in the insulation shall be filled and sealed with vapor retarder coating or PVDC adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape or greater than 3 ply laminate jacket - less than 0.0000 perm adhesive tape.

h. Installation of flexible elastomeric cellular pipe insulation shall be by slitting the tubular sections and applying them onto the piping or tubing. Alternately, whenever possible slide un-slit sections over the open ends of piping or tubing. All seams and butt joints shall be secured and sealed with adhesive. When using self seal products only the butt joints shall be secured with adhesive. Insulation shall be pushed on the pipe, never pulled. Stretching of insulation may result in open seams and joints. All edges shall be clean cut. Rough or jagged edges of the insulation shall not be permitted. Proper tools such as sharp knives shall be used. Grade 1, Type II sheet insulation

when used on pipe larger than 6 inches shall not be stretched around the pipe. On pipes larger than 12 inches, adhere sheet insulation directly to the pipe on the lower 1/3 of the pipe.

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. Precut or 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 precut/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.

3.3 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.

Corner angles shall be installed on external corners of insulation on ductwork in exposed finished spaces before covering with jacket unless otherwise shown. Air conditioned spaces shall be defined as those spaces directly supplied with cooled conditioned air (or provided with a cooling device such as a fan-coil unit) and heated conditioned air (or provided with a heating device such as a unit heater, radiator or convector).

3.3.1 Duct Insulation Thickness

Duct insulation thickness shall be in accordance with Table 4.

Table 4 - Minimum Duct Insulation (inches)

Cold 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. Flexible run-outs (field-insulated).
d. Plenums.
e. Coil casings.
f Fresh air intake ducts.
g. Filter boxes.
h. Site-erected air conditioner casings.

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 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. Duct insulation shall be formed with minimum jacket seams. Each piece of rigid insulation shall be fastened 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. Insulation shall be impaled on the fasteners; self-locking washers shall be installed and the pin trimmed and bent over.

d. Joints in the insulation jacket shall be sealed with a 4 inch wide strip of tape. Tape seams shall be sealed with a brush coat of vapor 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 brush coat of vapor retarder coating.

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 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.

3.3.4 Insulation for Evaporative Cooling Duct

Evaporative cooling supply duct located in spaces not evaporatively cooled, shall be insulated. Material and installation requirements shall be as specified for duct insulation for warm air duct.

3.3.5 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.

3.4 EQUIPMENT INSULATION SYSTEMS INSTALLATION

Install equipment insulation systems in accordance with the approved MICA Insulation Stds plates as supplemented by the manufacturer's published installation instructions.

3.4.1 General

Removable insulation sections shall be provided to cover parts of equipment that must be opened periodically for maintenance including vessel covers, fasteners, flanges and accessories. Equipment insulation shall be omitted on the following:

a. Hand-holes.
b. Boiler manholes.
c. Cleanouts.
d. ASME stamps.
e. Manufacturer's nameplates.
f. Duct Test/Balance Test Holes.

3.4.2 Insulation for Cold Equipment

Cold equipment below 60 degrees F: Insulation shall be furnished on equipment handling media below 60 degrees F including the following:

a. Pumps.
b. Refrigeration equipment parts that are not factory insulated.
c. Drip pans under chilled equipment.
d. Cold and chilled water pumps.

e. Air handling equipment parts that are not factory insulated.

3.4.2.1 Insulation Type

Insulation shall be suitable for the temperature encountered. Material and thicknesses shall be as shown in Table 5:

TABLE 5

Insulation Thickness for Cold Equipment (inches)

Equipment handling media at indicated temperature		
	Material	Thickness (inches)
35 to 60 degrees F		
	Cellular Glass	1.5
	Faced Phenolic Foam	1.5
	Flexible Elastomeric Cellular	1
	Flexible Polyolefin Cellular	1
1 to 34 degrees F		
	Faced Phenolic Foam	1.5
	Cellular Glass	3
	Flexible Elastomeric Cellular	1.5
	Flexible Polyolefin Cellular	1.5
Minus 30 to 0 degrees F		
	Faced Phenolic Foam	1.5
	Cellular Glass	3.5
	Flexible Elastomeric Cellular	1.5
	Flexible Polyolefin Cellular	1.5

3.4.2.2 Pump Insulation

a. Insulate pumps by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints that do not leave raw ends of insulation exposed. Joints between sides and between sides and bottom shall be joined by adhesive with lap strips for rigid mineral fiber and contact adhesive for flexible elastomeric cellular insulation. The box shall conform to the requirements of MICA Insulation Stds plate No. 49 when using flexible elastomeric cellular insulation. Joints between top cover and sides shall fit tightly forming a female shiplap joint on the side pieces and a male

joint on the top cover, thus making the top cover removable.

b. Exposed insulation corners shall be protected with corner angles.

c. Upon completion of installation of the insulation, including removable sections, two coats of vapor retarder coating shall be applied with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. Caulking shall be applied to parting line, between equipment and removable section insulation, and at all penetrations.

3.4.2.3 Other Equipment

a. Insulation shall be formed or fabricated to fit the equipment. To ensure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

b. Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 12 inch centers except flexible elastomeric cellular which shall be adhered with contact adhesive. Insulation corners shall be protected under wires and bands with suitable corner angles.

c. Phenolic foam insulation shall be set in a coating of bedding compound and joints shall be sealed with bedding compound as recommended by the manufacturer. Cellular glass shall be installed in accordance with manufacturer's instructions. Joints and ends shall be sealed with joint sealant, and sealed with a vapor retarder coating.

d. Insulation on heads of heat exchangers shall be removable. Removable section joints shall be fabricated using a male-female shiplap type joint. The entire surface of the removable section shall be finished by applying two coats of vapor retarder coating with a layer of glass cloth embedded between the coats. The total dry thickness of the finish shall be 1/16 inch.

e. Exposed insulation corners shall be protected with corner angles.

f. Insulation on equipment with ribs shall be applied over 6 by 6 inches by 12 gauge welded wire fabric which has been cinched in place, or if approved by the Contracting Officer, spot welded to the equipment over the ribs. Insulation shall be secured to the fabric with J-hooks and 2 by 2 inches washers or shall be securely banded or wired in place on 12 inch centers.

3.4.2.4 Vapor Retarder/Vapor Barrier

Upon completion of installation of insulation, penetrations shall be caulked. Two coats of vapor retarder coating or vapor barrier jacket shall be applied over insulation, including removable sections, with a layer of open mesh synthetic fabric embedded between the coats. The total dry thickness of the finish shall be 1/16 inch. Caulking or vapor barrier tape shall be applied to parting line between equipment and removable section insulation.

-- End of Section --

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SECTION 23 09 33.00 40

ELECTRIC AND ELECTRONIC CONTROL SYSTEM FOR HVAC

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	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 3R	Ventilated Enclosures - Raintight Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems

THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

CID A-A-2962	(Rev A; Notice 2) Enamel, Alkyd, Gloss, Low VOC Content
FED-STD-595	(Rev C; Notice 1) Colors Used in Government Procurement

1.2 SYSTEM DESCRIPTION

1.2.1 General Requirements

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

Section 26 60 13.00 40 LOW-VOLTAGE MOTORS applies to this section.

Submit Material, Equipment, and Fixture Lists for control and instrumentation systems including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and

fabrication site information.

Submit Records of Existing Conditions consisting of the results of survey of work area conditions and features of existing structures and facilities within and adjacent to the jobsite. Commencement of work constitutes acceptance of existing conditions.

1.2.2 System Requirements

Provide local control systems that are complete in all details and that include all necessary accessories to maintain conditions indicated or specified.

Provide electric/electronic automatic temperature control systems. As far as practical, provide control equipment that is the product of a single control systems manufacturer. Provide local systems components not the product of the control system manufacturer that are approved for use with the control system as indicated.

Provide automatically controlled valves to control environment that are furnished by the control systems manufacturer.

Provide automatically controlled dampers, independent of dampers integral with manufactured air-handling units, furnished by the automatic control systems manufacturer. Use a damper manufacturer that is licensed to display the AMCA seal.

Submit Fabrication Drawings for control and instrumentation systems consisting of fabrication and assembly details to be performed in the factory.

Submit Operating Instructions for control and instrumentation consisting of standard operating procedures including startup, shutdown, and emergency operation.

1.3 QUALITY ASSURANCE

1.3.1 Predictive Testing And Inspection Technology Requirements

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

1.3.2 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 similar material, design and workmanship. Provide standard products that have been in satisfactory commercial or industrial use for 2 years prior to bid opening that includes applications of equipment and materials under similar circumstances and of similar size. Provide a product that has been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.

1.3.3 Alternative Qualifications

Products having less than a two-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 or laboratory tests, are shown.

1.3.4 Service Support

Support the equipment items by service organizations. Submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. Provide service organizations that are 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 contract.

1.3.5 Manufacturer's Nameplate

Provide each item of equipment with 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 is not acceptable.

1.3.6 Modifications of References

In each of the publications referred to herein, consider the advisory provisions to be mandatory, wherever the words shall, should, will, would, or may appear. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the "Contracting Officer."

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists; G
Records of Existing Conditions; G

SD-02 Shop Drawings

Fabrication Drawings; G
Installation Drawings; G

SD-03 Product Data

Control Components; G
Thermometers; G
Pressure Gages; G
Valves; G
Dampers; G
Operators; G

SD-06 Test Reports

Set Points And Final Adjustments Of Controls; G
Test Reports; G

SD-07 Certificates

Listing of Product Installations; G
Qualified Permanent Service Organizations; G
Manufacturer's Standard Factory Finishing; G

SD-08 Manufacturer's Instructions

Operating Instructions; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G
Scheduled Instructional Services; G
Electric Operators; G

1.5 STORAGE AND HANDLING

Seal openings after manufacturing and inspection, until ready for installation.

Carefully handle instruments and equipment, do not subject to shock, and protect from weather, dust, construction materials, and damage.

1.6 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.

1.7 ELECTRICAL REQUIREMENTS

Furnish motors, controllers, disconnects and contactors with their respective pieces of equipment. Provide motors, controllers, disconnects and contactors that conform to and have electrical connections provided under Division 26 applicable sections. Furnish internal wiring for components of packaged equipment as an integral part of the equipment. Extended voltage range motors are not permitted. Provide controllers and contactors that have a maximum of 120 volt control circuits, and have auxiliary contacts for use with the controls furnished. When motors and equipment furnished are larger than sizes indicated, include the cost of additional electrical service and related work under the section that specified that motor or equipment. Provide power wiring and conduit for field installed equipment under and conforming to the requirements of Division 26 applicable sections.

PART 2 PRODUCTS

Submit Equipment and performance data for the following items consisting of use life, system functional flows, safety features, and mechanical automated details. Submit curves indicating tested and certified equipment response and performance characteristics.

a. Control Components

b. Thermometers
c. Pressure Gages
d. Valves
e. Dampers
f. Operators

2.1 CONTROL COMPONENTS

2.1.1 Temperature Sensors

Provide temperature sensors, sensor transmitters, and controller output signals that are directly proportional to the variations in the measured variable. Provide linearity that is within plus or minus 1/2 percent for a 200 degrees F span, and plus or minus 1 percent for a 50 degrees F span, throughout the scale range.

Where extremely accurate temperature sensing is required or the transmitter is a considerable distance from the receiver controller, use a two-pipe relay-type transmitter. Provide instrument that has feedback incorporated into the design and 50 degrees F temperature range. Provide capillary that is compensated and is available in 8 and 16-foot averaging lengths. Provide unit that operates on 20 pounds per square inch (psi)input pressure, and has a 03 to 15-psi output over the specified range.

2.1.2 Receiver Controllers

Provide receiver controllers that have a calibrated set point adjustment, minimum calibrated scale with no greater than 2 degrees F degrees divisions for duct and immersion application. Provide set point indication and an adjustable proportional band covering the complete range necessary for the specific application. Provide controller range that matches that of the temperature sensor. Provide devices that incorporate authority and remote set point calibrated adjustments, as required.

2.1.3 Receiver Indicators

Provide receiver indicators that have visual readout for temperature and humidity, using the transmitted signal from the sensor device to the receiver-controller device. Provide readout and accuracy of the receiver indicator that has the indicated value within plus or minus 1/2 percent of the span of the measured variable, as transmitted by the sensor. Mark factory calibration on back of instrument. Provide range that matches that of the temperature or humidity sensor.

Provide a combined accuracy of the sensor and the receiver indicator that is within 2 degrees F and 5 percent relative humidity of the span.

Provide ambient conditions to 150 degrees F that do not cause a shift in control point in pneumatic sensor, receiver controller, or indicator systems.

2.1.4 Immersion Thermostats

Provide remote-bulb type immersion thermostats, for proportional action with adjustable set point over the full operating range, and adjustable throttling range. Provide a nonferrous separable socket for each thermal element.

When used as a secondary controller, provide a remotely set adjustable set

point.

2.1.5 Airstream Thermostats

Provide remote-bulb type or functionally equivalent bimetallic rod and tube type airstream two-position thermostats, with adjustable set point. Provide set point in middle third of range of device.

Provide airstream thermostats for control of modulating devices that are the remote-bulb type for proportional action with adjustable set point over the full operating range, and adjustable throttling range.

Provide airstream thermostats for averaging service that have a remote-bulb element not less than one-half as long as the longest side of the airstream cross section, of a type suitable for averaging service with liquid-filled bulb or equivalent. Gas- or vapor-filled bulbs are not acceptable for averaging service. Locate bulb to sense average temperature.

Provide airstream temperature primary controllers for remote reset or compensating operation, that are remote-bulb type for proportional operation with adjustable set point over the full operating range, adjustable throttling range, and an adjustable authority of the secondary controller. Low- or high-limit thermostats, or other instruments having one-sided control, are not acceptable where reset or compensating controllers are indicated.

2.1.6 Electrical Low-Limit Duct Thermostat

Provide air-handling unit freeze protection. Make the lowest temperature across any 12 inches of bulb length, single tube, sufficient to trip a snap-acting, single-pole, single-throw switch when the temperature sensed is equal to, or below, set point. Provide 20 foot minimum length of bulb. Provide one limit thermostat for every 20 square feet of coil surface. Provide thermostats that have manual reset.

2.1.7 Fire Thermostats

Provide fire thermostats that are UL-approved and listed, are factory set in accordance with NFPA 90A, and have normally closed contacts. Perform reset manually.

2.1.8 Pressure Transmitter

Provide the indicating type pressure transmitters for gas, liquid, or steam service. Provide transmitter range suitable for system operating characteristics. Provide output that is proportional to system pressure and is electronic or pneumatic. Provide indicating receiver with a matched scale range.

Provide total system accuracy that is not less than 1/2 percent of system range.

2.1.9 Remote Element Instruments

Provide remote element instruments that have sufficient length of capillary to mount the instrument on the control panel in an accessible location. Provide excess capillary that is coiled and concealed. Provide armored capillary where indicated.

2.1.10 Switches

Provide switches as indicated.

Provide adjustable switches with indicating plates and accessible adjustment. Calibrate and mark minimum-positioning switches that control dampers in percent of maximum airflow determined by airflow test.

2.2 THERMOMETERS

Provide thermometers adjacent to thermostats with nonferrous separable sockets when in immersion service. Select thermometer scale range according to service. Provide thermometers that are readable from operating level.

Provide dial type temperature indicators that have a 3 inch diameter antiparallax dial face with white background and black markings.

Provide micrometer maximum-registering type pointer with external calibrator adjustment. Provide accuracy within 1 percent of dial range.

Provide corrosion-resistant steel bottom-connection type case, with corrosion-resistant steel close-type ring.

Provide vapor activating medium.

Provide stem length that is 1/2 inch taper pipe thread, fixed thread.

Provide dial type thermometers or thermometers with a minimum 9 inch vertical scale.

Provide temperature sensor, sensor transmitter, and output signals that are directly proportional to the variations in the measured variable. Provide linearity that is within plus or minus 1/2 percent throughout the scale range for a 200 degrees F span, and plus or minus 1 percent for 50 degrees F span.

When the transmitter is over 50 feet from the receiver indicator, use a signal booster to improve signal response. Provide a transmitter that has feedback incorporated in the design and has a 50 degrees F temperature range. Provide capillary that is compensated and is available in short style, 8 to 18 foot averaging lengths. Provide unit that operates on a 20 psi input pressure and has a 3 to 15 psi output over the specified range.

2.3 PRESSURE GAGES

Provide pressure gages used to indicate supply and outlet air pressures of automatic control instruments that are the manufacturer's standard, minimum 3-1/2 inch diameter.

2.4 CONTROL SYSTEM VALVES

Provide bronze valve bodies, 2 inch iron pipe size (ips) and smaller, with screwed end connections. If 2-1/2 inch ips and larger, provide cast iron valve bodies with flanged end connections.

Provide single seated valves for dead-end service except where otherwise indicated.

Provide modulating service valves with plugs matched to the characteristics of the coil for effective control. Provide tetrafluoroethylene, spring-loaded, and self-adjusting valve-stem packing.

Provide top and bottom guided and AISI, Type 303 corrosion-resistant steel valve stem. Cage construction is acceptable.

Provide valves with position indicators and, where indicated or required for proper operation, provide with positioners.

Provide valve linkage with an adjustment for valve lift.

2.4.1 Hydronic

Provide hydronic system valve bodies and trim that are rated for service pressures through 125 psi at 250 degrees F.

Provide hydronic system valves that have replaceable plugs and seats of AISI, Type 303 corrosion-resistant steel, selected for maximum life depending on application conditions.

Provide maximum pressure drop across any hydronic system valve at maximum flow of 5 feet of water.

2.5 POWER-OPERATED DAMPERS

2.5.1 Frame and Blade Assembly

Provide frames and blades that are constructed of extruded aluminum.

Provide mechanically attached, field replaceable resilient seals. Attachment by adhesive is not acceptable. Provide neoprene.

Provide frames that have corner reinforcement and stay rods, where necessary. Provide frames that are fabricated by welding or riveting. Repair damaged galvanized surfaces by coating with an equal weight of zinc.

For static pressures in excess of 3 inches wg, provide master-blade-driven dampers with blades longer than 24 inches with a maximum blade width of 8 inches. Provide maximum blade width for other services of 10 inches. Provide 48 inches maximum blade length. For dampers more than 48 inches wide, provide dampers that are made in two or more sections with intermediate mullions; with each section mechanically interlocked with adjoining section or sections.

Provide minimum shaft size of 1/2 inch, round.

Where linkage is such that operator torque is applied to a master blade and transmitted therefrom, provide a master blade that is reinforced and a shaft that is full length. This type construction is limited to 2 inch wg, static pressure.

Provide blades that are attached to round shafts by hardened cup-point setscrews, or by being pinned. Provide a minimum three-thread engagement. Where setscrews are used, provide two setscrews, 90 degrees apart, to secure master blade. Secure shaft end retainers by pins or spring washers in grooved shaft or by similar construction.

Caulk frames with elastomer compounds to prevent bypass leakage.

2.5.2 Bearings

Provide oil-impregnated sintered bronze shaft bearings, except as otherwise indicated. Provide thrust washers at bearings, when necessary to maintain blade alignment.

2.5.3 Installation

Install dampers in accordance with the manufacturer's instructions.

2.6 CONTROL SYSTEM VALVE AND DAMPER OPERATORS

2.6.1 Operators

Provide motor operators that provide smooth proportional control under operating conditions normal to the system.

Provide spring-return operators for two-position control.

Provide spring returns on reversible operators where required for fail-safe operation.

For operators operating in sequence with other operators, provide operators that have adjustable operating ranges and set points.

Provide operators that have sufficient power on closeoff to provide tight sealing against maximum system pressures.

Provide operators that close valves and dampers to fail-safe position indicated.

2.6.2 Dampers

Provide dampers that are equipped with operators of sufficient power to control dampers, without flutter or hunting, through the entire operating range at air velocities at least 20 percent greater than maximum design velocity.

2.6.3 Electric Operators

Provide reversible type electric motor operators for modulating control.

Provide split-phase type electric motor operators with oil-immersed gear train. Provide motor that has ample capacity to handle applied loads under operating conditions normal to the system. Heat locations where temperatures fall below minimum operating temperature of operator.

2.7 CENTRAL CONTROL CABINET

Provide control cabinet that consists of enclosed wall-mounted modular cabinet sections. Provide lockable cabinets with hinged fronts to provide access to the interior of each cabinet.

Provide a 60-mil thick, high-pressure laminate-covered writing surface and recessed storage drawers with locks.

2.7.1 Cabinet Construction

Provide cabinets made of aluminum, suitably reinforced and braced to provide a flat-faced, rigid-front panel. Cabinet shall be made of type NEMA 3R or better.

Provide surfaces that are free of scale, welding slag, and dirt, and are flat without waves. Do not distort or buckle the cabinet during installation handling.

Provide square cutouts with panels to ensure that instruments are installed level and square.

Make finished cutouts and holes free of burrs and sharp edges. Provide cutouts made up of modular sections in sizes suitable for handling. Provide neat and straight section joints. Securely fasten together and align cabinets, and securely wall or floor anchor each cabinet, as required.

Provide high-grade steel exterior hardware with polished-nickel finish.

Provide cadmium-plated steel interior hardware.

Provide access doors with hinges, latches, and locks. Provide sufficiently sturdy cabinet frames to prevent doors from sagging when open. Provide latches to hold doors open at 90 degrees and provide roller latches to hold doors closed. Furnish keys that are common to all access door locks.

2.7.2 Finish

Clean surfaces in accordance with SSPC SP 6/NACE No.3. Provide blast pattern that has a maximum surface profile of 2.0 mils. Not more than 8 hours after cleaning, follow the manufacturer's standard procedure for priming and finish painting. Conform to CID A-A-2962 or FED-STD-595 for final coat, semi-gloss green enamel for all external surfaces. Use soft gloss white paint for interior surfaces. When painting is not started within 8 hours after cleaning, reclean surfaces before painting.

2.7.3 Graphic System Portrayal

Provide cabinets with individual modules portraying systems configurations. Provide portrayals by approved color-coded graphic tapes in laminated plastic securely fastened to the front panel. Provide beveled edges that are finished smooth and free of waves, scratches, or gouges. Identify instruments and auxiliary equipment by engraved plastic labels. Tape is not acceptable.

2.7.4 Instruments and Components

Obtain approval of instruments prior to installation. Provide clean instruments that are free of foreign matter.

2.7.4.1 Receiver-Type Indicator

Provide receiver-type dial size indicators as indicated.

Provide indicator cases that are made of drawn steel, flush mounted with three equally spaced screws and panel cutout to match indicator as furnished.

Provide bourdon tube of material and construction suitable for 3 to 15 psig input.

Accomplish indicator movement by approved manufacturer's standard practice.

Provide a dial with black numerals and graduating marks on a flat white background.

Provide fixed needle pointer.

Provide indicator calibration by means of calibration screw on face of indicator, with dial accuracy to within 1 degree F in the applicable range.

Provide scale ranges that operate full scale between 3 and 15 psig, with scale ranges as indicated.

2.7.4.2 Electronic Temperature Indicator

Provide electronic temperature indicator that indicates the sensor input throughout the operating range of the system. Provide accuracy within plus or minus 1/2 percent of the system range. Provide input that is proportional to the measured variable. Provide scale range of minus 20 to plus 200 degrees F.

2.7.4.3 Electronic Pressure Indicator

Provide electronic pressure indicator, calibrated in inches wg, that indicates the pressure drop through range of transmitter. Provide accuracy of not less than plus or minus 0.05 inch wg.

2.7.4.4 Remote Control Point Adjuster

Provide remote adjustment for resetting the set point of the control device in 2-degree increments for the full range of the control span.

2.7.4.5 Manual Minimum Position Switch

Provide manual minimum position switch that has an adjustable minimum output between 3 and 13 psi, that is furnished with a calibrated 0 to 100 percent set point scale with scale divisions of 5 or less, and that has a set point-locking adjustment knob. Provide a switch suitable for a maximum pressure of not less than 25 psig.

2.7.4.6 Remote Temperature Transmitter

Provide remote temperature transmission of discharge air that transmits a signal in proportion to the measured temperature to an electronic thermometer in the central control panel. Provide plus or minus 0.5 degree F total system accuracy.

2.7.4.7 Remote Filter Pressure Transmitter

Provide filter pressure-drop transmitter that transmits an electronic signal to a common pressure indicator, calibrated in inches wg, at the control center. Provide accuracy of not less than plus or minus 0.05 inch wg. Provide pressure transmitter range from 0 to 6 inches wg.

2.8 FACTORY FINISHING

Manufacturer's standard factory finishing systems is acceptable with certification that the factory painting system applied withstands 125 hours in a salt-spray fog test, and equipment located outdoors withstands 500 hours in salt-spray fog test. Perform salt-spray fog test in accordance with ASTM B117, and for that test the acceptance criteria are the following: immediately after completion of the test, the paint shows no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen shows no signs of rust creepage beyond 0.125 inch on either side of the scratch mark.

Provide a film thickness of not less than the film thickness used on the test specimen for the factory finishing system applied on the equipment. If manufacturer's standard factory finishing system is being proposed for use on surfaces subject to temperatures above 120 degrees F, provide a factory finishing system designed for the temperature service.

PART 3 EXECUTION

3.1 INSTALLATION

Install control components using Contractor-certified control and instrumentation specialists.

Install in accordance with the manufacturer's instructions and as indicated.

Submit Installation Drawings and include details of equipment room layout and design.

Provide Listing of Product Installations for controls and instrumentation systems that include identification of at least 5 units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Include purchaser, address of installation, service organization, and date of installation on list.

3.2 VIBRATION ISOLATION

To prevent vibration, isolate controllers by location or by mounting devices supplied by the equipment manufacturer.

Install conduit to prevent the transmission of equipment vibration. Mount single tube runs in aircraft-type clamps containing an elastomer insert, preventing contact with ducting or air handling unit housing, casing, or enclosure. Provide multiple runs that conform to the same isolation requirements, but submit mounting details for approval. Refer to Section 23 05 48.00 40 VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT for vibration isolation considerations.

3.3 FIELD QUALITY CONTROL

Provide equipment to check the calibration of instruments. Recalibrate or replace instruments not in calibration.

Perform tests in accordance with referenced standards in this section.

After completion of control and instrument piping, test and adjust control equipment in terms of design, function, systems balance, and performance, and otherwise make ready for air handling systems acceptance tests.

Provide data showing set points and final adjustments of controls.

After air handling system acceptance and after the systems have operated in normal service for 2 weeks, check the adjustment on instruments and devices. Correct items found to be out of order. When air handling systems are in specified operating condition and when all other pertinent specifications requirements have been met, automatic temperature-control systems are acceptable.

Submit test reports to the Contracting Officer.

3.4 OPERATOR TRAINING

Provide written operating instructions and not less than 8 hours of operator training.

Provide classroom and field instructions in operation and maintenance of systems equipment where required by the technical provisions. Direct these services using the manufacturer's factory trained personnel or qualified representative. Give the Contracting Officer 7 calendar days written notice of scheduled instructional services. Make instructional materials belonging to the manufacturer or vendor available to the Contracting Officer.

3.5 SPECIAL TOOLS

Provide special tools as required for the operation and adjustment of controllers, instruments, or other control system devices.

3.6 OPERATION AND MAINTENANCE

Provide Operation and Maintenance Manuals that are consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures and safety precautions.

-- End of Section --

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-- End of Section Table of Contents --

SECTION 23 41 13.00 40

PANEL FILTERS

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

Provide panel filters complete with all components and accessory equipment as specified in this section.

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

Submit Manufacturer's Catalog Data, including physical characteristics and performance data for panel filters.

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 SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 52.2	(2007; Addenda B 2008; Errata 2009, Errata 2010; INT 2010; Errata 2011) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

ASTM INTERNATIONAL (ASTM)

ASTM D92	(2012) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-F-29177	(1985; Rev A; CANC Notice 1) Filter, Air-Extended Area, Initial Installation
MIL-STD-282	(2012a - Controlled Distribution Document) Filter Units, Protective Clothing, Gas-Mask Components and Related Products: Performance-Test Methods

UNDERWRITERS LABORATORIES (UL)

UL 900	(2004; Reprint Feb 2012) Standard for Air Filter Units

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G

SD-03 Product Data

Physical Characteristics; G
Performance Data; G
Air Filters; G
Filter Gages; G
Manometers; G

SD-06 Test Reports

Test Reports; G

SD-07 Certificates

Air Filters; G
Filter Gages; G
Manometers; G

1.4 GENERAL REQUIREMENTS

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

Submit physical characteristics information and performance data for air filters consisting of use life, system functional flows, safety features, and mechanical automated details. Also submit curves indicating tested and certified equipment responses and performance characteristics.

PART 2 PRODUCTS

2.1 FILTERS

Provide air filters with a net effective filtering area and a face area to provide the required airflow at the indicated initial pressure-drop.

Provide sufficient clearance for maintenance and operation in and around filter assembly.

Construct filter-holding frames of extruded aluminum. Provide frame assemblies and fasteners of corrosion-resistant metal or carbon steel with a corrosion-resistant finish to preclude surface degradation.

2.1.1 Filters, Disposable Type

Listed below is the minimum acceptable performance for the air filter:

DIMENSIONS (INCHES)	INITIAL RESISTANCE (INCH WG)	ARRESTANCE (PERCENT)	DUST-HOLDING CAPACITY (GM/SQ FT)
14 by 20 by 1	0.04	65	145

DIMENSIONS (INCHES)	INITIAL RESISTANCE (INCH WG)	ARRESTANCE (PERCENT)	DUST-HOLDING CAPACITY (GM/SQ FT)
16 by 20 by 1	0.04	65	145
16 by 25 by 1	0.04	65	145
20 by 20 by 1	0.04	65	145
20 by 25 by 1	0.04	65	145
16 by 20 by 2	0.08	75	190
16 by 25 by 2	0.08	75	190
20 by 20 by 2	0.08	75	190
20 by 25 by 2	0.08	75	190

For all sizes of filters, ensure the final resistance value is 0.50 inch, with air volume of 1,200 cubic feet per minute, and airflow velocity of 300 feet per minute.

2.1.2 Filters, Cleanable Type

Provide nonwoven synthetic-fabric-type filtering element, supported on rigid pleats of suitable grid material, with a nominal overall depth of 2 inches. Seal filter element into an enclosing frame of rigid chipboard, providing a unit that will not rack. Verify initial pressure drop at a face velocity of 500 fpm is 0.25 inch wg, with average dust-spot efficiency of 18 percent and arrestance of 87 percent when filter is operated to a final pressure drop of 1 inch wg. Verify, under these circumstances, the dust-holding capacity is 70 grams per square foot of face area.

Use test method in accordance with ASHRAE 52.2.

2.1.3 Filters, Replaceable Type

Provide filters conforming to MIL-F-29177, Type I or Type II. Base filter efficiency on ASHRAE 52.2. Efficiency, by definition, is dust-spot efficiency using atmospheric dust. Arrestance is weight efficiency using test dust. Provide type III filter arrestance efficiencies in accordance with MIL-STD-282 DOP test.

Provide each air filter with a permanent corrosion-resistant holding frame and a replaceable factory-assembled filter element. Supply permanent holding frame with suitable gaskets designed to maintain a positive pressure seal between the frame and the filter element(s).

Design and construct air filters to facilitate field maintenance. Make adjustments and ensure replaceable accessories are readily accessible. Conditions which may be hazardous to personnel or deleterious to equipment is not permitted.

Provide antiallergenic and nontoxic filter element, with no detectable odor, which have no adverse effect on the health of personnel handling or served by the filter element.

Use adhesive coatings on filters with a flashpoint of not less than 325 degrees F conforming to ASTM D92.

Provide Type II, Grade C filter with 85 percent commercially rated efficiency minimum of 58 percent per ASHRAE 52.2 using atmospheric dust conforming to UL 900, Class 2 and requirements specified herein. Provide filters, when operated at rated capacity of 500 cfm, having an initial pressure drop of not more than 0.25 inch wg, and final pressure drop not exceeding 1 inch wg, with initial filter efficiency of not less than 58 percent, and an average efficiency not less than 76 percent. Verify dust-holding capacity (grams per square foot), at a rated air flow (cubic feet per minute) is not less than 470 at 2,500, respectively.

2.2 FILTER GAGES AND MANOMETERS

Provide air-filter gages or manometers for each type filter assembly.

Provide dial-indicator type gages, graduated to read 0 to 2 inches wg, except that gages for HEPA filters are to read 0 to 3 inches wg. Provide manometers measuring from minus0.5 to 3 inches wg, equipped with a built-in indicator bubble. Connect gage or manometer to static-pressure ports of approved design and located so that resistance to airflow will be correctly indicated.

PART 3 EXECUTION

3.1 FILTER INSTALLATION

Coordinate filter supports and retention elements to provide a substantial, structurally sound, leakproof installation.

3.2 HOLDING FRAME INSTALLATION

Provide installation drawings in accordance with referenced standards in this section.

Gasket holding frames on perimeter, or caulked to each other, to supplementary steel, or to closures with elastomeric compounds recommended by the filter manufacturer. Prepare substrate in accordance with the elastomer manufacturer's instructions, including the priming of surfaces in areas where the elastomer is not confined.

3.3 TESTS

Submit test reports in accordance with ASHRAE 52.2.

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CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS

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	(1999; Addenda A 2000, Addenda B 2001; R 2004) Relief Valves for Hot Water Supply Systems

AMERICAN SOCIETY OF SANITARY ENGINEERING (ASSE)

ASSE 1003	(2009) Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems - (ANSI approved 2010)

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C606	(2011) Grooved and Shouldered Joints

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2011; Amendment 2012) Specification for Filler Metals for Brazing and Braze Welding
AWS BRH	(2007; 5th Ed) Brazing Handbook
AWS D1.1/D1.1M	(2012; Errata 2011) Structural Welding Code - Steel
AWS Z49.1	(2012) Safety in Welding and Cutting and Allied Processes

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(1983; R 2006) Pipe Threads, General Purpose (Inch)
ASME B16.1	(2010) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B16.11	(2011) Forged Fittings, Socket-Welding and Threaded
ASME B16.18	(2012) Cast Copper Alloy Solder Joint Pressure Fittings

ASME B16.21	(2011) Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22	(2012) Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ASME B16.26	(2011) Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3	(2011) Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.39	(2009) Standard for Malleable Iron Threaded Pipe Unions; Classes 150, 250, and 300
ASME B16.9	(2012) Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.9	(2011) Building Services Piping
ASME B40.100	(2005; R 2010) Pressure Gauges and Gauge Attachments

ASTM INTERNATIONAL (ASTM)

ASTM A106/A106M	(2011) Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
ASTM A183	(2003; R 2009) Standard Specification for Carbon Steel Track Bolts and Nuts
ASTM A47/A47M	(1999; R 2009) 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 2009) Standard Specification for Ductile Iron Castings
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A733	(2003; E 2009; R 2009) Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples
ASTM B117	(2011) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B32	(2008) Standard Specification for Solder Metal

ASTM B42	(2010) Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B62	(2009) Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75/B75M	(2011) Standard Specification for Seamless Copper Tube
ASTM B813	(2010) Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM B88	(2009) Standard Specification for Seamless Copper Water Tube
ASTM D2000	(2012) Standard Classification System for Rubber Products in Automotive Applications
ASTM D3308	(2012) PTFE Resin Skived Tape
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E84	(2012c) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F1007	(1986; R 2007) Pipeline Expansion Joints of the Packed Slip Type for Marine Application
ASTM F1120	(1987; R 2010) Standard Specification for Circular Metallic Bellows Type Expansion Joints for Piping Applications
ASTM F1199	(1988; R 2010) Cast (All Temperatures and Pressures) and Welded Pipe Line Strainers (150 psig and 150 degrees F Maximum)

EXPANSION JOINT MANUFACTURERS ASSOCIATION (EJMA)

EJMA Stds	(2008) EJMA Standards

HYDRAULIC INSTITUTE (HI)

HI 1.1-1.2	(2008) Rotodynamic (Centrifugal) Pump for Nomenclature and Definitions

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-25	(2008) Standard Marking System for Valves, Fittings, Flanges and Unions
MSS SP-58	(2009) Pipe Hangers and Supports -

	Materials, Design and Manufacture, Selection, Application, and Installation
MSS SP-67	(2011) Butterfly Valves
MSS SP-69	(2003; Notice 2012) Pipe Hangers and Supports - Selection and Application (ANSI Approved American National Standard)
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	(2008; Errata 2012) Bronze Gate, Globe, Angle and Check Valves
MSS SP-85	(2011) Gray Iron Globe & Angle Valves Flanged and Threaded Ends
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)	
NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2011) Motors and Generators
NEMA MG 11	(1977; R 2012) Energy Management Guide for Selection and Use of Single Phase Motors
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems
U.S. GENERAL SERVICES ADMINISTRATION (GSA)	
CID A-A-50541	(Basic; Notice 2) Valves, Tank Float, Angle and Globe Pattern (Inch-Pound

1.2 SYSTEM DESCRIPTION

Provide the water systems having the minimum service (design) temperature-pressure rating indicated. Provision of the piping systems, including materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with the required and advisory provisions of ASME B31.9 except as modified or supplemented by this specification section or design drawings. This specification section covers the water systems piping which is located within, on, and adjacent to building(s) within the building(s) 5 foot line.

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. Submit the following submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Grooved Mechanical Connections For Steel; G
Grooved Mechanical Connections For Copper; G
Calibrated Balancing Valves; G
Automatic Flow Control Valves; G
Pump Discharge Valve
Water Temperature Regulating Valves; G
Water Pressure Reducing Valve
Pressure Relief Valve
Combination Pressure and Temperature Relief Valves
Expansion Joints; G
Pumps; G
Combination Strainer and Pump Suction Diffuser

SD-06 Test Reports

Pressure tests reports; G

Report shall be provided in bound 8-1/2 by 11 inch booklets. In the reports, document all phases of the tests performed. Include initial test summaries, all repairs/adjustments made, and the final test results.

SD-07 Certificates

Employer's Record Documents (For Welding)

Welding Procedures and Qualifications

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Fittings and End Connections (Joints)
Fittings and End Connections (Solder and Flared Joints)
Flanged Connections

SD-08 Manufacturer's Instructions

Lesson plan for the Instruction Course; G

SD-10 Operation and Maintenance Data

Submit spare parts data for each different item of equipment specified, with operation and maintenance data packages. Include 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.

Submit a list of qualified permanent service organizations with

operation and maintenance data packages. Include service organization addresses and service area or expertise. 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.

Calibrated Balancing Valves, Data Package 3; G
Automatic Flow Control Valves, Data Package 3; G
Pump Discharge Valve, Data Package 2; G
Water Temperature Regulating Valves, Data Package 3; G
Water Pressure Reducing Valve, Data Package 3; G
Pressure Relief Valve, Data Package 2; G
Combination Pressure and Temperature Relief Valves,Data Package 2; G
Expansion Joints, Data Package 2; G
Pumps, Data Package 3; G
Combination Strainer and Pump Suction Diffuser, Data Package 2; G

1.4 MODIFICATIONS TO 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.

1.4.1 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." For Navy owned property, references to the "owner" shall be interpreted to mean the "Contracting Officer." For leased facilities, references to the "owner" shall be interpreted to mean the "lessor." References to the "permit holder" shall be interpreted to mean the "Contractor."

1.4.2 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.

1.5 SAFETY REQUIREMENTS

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.

1.6 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation shall be the Contractor's responsibility. Any materials found to be damaged shall be replaced at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter. Any porous materials found to be contaminated with mold or mildew will be replaced at the Contractor's expense. Non-porous materials found to be contaminated with mold or mildew will be disinfected and cleaned prior to installation.

1.7 PROJECT/SITE CONDITIONS

1.7.1 Verification of Dimensions

The Contractor shall become familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing any work.

1.7.2 Drawings

Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. The Contractor shall carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and shall arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.7.3 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 STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening.

The two 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 shall 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. System components shall be environmentally suitable for the indicated locations.

The equipment items shall be supported by service organizations. 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.

2.2 STEEL PIPING

Water piping shall be steel pipe or copper tubing. Provide steel piping with a ANSI/ASME Class 125 service rating, which for 150 degrees F, the pressure rating is 175 psig.

2.2.1 Pipe

Steel pipe, conform to ASTM A53/A53M, Schedule 40, Type E or S, Grades A or B. Do not use Type F pipe.

2.2.2 Fittings and End Connections (Joints)

Piping and fittings 1 inch and smaller shall have threaded connections. Piping and fittings larger than 1 inch and smaller than 3 inches shall have either threaded, grooved, or welded connections. Piping and fittings 3 inches and larger shall have grooved, welded, or flanged connections. The manufacturer of each fitting shall be permanently identified on the body of the fitting in accordance with MSS SP-25.

2.2.2.1 Threaded Connections

Use threaded valves and pipe connections conforming to ASME B1.20.1. Used threaded fitting conforming to ASME B16.3. Use threaded unions conforming to ASME B16.39. Use threaded pipe nipples conforming to ASTM A733.

2.2.2.2 Flanged Connections

Flanges shall conform to ASME B16.1, Class 150. Gaskets shall be nonasbestos compressed material in accordance with ASME B16.21, 1/16 inch thickness, full face or self-centering flat ring type. These gaskets shall contain aramid fibers bonded with styrene butadeine rubber (SBR) or nitrile butadeine rubber (NBR). Bolts, nuts, and bolt patterns shall conform to ASME B16.1.

2.2.2.3 Welded Connections

Welded valves and pipe connections (both butt-welds and socket-welds types) shall conform to ASME B31.9. Butt-welded fittings shall conform to ASME B16.9. Socket-welded fittings shall conform to ASME B16.11. Welded fittings shall be identified with the appropriate grade and marking symbol.

2.2.2.4 Grooved Mechanical Connections For Steel

Rigid grooved mechanical connections may only be used in serviceable aboveground locations where the temperature of the circulating medium does not exceed 230 degrees F. Flexible grooved connections shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein.

Each grooved mechanical joint shall be a system, including coupling housing, gasket, fasteners, all furnished by the same manufacturer. Joint installation shall be in compliance with joint manufacturer's written

instructions.

Use fitting and coupling houses of malleable iron conforming to ASTM A47/A47M, Grade 32510; ductile iron conforming to ASTM A536, Grade 65-45-12; or steel conforming ASTM A106/A106M, Grade B or ASTM A53/A53M. Use gaskets of molded synthetic rubber with central cavity, pressure responsive configuration and conforming to ASTM D2000 Grade No. 2CA615A15B44F17Z for circulating medium up to 230 degrees F or Grade No. M3BA610A15B44Z for circulating medium up to 200 degrees F. Grooved mechanical connections shall conform to AWWA C606. Coupling nuts and bolts shall be steel and shall conform to ASTM A183. Pipe connections and fittings shall be the product of the same manufacturer. Provide joint installation be in compliance with joint manufacturer's written instructions.

2.2.2.5 Dielectric Waterways and Flanges

Provide dielectric waterways with a water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint. When dry, insulation barrier shall be able to withstand a 600-volt breakdown test. Provide dielectric waterways constructed of galvanized steel and have threaded end connections to match connecting piping. Dielectric waterways shall be suitable for the required operating pressures and temperatures. Provide dielectric flanges with the same pressure ratings as standard flanges and provide complete electrical isolation between connecting pipe and/or equipment as described herein for dielectric waterways.

2.3 COPPER TUBING

Provide copper tubing and fittings with a ANSI/ASME Class 125 service rating, which for 150 degrees F., the pressure rating is 175 psig.

2.3.1 Tube

Use copper tube conforming to ASTM B88, Type L or M for aboveground tubing, and Type K for buried tubing.

2.3.2 Fittings and End Connections (Solder and Flared Joints)

Wrought copper and bronze solder joint pressure fittings, including unions ands flanges, shall conform to ASME B16.22 and ASTM B75/B75M. Provide adapters as required. Cast copper alloy solder-joint pressure fittings , including unions and flanges, shall conform to ASME B16.18. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B62. ASTM B42 copper pipe nipples with threaded end connections shall conform to ASTM B42.

Copper tubing of sizes larger than 4 inches shall have brazed joints.Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

Extracted brazed tee joints may be used if produced with an acceptable tool and installed in accordance with tool manufacturer's written procedures.

2.3.3 Grooved Mechanical Connections For Copper

Rigid grooved mechanical connections may only be used in serviceable aboveground locations where the temperature of the circulating medium does

not exceed 230 degrees F. Flexible grooved connections shall be used only as a flexible connector with grooved pipe system. Unless otherwise specified, grooved piping components shall meet the corresponding criteria specified for the similar welded, flanged, or threaded component specified herein.

Each grooved mechanical joint shall be a system, including coupling housing, gasket, fasteners, all furnished by the same manufacturer. Joint installation shall be in compliance with joint manufacturer's written instructions.

Grooved fitting and mechanical coupling housing shall be ductile iron conforming to ASTM A536. Provide gaskets for use in grooved joints shall constructed of molded synthetic polymer of pressure responsive design and shall conform to ASTM D2000 for circulating medium up to 230 degrees F. Provide grooved joints in conformance with AWWA C606.

2.3.4 Solder

Provide solder in conformance with ASTM B32, grade Sb5, tin-antimony alloy. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B813.

2.3.5 Brazing Filler Metal

Filler metal shall conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.4 VALVES

Provide valves with a ANSI/ASME Class 125 service rating, which for 150 degrees F, the pressure rating is 175 psig.

Valves in sizes larger than 1 inch and used on steel pipe systems, may be provided with rigid grooved mechanical joint ends. Such grooved end valves shall be subject to the same requirements as rigid grooved mechanical joints and fittings and, shall be furnished by the same manufacturer as the grooved pipe joint and fitting system.

2.4.1 Gate Valve

Gate valves 2-1/2 inches and smaller shall conform to MSS SP-80 Class 125 and shall be bronze with wedge disc, rising stem and threaded, soldered, or flanged ends. Gate valves 3 inches and larger shall conform to MSS SP-70, Class 125, cast iron with bronze trim, outside screw and yoke, and flanged or threaded ends.

2.4.2 Globe and Angle Valve

Globe and angle valves 2-1/2 inches and smaller shall conform to MSS SP-80, Class 125. Globe and angle valves 3 inches and larger shall conform to MSS SP-85, Class 125.

2.4.3 Check Valve

Check valves 2-1/2 inches and smaller shall conform to MSS SP-80. Check valves 3 inches and larger shall conform to MSS SP-71, Class 125.

2.4.4 Butterfly Valve

Butterfly valves shall conform to MSS SP-67, Type 1 and shall be either the wafer or lug type. Valves smaller than 8 inches shall have throttling handles with a minimum of 2 locking positions. Valves 8 inches and larger shall have totally enclosed manual gear operators with adjustable balance return stops and position indicators.

2.4.5 Plug Valve

Plug valves 2 inches and larger shall conform to MSS SP-78, have flanged or threaded ends, and have cast iron bodies with bronze trim. Valves 2 inches and smaller shall be bronze with NPT connections for black steel pipe and brazed connections for copper tubing. Valve shall be lubricated, non-lubricated, or tetrafluoroethylene resin-coated type. Valve shall be resilient, double seated, trunnion mounted with tapered lift plug capable of 2-way shutoff. Valve shall operate from fully open to fully closed by rotation of the handwheel to lift and turn the plug. Valves 8 inches or larger shall be provided with manual gear operators with position indicators.

2.4.6 Ball Valve

Full port design. Ball valves 1/2 inch and larger shall conform to MSS SP-72 or MSS SP-110 and shall be cast iron or bronze with threaded, soldered, or flanged ends. Valves 8 inches or larger shall be provided with manual gear operators with position indicators. Ball valves may be provided in lieu of gate valves.

2.4.7 Square Head Cocks

Provide copper alloy or cast-iron body with copper alloy plugs, suitable for 125 psig water working pressure.

2.4.8 Calibrated Balancing Valves

Copper alloy or cast iron body, copper alloy or stainless internal working parts. Provide valve calibrated so that flow can be determined when the temperature and pressure differential across valve is known. Valve shall have an integral pointer which registers the degree of valve opening. Valve shall function as a service valve when in fully closed position. Valve shall be constructed with internal seals to prevent leakage and shall be supplied with preformed insulation.

Provide valve bodies with tapped openings and pipe extensions with positive shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings for a portable differential pressure meter connections to verify the pressure differential. Provide metal tag on each valve showing the gallons per minute flow for each differential pressure reading.

2.4.9 Automatic Flow Control Valves

Valve shall automatically maintain the constant flow indicated on the design drawings. Valve shall modulate by sensing the pressure differential across the valve body. Valve shall be selected for the flow required and provided with a permanent nameplate or tag carrying a permanent record of the factory-determined flow rate and flow control pressure levels. Provide valve that controls the flow within 5 percent of the tag rating. Valve

materials shall be the same as specified for the ball or plug valves.

Provide valve that are electric type as indicated. Valve shall be capable of positive shutoff against the system pump head, valve bodies shall be provided with tapped openings and pipe extensions with shutoff valves outside of pipe insulation. The pipe extensions shall be provided with quick connecting hose fittings and differential meter, suitable for the operating pressure specified. Provide the meter complete with hoses, vent, integral metering connections, and carrying case as recommended by the valve manufacturer.

2.4.10 Pump Discharge Valve

Valve shall shall perform the functions of a nonslam check valve, a manual balancing valve, and a shutoff. Valve shall be of cast iron or ductile iron construction with bronze and/or stainless steel accessories. Provide an integral pointer on the valve which registers the degree of valve opening. Flow through the valve shall be manually adjustable from bubble tight shutoff to full flow. Valves smaller than 2 inches shall have NPT connections. Valves 2 inches and larger shall have flanged or grooved end connections. Valve design shall allow the back seat for the stem to be replaced in the field under full line pressure.

2.4.11 Water Temperature Regulating Valves

Provide copper alloy body, direct acting, pilot operated, for the intended service.

2.4.12 Water Pressure Reducing Valve

Valve, ASSE 1003 for water service, copper alloy body, automatic re-seating, with test lever.

2.4.13 Pressure Relief Valve

Valve shall prevent excessive pressure in the piping system when the piping system reaches its maximum heat buildup. Valve, ANSI Z21.22/CSA 4.4 and shall have cast iron bodies with corrosion resistant internal working parts. The discharge pipe from the relief valve shall be the size of the valve outlet unless otherwise indicated.

2.4.14 Combination Pressure and Temperature Relief Valves

ANSI Z21.22/CSA 4.4, copper alloy body, automatic re-seating, test lever, and discharge capacity based on AGA temperature steam rating.

2.4.15 Float Valve

Valve, CID A-A-50541, Style A (angle pattern) or Style B (globe pattern). Where float rods are extended for tank applications, extension shall be properly supported and guided to avoid bending of float rod or stressing of valve pilot linkage.

2.4.16 Drain Valves

Valves, MSS SP-80 gate valves. Valve shall be manually-operated, 3/4 inch pipe size and above with a threaded end connection. Provide valve with a water hose nipple adapter. Freeze-proof type valves shall be provided in installations exposed to freezing temperatures.

2.4.17 Air Venting Valves

Automatic type air venting shall be the ball-float type with brass/bronze or brass bodies, 300 series corrosion-resistant steel float, linkage and removable seat. Air venting valves on water coils shall have not less than 1/8 inch threaded end connections. Air venting valves on water mains shall have not less than 3/4 inch threaded end connections. Air venting valves on all other applications shall have not less than 1/2 inch threaded end connections.

2.5 PIPING ACCESSORIES

2.5.1 Strainer

Strainer, ASTM F1199, except as modified and supplemented in this specification. Strainer shall be the cleanable, basket or "Y" type, the same size as the pipeline. Strainer bodies shall be fabricated of cast iron with bottoms drilled, and tapped. Provide blowoff outlet with pipe nipple, gate valve, and discharge pipe nipple. The bodies shall have arrows clearly cast on the sides indicating the direction of flow.

Provide strainer with removable cover and sediment screen. The screen shall be made of minimum 22 gauge corrosion-resistant steel, with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. The flow shall be into the screen and out through the perforations.

2.5.2 Cyclonic Separator

Metal- bodied, with removal capability of removing solids 45 microns/325 mesh in size and heavier than 1.20 specific gravity, maximum pressure drop of 5 psid, with cleanout connection.

2.5.3 Combination Strainer and Pump Suction Diffuser

Angle type body with removable strainer basket and internal straightening vanes, a suction pipe support, and a blowdown outlet and plug. Strainer shall be in accordance with ASTM F1199, except as modified and supplemented by this specification. Unit body shall have arrows clearly cast on the sides indicating the direction of flow.

Strainer screen shall be made of minimum 22 gauge corrosion-resistant steel, with small perforations numbering not less than 400 per square inch to provide a net free area through the basket of at least 3.30 times that of the entering pipe. Flow shall be into the screen and out through the perforations. Provide an auxiliary disposable fine mesh strainer which shall be removed 30 days after start-up. Provide warning tag for operator indicating scheduled date for removal.

Casing shall have connection sizes to match pump suction and pipe sizes, and be provided with adjustable support foot or support foot boss to relieve piping strains at pump suction. Provide unit casing with blowdown port and plug. Provide a magnetic insert to remove debris from system.

2.5.4 Flexible Pipe Connectors

Provide flexible bronze or stainless steel piping connectors with single braid. Equip flanged assemblies with limit bolts to restrict maximum

travel to the manufacturer's standard limits. Unless otherwise indicated, the length of the flexible connectors shall be as recommended by the manufacturer for the service intended. Internal sleeves or liners, compatible with circulating medium, shall be provided when recommended by the manufacturer. Provide covers to protect the bellows where indicated.

2.5.5 Pressure and Vacuum Gauges

Gauges, ASME B40.100 with throttling type needle valve or a pulsation dampener and shut-off valve. Provide gauges with 4.5 inch dial, brass or aluminum case, bronze tube, and siphon. Gauge shall have a minimum of with a range from 0 psig to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.

2.5.6 Temperature Gauges

Temperature gauges, shall be the industrial duty type and be provided for the required temperature range. Provide gauges with fixed thread connection, dial face gasketed within the case; and an accuracy within 2 percent of scale range. Gauges shall have Fahrenheit scale in 2 degree graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 5 feet of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 5 to 7 feet above the finished floor or in locations indicated. Remote element type temperature gauges shall be provided in thermal wells located 7 feet above the finished floor or in locations indicated.

2.5.6.1 Stem Cased-Glass

Stem cased-glass case shall be polished stainless steel or cast aluminum, 9 inches long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

2.5.6.2 Bimetallic Dial

Bimetallic dial type case shall be not less than 3-1/2 inches, stainless steel, and shall be hermetically sealed with clear acrylic lens. Bimetallic element shall be silicone dampened and unit fitted with external calibrator adjustment.

2.5.6.3 Liquid-, Solid-, and Vapor-Filled Dial

Liquid-, solid-, and vapor-filled dial type cases shall be not less than 3-1/2 inches, stainless steel or cast aluminum with clear acrylic lens. Fill shall be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing shall be double-braided bronze.

2.5.6.4 Thermal Well

Thermal well shall be identical size, 1/2 or 3/4 inch NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type 1/2 inch NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 1 inch.

2.5.7 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, guides, and supports: to MSS SP-58 and MSS SP-69.

2.5.8 Escutcheons

Provide one piece or split hinge metal plates for piping entering floors, walls, and ceilings in exposed spaces. Secure plates in place by internal spring tension or set screws. Provide polished stainless steel plates or chromium-plated finish on copper alloy plates in finished spaces. Provide paint finish on metal plates in unfinished spaces.

2.5.9 Expansion Joints

2.5.9.1 Slip-Tube Type

Slip-tube expansion joints, ASTM F1007, Class I or II. Joints shall be provided with internally-externally alignment guides, injected semi-plastic packing, and service outlets. End connections shall be flanged or beveled for welding as indicated. Initial settings shall be made in accordance with the manufacturer's recommendations to compensate for ambient temperature at time of installation. Pipe alignment guides shall be installed as recommended by the joint manufacturer.

2.5.9.2 Flexible Ball Type

Flexible ball expansion joints shall be capable of 360 degrees rotation plus 15 degrees angular flex movement. Joints shall be constructed of carbon steel with the exterior spherical surface of carbon steel balls plated with a minimum 5 mils of hard chrome in accordance with EJMA Stds. Joint end connections shall be threaded for piping 2 inches or smaller. Joint end connections larger than 2 inches shall be grooved, flanged, or beveled for welding. Provide joint with pressure-molded composition gaskets suitable for continuous operation at twice design temperature.

2.5.9.3 Bellows Type

Bellows expansion type joints, ASTM F1120 with Type 304 stainless steel corrugated bellows, reinforced with equalizing rings, internal sleeves, and external protective covers. Joint end connections shall be grooved, flanged, or beveled for welding. Guiding of piping on both sides of expansion joint shall be in accordance with the published recommendations of the manufacturer of the expansion joint.

2.6 PUMPS

Pumps shall be the electrically driven, non-overloading, centrifugal type which conform to HI 1.1-1.2. Pumps shall be selected at or within 5 percent of peak efficiency. Pump curve shall rise continuously from maximum capacity to shutoff. Pump motor shall conform to NEMA MG 1, be totally enclosed, and have sufficient horsepower for the service required. Pump motor shall have the required capacity to prevent overloading with pump operating at any point on its characteristic curve. Pump speed shall not exceed 3,600 rpm, except where the pump head is less than 60 feet of water, the pump speed shall not exceed 1,750 rpm. Pump motor shall be equipped with an across-the-line magnetic controller in a NEMA 250, Type 1 enclosure with "START-STOP" switch in the cover.

2.6.1 Construction

Each pump casing shall be designed to withstand the discharge head specified plus the static head on system plus 50 percent of the total, but not less than 125 psig. Pump casing and bearing housing shall be close grained cast iron. High points in the casing shall be provided with manual air vents; low points shall be provided with drain plugs. Provide threaded suction and discharge pressure gage tapping with square-head plugs.

Impeller shall be statically and dynamically balanced. Impeller, impeller wearing rings, glands, casing wear rings, and shaft sleeve shall be bronze. Shaft shall be carbon or alloy steel, turned and ground. Bearings shall be ball-bearings, roller-bearings, or oil-lubricated bronze-sleeve type bearings, and be efficiently sealed or isolated to prevent loss of oil or entrance of dirt or water.

Pump and motor shall be mounted on a common cast iron base having lipped edges and tapped drainage openings or structural steel base with lipped edges or drain pan and tapped drainage openings.Pump shall be provided with steel shaft coupling guard. Base-mounted pump, coupling guard, and motor shall each be bolted to a fabricated steel base which shall have bolt holes for securing base to supporting surface. Pump shall be accessible for servicing without disturbing piping connections. Shaft seals shall be mechanical-seals or stuffing-box type.

2.6.2 Mechanical Shaft Seals

Seals shall be single, inside mounted, end-face-elastomer bellows type with stainless steel spring, brass or stainless steel seal head, carbon rotating face, and tungsten carbide or ceramic sealing face. Glands shall be bronze and of the water-flush design to provide lubrication flush across the face of the seal. Bypass line from pump discharge to flush connection in gland shall be provided, with filter or cyclone particle separator in line.

2.6.3 Stuffing-Box Type Seals

Stuffing box shall include minimum 4 rows of square, impregnated TFE (Teflon) or graphite cord packing and a bronze split-lantern ring. Packing gland shall be bronze interlocking split type.

2.7 ELECTRICAL WORK

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 Division 26 applicable sections. 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, shall be provided. For packaged equipment, the manufacturer shall provide controllers including the required monitors and timed restart.

Provide high efficiency type, single-phase, fractional-horsepower alternating-current motors, including motors that are part of a system, in accordance with NEMA MG 11.

Provide polyphase, squirrel-cage medium induction motors, including motors that are part of a system, that meet the efficiency ratings for premium efficiency motors in accordance with NEMA MG 1. 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.

Motors shall be rated for continuous duty with the enclosure specified. Motor duty requirements shall allow for maximum frequency start-stop operation and minimum encountered interval between start and stop. Motor torque shall be capable of accelerating the connected load within 20 seconds with 80 percent of the rated voltage maintained at motor terminals during one starting period. Provide motor starters complete with thermal overload protection and other necessary appurtenances. Motor bearings shall be fitted with grease supply fittings and grease relief to outside of the enclosure.

2.8 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.

2.8.1 Factory Painting Systems

Manufacturer's standard factory painting systems may be provided. 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 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.

2.8.2 Shop Painting Systems for Metal Surfaces

Clean, retreat, 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 hot-dip galvanized steel has been cut, resulting surfaces with no galvanizing shall be coated with a zinc-rich coating conforming to ASTM D520, Type I.

Where more than one coat of paint is specified, apply the second coat after the preceding coat is thoroughly dry. Lightly sand damaged painting and retouch before applying the succeeding coat. Color of finish coat shall be aluminum or light gray.

a. Temperatures Less Than 120 Degrees F: Immediately after cleaning, the metal surfaces subject to temperatures less than 120 degrees F shall receive one coat of pretreatment primer applied to a minimum dry film thickness of 0.3 mil, one coat of primer applied to a minimum dry film

thickness of one mil; and two coats of enamel applied to a minimum dry film thickness of one mil per coat.

b. Temperatures Between 120 and 400 degrees F: Metal surfaces subject to temperatures between 120 and 400 degrees F shall receive two coats of 400 degrees F heat-resisting enamel applied to a total minimum thickness of 2 mils.

c. Temperatures Greater Than 400 degrees F: Metal surfaces subject to temperatures greater than 400 degrees F shall receive two coats of 600 degrees F heat-resisting paint applied to a total minimum dry film thickness of 2 mils.

2.9 FACTORY APPLIED INSULATION

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.

2.10 NAMEPLATES

Major equipment including pumps, pump motors, expansion tanks, and air separator tanks shall have the manufacturer's name, type or style, model or serial number on a plate secured to the item of equipment. The nameplate of the distributing agent will not be acceptable. 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.

2.11 RELATED COMPONENTS/SERVICES

2.11.1 Field Applied Insulation

Requirements for field applied insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS.

2.11.2 Field Applied Insulation

Requirements for field installed insulation is specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as supplemented and modified by this specification section.

PART 3 EXECUTION

3.1 INSTALLATION

Cut pipe accurately to measurements established at the jobsite, and work into place without springing or forcing, completely clearing all windows,

doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation is not permitted without written approval. Cut pipe or tubing square, remove burrs by reaming, and fashion to permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

Notify the Contracting Officer in writing at least 15 calendar days prior to the date the connections are required. Obtain approval before interrupting service. Furnish materials required to make connections into existing systems and perform excavating, backfilling, compacting, and other incidental labor as required. Furnish labor and tools for making actual connections to existing systems.

3.1.1 Welding

Provide welding work specified this section for piping systems in conformance with ASME B31.9, as modified and supplemented by this specification section and the accompanying drawings. The welding work includes: qualification of welding procedures, welders, welding operators, brazers, brazing operators, and nondestructive examination personnel; maintenance of welding records, and examination methods for welds.

3.1.1.1 Employer's Record Documents (For Welding)

Submit for review and approval the following documentation. This documentation and the subject qualifications shall be in compliance with ASME B31.9.

a. List of qualified welding procedures that is proposed to be used to provide the work specified in this specification section.

b. List of qualified welders, brazers, welding operators, and brazing operators that are proposed to be used to provide the work specified in this specification section.

c. List of qualified weld examination personnel that are proposed to be used to provide the work specified in this specification section.

3.1.1.2 Welding Procedures and Qualifications

a. Specifications and Test Results: Submit copies of the welding procedures specifications and procedure qualification test results for each type of welding required. Approval of any procedure does not relieve the Contractor of the responsibility for producing acceptable welds. Submit this information on the forms printed in ASME BPVC SEC IX or their equivalent.

b. Certification: Before assigning welders or welding operators to the work, submit a list of qualified welders, together with data and certification that each individual is performance qualified as specified. Do not start welding work prior to submitting welder, and welding operator qualifications. The certification shall state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

3.1.1.3 Examination of Piping Welds

Conduct non-destructive examinations (NDE) on piping welds and brazing and

verify the work meets the acceptance criteria specified in ASME B31.9. NDE on piping welds covered by ASME B31.9 is visual inspection only. Submit a piping welds NDE report meeting the requirements specified in ASME B31.9.

3.1.1.4 Welding Safety

Welding and cutting safety requirements shall be in accordance with AWS Z49.1.

3.1.2 Directional Changes

Make changes in direction with fittings, except that bending of pipe 4 inches and smaller is permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees is not permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations is not acceptable.

3.1.3 Functional Requirements

Pitch horizontal supply mains down in the direction of flow as indicated. The grade shall not be less than 1 inch in 40 feet. Reducing fittings shall be used for changes in pipe sizes. Cap or plug open ends of pipelines and equipment during installation to keep dirt or other foreign materials out of the system.

Pipe not otherwise specified shall be uncoated. Connections to appliances shall be made with malleable iron unions for steel pipe 2-1/2 inches or less in diameter, and with flanges for pipe 3 inches and above in diameter. Connections between ferrous and copper piping shall be electrically isolated from each other with dielectric waterways or flanges.

Piping located in air plenums shall conform to NFPA 90A requirements. Pipe and fittings installed in inaccessible conduits or trenches under concrete floor slabs shall be welded. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance. Electric isolation fittings shall be provided between dissimilar metals.

3.1.4 Fittings and End Connections

3.1.4.1 Threaded Connections

Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

3.1.4.2 Brazed Connections

Brazing, AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Do not use brazing flux. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the

manufacturer's recommendations. Piping shall be supported prior to brazing and not be sprung or forced.

3.1.4.3 Welded Connections

Branch connections shall be made with welding tees or forged welding branch outlets. Pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding, the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.9. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

3.1.4.4 Grooved Mechanical Connections

Prepare grooves in accordance with the coupling manufacturer's instructions. 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, or 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.

3.1.4.5 Flared Connections

When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

3.1.4.6 Flanges and Unions

Except where copper tubing is used, union or flanged joints shall be provided in each line immediately preceding the connection to each piece of equipment or material requiring maintenance such as coils, pumps, control valves, and other similar items. Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for the intended application.

3.1.5 Valves

Isolation gate or ball valves shall be installed on each side of each piece of equipment, at the midpoint of all looped mains, and at any other points indicated or required for draining, isolating, or sectionalizing purpose. Isolation valves may be omitted where balancing cocks are installed to provide both balancing and isolation functions. Each valve except check valves shall be identified. Valves in horizontal lines shall be installed with stems horizontal or above.

3.1.6 Air Vents

Air vents shall be provided at all high points, on all water coils, and where indicated to ensure adequate venting of the piping system.

3.1.7 Drains

Drains shall be provided at all low points and where indicated to ensure complete drainage of the piping. Drains shall be accessible, and shall consist of nipples and caps or plugged tees unless otherwise indicated.

3.1.8 Flexible Pipe Connectors

Connectors shall be attached to components in strict accordance with the latest printed instructions of the manufacturer to ensure a vapor tight joint. Hangers, when required to suspend the connectors, shall be of the type recommended by the flexible pipe connector manufacturer and shall be provided at the intervals recommended.

3.1.9 Temperature Gauges

Temperature gauges shall be located on coolant supply and return piping at each heat exchanger, on condenser water piping entering and leaving a condenser, at each automatic temperature control device without an integral thermometer, and where indicated or required for proper operation of equipment. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 1 inch.

3.1.10 Pipe Hangers, Inserts, and Supports

Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as supplemented and modified in this specification section. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 2 inches and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

3.1.10.1 Hangers

Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

3.1.10.2 Inserts

Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

3.1.10.3 C-Clamps

Type 19 and 23 C-clamps shall be torqued per MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

3.1.10.4 Angle Attachments

Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

3.1.10.5 Saddles and Shields

Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4 inches and larger when the temperature of the medium is 60 degrees F or higher. Type 40 shields shall be used on all piping less than 4 inches and all piping 4 inches and larger carrying medium less than 60 degrees F. A high density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2 inches and larger.

3.1.10.6 Horizontal Pipe Supports

Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 foot from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 feet apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.

3.1.10.7 Vertical Pipe Supports

Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 feet, not more than 8 feet from end of risers, and at vent terminations.

3.1.10.8 Pipe Guides

Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

3.1.10.9 Steel Slides

Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4 inches and larger, a Type 39 saddle shall be used. On piping under 4 inches, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

3.1.10.10 Multiple Pipe Runs

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.

3.1.10.11 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 metal decking. Supports shall not be attached to the underside of concrete filled floors or concrete roof decks unless approved by the Contracting Officer. Masonry anchors for overhead applications shall be constructed of ferrous materials only. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section. Material used for support

shall be as specified under Section 05 12 00 STRUCTURAL STEEL.

3.1.11 Pipe Alignment Guides

Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 feet on each side of each expansion joint, and in lines 4 inches or smaller not more than 2 feet on each side of the joint.

3.1.12 Pipe Anchors

Anchors shall be provided where indicated. Unless indicated otherwise, anchors shall comply with the requirements specified.Anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required.

Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal.

3.1.13 Building Surface Penetrations

Sleeves shall not be installed in structural members except where indicated or approved. Except as indicated otherwise piping sleeves shall comply with requirements specified. Sleeves in nonload bearing surfaces shall be galvanized sheet metal, conforming to ASTM A653/A653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A53/A53M, Standard weight. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than 1/2 inch depth. Sleeves shall not be installed in structural members.

3.1.13.1 General Service Areas

Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of 1/4 inch all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07 92 00 JOINT SEALANTS.

3.1.13.2 Waterproof Penetrations

Pipes passing through roof or floor waterproofing membrane shall be installed through a .17 ounce copper sleeve, or a 0.032 inch thick aluminum sleeve, each within an integral skirt or flange.

Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 8 inches from the pipe and be set over the roof or floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 2 inches above the roof or floor

penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

a. Waterproofing Clamping Flange: Pipes up to and including 10 inches in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

b. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut.

   After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

3.1.13.3 Fire-Rated Penetrations

Penetration of fire-rated walls, partitions, and floors shall be sealed as specified in Section 07 84 00 FIRESTOPPING.

3.1.13.4 Escutcheons

Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

3.2 ELECTRICAL INSTALLATION

Install electrical equipment in accordance with NFPA 70 and manufacturers instructions.

3.3 CLEANING AND ADJUSTING

Pipes shall be cleaned free of scale and thoroughly flushed of all foreign matter. A temporary bypass shall be provided for all water coils to prevent flushing water from passing through coils. Strainers and valves shall be thoroughly cleaned. Prior to testing and balancing, air shall be removed from all water systems by operating the air vents. Temporary measures, such as piping the overflow from vents to a collecting vessel shall be taken to avoid water damage during the venting process. Air vents shall be plugged or capped after the system has been vented. Control valves and other miscellaneous equipment requiring adjustment shall be

adjusted to setting indicated or directed.

3.4 FIELD TESTS

Field tests shall be conducted in the presence of the QC Manager or his designated representative to verify systems compliance with specifications. Any material, equipment, instruments, and personnel required for the test shall be provided by the Contractor.

3.4.1 Equipment and Component Isolation

Prior to testing, equipment and components that cannot withstand the tests shall be properly isolated.

3.4.2 Pressure Tests

Each piping system shall be hydrostatically tested at a pressure not less than 188 psig for period of time sufficient to inspect every joint in the system and in no case less than 2 hours. Test pressure shall be monitored by a currently calibrated test pressure gauge. Leaks shall be repaired and piping retested until test requirements are met. No leakage or reduction in gage pressure shall be allowed.

Leaks shall be repaired by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Concealed and insulated piping shall be tested in place before concealing.

Submit for approval pressure tests reports covering the above specified piping pressure tests; describe the systems tested, test results, defects found and repaired, and signature of the pressure tests' director. Obtain approval from the QC Manager before concealing piping or applying insulation to tested and accepted piping.

3.4.3 Related Field Inspections and Testing

3.4.3.1 Piping Welds

Examination of Piping Welds is specified in the paragraph above entitled "Examination of Piping Welds".

3.4.3.2 HVAC TAB

Requirements for testing, adjusting, and balancing (TAB) of HVAC water piping, and associated equipment is specified in Section 23 05 93 TESTING,ADJUSTING, AND BALANCING FOR HVAC. Coordinate with the TAB team, and provide support personnel and equipment as specified in Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC to assist TAB team to meet the TAB work requirements.

3.5 INSTRUCTION TO GOVERNMENT PERSONNEL

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 chilled water. Instructors shall be thoroughly familiar with all parts of the installation and shall be instructed in operating theory as well as practical operation and maintenance work. Submit a lesson plan for the instruction course for approval. The lesson plan and instruction course shall be based on the approved operation and maintenance data and

maintenance manuals.

Conduct a training course for the operating staff and maintenance staff selected by the Contracting Officer. Give the instruction 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 one man-day. Use approximately half of the time for classroom instruction and the other time for instruction at the location of 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.

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SECTION 23 73 13.00 40

MODULAR INDOOR CENTRAL-STATION AIR-HANDLING UNITS

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 210	(2007) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
AMCA 211	(2005; Rev 6 2012) Certified Ratings Programme - Product Rating Manual for Air Fan Performance
AMCA 300	(2008) Reverberant Room Method for Sound Testing of Fans
AMCA 301	(2006; INT 2007; Errata 2008) Methods for Calculating Fan Sound Ratings from Laboratory Test Data
AMCA 500-D	(2012) Laboratory Methods of Testing Dampers for Rating
AMCA 99	(2010) Standards Handbook

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 430	(2009) Central-Station Air-Handling Units

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 51	(2007) Laboratory Methods of Testing Fans for Aerodynamic Performance Rating
ASHRAE 52.2	(2007; Addenda B 2008; Errata 2009, Errata 2010; INT 2010; Errata 2011) Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size

ASTM INTERNATIONAL (ASTM)

ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; Cor 2005) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2011) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code
NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems

UNDERWRITERS LABORATORIES (UL)

UL 900	(2004; Reprint Feb 2012) Standard for Air Filter Units

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Installation Drawings; G

SD-03 Product Data

Equipment and Performance Data; G
Sample Warranty; G

SD-07 Certificates

Listing of Product Installations; G
Certificates of Conformance; G
Unit Cabinet; G
Fan
Drain Pans
Warranty; G

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G

1.3 QUALITY ASSURANCE

Submit listing of product installations for air handling units showing a minimum of 5 installed units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Provide list that includes purchaser, address of installation, service organization, and

date of installation.

1.3.1 Certification of Conformance

Submit certificates of conformance for the following items, showing conformance with the referenced standards contained in this section:

a. Unit Cabinet
b. Fan
c. Drain Pans
d. Insulation
e. Plenums
f. Spare Parts

1.3.2 Sample Warranty

Submit sample warranty for the following items:

a. Unit Cabinet
b. Fan
c. Drain Pans
d. Insulation
e. Plenums
f. Spare Parts

1.4 DELIVERY, STORAGE , AND HANDLING

Deliver, handle, and store equipments and accessories in a manner that will prevent damage or deformity.

1.5 WARRANTY

Submit samples of warranty language concurrently with Certificates for review and approval by the Contracting Officer. Ensure Warranty is valid for a minimum of 2 years from the date of project closeout, showing Government as warranty recipient.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Section 23 00 00 AIR SUPPLY, DISTRIBUTION, VENTILATION, AND EXHAUST SYSTEMS applies to work specified in this section.

Submit equipment and performance data for air handling units in accordance with the specification. Provide data that consists of use life, total static pressure and coil face area classifications, and performance ratings.

Submit drawings and manuals that include a spare parts data sheet, with manufactures recommended stock levels.

2.2 AIR HANDLING UNIT (AHU)

Provide central-station type, factory fabricated, and sectionally assembled air handling unit (AHU). Provide AHU that includes components and auxiliaries in accordance with AHRI 430. Balance AHU fan and motor to ISO 1940-1-2005. Provide AHUs that will operate in ambient conditions of 85% Fahrenheit DB/100% RH on a continuous basis.

Provide total static pressure and coil face area classification that conform to AMCA 99.

Fans with enlarged outlets are not permitted.

2.2.1 General

Furnish and install where shown on the plans, mechanical frame style air handling units with construction features as specified below. The units shall be provided and installed in strict accordance with the specifications. All units shall be complete with all components and accessories as specified. Any exceptions must be clearly defined. The contractor shall be responsible for any additional expenses that may occur due to any exception made.

2.2.2 Unit Construction Description

2.2.2.1 General

Provide factory-fabricated air handling units with capacity as indicated on the schedule. Units shall have overall dimensions as indicated and fit into the space available with adequate clearance for service as determined by the Engineer. Units shall be completely assembled. Multiple sectioned units shall be shipped as a single factory assembled piece (except where shipping limitations prevent) de-mounted into modular sections in the field by the contractor. Units shall be furnished with sufficient gasket and bolts for reassembly in the field by the contractor. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 210; AMCA 301; AMCA 500-D; and ARI 410. All electrical components and assemblies shall comply with NEMA standards.

Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems." Units shall comply with NFPA 70, "National Electrical Code" as applicable for installation and electrical connections of ancillary electrical components of air handling units. Tags and decals to aid in service or indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and maintenance manuals shall be furnished with each unit. Units shall be UL or ETL listed.

Units shipped in multiple sections shall be engineered for field assembly. The base frame shall have integral lifting lugs. The lifting lugs shall be fabricated from structural steel with an appropriate rigging hole. Lifting lugs shall be located at the corner of each section (and along the sides if required) and sized to allow rigging and handling of the unit. All gasket and necessary assembly hardware shall ship loose with unit. Junction boxes with a factory supplied numbered terminal strip shall be supplied at each shipping split for reconnection of control wiring.

2.2.2.2 Units Base - Floor

The unit floor and base perimiter shall be insulated with a minimum of not less than 2 1/2 inch thick high (1.5- pcf) density spray foam of R-24 insulation ot form a vapor barrier. The bottom of the vapor barrier is them protectee by a 0.040 inch thick aluminum sheet attracted to the bottom of the base.

2.3 UNIT CABINET

Provide AHU cabinet that is suitable for pressure class shown and that has leaktight joints, closures, penetrations, and access provisions. Provide cabinet that does not expand or contract perceptibly during starting and stopping of fans and that does not pulsate during operation. Reinforce cabinet surfaces with deflections in excess of 0.004167 of unsupported span prior to acceptance. Stiffen pulsating panels, which produce low frequency noise due to diaphragming of unstable panel walls, to raise natural frequency to an easily attenuated level. Fabricate enclosure from 16 gage G-90 finish panels with 20 gage aluminum liner, to match industry standard. Provide mill-galvanized sheet metal that conforms to ASTM A653/A653M and that is coated with not less than 1.25 ounces of zinc per square foot of two-sided surface. Provide mill-rolled structural steel that is hot-dip galvanized or primed and painted. Corrosion protect cut edges, burns, and scratches in galvanized surfaces.

Contractor shall work closely with Air Handling Unit manufacturer to provide equipment that will withstand unit exterior sweating due to continuous operation in high ambient dew point conditions.

Where cabinet size is such that personnel access is possible, strengthen cabinet floor to permit entry without damage to any component. Hinge and latch access doors and panels at a spacing sufficiently close to preclude leaks caused by distortion, and effectively gasket.

Interior surfaces of cabinets constructed of intact mill-galvanized steel require no further protection.

Provide cabinets with exterior surfaces constructed of mill-galvanized steel that are left unpainted.

Provide cabinets and casings that are double walled with 3 inch insulation. Provide interior wall that is galvanized.

All panels shall be double wall -aluminum construction with minimum 0.040 inch exterior and interior skin thicknesses. Interior finish to be smooth, mill finish; exterior finish to be a low-reflective textured mill finish. Each panel shall contain an integral frame or be properly supported by structural framing system. Panel shall have continuous tight seal at the interior and exterior skins completely encapsulating the insulation. The entire double seal wall panel shall be removable from outside of the unit without affecting the structural integrity of the unit.

The minimum panel thickness shall be 3 inch thick with 3-pcf high density polyisocyanurate foam insulation. The panel R value shall be a minimum of 24. Thermal drift from degassing shall be accounted for during the manufacturers design wall thickness of the unit wall and ceiling panels.

Panel shall incorporate an integral thermal break system downstream cooling coil such that is no through metal path between the interior and exterior surface of the unit casing at all locations. The thermal break shall consist of a maximum 1/2 inch structural epoxy bridge. Adhesive tapes or gaskets do not constitute an acceptable thermal break. Criteria to evaluate requirement for thermal break system shall be based upon schedule unit performance and ambient conditions anticipated around the units.

Casing leakage to be guaranteed at no more than 1/2 percent of the design volume 30 cfm whichever is greater when measured at the larger of 1-1/2

inch design operating pressure or 10 inch. wg. " Manufacturer shall submit maximum allowable leakage (cfm) and corresponding test procedures for positive and negative parts of the unit for approval prior of testing.

All sheet metal joints throughout the air-handling unit and between panelized sections shall be sealed with butyl sealant between panels and mullions and foam to fill the voids.

Provide a thermal break consisting of a minimum 1/2 inch structural epoxy between exterior panel and frame to ensure and air-tight fit. Configure casing assembly to eliminate all through-metal portions of the unit so that there will be no external condensation.

The underneath side of the base pan and base perimeter shall be insulated with a minimum of not less than 2-12 inch thick high (1.5-pcf) density polyisocyanurate of R-24 foam insulation to form a vapor barrier. The bottom of the vapor barrier is then protected by 0.040 - inch thick aluminum sheet attached to the bottom of the base. Insulation shall be water impervious rigid type, after curing, and shall occupy all voids and areas between drain pan and outer wall to prevent the occurrence of tapped water condensation, and microbial growth.

Unit Base - Floor: Unit perimeter base rail shall be fabricated using heavy gauge steel. C-Channel cross supports shall be welded to perimeter base steel and located on maximum 24 inch centers to provide support for internal components. Base rails shall include lifting lugs at the corner of the unit or each section if de-mounted. Internal walk-on floor shall be treated plate type 16 gauge galvanized steel. The outer sub-floor of the unit shall be made from 20 gauge galvanized steel. The floor cavity shall be spray foam insulated with floor seams gasketed for thermal break and sealed for airtight / watertight construction. Where access is provided to the unit interior, floor openings shall be covered with walk on phenolic coated steel safety grating. Single wall floors with glued and pined insulation and no sub floor are not acceptable. Base frame shall be attached to the unit at the factory.

Dynamically and statically balance fan wheels at the factory. Provide fan with RPM that is 25 percent less than the first critical speed. Provide fan shaft that is solid, ground and polished steel and coated with a rust inhibitor. Provide V-belt driven fans that are designed for 50 percent overload capacity. For variable air volume air handling units that are provided with variable frequency drives, have their fans balanced over the entire range of operation (20 percent - 100 percent RPM). Balancing fans of only 100 percent design of RPM is not acceptable for air handling units to be used with variable frequency drives.

Mount fans on isolation bases. Internally mount motors on same isolation bases and internally isolate fans and motors with 2-inch. Install flexible canvas ducts or vibration absorbent fan discharge seal between fan and casings to ensure complete isolation. Provide flexible canvas ducts that comply with NFPA 90A.

Weigh fan and motor assembly at air handling unit manufacturer's factory for isolator selection. Statically and dynamically balance fan section assemblies. Fan section assemblies include fan wheels, shafts, bearings, drives, belts, isolation bases and isolators. Allow isolators to free float when performing fan balance. Measure vibration at each fan shaft bearing in horizontal, vertical and axial directions.

Factory install all motors on slide bases to permit adjustment of belt tension.

Provide heavy duty, open drip-proof, operable at 460 volts, 60 hertz, 3-phase fan motors. Provide high efficiency motors. Refer to specification Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.4 FAN

Provide an overall fan-section depth that is equal to or greater than the manufacturer's free-standing fan.

Provide single-wheel fans.

Locate fan inlet where it provides not less than one-half fan-wheel diameter clearance from cabinet wall or adjacent fan inlet where double wheels are permitted.

Install AHU fan motor and drive inside fan cabinet. Provide motor that conforms to NEMA MG 1 and is installed on an adjustable base. Provide an access door of adequate size for servicing motor and drive. Provide a belt guard inside the cabinet, or interlock the access door with the supply fan so that power to the fan is interrupted when the access door is opened.

2.5 DRAIN PANS

Provide intermediate-coil, 3-inch deep drip pans for each tiered coil bank.

Extend top pan 12 inches beyond face of coil, and extend bottom pan not less than 24 inches beyond face of coil. Where more than two pans are used, make pan extension proportional. Make adequate supports from the same type material as pans or hot-dip galvanized angle iron with isolation at interface. Provide pan material that is 22 gage stainless steel with silver-soldered joints. Minimum size of drain opening is 1-1/4 inches. Pipe pan to drain.

Extend integral cabinet drain pan under all areas where condensate is collected and make watertight with welded or brazed joints, piped to drain, corrosion protect in condensate collection area, and insulate against sweating. Provide minimum 14-gage sheet metal, except that 16-gage double-drain-pan construction is acceptable.

Provide cooling coil ends that are enclosed by cabinet and are factory insulated against sweating.

Provide drain pans that are double pan construction, thermally isolated from the exterior casing with 1-inch thick fiberglass insulation. Provide drain pans that slope to drain and drain substantially dry by gravity alone when drains are open.

Provide pans that have a double slope to the drain point.

2.6 COILS

2.6.1 Coil Section

Provide coil section that encases cooling coils and drain pipes. Arrange coils for horizontal air flow. Provide intermediate drain pans for

multiple coils installation. Completely enclose coil headers with the insulated casing with only connections extended through the cabinet. Coil connections extending through case shall have gasket and completly sealed to minimize heat transefer to unit framing.

2.6.2 Coil Pressure and Temperature Ratings

Provide coils that are designed for the following fluid operating pressures and temperatures:

SERVICE	PRESSURE	TEMPERATURE
Chilled Water	200 PSI	40 degrees F

Provide coils that are air-pressure tested under water at the following minimum pressures:

SERVICE	PRESSURE
Water (chilled)	250 PSI

2.6.3 Coil Casings

Provide stainless steel casings. Provide copper coil headers. Fit water coil headers with .25 inch ops spring-loaded plug drains and vent petcocks. Provide automatic air vents with ball type isolation valves for each coil piped to the drain pan.

Provide coils that are factory tested, dehydrated, vacuum tested, purged with inert gas, and sealed prior to shipment to the job site.

2.6.4 Chilled Water coils

Provide 0.625 inch outside diameter copper tubing for coils. Provide fins that are copper mechanically bonded by tubing expansion with a maximum spacing of 12 fins per 1 inch unless otherwise noted. Provide coils that have supply and return connections on the same end. Provide a maximum of four coil rows.

2.6.5 Drainable Coils

Provide drainable coils that are capable of being purged free of water with compressed air.

Provide self-draining coils that have a drain point at the end of every tube and are pitched to that point. Provide drain provisions that include: drained headers; U-bends with integral plugs; or nonferrous plugs in cast-iron headers. Provide tubes that drain substantially dry by gravity alone when drains and vents are open.

2.7 ELIMINATORS

Provide eliminators that are SMACNA three-break, hooked-edge design, constructed of reinforced 16 gage galvanized steel with assembled brazed joints. Provide easily removable eliminator sections for cleaning from side of the air handling unit without causing partial or complete disassembly of the Air Handler Unit casing.

2.8 FILTERS

2.8.1 Filter Housing

Provide factory fabricated filter section of the same construction and finish as unit casings. Provide filter sections that have filter guides and full height, double wall, hinged and removable access doors for filter removal. Provide air sealing gaskets to prevent air bypass around filters. Provide visible identification on media frames showing model number and airflow direction. Where filter bank is indicated or required, provide means of sealing to prevent bypass of unfiltered air. Performance in accordance with ASHRAE 52.2.

2.8.2 Replaceable Air Filters

UL 900, Class 1, those which, when cleaned, do not contribute fuel when attacked by flame and emit only negligible amount of smoke. Permanent frames with replaceable media, 1-inch thickness and size as indicated.

2.8.3 Disposable Cartridge Air Filters

UL 900, Class 2, UL classified, and factory assembled. Provide media of ultra-fine glass fibers having 50-55 percent average dust spot efficiencies with maximum final resistance 0.75 inch water gage and maximum face velocity of 500 feet per minute. Construct filter frame of 18 gage galvanized steel or aluminum with welded or riveted joints. Caulk or gasket entire assembly to prevent air leakage around frames. Ensure minimum efficiency of filter is 60 percent per ASHRAE 52.2

2.8.4 Outside Air Filters

The factory assembled air filters of the extended surface type with supported cartridges for removal of particulate matter in air conditioning, heating, and ventilating systems. Provide the extended surface type filter units fabricated for disposal when the dust-load limit is reached as indicated by maximum (final) pressure drop.

Filter Classification: UL approved for Class 1 or 2 conforming to UL 900.

Filter Grades, Nominal Efficiency and Application:

Grade B: 80-85 percent nominal efficiency outfitter

Grade D: 25-30 percent nominal efficiency prefilter

Filter Media: Grade B Supported (Rigid Pleated) Type: Provide media that is composed of high density glass fibers or other suitable fibers. Fastening methods used to maintain pleat shape, seal aluminum separators in a proper enclosing frame to ensure no air leakage for life or filter. Staples and stays are prohibited.

Grade D Type: Provide media that is composed of synthetic/natural fibers. Bond a metal grid backing to the air leaving side of the media to maintain uniform pleat shape and stability for proper airflow and maximum dist loading. Provide a media frame that is constructed of high strength moisture resistant fiber or beverage board. Bond the pleated media pack on all four edges to ensure no air leakage of the life of the filter. Staples and stays are prohibited.

Filter Efficiency and Arrestance: Determine efficiency and arrestance of filters in accordance with ASHRAE 52.2 Standard Atmospheric dust spot efficiency and synthetic dust weight arrestance that is not less than the following:

	Initial Efficiency (Percent)	Average Efficiency (Percent)	Average Efficiency (Percent)
Grade B	58	79	98
Grade D	Less than 20	22	89

Maximum initial and final resistance, inches of water gauge, for each filter cartridge when operated at 500 feet per minute face velocity:

	Initial Resistance	Final Resistance
Grade B, Rigid Pleated	0.60	1.00
Grade D, 2 inches Deep	0.32	0.70

Dust Holding Capacity: When tested to 1.00 inch w.g. at 500 feet per minute face velocity, provide a dust holding capacity from each 24-inch by 24-inch (face area) filter at least equal to the values listed below. For other filter sizes, provide a dust holding capacity that is proportionally higher or lower.

Grade B, Rigid Pleated	6.17 ounces
Grade D, 2 inches Deep	2.29 ounces
Grade D, 4 inches Deep	10.58 ounces

Minimum Media Area: Provide minimum net effective area in square feet for each 24-inch by 24-inch (face area) filter at 500 feet per minute face velocity of at least the values listed below. For other filter sizes, provide a net effective media that is proportionally higher or lower.

Grade B, Rigid Pleated	57.0
Grade D, 2 inches Deep	14.8

2.8.5 Air Filter Gauges

Provide manometer air filter gauges of the inclined tube differential type, of solid acrylic plastic construction with built-in level vial and with an adjustable mirror-polished scale. Equip gauges with vent valves for zeroing and over-pressure safety traps. Provide adequate gauge range for the particular installation. Provide gauges manufactured by Dwyer or approved equal.

Provide one (1) air filter gauge at each filter bank.

PART 3 EXECUTION

3.1 AHU EQUIPMENT INSTALLATION

Install equipment in accordance with manufacturer's recommendations.

Provide installation drawings in accordance with referenced standards in this section.

Submit listing of product installations for air handling units showing a

minimum of 5 installed units, similar to those proposed for use, that have been in successful service for a minimum period of 5 years. Provide list that includes purchaser, address of installation, service organization, and date of installation.

3.2 ACCEPTANCE

Prior to final acceptance, use dial indicator gages to demonstrate that fan and motor are aligned as specified.

Prior to final acceptance, verify conformance to specifications using vibration analysis. Ensure maximum vibration levels are .075 in/sec at 1 times run speed and at fan/blade frequency, and .04 in/sec at other multiples of run speed.

3.3 AHU TESTING

Performance test and rate AHU and components in accordance with AMCA 211, AMCA 300, and ASHRAE 51. Provide AHU ratings in accordance with AHRI 430.

Provide final test reports to the Contracting Officer. Provide reports with a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

Perform air handling unit start-up in the presence of the Contracting Officer.

3.4 OPERATION AND MAINTENANCE

Submit operation and maintenance manuals prior to testing the air handling units. Update and resubmit data for final approval no later than 30 calendar days prior to contract completion.

3.5 COORDINATION

Coordinate the size and location of concrete equipment pads, variable frequency drives, control and electrical requirements.

3.6 TEMPORARY CONSTRUCTION FILTERS

Have temporary construction filters in place during normal building construction whenever the air handling units are run for general ventilation, building dehumidification, and for other purposes during construction. Install two (2) layers of blanket filter at a time. Replace temporary construction filters as required during construction and after completion of duct system cleaning.

After systems have been cleaned and temporary construction filers are removed, and before test and balance operations are started, install set of final filters. Do not have final filters in place while general building construction is taking place, to avoid unnecessary loading with construction dust. Clean permanent filter bank before testing and balancing.

Submit all required installation, Fabrication and Connection drawings and obtain approval prior to the start of work detailed on these drawings.

Maximum number of coil rows is four (4). Maximum number of fins per inch is ten (10).

3.7 ACCEPTANCE

Final acceptance is dependent upon providing Warranty, based on approved sample warranty, to the Contracting Officer, along with final test reports. With Warranty and final test reports, provide a cover letter/sheet clearly marked with the system name, date, and the words "Equipment Warranty" - "Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

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DIVISION 26 - ELECTRICAL

SECTION 26 00 00.00 20

BASIC ELECTRICAL MATERIALS AND METHODS

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PART 3 EXECUTION

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SECTION 26 00 00.00 20

BASIC ELECTRICAL MATERIALS AND METHODS

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	(2001; R 2007) 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 2012; INT 1 2012; INT 2 2012) National Electrical Safety Code
IEEE C57.12.28	(2005; INT 3 2011) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

1.2 RELATED REQUIREMENTS

This section applies to certain sections of Division 02, EXISTING CONDITIONS Division 14, CONVEYING EQUIPMENT and Divisions 22 and 23, PLUMBING and HEATING VENTILATING AND AIR CONDITIONING. This section applies to all sections of Division 26 and 33, ELECTRICAL and UTILITIES, 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.

Section 26 51 00.00 40 INTERIOR LIGHTING

Section 27 10 00 BUILDING TELECOMMUNICATIONS CABLING SYSTEM

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.

1.4 ELECTRICAL CHARACTERISTICS

Electrical characteristics for this project shall be 480V volts secondary, three phase, four wire. Final connections to the power distribution system at the existing substation shall be made by the Contractor as directed by the Contracting Officer.

1.5 ADDITIONAL SUBMITTALS INFORMATION

Submittals required in other sections that refer to this section must conform to the following additional requirements as applicable.

1.5.1 Shop Drawings (SD-02)

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.

1.5.2 Product Data (SD-03)

Submittal shall include performance and characteristic curves.

1.6 QUALITY ASSURANCE

1.6.1 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.

1.6.2 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.

1.6.2.1 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.

1.6.2.2 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.

1.7 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.

1.8 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.

1.9 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.

1.10 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 one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

1.11 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 and pad-mounted SF6 switches, 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.

b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field.

1.12 ELECTRICAL REQUIREMENTS

Electrical installations shall conform to IEEE C2, NFPA 70, and requirements specified herein.

1.13 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.

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COMMON WORK RESULTS FOR ELECTRICAL

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 D709	(2001; R 2007) Laminated Thermosetting Materials

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 480	(1981) Toggle Switches

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C57.12.28	(2005; INT 3 2011) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

INTERNATIONAL CODE COUNCIL (ICC)

ICC/ANSI A117.1	(2009) Accessible and Usable Buildings and Facilities

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI Z535.1	(2006; R 2011) American National Standard for Safety--Color Code
ANSI/NEMA OS 1	(2008; Amd 2010) Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA FB 1	(2012) Standard for Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit,

	Electrical Metallic Tubing, and Cable
NEMA KS 1	(2001; R 2006) Enclosed and Miscellaneous Distribution Equipment Switches (600 V Maximum)
NEMA PB 1	(2011) Panelboards
NEMA RN 1	(2005) Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC 2	(2003) Standard for Electrical Polyvinyl Chloride (PVC) Conduit
NEMA TC 3	(2004) Standard for Polyvinyl Chloride (PVC) Fittings for Use With Rigid PVC Conduit and Tubing
NEMA VE 1	(2009) Standard for Metal Cable Tray Systems
NEMA WD 6	(2002; R 2008) Wiring Devices Dimensions Specifications

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1	(2005; Reprint Jul 2007) Standard for Flexible Metal Conduit
UL 1242	(2006; Reprint Jul 2007) Standard for Electrical Intermediate Metal Conduit -- Steel
UL 489	(2009; Reprint Jun 2011) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 506	(2008; Reprint Mar 2010) Specialty Transformers
UL 6	(2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel
UL 797	(2007) Electrical Metallic Tubing -- Steel
UL 870	(2008) Standard for Wireways, Auxiliary Gutters, and Associated Fittings

1.2 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 Stds Dictionary.

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.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit Material, Equipment, and Fixture Lists for the following:

Conduits, Raceway sand Fittings

Wire and Cable

Splices and Connectors

Switches

Receptacles

Outlets, Outlet Boxes, and Pull Boxes

Circuit Breakers

Panelboards

Lamps and Lighting Fixtures

Dry-Type Distribution Transformers

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Conduits, Raceway sand Fittings

Wire and Cable

Splices and Connectors

Switches

Receptacles

Outlets, Outlet Boxes, and Pull Boxes

Circuit Breakers

Panelboards

Lamps and Lighting Fixtures

Dry-Type Distribution Transformers

Spare Parts

Certification

SD-06 Test Reports

Continuity Test

Phase-Rotation Tests

Insulation Resistance Test

SD-08 Manufacturer's Instructions

Submit Manufacturer's Instructions.

1.4 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.1.5 PREVENTION OF CORROSION

Protect metallic materials against corrosion. Provide equipment enclosures with the standard finish by the manufacturer when used for most indoor installations. For harsh indoor environments (any area subjected to chemical and/or abrasive action), and all outdoor installations, refer to Section 09 90 00.00 98 GENERAL COATINGS. Do not use aluminum when in contact with earth or concrete and, where connected to dissimilar metal, protect by approved fittings and treatment. Ferrous metals such as, but not limited to, anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous spare parts not of corrosion-resistant steel shall be hot-dip galvanized except where other equivalent protective treatment is specifically approved in writing.

1.6 GENERAL REQUIREMENTS

Submit material, equipment, and fixture lists for the following items showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

Submit manufacturer's instructions including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

Submit certification required to install equipment components and system packages.

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 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 one 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 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.

b. When such equipment is guarded by a fence, mount signs on the fence. Provide metal signs having nominal dimensions of 14 by 10 inches with the legend "DANGER HIGH VOLTAGE KEEP OUT" printed in three lines of nominal 3 inch high white letters on a red and black field.

PART 2 PRODUCTS

2.1 MATERIALS

Materials and equipment to be provided shall be the standard cataloged products of manufacturers regularly engaged in the manufacture of the products.

2.1.1 Rigid Steel Conduit

Rigid steel conduit shall comply with UL 6 and be galvanized by the hot-dip process. Rigid steel conduit shall be polyvinylchloride (PVC) coated in accordance with NEMA RN 1, where underground and in corrosive areas, or must be painted with bitumastic.

Fittings for rigid steel conduit shall be threaded.

Gaskets shall be solid. Conduit fittings with blank covers shall have gaskets, except in clean, dry areas or at the lowest point of a conduit run where drainage is required.

Covers shall have captive screws and be accessible after the work has been completed.

2.1.2 Electrical Metallic Tubing (EMT)

EMT shall be in accordance with UL 797 and be zinc coated steel. Couplings and connectors shall be zinc-coated, raintight, gland compression with insulation throat. Crimp, spring, or setscrew type fittings are not acceptable.

2.1.3 Flexible Metallic Conduit

Flexible metallic conduit shall comply with UL 1 and be galvanized steel.

Fittings for flexible metallic conduit shall be specifically designed for such conduit.

Provide liquidtight flexible metallic conduit with a protective jacket of PVC extruded over a flexible interlocked galvanized steel core to protect wiring against moisture, oil, chemicals, and corrosive fumes.

Specifically design fittings for liquidtight flexible metallic conduit for such conduit.

2.1.4 Intermediate Metal Conduit

Intermediate metal conduit shall comply with UL 1242 and be galvanized.

2.1.5 Rigid Nonmetallic Conduit

Rigid nonmetallic conduit shall comply with NEMA TC 2 and NEMA TC 3 with wall thickness not less than Schedule 40.

2.1.6 Wireways and Auxiliary Gutters

Wireway and auxiliary gutters shall be a minimum 4- by 4 inch trade size conforming to UL 870.

2.1.7 Cable Trays

Provide ladder type cable trays conforming to NEMA VE 1.

2.2 WIRE AND CABLE

Conductors installed in conduit shall be copper 600-volt type THHN or XHHW as indicated. All conductors AWG No. 8 and larger, shall be stranded. All conductors smaller than AWG No. 8 shall be solid.

Flexible cable shall be Type SO and contain a grounding conductor with green insulation.

Conductors installed in plenums shall be marked plenum rated.

2.3 SPLICES AND CONNECTORS

Make all splices in AWG No. 8 and smaller with approved insulated electrical type.

Make all splices in AWG No. 6 and larger with indentor crimp-type connectors and compression tools. Joints shall be wrapped with an insulating tape that has an insulation and temperature rating equivalent to that of the conductor.

2.4 SWITCHES

2.4.1 Safety Switches

Safety switches shall comply with NEMA KS 1, and be the heavy-duty type with enclosure, voltage, current rating, number of poles, and fusing as indicated. Switch construction shall be such that, when the switch handle in the "ON" position, the cover or door cannot be opened. Cover release device shall be coinproof and be so constructed that an external tool shall be used to open the cover. Make provisions to lock the handle in the "OFF" position, but the switch shall not be capable of being locked in the "ON" position.

Provide switches of the quick-make, quick-break type. Approve terminal lugs for use with copper conductors.

Safety color coding for identification of safety switches shall conform to ANSI Z535.1.

2.4.2 Toggle Switches

Toggle switches shall comply with EIA 480, control incandescent, mercury, and fluorescent lighting fixtures and be of the heavy duty, general purpose, noninterchangeable flush-type.

Toggle switches shall be commercial grade toggle type, single double-pole, three-way two-position devices (as indicated) rated 20 amperes at 277 volts, 60 hertz alternating current (ac) only.

All toggle switches shall be products of the same manufacturer.

2.5 RECEPTACLES

Receptacles shall be commercial grade, 20A, 125 VAC, 2-pole, 3-wire duplex conforming to NEMA WD 6, NEMA 5-20R.

Special purpose receptacles shall be as indicated.

2.6 OUTLETS, OUTLET BOXES, AND PULL BOXES

Outlet boxes for use with conduit systems shall be in accordance with NEMA FB 1 and ANSI/NEMA OS 1 and be not less than 1-1/2 inches deep. Furnish all pull and junction boxes with screw-fastened covers.

2.7 PANELBOARDS

Lighting and appliance branch circuit panelboards shall be the circuit-breaker type in accordance with NEMA PB 1. Bolt circuit breakers to the bus. Plug-in circuit breakers are not acceptable. Buses shall be copper of the rating indicated, with main lugs or main circuit breaker as indicated. Provide all panelboards for use on grounded ac systems with a full-capacity isolated neutral bus and a separate grounding bus bonded to the panelboard enclosure. Panelboard enclosures shall be NEMA 250, Type 1, in accordance with NEMA PB 1. Provide enclosure fronts with latchable hinged doors.

2.8 CIRCUIT BREAKERS

Circuit-breaker interrupting rating shall be not less than those indicated and in no event less than 10,000 amperes root-mean-square (rms) symmetrical at 208 volts, respectively. Multipole circuit breakers shall be the common-trip type with a single handle. Molded case circuit breakers shall be bolt-on type conforming to UL 489.

2.9 LAMPS AND LIGHTING FIXTURES

Manufacturers and catalog numbers shown are indicative of the general type desired and are not intended to restrict the selection to fixtures of any particular manufacturer. Fixtures with the same salient features and equivalent light distribution and brightness characteristics, of equal finish and quality, are acceptable. Provide lamps of the proper type and wattage for each fixture.

Ballasts shall be high power factor and be energy efficient. Ballasts shall have a Class P terminal protective device for multi-volt operation as indicated and be rapid-start fluorescent. Ballasts shall be "A" sound rated. Fluorescent lamps shall be standard reduced wattage type.

High intensity discharge (HID) lighting fixtures shall have prewired integral ballasts and cast aluminum housings complete with tempered glass lenses suitable for installation in damp or wet locations. Provide fixtures and lamps.

2.10 DRY-TYPE DISTRIBUTION TRANSFORMERS

General purpose dry-type transformers with windings 600 volts or less shall be two-winding, 60 hertz, self-cooled in accordance with UL 506. Windings shall have a minimum of two 2-1/2-percent taps above and below nominal voltage.

PART 3 EXECUTION

3.1 CONDUITS, RACEWAYS AND FITTINGS

Conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of three 90-degree bends, including those bends located immediately at the outlet or fitting.

Do not install crushed or deformed conduit. Avoid trapped conduit runs where possible. Take care to prevent the lodgment of foreign material in the conduit, boxes, fittings, and equipment during the course of construction. Clear any clogged conduit of obstructions or be replaced.

Conduit and raceway runs concealed in or behind walls, above ceilings, or exposed on walls and ceilings 5 feet or more above finished floors and not subject to mechanical damage may be electrical metallic tubing (EMT).

3.1.1 Rigid Steel Conduit

Make field-made bends and offsets with approved hickey or conduit bending machine. Conduit elbows larger than 2-1/2 inches shall be long radius.

Provide all conduit stubbed-up through concrete floors for connections to free-standing equipment with the exception of motor-control centers, cubicles, and other such items of equipment, with a flush coupling when the floor slab is of sufficient thickness. Otherwise,provide a floor box set flush with the finished floor. Conduits installed for future use shall be terminated with a coupling and plug set flush with the floor.

3.1.2 Electrical Metallic Tubing (EMT)

EMT shall be grounded in accordance with NFPA 70, using pressure grounding connectors especially designed for EMT.

3.1.3 Flexible Metallic Conduit

Use flexible metallic conduit to connect recessed fixtures from outlet boxes in ceilings, transformers, and other approved assemblies.

Bonding wires shall be used in flexible conduit as specified in NFPA 70, for all circuits. Flexible conduit shall not be considered a ground conductor.

Electrical connections to vibration-isolated equipment shall be made with flexible metallic conduit.

Liquidtight flexible metallic conduit shall be used in wet and oily locations and to complete the connection to motor-driven equipment.

3.1.4 Intermediate Conduit

Make all field-made bends and offsets with approved hickey or conduit bending machine. Use intermediate metal conduit only for indoor installations.

3.1.5 Rigid Nonmetallic Conduit

Rigid PVC conduit shall be direct buried.

A green insulated copper grounding conductor shall be in conduit with conductors and be solidly connected to ground at each end. Grounding wires shall be sized in accordance with NFPA 70.

3.1.6 Wireway and Auxiliary Gutter

Straight sections and fittings shall be bolted together to provide a rigid, mechanical connection and electrical continuity. Dead ends of wireways and auxiliary gutters shall be closed. Plug all unused conduit openings.

Auxiliary gutters used to supplement wiring spaces for equipment not contained in a single enclosure shall contain no switches, overcurrent devices, appliances, or apparatus and be not more than 30 feet long.

3.1.7 Surface Raceways and Assemblies

Surface raceways shall be mounted plumb and level, with the base and cover secured. Minimum circuit run shall be three-wire with one wire designated as ground.

3.1.8 Cable Trays

Support cable trays from ceiling hangers, equipment bays, or floor or wall supports. Cable trays may be mounted on equipment racks. Provide support when the free end extends beyond 2 feet. Maximum support spacing shall be 6 feet. Trays 10-inches wide or less shall be supported by one hanger. Trays greater than 10-inches wide shall be supported by two hangers. Bond cable trays at splices.

3.2 WIRING

Feeder and branch circuit conductors shall be color coded as follows:

CONDUCTOR	120/208VAC COLOR	277/480VAC COLOR
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Natural Gray
Equipment Grounds	Green	Green

For conductors size 4/0 and smaller, the Contractor shall use colored isolation for 600 VAC cable as identified for phase, grounded, and equipment grounding conductors noted in this specification. For sizes

greater than 4/0, the manufacturer may use black (non-colored) insulation, but must identify the cables with approved markings, as noted in this specification, at all terminations, junction boxes, and condulets as required by the latest version of NFPA 70.

Splice in accordance with the NFPA 70. Provide conductor identification within each enclosure where a tap, splice, or termination is made and at the equipment terminal of each conductor. Terminal and conductor identification shall match as indicated.

Where several feeders pass through a common pullbox, the feeders shall be tagged to clearly indicate the electrical characteristics, circuit number, and panel designation.

3.3 SAFETY SWITCHES

Securely fasten switches to the supporting structure or wall, utilizing a minimum of four 1/4 inch bolts. Do not use sheet metal screws and small machine screws for mounting. Do not mount switches in an inaccessible location or where the passageway to the switch may become obstructed. Mounting height shall be 5 feet above floor level, when possible.

3.4 WIRING DEVICES

3.4.1 Wall Switches and Receptacles

Install wall switches and receptacles so that when device plates are applied, the plates will be aligned vertically to within 1/16 inch.

Ground terminal of each flush-mounted receptacle shall be bonded to the outlet box with an approved green bonding jumper when used with dry wall type construction.

3.4.2 Device Plates

Device plates for switches that are not within sight of the loads controlled shall be suitably engraved with a description of the loads.

Device plates and receptacle cover plates for receptacles other than 125-volt, single-phase, duplex, convenience outlets shall be suitably marked, showing the circuit number, voltage, frequency, phasing, and amperage available at the receptacle. Required marking shall consist of a self-adhesive label having 1/4 inch embossed letters.

Device plates for convenience outlets shall be similarly marked indicating the supply panel and circuit number.

3.5 BOXES AND FITTINGS

Furnish and install pullboxes where necessary in the conduit system to facilitate conductor installation. Conduit runs longer than 100 feet or with more than three right-angle bends shall have a pullbox installed at a convenient intermediate location.

Securely mount boxes and enclosures to the building structure with supporting facilities independent of the conduit entering or leaving the boxes.

Mounting height of wall-mounted outlet and switch boxes, measured between

the bottom of the box and the finished floor, shall be in accordance with ICC/ANSI A117.1 and as follows:

LOCATION	MOUNTING HEIGHT
Receptacles in offices	18 inches
Receptacles in corridors	18 inches
Receptacles in shops and laboratories	48 inches
Receptacles in rest rooms	48 inches
Switches for light control	48 inches

3.6 LAMPS AND LIGHTING FIXTURES

Install new lamps of the proper type and wattage in each fixture. Securely fasten fixtures and supports to structural members and install parallel and perpendicular to major axes of structures.

3.7 PANELBOARDS

Securely mount panelboards so that the top operating handle does not exceed 72-inches above the finished floor. Do not mount equipment within 36 inches of the front of the panel. Directory card information shall be complete and legible.

3.8 DRY-TYPE DISTRIBUTION TRANSFORMERS

Connect dry-type transformers with flexible metallic conduit.

3.9 IDENTIFICATION PLATES AND WARNINGS

Furnish and install identification plates for lighting and power panelboards, motor control centers, all line voltage heating and ventilating control panels, fire detector and sprinkler alarms, door bells, pilot lights, disconnect switches, manual starting switches, and magnetic starters. Process control devices and pilot lights shall have identification plates.

Furnish identification plates for all line voltage enclosed circuit breakers, identifying the equipment served, voltage, phase(s) and power source. Circuits 480 volts and above shall have conspicuously located warning signs in accordance with OSHA requirements.

3.10 PAINTING

Exposed conduit, supports, fittings, cabinets, pull boxes, and racks shall be thoroughly cleaned and painted as specified in Section 09 90 00.00 98 GENERAL COATINGS.

3.11 FIELD TESTING

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

Submit Test Reports in accordance with referenced standards in this section.

After completion of the installation and splicing, and prior to energizing the conductors, perform wire and cable continuity and insulation tests as herein specified before the conductors are energized.

Contractor shall provide all necessary test equipment, labor, and personnel to perform the tests, as herein specified.

Isolate completely all wire and cable from all extraneous electrical connections at cable terminations and joints. Substation and switchboard feeder breakers, disconnects in combination motor starters, circuit breakers in panel boards, and other disconnecting devices shall be used to isolate the circuits under test.

Perform insulation-resistance test on each field-installed conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Take readings after 1 minute and until the reading is constant for 15 seconds. Minimum insulation-resistance values shall not be less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable. For circuits with conductor sizes 8AWG and smaller insulation resistance testing is not required.

Perform continuity test to insure correct cable connection (i.e correct phase conductor, grounded conductor, and grounding conductor wiring) end-to end. Any damages to existing or new electrical equipment resulting from contractor mis-wiring will be repaired and re-verified at contractor's expense. All repairs shall be approved by the CO prior to acceptance of the repair.

Conduct phase-rotation tests on all three-phase circuits using a phase-rotation indicating instrument. Perform phase rotation of electrical connections to connected equipment clockwise, facing the source.

Final acceptance will depend upon the successful performance of wire and cable under test. Do not energize any conductor until the final test reports are reviewed and approved by the CO.

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COORDINATED POWER SYSTEM PROTECTION AND ARC FLASH ANALYSIS

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.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 1584	(2002, Am 1 2004, Int 1-3 2008) Guide for Performing Arc-Flash Hazard Calculations
IEEE 242	(2001; Errata 2003) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - Buff Book
IEEE 399	(1997) Brown Book IEEE Recommended Practice for Power Systems Analysis
IEEE C2	(2012; Errata 2012; INT 1 2012; INT 2 2012) National Electrical Safety Code

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA Z535.4	(2011) American National Standard for Product Safety Signs and Labels

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code
NFPA 70E	(2012) Standard for Electrical Safety in the Workplace

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Fault Current and Arc Flash Analysis Review Submittals;G

Protective Device Coordination Study Review Submittals; G

Proposed Test Plan; G

SD-03 Product Data

Fault Current and Arc Flash Analysis; G

Protective Device Coordination Study; G

Equipment; G

System Coordinator; G

Protective Relays; G

Installation Procedures; G

SD-06 Test Reports

Field Testing; G

SD-07 Certificates

Certificates of Conformance for Devices and Equipment; G

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Submittals and Meetings

No later than 90 days after Contract Award, submit the following to the Contracting Officer for review and approval:

a. Fault Current and Arc Flash Analysis Review Submittals

b. Protective Device Coordination Study Review Submittals

c. Proposed Test Plan

The Contractor and System Coordinator agree to attend a review meeting at a location designated by the Contracting Officer and provide review submittals as follows:

a. 90 percent submittal and review meeting: Study is complete except for disposition of Government comments. Coordinate submittal date and review meeting with Contracting Officer.

b. 100 percent submittal: Incorporates approved Government comments. Setting sheets and test procedures from these documents are to be used to implement protective device settings. Coordinate submittal and implementation of settings with Contracting Officer.

1.3.1.1 Proposed Test Plan

Submit a proposed test plan, consisting of complete field test procedure including tests to be performed, test equipment required, and tolerance limits, including complete testing and verification of the ground fault

protection equipment, where used.

1.3.1.2 Review and Final Submittals Format

For review and final submittals, submit 5 bound copies and a PDF file formatted on Compact Disc (CD) and or electronic storage media. Also provide on a final submittal CD all power system analysis software data files necessary to restore and edit the model.

Submit performance 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, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

a. Equipment data

Submit data consisting of manufacturer's time-current characteristic curves for individual protective devices, recommended settings of adjustable protective devices, and recommended ratings of non-adjustable protective devices.

Review protective device submittals of equipment to be provided and indicate any options or modifications required to achieve the requirements of this section. No time extensions or similar contact modifications will be granted for work arising out of the requirements for this study. The Government is not responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

b. Protective Relays

Submit data including calibration and testing procedures and instructions pertaining to the frequency of calibration, inspection, adjustment, cleaning, and lubrication.

c. Installation Procedures

Submit written description of procedures including diagrams, instructions, and precautions required to properly install, adjust, calibrate, and test the devices and equipment.

1.3.2 Final Submittals

After completion of installation and testing submit the following to the Contracting Officer for review and approval:

Field Test Results - Submit 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, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

1.3.3 Field Changes

If field changes are required due to discrepancies between the setting sheet documents and the available setting selections on the protective device, submit within 10 days after installation the following to the Contracting Officer for review and approval:

a. Fault Current and Arc Flash Analysis

b. Protective Device Coordination Study

1.4 QUALITY ASSURANCE

Ensure all work performed is in conformance with the following standards:

IEEE C2

IEEE 1584

NEMA Z535.4

NETA ATS

NFPA 70

NFPA 70E

1.4.1 System Coordinator

Provide documentation verifying that system coordination, recommended ratings and settings of protective devices, and design analysis are prepared (performed/reviewed/approved) by a registered professional electrical power engineer with a minimum of 3 years of current experience in the coordination of electrical power systems.

1.4.2 System Installer

Ensure all final calibration, testing, adjustment, and placing into service of the protective devices is accomplished by a manufacturer's product field service engineer or independent testing company with a minimum of two years of current product experience in protective devices.

1.5 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this Section.

1.6 PROJECT/SITE CONDITIONS

Provide devices and equipment suitable for the following site conditions:

a. Altitude: 0'

b. Ambient Temperature: 95 degrees

c. Frequency: 60 HZ

e. Hazardous Classification: Refer to contract drawings: EH-001, EH-101 thru EH-128 and EH-301

f. Humidity Control: 95 percent

g. Ventilation: Minimal

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The power system covered by this specification as shown on the drawings.

The Government will provide the short circuit values for the following connection points on the electrical system:

SS810, SS811, SS809, SS808, SS880, SS878

The Government will provide the existing protective device settings for the following devices on the electrical system:

SS810, SS811, SS809, SS808, SS880, SS878

2.2 ARC FLASH LABELS

Provide weatherproof detailed arc flash warning labels for all electrical equipment as required by NFPA 70 and NFPA 70E, including, medium voltage switches, transformers, switchgear main breakers, switchgear bus-tie breaker, switchgear feeder breakers, switchgear cable compartments, switchboards, panel boards, motor control centers, enclosed breakers, safety switches automatic transfer switches, motor starters, control panels, and other equipment modified or installed by the project that is likely to require examination, adjustment, servicing, or maintenance while energized.

2.2.1 Label Format

Label format is to be NFPA 70E detailed format type. Conform in detail with samples provided at the time of award. Format includes different colors and formatting per NEMA Z535.4 for different hazard levels and the following information:

a. Flash hazard boundary

b. Incident energy

c. Hazard Category and PPE

d. Shock Voltage

e. Minimum insulated glove rating

f. Limited approach boundary distance

g. Restricted approach boundary distance

h. Prohibited approach boundary distance

2.2.2 Label Content

Ensure arc flash label content is based on the operational scenario, fault location, and fault type (arcing or bolted) that results in the highest incident energy.

2.3 COORDINATED POWER SYSTEM PROTECTION

Prepare and submit analyses to demonstrate that the equipment selected and system constructed meet the contract requirements for ratings, coordination, and protection. Include a fault current and arc flash analysis, equipment evaluation report, and a protective device coordination study. Submit Certificates of Conformance verifying that the studies have been prepared (performed/reviewed/approved) by a registered professional engineer with demonstrated experience in power system coordination in the last 3 years. Provide a list of references complete with points of contact, addresses and telephone numbers. The selection of the engineer is subject to the approval of the Contracting Officer.

Prepare and submit short circuit studies, load flow studies, motor starting analysis, coordination studies, and arc-flash hazard analysis in accordance with NETA ATS and as specified herein.

2.3.1 Scope of Analyses

Ensure the fault current and arc flash analysis, and protective device coordination study begin at:

The source bus and extend down to system buses where fault availability is 10,000 amperes (symmetrical) for building/facility 600 volt level distribution buses.

2.3.2 Determination of Facts

Perform field inspections to determine and document the time-current characteristics, features, and nameplate data for each existing protective device. Utilize the fault current availability provided by the government as a basis for fault current studies.

2.3.3 Single Line Diagram

Prepare a single line diagram to show the electrical system buses, devices, transformation points, and all sources of fault current (including generator and motor contributions). A fault-impedance diagram or a computer analysis diagram may be provided. Ensure each bus, device or transformation point has a unique identifier. If a fault-impedance diagram is provided, show impedance data. Show the location of switches, breakers, and circuit interrupting devices on the diagram together with available fault data, and the device interrupting rating.

2.3.4 Fault Current Analysis

2.3.4.1 Method

Perform the fault current analysis in accordance with methods described in IEEE 242, and IEEE 399. Single line drawings based on existing hardware will be provided to the Contractor for reference. Utilize specialized computer aided engineering software designed for fault current analysis, including the following capabilities:

a. Single-ended substation source operation

b. Double-ended substation source operation

c. Generator source operation

Perform analysis and provide separate study report generated for each operational scenario.

2.3.4.2 Data

Utilize actual hardware data in fault calculations. Ensure bus characteristics and transformer impedance are those proposed. Document all data in the report.

2.3.4.3 Fault Current Availability

Provide balanced three-phase fault, bolted line-to-line fault, and line-to-ground fault current values at each voltage transformation point and at each power distribution bus. Show the maximum and minimum values of fault available at each location in tabular form on the diagram or in the report.

2.3.5 Coordination Study

Ensure the study demonstrates that the maximum possible degree of selectivity has been obtained between devices specified, consistent with protection of equipment and conductors from damage from overloads and fault conditions. Include a description of the coordination of the protective devices in this project. Provide a written narrative describing:

a. Which devices may operate in the event of a fault at each bus; the logic used to arrive at device ratings and settings;

b. Situations where system coordination is not achievable due to device limitations (an analysis of any device curves which overlap);

c. Coordination between upstream and downstream devices; and relay settings.

d. Provide recommendations to improve or enhance system reliability by reducing the incident energy level, and detail where such changes would involve additions or modifications to the contract and cost damages (addition or reduction).

Provide composite coordination plots on log-log graph paper.

a. Provide separate plots for phase and ground faults.

b. Include applicable cable and transformer damage curves on phase fault plots.

c. Limit the number of protective device curves on any plot to 5.

2.3.6 Study report

Include the following in the report:

a. A cover sheet and table of contents. Provide separate sections with all applicable content, for all operating scenarios.

b. A narrative describing:

(1) The analyses performed;

(2) The basis and methods used;

(3) The desired method of coordinated protection of the power system.

c. Descriptive and technical data for existing devices and new protective devices proposed, including manufacturers published data, nameplate data, time-current curves, and definition of the fixed or adjustable features of the existing or new protective devices.

d. Document utility data including system voltages, fault MVA, system X/R ratio, time-current characteristic curves, current transformer ratios, and relay device numbers and settings; and existing power system data including time-current characteristic curves and protective device ratings and settings.

e. Provide time-current characteristics curves for each bus in the system, as required to ensure coordinated power system protection between protective devices or equipment, including recommended ratings and settings of all protective devices in tabulated form.

f. Provide all calculations performed for the analyses, including computer analysis programs utilized, the name of the software package, developer, and version number. Include all information input to (define) nodes such as cable data, conduit type, circuit length, transformer impedance, bus impedance, generator impedances, etc. For all nodes include phase fault short circuit levels and X/R ratios, ground fault short circuit levels and X/R ratios, load flow levels, arc flash energy (for both bolted and arcing short circuit levels), and motor starting studying results. Indicate which study options have been chosen which the SKM software utilizes to generate the Short Circuit Analysis and Arc Flash Hazard Analysis results; use preferred method below when available. Options included are, but not limited to the following:

(1) Standard used for arc-flash calculations: (IEEE 1584 - preferred method).

(2) 240 Volt Exceptions (report Cat 0 if XFMR less than 125kVA - preferred method).

(3) Maximum arcing time: (2 sec - preferred - fully dependent on task performed). For certain tasks, such as working in manholes, elevated work areas, or underneath equipment, it may not be possible for trained personnel to distance themselves from the Arc Flash within 2 seconds.

(4) Motor fault contributions: (5 cycles preferred - motors with 50 hp or greater are to be evaluated).

(5) Levels Mis-coordination checked (5 levels-preferred).

(6) Mis-coordination Ratio: (80 percent - preferred - ensure Cleared Fault Threshold matches Mis-coordination Ratio).

(7) Flash Boundary Calculation Adjustments above 1kV, Trip Time less than =0.1s: (1.5 cal/square meter - preferred).

(8) Properly categorize all equipment types in Arc Flash Evaluation:

(Ensure switchgear, panel boards have proper gap distance).

(9) Utility information from latest Area Load Flow and Fault Study (provided by the Governemnt -preferred).

(10) Short Circuit Study Utilized: (Comprehensive-preferred).

(11) Fault types analyzed: (Three Phase, Single Line to Ground, Line to Line, Line to Line to Ground, All -preferred).

g. Single line diagram(s)

h. Protective device setting sheets, as separate pages, suitable for use by installing technicians, separate from other report analysis and data. Include recommended changes to existing protective device settings and settings for all new protective devices. Provide all information to field install the settings, including settings or features not used or turned off.

i. Tabulated Arc Flash data for all equipment requiring an arc flash warning label and all modified equipment also requiring an arc flash label.

j. Equipment Evaluation Report (EER) showing the AIC/SCCR ratings for all equipment evaluated and the required rating for the application where the equipment is installed. Ensure the EER identifies underrated and marginally rated equipment. Underrated equipment is defined as equipment with actual AIC/SCCR ratings that do not meet the required AIC/SCCR rating for the application/installation. Marginally rated equipment is defined as equipment within 90 percent to 100 percent of the required rated AIC/SCCR for the application/installation.

PART 3 EXECUTION

3.1 INSTALLATION

Install and test protective devices settings in accordance with the manufacturer's published instructions and in accordance with the protective device coordination study protective device setting sheets and test plan.

Affix detailed arc flash warning labels to all electrical equipment as required by NFPA 70 and NFPA 70E.

3.2 FIELD TESTING

3.2.1 General

Section 26 08 00 APPARATUS INSPECTION AND TESTING, applies to this section, with the additions and modifications specified herein. Submit Performance 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, upon completion and testing of the installed system. Indicate in each test report the final position of controls. Submit Certificates of Conformance for Devices and Equipment to the Contracting Officer, certifying that all devices or equipment meet the requirements of the contract documents.

3.2.2 Safety

Provide and use safety devices such as arc flash personal protective equipment, electrically insulating rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. Replace any devices or equipment which are damaged due to improper test procedures or handling.

3.2.3 Molded-Case Circuit Breakers

Visually inspect circuit breakers. Verify current ratings and adjustable settings incorporated in accordance with the coordination study.

3.2.4 Power Circuit Breakers

3.2.4.1 General

Visually inspect the circuit breaker and implement settings in accordance with the coordination study.

3.2.4.2 Current Injection Tests

Test with approved settings installed in accordance with NETA ATS and the Test Plan; document results in the field test reports.

a. Determine long time pick-up value and delay by primary current injection.

b. Determine short time pick-up value and delay by primary current injection.

c. Determine instantaneous pick-up value by primary current injection.

d. Determine ground-fault pick-up value and delay by primary current injection.

e. Test trip unit functions by secondary current injection or in accordance with the manufacturer's requirements.

3.2.5 Protective Relays

3.2.5.1 General

Visually inspect protective relays. Implement relay settings in accordance with the coordination study.

3.2.5.2 Current Injection Tests

Test with approved settings installed in accordance with NETA ATS and the Test Plan; document results in the field test reports.

a. Determine long time pick-up value and delay by secondary current injection.

b. Determine short time pick-up value and delay by secondary current injection.

c. Determine instantaneous pick-up value by secondary current injection.

d. Determine ground fault pick-up value and delay by secondary current injection.

-- End of Section --

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SECTION 26 05 71.00 40

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LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES

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 C39.1	(1981; R 1992) Requirements for Electrical Analog Indicating Instruments

ASTM INTERNATIONAL (ASTM)

ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM D877	(2002; R 2007) Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes

ELECTRONIC INDUSTRIES ALLIANCE (EIA)

EIA 443	(1979) NARM Standard for Solid State Relays Service

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.17	(1997) Standard for Trip Devices for AC and General-Purpose DC Low-Voltage Power Circuit Breakers
IEEE C37.90	(2005) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C57.13	(2008) Standard Requirements for Instrument Transformers
IEEE C63.2	(2009) Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 Hz to 40 GHz - Specifications
IEEE C63.4	(2009) American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

IPC - ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES (IPC)

IPC D330	(1992) Design Guide Manual

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C12.1	(2008) Electric Meters Code for Electricity Metering
ANSI C78.23	(1995; R 2003) American National Standard for Incandescent Lamps - Miscellaneous Types
NEMA 107	(1987; R 1993) Methods of Measurement of Radio Influence Voltage (RIV) of High-Voltage Apparatus (inactive)
NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA AB 3	(2006) Molded Case Circuit Breakers and Their Application
NEMA FU 1	(2002; R 2007) Low Voltage Cartridge Fuses
NEMA ICS 1	(2000; R 2005; R 2008) 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 6	(1993; R 2011) Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 20	(2010) General-Use Snap Switches
UL 489	(2009; Reprint Jun 2011) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 50	(2007; Reprint Apr 2012) Enclosures for Electrical Equipment, Non-environmental Considerations
UL 508	(1999; Reprint Apr 2010) Industrial Control Equipment

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit Connection Diagrams and Fabrication Drawings for the following items in accordance with paragraph entitled, "General Requirements," of this section.

Submit Installation drawings for the following items in accordance with the paragraph entitled, "Installation," of this section.

Control Devices
Protective Devices

SD-03 Product Data

Submit manufacturer's equipment and performance data for the following items including use life, system functional flows, safety features, and mechanical automated details.

Motor Control
Instrument Transformers
Fuses
Enclosures
Circuit Breakers
Control Devices
Time Switches
Protective Relays
Indicating Instruments
Indicating Lights

SD-07 Certificates

Submit certificates for Circuit Tests on similar motor-control or submit motor-circuit protector (MCP) units under actual conditions in lieu of factory tests on the actual units provided. Also include dielectric tests.

SD-08 Manufacturer's Instructions

Submit manufacturer's instructions for the following items, including special provisions required to install equipment components and system packages. Provide detail on resistance impedances, hazards and safety precautions within the special notices.

Control Devices
Protective Devices

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals for the following equipment:

Manual Motor Controllers
Magnetic Motor Controllers
Combination Motor Controllers
Circuit Breakers

Time Switches
Protective Relays
Indicating Instruments

1.3 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Submit Connection Diagrams showing the relations and connections of control devices and protective devices by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another, and internal tubing, wiring, and other devices.

Submit Fabrication Drawings for control devices and protective devices consisting of fabrication and assembly details to be performed in the factory.

PART 2 PRODUCTS

2.1 MOTOR CONTROL

Conform to NEMA ICS 1, NEMA ICS 2, and UL 508 for motor controllers. Provide controllers that have thermal overload protection in each phase.

2.1.1 Manual Motor Controllers

Provide full-voltage, manually operated manual motor controllers for the control and protection of single-phase 60-hertz ac fractional-horsepower squirrel-cage induction motors.

Provide single-throw, single- or double-pole, three-position controllers rated at not more than 1 horsepower at 115- and 230-volts single phase. Include a supporting base or body of electrical insulating material with enclosed switching mechanism, yoke, thermal overload relay, and terminal connectors. Provide controllers that clearly indicate operating condition: on, off, or tripped.

Provide toggle- or key-operated type manual motor controllers as indicated and arrange so that they are lockable with a padlock in the "OFF" position.

Provide recessed manual motor controllers for single-speed, fractional-horsepower squirrel-cage induction motors, that include a single controller and indicating light in a 4-inch square wall outlet box, for flush-wiring devices with matching corrosion-resistant steel flush cover plate. Provide surface-mounted manual motor controllers for single-speed, fractional-horsepower squirrel cage induction motors that include a single controller and indicating light in a NEMA 250, enclosure type as indicated.

Provide recessed and surface-mounted manual motor controllers for two-speed, fractional-horsepower squirrel-cage induction motors, that include two controllers, two indicating lights, and a selector switch in a multiple-gang wall outlet box for flush-wiring devices, with matching corrosion-resistant steel flush-cover plate. Provide surface-mounted manual motor controllers for two-speed fractional-horsepower squirrel-cage induction motors, that include two controllers, two indicating lights, and a selector switch in a NEMA 250, enclosure type as indicated.

2.1.2 Magnetic Motor Controllers

2.1.2.1 Full-Voltage Controllers

Provide full-voltage, full magnetic devices in accordance with NEMA ICS 1, NEMA ICS 2, and UL 508for magnetic motor controllers for the control and protection of single- and three-phase, 60-hertz, squirrel-cage induction motors.

Provide operating coil assembly that operates satisfactorily between 85 and 110 percent of rated coil voltage. Provide 120 volts, 60 hertz motor control circuits.

Provide controller with two normally open and two normally closed auxiliary contacts rated per NEMA ICS 1 and NEMA ICS 2 in addition to the sealing-in contact for control circuits.

Provide solderless pressure wire terminal connectors for line-and load-connections to controllers.

Include three manual reset thermal overload devices for overcurrent protection, one in each pole of the controller. Provide thermal overload relays of melting-alloy type with continuous current ratings and service-limit current ratings, and with a plus or minus 15 percent adjustment to compensate for ambient operating conditions.

Provide an externally operable manual-reset button to re-establish control power to the holding coil of the electromagnet. After the controller has tripped from overload, ensure that resetting the motor-overload device does not restart the motor.

Provide enclosure in accordance with NEMA 250, Type as indicated.

2.1.2.2 Reduced-Voltage Starters

Conform to the requirements for full-voltage controllers for reduced-voltage starters, except for voltage, and to the following additional requirements.

Fully protect the motor during all phases of motor starting with an overload device in each motor leg. Rate starter contacts to withstand the switching surges during selector to full voltage. Provide starter that contains the necessary sensing and timing devices to monitor motor operation and select the correct time for selector to full voltage.

Adequately ventilate resistors and autotransformers used for starting. Ventilate solid-state starters for starting cycles as well as any follow-on restart-run cycles. Operate external control circuits or solid-state starters at a maximum of 120 volts ac.

For solid-state starters, provide adjustable starting torque from 0 to 50 percent of applied voltage, minimum. Provide autotransformer starters with a minimum of three taps above 50 percent reduced voltage.

2.1.3 Combination Motor Controllers

Following requirements are in addition to the requirements specified for magnetic motor controller:

Provide combination motor controllers for the control and protection of single-and three-phase 60-hertz alternating-current squirrel-cage induction motors with branch-circuit disconnecting and protective devices in accordance with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.

For combination motor controllers include magnetic motor controllers and molded-case circuit breakers or MCP in metal enclosures in accordance with NEMA 250 or motor-control center draw-out assemblies with control-power transformers, selector switches, pushbuttons, and indicating lights as follows:

Provide full-voltage, full-magnetic devices as specified in this section under paragraph entitled, "Remote-Control Station Enclosures." for magnetic motor controllers and enclosures.

Provide thermal-magnetic breakers as specified in paragraph entitled, "Manual Motor Controllers."for molded-case circuit breakers. Manufacturer's standard MCP may be used in lieu of molded-case circuit breakers.

Provide control-power transformers 120-volt ac maximum, selector switches, pushbuttons, and pilot lights as required.

Identify combination motor controllers with identification plates affixed to front cover of the controller.

2.1.3.1 Nonreversing Combination Motor Controllers

Following requirements are in addition to the requirements for magnetic motor controllers:

For nonreversing combination motor controllers for the control and protection of single-speed squirrel-cage induction motors, include a magnetic controller with molded-case circuit breaker or MCP with selector switch or start/stop pushbutton and indicating light in the cover of the enclosure.

Provide rating of three-phase single-speed full-voltage magnetic controllers for nonplugging and nonjogging duty in accordance with NEMA ICS 1 and NEMA ICS 2.

Provide wiring and connections for full-voltage single-speed magnetic controllers in accordance with NEMA ICS 1 and NEMA ICS 2.

2.1.3.2 Reversing Combination Motor Controllers

Following requirements are in addition to the requirements for magnetic motor controllers:

For reversing combination motor controllers for the control and protection of single-speed squirrel-cage induction motors, include two interlocked magnetic controllers with molded-case circuit breaker or MCP, with selector switch or forward/reverse/stop pushbutton and two indicating lights in the cover of the enclosure. Indicate with indicating lights the forward and reverse running connection of the motor controller.

Provide rating of three-phase single-speed full-voltage magnetic controllers for plug-stop, plug-reverse, or jogging duty in accordance with NEMA ICS 1 and NEMA ICS 2.

Provide wiring and connections for full-voltage single-speed magnetic controllers in accordance with NEMA ICS 1 and NEMA ICS 2.

2.1.3.3 Two-Speed Combination Motor Controllers

Following requirements are in addition to the requirements for magnetic motor controllers:

For two-speed combination motor controllers for the control and protection of single- and two-winding, two-speed, three-phase, squirrel-cage induction motors, include two magnetic controllers with molded-case circuit breaker or MCP, with selector switch or fast/slow/stop pushbutton and two indicating lights in the cover of the enclosure. Indicate with indicating lights the high- and low-speed running connection of the motor controller.

Provide rating of three-phase, two-speed, full-voltage, magnetic controllers for nonplugging and nonjogging duty for constant- and variable-torque motors in accordance with NEMA ICS 1 and NEMA ICS 2.

Provide rating of three-phase, two-speed, full-voltage, magnetic controllers for nonplugging and nonjogging duty for constant-horsepower motors in accordance with NEMA ICS 1 and NEMA ICS 2.

Provide rating of three-phase, two-speed, full-voltage, magnetic controllers for plug-stop, plug-reverse, or jogging duty for constant-torque, variable-torque, and constant horsepower motors in accordance with NEMA ICS 1 and NEMA ICS 2.

2.2 INSTRUMENT TRANSFORMERS

Comply with the interference requirements listed below, measured in accordance with IEEE C63.2, IEEE C63.4, and NEMA 107 for Instrument transformers.

Insulation Class, kV	Basic Insulation Level, kV	Preferred Nominal System Voltage, kV	Test Voltage for Potential Transformers, kV	Test Voltage for Current Transformers, kV	Radio Influence Voltage Level, Microvolts Dry Type	Oil Filled
0.6	10	.....	.....	0.76	250	250
1.2	30	0.208 0.416 0.832 1.04	0.132 0.264 0.528 0.66	0.76	250	250
2.5	45	2.40	1.52	1.67	250	250
5.0	60	4.16 4.80	2.64 3.04	3.34	250	250
8.7	75	7.20 8.32	4.57 5.28	5.77	250	250
15L or 15H	95-110	12.00 12.47	7.62 7.92	9.41	1000	250

Insulation Class, kV	Basic Insulation Level, kV	Preferred Nominal System Voltage, kV	Test Voltage for Potential Transformers, kV	Test Voltage for Current Transformers, kV	Radio Influence Voltage Level, Microvolts Dry Type	Oil Filled
		14.40	9.14			
25	150	23.00	14.60	15.70	2500	650
34.5	200	34.50	21.90	23.0	....	650
46	250	46.00	29.20	29.30	....	1250
69	350	69.00	43.80	44.00	....	1250
92	450	92.00	58.40	58.40	....	2500
115	550	115.00	73.40	73.40	....	2500
138	650	138.00	88.00	88.00	....	2500

2.2.1 Current Transformers

Provide current transformers that conform to IEEE C57.13 for installation in metal-clad switchgear. Use standard 3-A secondary transformer.

Provide wound, bushing, bar and window type transformers as required.

Provide transformers that have single or double secondary winding as required.

Provide transformers that are complete with secondary short-circuiting device.

For window-type current transformers, provide indoor dry type construction with secondary current ratings as indicated with specified burden, frequency, and accuracy.

2.2.2 Potential Transformers

For potential transformers, conform to IEEE C57.13 for installation in metal-clad switchgear. Use standard 120-volt secondary transformers.

Provide transformers that have single, tapped, or double secondary as required.

Provide burden, frequency, and accuracy as required.

For disconnecting potential transformers with integral fuse mountings and current-limiting fuses, provide indoor dry type two-winding construction with primary and secondary voltage ratings as required.

2.3 ENCLOSURES

2.3.1 Equipment Enclosures

Provide enclosures for equipment in accordance with NEMA 250.

Contain equipment installed inside, clean, dry locations in a NEMA Type 1, general-purpose sheet-steel enclosure.

Contain equipment installed in wet locations or as indicated in a NEMA Type 4 watertight, corrosion-resistant sheet-steel enclosure, constructed to prevent entrance of water when tested in accordance with NEMA ICS 6 for Type 4 enclosures.

Contain equipment installed in industrial locations in a NEMA Type 12 industrial use, sheet-steel enclosure, constructed to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

Contain equipment installed in Class I, Division I, Group A, B, C, and D, hazardous locations, in NEMA Type 7 enclosures approved for the specific flammable gas or vapor that is possibly present under normal operating conditions.

Fabricate sheet-steel enclosures from uncoated carbon-steel sheets of commercial quality, with box dimensions and thickness of sheet steel in accordance with UL 50.

Fabricate steel enclosures from corrosion-resistant, chromium-nickel steel sheet conforming to ASTM A167 Type 300 series with ASM No. 4 general-purpose polished finish, with box dimensions and thickness of sheet steel in accordance with UL 50.

2.3.2 Remote-Control Station Enclosures

Provide remote-control station enclosures for pushbuttons, selector switches, and indicating lights in accordance with the appropriate articles of NEMA ICS 6 and NEMA 250.

Contain remote-control stations installed in indoor, clean, dry locations in NEMA Type 1 general-purpose, sheet-steel enclosures. Contain recessed remote-control stations in standard wall outlet boxes with matching corrosion-resistant steel flush cover plate.

Contain remote-control stations installed in wet locations in NEMA Type 4 watertight, corrosion-resistant sheet-steel enclosures constructed to prevent entrance of water when tested in accordance with NEMA ICS 6 and NEMA 250 for Type 4 enclosures.

Contain remote-control stations installed in industrial locations in NEMA Type 12 industrial-use, sheet-steel enclosures, constructed to prevent the entrance of dust, lint, fibers, flyings, oil, and coolant seepage.

Contain remote-control stations installed in Class I, Division I, Group A, B, C, and D, hazardous locations in NEMA Type 7 enclosures, approved for the specific flammable gas or vapor which is possibly present under normal operating conditions.

Fabricate sheet-steel enclosures from uncoated carbon-steel sheets of commercial quality, with box dimensions and thickness of sheet steel in accordance with UL 50.

Fabricate steel enclosures from corrosion-resistant, chromium-nickel steel sheet, conforming to ASTM A167, Type 300 series with ASM No. 4 general-purpose polished finish, with box dimensions and thickness of sheet steel in accordance with UL 50.

Install remote-control stations with the centerline 66 inches above the finished floor.

2.4 CIRCUIT BREAKERS

Provide circuit breakers that conform to UL 489, and NEMA AB 3.

2.4.1 Molded-Case Circuit Breakers

Provide molded case, manually operated, trip-free, circuit breakers, with inverse-time thermal-overload protection and instantaneous magnetic short-circuit protection as required. Completely enclose circuit breakers in a molded case, with the calibrated sensing element factory-sealed to prevent tampering.

Locate thermal-magnetic tripping elements in each pole of the circuit breaker, and provide inverse-time-delay thermal overload protection and instantaneous magnetic short-circuit protection. Provide instantaneous magnetic tripping element, that is adjustable and accessible from the front of the breaker on frame sizes larger than 100 amperes.

Size breaker as required for the continuous current rating of the circuit. Provide breaker class as required.

Provide sufficient interrupting capacity of the panel and lighting branch circuit breakers, to successfully interrupt the maximum short-circuit current imposed on the circuit at the breaker terminals. Provide circuit breaker interrupting capacities as indicated.

Provide the common-trip type multipole circuit breakers having a single operating handle and a two-position on/off indication. Provide circuit breakers with temperature compensation for operation in an ambient temperature of 104 degrees F. Provide circuit breakers that have root mean square (rms) symmetrical interrupting ratings sufficient to protect the circuit being supplied. Interrupting ratings may have selective type tripping (time delay, magnetic, thermal, or ground fault).

Provide phenolic composition breaker body capable of having such accessories as handle-extension, handle-locking, and padlocking devices attached where required.

Provide circuit breakers used for meter circuit disconnects that meet the applicable requirements of NFPA 70 and that are of the motor-circuit protector type.

For circuit breakers used for service disconnection, provide an enclosed circuit-breaker type with external handle for manual operation. Provide sheet metal enclosures with a hinged cover suitable for surface mounting.

2.4.2 Enclosed Molded-Case Circuit Breakers

For enclosed circuit breakers, provide thermal-magnetic molded-case circuit breakers in surface-mounted, nonventilated enclosures conforming to the appropriate articles of NEMA 250 and UL 489.

Provide enclosed circuit breakers in nonhazardous locations as follows:

Contain circuit breakers installed inside clean, dry locations in NEMA

Type 1, general purpose sheet steel enclosures.

Contain circuit breakers installed in unprotected outdoor locations or as indicated, in NEMA Type 3R, weather-resistant sheet steel enclosures that are splashproof, weatherproof, sleetproof, and moisture resistant.

Contain circuit breakers installed in wet locations or as indicated, in NEMA Type 4, watertight corrosion-resistant sheet steel enclosures constructed to prevent entrance of water.

Contain circuit breakers installed in industrial locations in NEMA Type 12, industrial-use sheet steel enclosures, constructed to prevent the entrance of dust, lint, fibers and flyings, and oil and coolant seepage.

Fabricate steel enclosures from corrosion-resistant steel sheet, conforming to ASTM A167, 300 series corrosion-resistant steel, with box dimensions and thickness of sheet steel in accordance with UL 50.

2.5 FUSES

Provide a complete set of fuses for all switches and switchgear. Rate fuses that have a voltage rating of not less than the circuit voltage.

Make no change in continuous-current rating, interrupting rating, and clearing or melting time of fuses unless written permission has first been secured.

Provide nonrenewable cartridge type fuses for ratings 30 amperes, 125 volts or less. Provide renewable cartridge type fuses for ratings above 30 amperes 600 volts or less with time-delay dual elements, except where otherwise indicated. Conform to NEMA FU 1 for fuses.

Install special fuses such as extra-high interrupting-capacity fuses, fuses for welding machines, and capacitor fuses where required. Plug fuses are not permitted.

Label fuses showing UL class, interrupting rating, and time-delay characteristics, when applicable. Additionally, clearly list fuse information on equipment drawings.

Provide porcelain fuse holders when field-mounted in a cabinet or box. Do not use fuse holders made of such materials as ebony asbestos, Bakelite, or pressed fiber for field installation.

2.6 CONTROL DEVICES

2.6.1 Magnetic Contactors

Provide magnetic contactors in accordance with NEMA ICS 1 and NEMA ICS 2 as required for the control of low-voltage, 60-hertz, tungsten-lamp loads, fluorescent-lamp loads, resistance-heating loads, and the primary windings of low-voltage transformers.

Provide core-and-coil assembly that operates satisfactorily with coil voltage between 85 and 110 percent of its voltage rating.

Provide contactor that is designed with a normally open holding circuit auxiliary contact for control circuits, with a rating in accordance with NEMA ICS 1 and NEMA ICS 2.

Furnish solderless pressure wire terminal connectors, or make available for line-and-load connections to contactors in accordance with NEMA ICS 1 and NEMA ICS 2.

Provide magnetic contactors with a rating in accordance with NEMA ICS 1and NEMA ICS 2.

2.6.2 Control-Circuit Transformers

Provide control-circuit transformers within the enclosure of magnetic contactors and motor controllers when the line voltage is in excess of 120 volts. Provide encapsulated dry type, single-phase, 60-hertz transformer, with a 120-volt (or 24-volt) isolated secondary winding.

Do not provide a transformer with a rated primary voltage less than the rated voltage of the controller, or a rated secondary current less than the continuous-duty current of the control circuit.

Provide voltage regulation of the transformer such that, with rated primary voltage and frequency, the secondary voltage is not less than 95 percent nor more than 105 percent of rated secondary voltage.

Provide source of supply for control-circuit transformers at the load side of the main disconnecting device. Protect secondary winding of the transformer and control-circuit wiring against overloads and short circuits, with fuses selected in accordance with NEMA ICS 6. Ground secondary winding of the control-circuit transformer in accordance with NEMA ICS 6.

2.6.3 Magnetic Control Relays

Provide magnetic control relays for energizing and de-energizing the coils of magnetic contactors or other magnetically operated devices, in response to variations in the conditions of electric control devices in accordance with NEMA ICS 1, and NEMA ICS 2.

Provide core-and-coil assembly that operates satisfactorily with coil voltages between 85 and 110 percent of their voltage rating.

Provide relays that are designed to accommodate normally open and normally closed contacts.

Provide 120-volt, 60-hertz, Class AIB magnetic control relays with a continuous contact rating of 10 amperes, and with current-making and -breaking ability in accordance with NEMA ICS 1 and NEMA ICS 2, two normally open and two normally closed.

2.6.4 Pushbuttons and Switches

2.6.4.1 Pushbuttons

For pushbuttons for low-voltage ac full-voltage magnetic controllers, provide heavy-duty oiltight NEMA 250, Type 4 or as indicated, momentary-contact devices rated 600 volts, with pilot light, and with the number of buttons and the marking of identification plates as shown. Furnish pushbutton color code in accordance with NEMA ICS 6.

Provide pushbuttons that are designed with normally open, circuit-closing

contacts; normally closed circuit-opening contacts; and two-circuit normally open and normally closed circuit-closing and -opening contacts. Provide pushbutton-contact ratings in accordance with NEMA ICS 1 and NEMA ICS 2 with contact designation A600.

Identify pushbuttons in remote control stations with identification plates affixed to front cover in a prominent location. Carry the identification of the system being controlled on the identification plate.

2.6.4.2 Selector Switches

Provide heavy-duty oiltight maintained-contact selector switches for low-voltage control circuits, with the number of positions and the marking of identification plates in accordance with NEMA ICS 1 and NEMA ICS 2.

Identify selector switches in remote control stations with engraved identification plates affixed to front cover in a prominent location. Carry the identification of the system being controlled on the identification plate.

2.6.4.3 Miscellaneous Switches

Provide float, limit, door, pressure, proximity, and other types of switches in accordance with IPC D330 and of the types and classes indicated.

2.7 TIME SWITCHES

Provide time switches for the control of tungsten-lamp loads, fluorescent-lamp loads, resistive-heating loads, motors, and magnetically operated devices, consisting of a motor-driven time dial and switch assembly in a NEMA 250, Type 1 general-purpose enclosure.

Provide motor drives consisting of 120-volt, single-phase, 60-hertz, heavy-duty, self-starting synchronous motors, directly connected to the time dial through a geartrain operating mechanism. Provide a spring-wound stored-energy source of reserve power that will automatically operate the mechanism for a period of not less than 12 hours in case of electric power failure. Provide spring that automatically rewinds electrically in not more than 3 hours of time after electric power is restored.

Include a heavy-duty general-purpose precision snap-action switch in accordance with UL 20 for switch mechanism, with provision for a manual "OFF" and "ON" operation of the switch.

Provide time switches for the control of 120/240-volt, 2- and 3-wire, single-phase, 60-hertz circuits and 120/208-volt, three-phase, 4-wire, 60-hertz circuits, with a continuous-current tungsten-lamp load rating of 35 amperes.

Provide astronomic type time dials which automatically change settings each day, in accordance with the seasonal time changes in sunrise and sunset. Provide astronomic type dials that have adjustable on and off trippers, for repetitive switching operations at solar time each day and each day in the year and that make one revolution in a 24-hour period of time. Provide time dials that are designed to operate in the "ON" position at sunset and be fully adjustable upward in 15-minute intervals of time throughout each day, and that indicate the day and month of the year. Calibrate dial in 15-minute intervals over a 24-hour period of time around its circumference. Make provision to defeat the switching operation over

weekends or up to 6 preselected calendar days each week.

2.8 PROTECTIVE RELAYS

2.8.1 Overcurrent Relays

Conform to IEEE C37.90 for overcurrent relays.

For protection against phase and ground faults, provide single-phase nondirectional removable induction type overcurrent relays with built-in testing facilities designed for operation on the dc or ac control circuit indicated.

Provide ground-fault overcurrent relays with short-time inverse time characteristics with adjustable current tap range as required.

Provide phase-fault overcurrent relays with varied inverse-time characteristics with adjustable current tap range as required, and indicating instantaneous-trip attachments with adjustable current range as required.

Semiflush-mount case with matching cover to the hinged instrument panel.

Provide solid-state static-type trips for low-voltage power circuit breakers in accordance with EIA 443 and IEEE C37.17.

Provide a trip unit that employs a combination of discreet components and integrated circuits to provide the time-current protection functions required in a modern selectively coordinated distribution system.

Provide complete system selective coordination by utilizing a combination of the following time-current curve-shaping adjustments: ampere setting; long-time delay; short-time pickup; short-time delay; instantaneous pickup; and ground fault.

Provide switchable or easily defeatable instantaneous and ground fault trips.

Make all adjustments using non-removable, discrete step, highly reliable switching plugs for precise settings. Provide a sealable, transparent cover over the adjustments to prevent tampering.

Furnish trip devices with three visual indicators to denote the automatic tripping mode of the breaker including: overload; short circuit; and ground fault.

Wire trip unit to appropriate terminals whereby an optional remote automatic trip accessory can be utilized to provide the same indication.

Make available for use a series of optional automatic trip relays for use with the trip unit to provide remote alarm and lockout circuits.

Provide all trip units with test jacks for in-service functional testing of the long-time instantaneous and ground fault circuits using a small hand-held test kit.

2.8.2 Directional Overcurrent Relays

Provide directional overcurrent relays in accordance with IEEE C37.90.

For directional overcurrent relays for protection against reverse-power faults, provide single-phase induction type with adjustable time-delay and instantaneous trip attachments. Provide removable type relays with inverse-time directional and overcurrent units with built-in testing facilities.

Semi-flush mount case with matching cover to the hinged instrument panel.

2.8.3 Undervoltage Relays

For undervoltage relays conform to IEEE C37.90.

Provide three-phase induction type undervoltage relays, including inverse timing with adjustable high- and low-voltage contacts and calibrated scale for protection against loss of voltage, undervoltage, and overvoltage. Equip relays with indicating contactor and voltage switches to provide electrically separate contact circuits. Provide relays that are removable with built-in testing facilities and that are suitable for operation on 120-volt ac circuits, with contacts that are suitable for operation on dc or ac control circuits.

Semi-flush mount case with matching cover to the hinged instrument panel.

2.9 INDICATING INSTRUMENTS

2.9.1 Specialty-Type Meters

For specialty meters, conform to ANSI C39.1. Specialty-type meters are panel meters applicable to specific situations, such as pyrometers and dc parameter meters that conform to the panel layout specified. Provide meter scales that are not less than 180 degrees. Do not use edgewise meters for circuit current and voltage measurements.

2.10 FACTORY TESTING

Perform factory tests on control and low voltage protective devices in accordance with the manufacturer's recommendations.

Conduct short-circuit tests in accordance with Section 2 of NEMA ICS 1.

2.11 INDICATING LIGHTS

2.11.1 General-Purpose Type

For indicating lights, provide oiltight instrument devices with threaded base and collar for flush-mounting, translucent convex lens, candelabra screw-base lampholder, and 120-volt, 6-watt, Type S-6 incandescent lamp in accordance with ANSI C78.23. Provide indicating lights color coded in accordance with NEMA ICS 6.

Provide indicating lights in remote-control stations when pushbuttons and selector switches are out of sight of the controller.

2.12 FINISH

Protect metallic materials against corrosion. Provide equipment with the standard finish by the manufacturer when used for most indoor installations.

PART 3 EXECUTION

3.1 INSTALLATION

Install Control devices and protective devices that are not factory installed in equipment, in accordance with the manufacturer's recommendations and field adjusted and operation tested. Conform to NFPA 70, NEMA ICS 1 and NEMA ICS 2 requirements for installation of control and protective devices.

3.2 FIELD TESTING

Demonstrate to operate as indicated control and protective devices not factory installed in equipment.

Ratio and verify tap settings of instrumentation, potential, and current transformers.

Perform dielectric tests on insulating oil in oil circuit breakers before the breakers are energized. Test oil in accordance with ASTM D877, and provide breakdown voltage that is not less than 25,000 volts. Provide manufacturer certification that the oil contains no PCB's, and affix a label to that effect on each breaker tank and on each oil drum containing the insulating oil.

Field adjust reduced-voltage starting devices to obtain optimum operating conditions. Provide test meters and instrument transformers that conform to ANSI C12.1 and IEEE C57.13.

Do not energize control and protective devices until recorded test data has been approved. Provide final test reports with a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

-- End of Section --

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SECTION 26 08 00

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SECTION 26 08 00

APPARATUS INSPECTION AND TESTING

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.

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to this section with additions and modifications specified herein.

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. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-06 Test Reports

Acceptance tests and inspections; G

SD-07 Certificates

Qualifications of organization, and lead engineering technician; G

Acceptance test and inspections procedure; G

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Contractor shall engage the services of a qualified testing organization to provide inspection, testing, calibration, and adjustment of the electrical distribution system and generation equipment listed in paragraph entitled "Acceptance Tests and Inspections" herein. Organization shall be independent of the supplier, manufacturer, and installer of the equipment. The organization shall be a first tier subcontractor. No work required by this section of the specification shall be performed by a second tier subcontractor.

a. Submit name and qualifications of organization. Organization shall have been regularly engaged in the testing of electrical materials, devices, installations, and systems for a minimum of 5 years. The

organization shall have a calibration program, and test instruments used shall be calibrated in accordance with NETA ATS.

b. Submit name and qualifications of the lead engineering technician performing the required testing services. Include a list of three comparable jobs performed by the technician with specific names and telephone numbers for reference. Testing, inspection, calibration, and adjustments shall be performed by an engineering technician, certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) with a minimum of 5 years' experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.

1.4.2 Acceptance Tests and Inspections Reports

Submit certified copies of inspection reports and test reports. Reports shall include certification of compliance with specified requirements, identify deficiencies, and recommend corrective action when appropriate. Type and neatly bind test reports to form a part of the final record. Submit test reports documenting the results of each test not more than 10 days after test is completed.

1.4.3 Acceptance Test and Inspections Procedure

Submit test procedure reports for each item of equipment to be field tested at least 45 days prior to planned testing date. Do not perform testing until after test procedure has been approved.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

3.1 ACCEPTANCE TESTS AND INSPECTIONS

Testing organization shall perform acceptance tests and inspections. Test methods, procedures, and test values shall be performed and evaluated in accordance with NETA ATS, the manufacturer's recommendations, and paragraph entitled "Field Quality Control" of each applicable specification section. Tests identified as optional in NETA ATS are not required unless otherwise specified. Equipment shall be placed in service only after completion of required tests and evaluation of the test results have been completed. Contractor shall supply to the testing organization complete sets of shop drawings, settings of adjustable devices, and other information necessary for an accurate test and inspection of the system prior to the performance of any final testing. Contracting Officer shall be notified at least 14 days in advance of when tests will be conducted by the testing organization. Perform acceptance tests and inspections on applicable equipment and systems specified in the following sections:

a. Section 26 28 21.00 40 AUTOMATIC TRANSFER SWITCHES

b. Section 26 29 23 VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS.

c. Section 26 60 13.00 40 LOW-VOLTAGE MOTORS

3.2 SYSTEM ACCEPTANCE

Final acceptance of the system is contingent upon satisfactory completion of acceptance tests and inspections.

3.3 PLACING EQUIPMENT IN SERVICE

A representative of the approved testing organization shall be present when equipment tested by the organization is initially energized and placed in service.

-- End of Section --

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SECTION 26 09 23.00 40

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SECTION 26 09 23.00 40

LIGHTING CONTROL DEVICES

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.

GREEN SEAL (GS)

GC-12	(1997) Occupancy Sensors

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS 1	(2000; R 2005; R 2008) 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 6	(1993; R 2011) Enclosures

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Submit Installation Drawings for occupancy sensitive and motion sensitive control devices in accordance with the manufacturer's recommended instructions for installation.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Submit Installation Drawings for devices in accordance with paragraph entitled, "General Requirements," of this section.

Lighting Contactor; G

Time Switch; G

Occupancy Sensors; G

SD-06 Test Reports

Submit test reports for System Operation Tests in the presence of the Contracting Officer.

1.4 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

PART 2 PRODUCTS

2.1 TIME CONTROL SWITCHES

Install switches with not less than four 1/4 inch bolts. The use of sheet metal screws is not allowed.

Provide with a time delay in excess of 5 seconds as an available option.

2.2 LIGHTING CONTACTOR

Provide NEMA ICS 2, mechanically held contactor. Rate contactor as indicated. Provide in enclosure as indicated conforming to NEMA ICS 6. Provide contactor with silver alloy double-break contacts and coil clearing contacts for mechanically held contactor requiring no arcing contacts.

2.3 TIME SWITCH

Provide astronomic dial type or electronic type, arranged to turn "ON" at sunset and turn "OFF" at predetermined time between 8:30 p.m. and 2:30 a.m. or sunrise, automatically changing the settings each day in accordance with seasonal changes of sunset and sunrise. Provide switch rated as indicated, having automatically wound spring mechanism or capacitor, to maintain accurate time for a minimum of 7 hours following power failure. Provide time switch with a manual on-off bypass switch. Surface mount the housing for the time switch, enclosure as indicated conforming to NEMA ICS 6.

2.4 OCCUPANCY SENSORS

Provide UL listed occupancy sensor complying with GC-12. Design occupancy sensors and power packs to operate on the voltage indicated. Provide sensors and power packs with circuitry that only allows load switching at or near zero current crossing of supply voltage, with mounting as indicated. Provide sensor with an LED occupant detection indicator, adjustable sensitivity, and adjustable delayed-off time range of 5 minutes

to 15 minutes. Provide wall mounted sensors, and white ceiling mounted sensors. Provide ceiling mounted sensors with 360 degree coverage unless otherwise indicated.

c. Ultrasonic/Infrared Combination Sensor

2.5 EQUIPMENT IDENTIFICATION

2.5.1 Manufacturer's Nameplate

Provide each item of equipment with a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in an inconspicuous place; the nameplate of the distributing agent is not acceptable.

2.5.2 Labels

Provide labeled control devices, clearly marked for operation of specific lighting functions according to type.

Make markings related to control device type clear and locate to be readily visible to service personnel, but unseen from normal viewing angles when devices are in place.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 Time Control Switches

Install switches with not less than four 1/4 inch bolts. The use of sheet metal screws is not allowed.

3.1.2 Magnetic Contactors

Provide magnetic contactors mechanically held, electrically operated, conforming to NEMA ICS 1 and NEMA ICS 2, suitable for voltages as indiccated, 60 Hz, with coil voltage as indicated. Provide with maximum continuous ampere rating and number of poles as indicated on drawings. Provide enclosures for contactors mounted indoors conforming to NEMA ICS 6, Type 1. Provide each contactor with a spare, normally open auxiliary contact.

Coordinate terminal lugs with the wire size. Securely fasten switches to the supporting structure or wall using not less than four 1/4 inch bolts. The use of sheet metal screws is not allowed.

3.2 FIELD TESTING

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

Demonstrate that photoconductive control devices operate satisfactorily in the presence of the Contracting Officer.

Perform System Operation Tests in accordance with referenced standards in this section.

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SWITCHBOARDS

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 A123/A123M	(2012) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2009) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A167	(2011) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A653/A653M	(2011) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780/A780M	(2009) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM D1535	(2012) Specifying Color by the Munsell System
ASTM D709	(2001; R 2007) 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 2012; INT 1 2012; INT 2 2012) National Electrical Safety Code
IEEE C57.12.28	(2005; INT 3 2011) Standard for Pad-Mounted Equipment - Enclosure Integrity
IEEE C57.12.29	(2005) Standard for Pad-Mounted Equipment - Enclosure Integrity for Coastal Environments

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA PB 2.1	(2007) General Instructions for Proper Handling, Installation, Operation and Maintenance of Deadfront Distribution Switchboards Rated 600 V or Less
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA LI 1	(1998; R 2011) Industrial Laminating Thermosetting Products
NEMA PB 2	(2011) Deadfront Distribution Switchboards

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Grounding and Bonding Equipment
UL 891	(2005) Switchboards

1.2 RELATED REQUIREMENTS

Section 26 08 00 APPARATUS INSPECTION AND TESTING applies to this section, with the additions and modifications specified herein.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE 100.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Switchboard Drawings; 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. 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. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

All Shop Drawings shall be computer aided design (CAD) generated. Provide Digital media compact disc (CD) with all submittals including .DWG or .DXF files for all drawings. Also on this CD provide a complete copy of the drawings in PDF format.

Submit Shop Drawings for approval prior to equipment manufacturing.

Submit "As-Built" Shop Drawings after installation, inspection and testing is complete which document all field changes made.

SD-03 Product Data

Switchboard; G

SD-06 Test Reports

Acceptance checks and tests; G

Submit test forms showing compliance with NETA ATS inspections and tests for approval prior to testing.

Submit completed test forms showing the results of all inspections and tests in accordance with NETA ATS inspections and tests after inspections and testing is complete.

SD-10 Operation and Maintenance Data

Switchboard Operation and Maintenance, Data Package 5; G

SD-11 Closeout Submittals

Assembled Operation and Maintenance Manuals; G

1.5 QUALITY ASSURANCE

1.5.1 Switchboard Product Data

Each submittal shall include manufacturer's information for each component, device and accessory provided with the switchboard including:

a. Circuit breaker type, interrupting rating, and trip devices, including available settings.

b. Manufacturer's instruction manuals and published time-current curves (on full size logarithmic paper) of the main secondary breaker and largest secondary feeder device.

c. Manufacturer's standard switchboard application, installation, operation and maintenance manuals.

1.5.2 Switchboard Drawings

Drawings shall include, but are not limited to the following:

a. One-line diagram including breakers

b. Outline drawings including front elevation, section views, footprint, and overall dimensions

c. Bus configuration including dimensions and ampere ratings of bus bars

d. Markings and NEMA nameplate data

e. Circuit breaker type, interrupting rating, and trip devices, including available settings

1.5.3 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.

1.5.4 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.

1.5.4.1 Material and Equipment Manufacturing Date

Products manufactured more than 2 years prior to date of delivery to site shall not be used, unless specified otherwise.

1.6 MAINTENANCE

1.6.1 Switchboard Operation and Maintenance Data

Submit Operation and Maintenance Manuals in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.6.2 Assembled Operation and Maintenance Manuals

Manuals shall be assembled and bound securely in durable, hard covered, water resistant binders. The manuals shall be assembled and indexed in the following order with a table of contents. The contents of the assembled operation and maintenance manuals shall be as follows:

a. Manufacturer's O&M information required by the paragraph entitled "SD-10, Operation and Maintenance Data."

b. Catalog data required by the paragraph entitled, "SD-03, Product Data."

c. Drawings required by the paragraph entitled, "SD-02, Shop Drawings." Drawings shall be "as-built" indicating all changes made during the installation.

d. Spare parts and supply list.

PART 2 PRODUCTS

2.1 SWITCHBOARD

NEMA PB 2 and UL 891.

2.1.1 Ratings

The voltage rating of the switchboard shall be 480Y/277 volts AC, 4-wire, 3 phase. The continuous current rating of the main bus shall be as indicated. The short-circuit current rating shall beas indicated. The switchboard shall be UL listed and labeled for its intended use.

2.1.2 Construction

The switchboards shall be dead-front switchboards conforming to NEMA PB 2 and labeled under UL 891. The switchboards shall be completely enclosed self-supporting metal structures with the required number of vertical panel sections, buses, and molded-case circuit breakers as shown on the drawings. Switchboards shall be fully rated for a short-circuit current indicated.

Switchboard shall consist of vertical sections bolted together to form a rigid assembly and shall be front and rear aligned. All circuit breakers shall be front accessible. Switchboards shall have front accessible load connections. Where indicated, "space for future" or "space" shall mean to include bus, device supports, and connections. Provide insulating barriers in accordance with NEMA LI 1, Type GPO-3, 0.25 inch minimum thickness. Apply moisture resistant coating to all rough-cut edges of barriers. Switchboard shall be completely factory engineered and assembled, including protective devices and equipment indicated with necessary interconnections.

2.1.2.1 Enclosure

The switchboard enclosure shall be indoor NEMA 1 or outdoor NEMA 3R stainless steel (ASTM A167 Type 304 or 304L) per NEMA ICS 6 as indicated built with selected smooth panels not less than 14 gauge. Exposed panels on the front and ends shall have bent angle or channel edges with all corner seams welded and ground smooth. The front outside surfaces shall not be drilled or welded for the purpose of attaching wires or mounting devices if such holes or fastenings will be visible from the front. The front panels shall be made in sections flanged on four sides and attached to the framework by screws and arranged for ready removal for inspection or maintenance.

Enclosure shall be bolted together with removable bolt-on covers, and sloping roof downward toward the rear. Front doors shall be provided with stainless steel padlockable vault handles with a three point catch. Ventilating openings shall be provided as required and shall be of the grille or louver type. All ventilating openings shall be provided with

corrosion-resistant, inspect-proof screens on the inside.

Bases, frames and channels of enclosure shall be corrosion resistant and shall be fabricated of ASTM A167 type 304 or 304L stainless steel for outdoor units and galvanized steel for indoor units. Base shall include any part of enclosure that is within 3 inches of concrete pad. Galvanized steel shall be ASTM A123/A123M, ASTM A653/A653M G90 coating, and ASTM A153/A153M, as applicable. Galvanize after fabrication where practicable.

Paint enclosure, including bases, ASTM D1535 light gray No. 61 or No. 49. Paint coating system shall comply with IEEE C57.12.28 for galvanized steel and IEEE C57.12.29 for stainless steel. Treat all interior and exterior steel parts to inhibit corrosion.

2.1.2.2 Bus Bars

Bus bars shall be copper with silver-plated contact surfaces. Plating shall be a minimum of 0.0002 inch thick. Make bus connections and joints with hardened steel bolts. The through-bus shall be rated at the full ampacity of the main throughout the switchboard. Provide copper ground bus secured to each vertical section along the entire length of the switchboard. The neutral bus shall be rated 100 percent of the main bus continuous current rating as indicated.

2.1.2.3 Main and Distribution Sections

The main and distribution sections shall consist of individually mounted, molded-case circuit breakers as indicated.

Provide integral factory installed surge suppression equipment in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.1.3 Protective Device

2.1.3.1 Molded-Case Circuit Breaker

Provide molded-case circuit breakers in accordance with Section 26 05 71.00 40 LOW-VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.2 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. This nameplate and method of attachment may be the manufacturer's standard if it contains the required information.

2.3 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each switchboard and device. 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 one by 2.5 inches. Lettering shall be a minimum of 0.25 inch high normal block style.

2.4 COORDINATED POWER SYSTEM PROTECTION

Provide a power system study as specified in Section 26 05 63.00 98 COORDINATED POWER SYSTEM PROTECTION AND ARC FLASH ANALYSIS. Set switchboard protective devices in accordance with the approved study submittal.

PART 3 EXECUTION

3.1 INSTALLATION

Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.2 GROUNDING

3.2.1 Grounding and Bonding Equipment

UL 467, except as indicated or specified otherwise.

3.3 INSTALLATION OF EQUIPMENT AND ASSEMBLIES

Install and connect equipment furnished under this section as indicated on project drawings, the approved shop drawings, and as specified herein.

3.3.1 Switchboard

ANSI/NEMA PB 2.1.

3.3.2 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.

3.3.3 Galvanizing Repair

Repair damage to galvanized coatings using ASTM A780/A780M, zinc rich paint, for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces that repair paint has been applied to.

3.3.4 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.

3.4 FOUNDATION FOR EQUIPMENT AND ASSEMBLIES

3.4.1 Exterior Location

Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least 8 inches thick, reinforced with a 6 by 6 inch No. 6 mesh placed uniformly 4 inches from the top of the slab. Slab shall be placed on a 6 inch thick, well-compacted gravel base. The top of the concrete slab shall be approximately 4 inches above the finished grade. Edges above grade shall have 1/2 inch chamfer. The slab shall be of adequate size to project at least 8 inches beyond the equipment. Provide conduit turnups and cable entrance space required by the equipment to be mounted. Seal

voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches above slab surface. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.4.2 Interior Location

Mount switchboard on concrete slab. Unless otherwise indicated, the slab shall be at least 4 inches thick. The top of the concrete slab shall be approximately 4 inches above finished floor. Edges above floor shall have 1/2 inch chamfer. The slab shall be of adequate size to project at least 8 inches beyond the equipment. Provide conduit turn-ups and cable entrance space required by the equipment to be mounted. Seal voids around conduit openings in slab with water- and oil-resistant caulking or sealant. Cut off and bush conduits 3 inches above slab surface. Concrete work shall be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE.

3.5 FIELD QUALITY CONTROL

3.5.1 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 and Section 26 08 00 APPARATUS INSPECTION AND TESTING, with the additions and modifications specified herein.

3.5.1.1 Switchboard Assemblies

a. Perform applicable inspections and electrical tests for switchboard and molded case circuit breaker equipment including but not limited to:

1. Compare equipment nameplate data with specifications and approved shop drawings.

2. Inspect physical, electrical, and mechanical condition.

3. Verify appropriate anchorage, required area clearances, and correct alignment.

4. Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.

5. Verify that circuit breaker sizes and types correspond to approved shop drawings.

6. Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter and by verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

7. Clean switchboard.

8. Inspect insulators for evidence of physical damage or contaminated surfaces.

9. Exercise all active components.

b. Electrical Tests

1. Perform insulation-resistance tests on each bus section.

2. Verify operation of switchboard heaters.

3.5.1.2 Circuit Breakers

a. Visual and Mechanical Inspection

1. Compare nameplate data with specifications and approved shop drawings.

2. Inspect circuit breaker for correct mounting.

3. Operate circuit breaker to ensure smooth operation.

4. Inspect case for cracks or other defects.

5. Inspect all bolted electrical connections for high resistance using low resistance ohmmeter and verifying tightness of accessible bolted connections and/or cable connections by calibrated torque-wrench method.

b. Electrical Tests

1. Perform breaker adjustments for final settings in accordance with Government provided settings.

3.5.1.3 Grounding System

a. Perform inspections and electrical tests in accordance to include the following:

1. Inspect ground system for compliance with contract plans and specifications.

b. Electrical Tests

1. Measure bond resistance between the switchboard ground bus and the supplying source ground bus and between the switchboard ground bus and the earth ground.

3.5.2 Follow-Up Verification

Upon completion of acceptance checks, settings, 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. Circuit breakers shall be tripped by operation of each protective device. Test shall require each item to perform its function not less than three times. 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 for checks, settings, and tests.

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PANELBOARDS

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PANELBOARDS

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.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA PB 1	(2011) Panelboards

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev C; Notice 1) Colors Used in Government Procurement

UNDERWRITERS LABORATORIES (UL)

UL 489	(2009; Reprint Jun 2011) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 67	(2009; Reprint Sep 2010) Standard for Panelboards

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Submit Detail Drawings for the panelboards consisting of fabrication and assembly drawings for all parts of the work in sufficient detail to enable the Government to check conformity with the requirements of the contract documents. Include within drawings details of bus layout.

Ensure Outline Drawings for panelboards indicate overall physical features, dimensions, ratings, service requirements, and weights of equipment.

Statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meet specified requirements. Statements must be dated after the award of this contract, name the project, and list the specific requirements which it is intended to address.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Submit Detail Drawings and Outline Drawings for panelboards in accordance with paragraph entitled, "General Requirements," of this section.

SD-03 Product Data

Submit manufacturer's catalog data for the following items:

Panelboards

Directory Card and Holder

SD-04 Samples

Ensure that Keys are properly tagged and delivered to the Contracting Officer.

SD-06 Test Reports

Submit test reports for the following tests in accordance with the paragraph entitled, "Site Testing," of this section. Do not energize panelboards until the recorded test data has been submitted to and approved by the Contracting Officer.

Continuity Tests

Insulation Tests

SD-07 Certificates

Submit Statements in accordance with paragraph entitled, "General Requirements," of this section.

SD-08 Manufacturer's Instructions

Submit manufacturer's instructions for Panelboards including special provisions required to install equipment components and system packages. Special notices shall detail impedances, hazards and safety precautions.

1.4 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance

requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

PART 2 PRODUCTS

2.1 PANELBOARDS

Totally enclose power-distribution panelboards and lighting and appliance branch-circuit panelboards in a steel cabinet, dead-front circuit breaker type with copper buses, surface- or flush-mounted as indicated. Ensure panelboards conform to NEMA PB 1 and UL 489. Branch circuit panels shall have buses fabricated for bolt-on type circuit breakers.

An outer door or cover, hinged on one side, shall be provided on surface-mounted panelboards to provide gutter space access. Provide a center door for circuit breaker/switch access only.

Voltage and current rating, number of phases, and number of wires shall be as indicated. Provide four-wire distribution panelboards and lighting and appliance branch-circuit panelboards with an isolated full-capacity neutral bus. Ensure panelboards are rated for 120/208-volt, three-phase or 277/480-volt, three-phase, 60-hertz current as indicated.

Provide three-phase, 4-wire and single-phase, 3-wire distribution lighting and branch circuit panelboards with an isolated full-capacity bus providing spaces for single-pole circuit breakers/switches and spaces indicated as spare.

Provide panelboards with a separate grounding bus bonded to the enclosure. Grounding bus shall be a solid bus bar of rectangular cross section equipped with binding screws for the connection of equipment grounding conductors.

Each panelboard, as a complete unit, shall have a short-circuit current rating equal to or greater than the integrated equipment rating shown on the panelboard schedule or as indicated.

Ensure panelboards and main lugs or main breaker have current ratings as shown on the panelboard schedule.

Bus bar connections to the branch circuit breakers shall be the "distributed phase" or "phase sequence" type. Single-phase, three-wire panelboard busing shall be such that when any two adjacent single-pole breakers are connected to opposite phases, two-pole breakers can be installed in any location. Three-phase, four-wire busing shall be such that when any three adjacent single-pole breakers are individually connected to each of the three different phases, two- or three-pole breakers can be installed at any location. Current-carrying parts of the bus assembly shall be plated. Mains ratings shall be as shown.

Mechanical lugs furnished with panelboards shall be cast copper or copper alloys of sizes suitable for the conductors indicated to be connected thereto.

Panelboard box shall be galvanized code-gage sheet steel without knockouts. Ensure entire panelboard front is hinged on one side with a

piano hinge for the full height and has captive screws opposite the hinged side. Where panelboards are installed flush with the walls, the installation details shall be such that the hinged front can be opened without damage to the adjacent wall surfaces. Ensure that the color of the finished coat of trim and front matches the adjacent walls except when the box is installed in electrical closets or equipment rooms, the gray finish as specified is acceptable.

Panelboard enclosures shall be NEMA 250, Type as indicated. Provide enclosures with hinged fronts and corrosion-resistant steel pin-tumbler cylinder locks. Key locks alike and provide two keys for each enclosure.

Finish panelboards with baked enamel. Finish color is to be No. 61 gray conforming to FED-STD-595.

2.2 CIRCUIT BREAKERS

Circuit breakers shall be the molded-case type as specified in Section 26 05 71.00 40 LOW VOLTAGE OVERCuRRECT PROTECTIVE DEVICES. Frame and trip ratings shall be as indicated.

Interrupting rating of circuit breakers shall be as indicated. If not shown, the interrupting rating for circuit breakers in 120/208-volt panelboards shall be not less than 10,000 amperes rms symmetrical, and that for breakers in 277/480-volt panelboards shall be not less than 25,000 amperes rms symmetrical.

Circuit breakers shall be bolt-on type. Plug-in type is not acceptable.

Provide shunt trips where indicated.

In branch circuit panelboards, branch circuit breakers feeding convenience outlets shall have sensitive instantaneous trip settings of not more than 10 times the trip rating of the breaker to prevent repeated arcing shorts resulting from frayed appliance cords. Single-pole 15- and 20-ampere circuit breakers shall be UL listed as "Switching Breakers" at 120 volts ac or 277 volts ac. Provide UL Class A (5-milliampere sensitivity) ground fault circuit protection on 120-volt ac branch circuit as indicated. This protection is an integral part of the branch circuit breaker that also provides overload and short-circuit protection for branch circuit wiring. Tripping of a branch circuit breaker containing ground fault circuit interruption is not to disturb the feeder circuit to the panelboard. A single-pole circuit breaker with integral ground fault circuit interruption requires no more panelboard branch circuit space than a conventional slide pole circuit breaker.

Ensure connections to the bus are bolt-on type.

When multiple wires per phase are specified, furnish the circuit breakers with connectors made to accommodate multiple wires.

Ensure circuit breaker spaces called out on the drawings are complete with mounting hardware to permit ready installation of the circuit breakers.

2.3 DIRECTORY CARD AND HOLDER

Mount a directory card on the inside of hinged fronts and doors 0.030-inch thick minimum plastic in a metal frame, with spaces for circuit numbers, outlets controlled, and room numbers. Where hinged fronts or doors are not

required, provide the directory card 0.030-inch thick minimum plastic in a metal frame mounted on the left-hand side of the front trim. Directory card shall identify each branch circuit with its respective and numbered circuit breaker.

2.4 FACTORY TESTING

Test complete panelboards in accordance with UL 67.

2.5 PRECAUTIONARY LABEL

To ensure persons are aware of immediate or potential hazard in the application, installation, use, or maintenance of panelboards, each panelboard shall be conspicuously marked on the trim or dead front shield with the text (or equivalent) **DANGER** symbol. If the panel is supplied with a door, ensure the label is visible when the door is in the open position.

PART 3 EXECUTION

3.1 INSTALLATION

Install panelboards as indicated and in accordance with the manufacturer's instructions. Fully align and mount panels so that the height of the top operating handle does not exceed 72-inches above the finished floor.

Directory-card information shall be typewritten in capital letters to indicate outlets controlled and final room numbers served by each circuit and shall be mounted in holders behind protective covering.

3.2 SITE TESTING

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

Each panelboard enclosure key shall be shown to operate the enclosure locks in the presence of the Contracting Officer.

Panelboards shall be given continuity and insulation tests after the installation has been completed and before the panelboard is energized.

Provide test equipment, labor, and personnel as required to perform the tests as specified. Conduct Continuity tests using a dc device with bell.

Conduct insulation tests on 480-volt panelboards using a 1,000-volt insulation-resistance test set. Record readings every minute until three equal and consecutive readings have been obtained. Resistance between phase conductors and between phase conductors and ground shall be not less than 50 megohms.

Conduct insulation tests on panelboards rated 300 volts or less using a 500-volt minimum insulation-resistance test set. Record readings after 1 minute and until the reading is constant for 15 seconds. Resistance between phase conductors and between phase conductors and ground shall be not less than 25 megohms.

Record test data and include the location and identification of panelboards and megohm readings versus time.

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AUTOMATIC TRANSFER SWITCHES

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AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

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.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1008	(2011) Transfer Switch Equipment
UL 508	(1999; Reprint Apr 2010) Industrial Control Equipment

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Connection Diagrams; G

Fabrication Drawings; G

Installation Drawings; G

SD-03 Product Data

Equipment and Performance Data; G

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SD-06 Test Reports

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SD-08 Manufacturer's Instructions

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1.3 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

1.4 QUALIFICATION TESTING

Provide certified independent laboratory test data for the furnished unit or an identical unit. Ensure tests meet the general use requirements of UL 508, Table 22.1. Subject the complete automatic transfer switch to a test as outlined in NEMA ICS 1, paragraph 109.5. One cycle of operation tests under the UL 508 test requirements consists of a transfer of load from the normal source to the emergency source and retransfer to the normal source. After the required number of test cycles, ensure the temperature rise of the contacts has not exceeded 149 degrees F. Test the switch operating time and the sense relay pickup and dropout times.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide a complete automatic transfer switch system for use with engine-generator sets for standby power. Submit the following:

a. Connection diagrams showing the relations and connections of contacts, indicating lights, and terminal board by showing the general physical layout of all controls, the interconnection of one system (or portion of system) with another.

b. Fabrication drawings for contacts, indicating lights, terminal board enclosures, and accessories consisting of fabrication and assembly details to be performed in the factory.

c. Installation drawings for automatic transfer equipment in accordance with the paragraph entitled, "Installation," of this section.

d. Equipment and performance data for automatic transfer equipment including life, test, system functional flows, safety features, and mechanical automated details.

2.1.1 Design Requirements

Ensure control and protective devices associated with automatic transfer switches are in accordance with Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

Provide an automatic transfer switch of the two-pole type for single-phase application, and three-pole type for three-phase application. Provide an additional switched neutral pole.

2.1.2 Performance Requirements

Provide an automatic transfer switch capable of transferring the load from the normal power source to emergency power source, and from an emergency source to the normal power source. Locate switch where indicated. Provide a switch that is solenoid-operated, mechanically held, double-throw, rated for continuous duty, capable of transferring in 100 milliseconds or less, and conforming to the applicable requirements of UL 1008 and NFPA 70, Article 700, except as herein modified.

Ensure the automatic transfer switch is capable of being placed in either the normal or the emergency position.

2.2 FABRICATION

2.2.1 Short Circuit Withstand Current Rating

Provide switch with short-circuit current rating of TBD. Ensure switch is capable of withstanding TBD amperes for a period of TBD seconds without damage.

2.2.2 Self-Test Capability

Provide an automatic transfer switch with a control-circuit self-test feature capable of verifying the proper operation of the switch control circuit without moving the main contactor or causing discontinuity of

service to the load. Include the following characteristics in the self-test circuit:

a. A key-operated switch that disconnects the main actuator and connects in its place, an indicator light. Design the key-operated switch to prevent removal of the key while the switch is in the self-test mode.

b. A power-failure simulator switch that removes voltage from the voltage-sensing devices so that emergency power activates the test light.

2.2.3 Enclosures

Provide automatic transfer switch enclosures with solid, unventilated, code-gage 14-gage, minimum sheet metal, NEMA 250, Type 1, with manufacturer's standard finish.

2.3 COMPONENTS

2.3.1 Contacts

Provide main contacts with a wiping-action silver alloy that, when rated for operation at 50 amperes or greater, are protected against arcing. Ensure auxiliary contacts and control transfer relay contacts have a minimum continuous current rating of not less than 10-amperes inductive at 120 volts ac. Provide the following auxiliary contacts:

a. Generator-control contacts, normally open, that close on undervoltage or loss of normal power as specified, remaining closed until transfer back to normal power

b. Emergency-position contacts, normally open when the switch is in the normal position, that close when the switch is in the emergency position

c. Normal position contacts, normally closed when the switch is in the normal position, that open when the switch is in the emergency position

Use two pole auxiliary contacts.

Provide a test automatic transfer switch mounted TBD with contacts rated for operation at 10 amperes.

Provide automatic transfer switch with overlapping neutral transfer contacts in addition to the two- or three-pole main bus contacts. Normal and emergency neutral are connected together only during the transfer and retransfer operation. They remain connected only until the power source contacts close/open to transfer from one source to the other. Ensure overlapping neutral transfer contacts connection time does not exceed 100 milliseconds.

2.3.2 Indicating Lights

Furnish automatic transfer switch with two indicating lamps. One light to indicate that the switch is operating on normal power, and the other light to indicate that the switch is operating on emergency power. Fuse each indicating circuit.

2.3.3 Terminal Board

Internally wire control devices, indicating lights, auxiliary contacts, and internal control devices or auxiliary switches to a common output terminal board. Wire the internal functions to facilitate remote connections or monitoring.

2.4 OPERATION

Monitor normal source voltage across phase lines by sensing devices. If the normal source voltage in phase drops to 90 percent or less for a timed period, the automatic transfer switch starts the emergency source and transfer the load to the emergency source when voltage and frequency reach rated values or, if the emergency source is on, verify voltage and frequency of the alternate source and transfer the load to the alternate source. Field adjust this time period from 1 to 30 seconds. Provide a voltage and frequency sensor relay to monitor rated values on the emergency side to prohibit transfer until the emergency source voltage and frequency reach at least 95 percent of the required rating. Provide phase failure protection, with 65 to 70 percent drop and 92 to 95 percent voltage pickup ratings.

Furnish the automatic transfer switch with a time-delay feature, field adjustable from 2 to 30 minutes, that operates to delay automatic transfer back to normal power until the normal source voltage and frequency reach at least 95 percent of the rated voltage. However, if the emergency power fails, and the normal source is again available at 90 percent of the rated voltage, bypass the time-delay circuitry, and the load immediately transferred back to the normal source. Provide capability for manual transfer in either direction. Operate sensing relays without contact chatter or false response during voltage variations between dropout and pickup.

2.5 ACCESSORIES

Incorporate with the automatic transfer switch a 24-volt solid-state, high-and low-rate charger complete with rheostat and ammeter, to maintain the engine-generator cranking batteries in a fully charged condition.

Incorporate an engine-generator exerciser timer with the automatic transfer switch to permit weekly programming of engine-generator set test runs under load.

PART 3 EXECUTION

3.1 INSTALLATION

Install automatic transfer switch as indicated, and in accordance with the manufacturer's installation instructions. Fully align and install wall-mounted enclosures at the indicated mounting height using a minimum of six 3/8-inch bolts. Use of sheet metal screws or small machine screws is not permitted.

Submit listing of product installations for automatic transfer switches showing the manufacturer has successfully manufactured automatic transfer switches of the size specified for a minimum period of 10 years. Include on the list, purchaser, address of installation, service organization, and date of installation.

3.2 FIELD TESTING

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

Demonstrate the automatic transfer switch operates in accordance with the specification requirements in conjunction with the normal and emergency power sources.

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SECTION 26 29 23

VARIABLE FREQUENCY DRIVE SYSTEMS UNDER 600 VOLTS

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.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 519	(1992; R 1993; Errata 2004) Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
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

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 1	(2000; R 2005; R 2008) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 3.1	(2009) Guide for the Application, Handling, Storage, Installation and Maintenance of Medium-Voltage AC Contactors, Controllers and Control Centers
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA ICS 7	(2006) Adjustable-Speed Drives

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-461	(2007; Rev F) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

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

47 CFR 15	Radio Frequency Devices

UNDERWRITERS LABORATORIES (UL)

UL 489	(2009; Reprint Jun 2011) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 508C	(2002; Reprint Nov 2010) Power Conversion Equipment

1.2 RELATED REQUIREMENTS

Sections 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS and 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL, apply to this section with additions and modifications specified herein.

1.3 SYSTEM DESCRIPTION

1.3.1 Performance Requirements

1.3.1.1 Electromagnetic Interference Suppression

Computing devices, as defined by 47 CFR 15, MIL-STD-461 rules and regulations, shall be certified to comply with the requirements for class A computing devices and labeled as set forth in part 15.

1.3.1.2 Electromechanical and Electrical Components

Electrical and electromechanical components of the Variable Frequency Drive (VFD) shall not cause electromagnetic interference to adjacent electrical or electromechanical equipment while in operation.

1.3.2 Electrical Requirements

1.3.2.1 Power Line Surge Protection

IEEE C62.41.1 and IEEE C62.41.2, IEEE 519 Control panel shall have surge protection, included within the panel to protect the unit from damaging transient voltage surges. Surge arrestor shall be mounted near the incoming power source and properly wired to all three phases and ground. Fuses shall not be used for surge protection.

1.3.2.2 Sensor and Control Wiring Surge Protection

I/O functions as specified shall be protected against surges induced on control and sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested in both normal mode and common mode using the following two waveforms:

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.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Schematic diagrams; G

Interconnecting diagrams; G

Installation drawings; G

Submit drawings for government approval prior to equipment construction or integration. Modifications to original drawings made during installation shall be immediately recorded for inclusion into the as-built drawings.

SD-03 Product Data

Variable frequency drives; G

Wires and cables

Equipment schedule

Include data indicating compatibility with motors being driven.

SD-06 Test Reports

VFD Test

Performance Verification Tests

Endurance Test

SD-08 Manufacturer's Instructions

Installation instructions

SD-09 Manufacturer's Field Reports

VFD Factory Test Plan; G

Factory test results

SD-10 Operation and Maintenance Data

Variable frequency drives, Data Package 4

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA. Provide service and maintenance information including preventive maintenance, assembly, and disassembly procedures. Include electrical drawings from electrical general sections. Submit additional information necessary to provide complete operation, repair, and maintenance information, detailed to the smallest replaceable unit. Include copies of as-built

submittals. Provide routine preventative maintenance instructions, and equipment required. Provide instructions on how to modify program settings, and modify the control program. Provide instructions on drive adjustment, trouble-shooting, and configuration. Provide instructions on process tuning and system calibration.

1.5 QUALITY ASSURANCE

1.5.1 Schematic Diagrams

Show circuits and device elements for each replaceable module. Schematic diagrams of printed circuit boards are permitted to group functional assemblies as devices, provided that sufficient information is provided for government maintenance personnel to verify proper operation of the functional assemblies.

1.5.2 Interconnecting Diagrams

Show interconnections between equipment assemblies, and external interfaces, including power and signal conductors. Include for enclosures and external devices.

1.5.3 Installation Drawings

Show floor plan of each site, with V.F.D.'s and motors indicated. Indicate ventilation requirements, adequate clearances, and cable routes.

1.5.4 Equipment Schedule

Provide schedule of equipment supplied. Schedule shall provide a cross reference between manufacturer data and identifiers indicated in shop drawings. Schedule shall include the total quantity of each item of equipment supplied. For complete assemblies, such as VFD's, provide the serial numbers of each assembly, and a sub-schedule of components within the assembly. Provide recommended spare parts listing for each assembly or component.

1.5.5 Installation instructions

Provide installation instructions issued by the manufacturer of the equipment, including notes and recommendations, prior to shipment to the site. Provide operation instructions prior to acceptance testing.

1.5.6 Factory Test Results

Document test results and submit to government within 7 working days after completion of test.

1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variations, dirt and dust, or other contaminants.

1.7 WARRANTY

The complete system shall be warranted by the manufacturer for a period of one year, or the contracted period of any extended warrantee agreed upon by

the contractor and the Government, after successful completion of the acceptance test. Any component failing to perform its function as specified and documented shall be repaired or replaced by the contractor at no additional cost to the Government. Items repaired or replaced shall be warranted for an additional period of at least one year from the date that it becomes functional again, as specified in the FAR CLAUSE 52.246-21.

1.8 MAINTENANCE

1.8.1 Spare Parts

Manufacturers provide spare parts in accordance with recommended spare parts list.

1.8.2 Maintenance Support

During the warranty period, the Contractor shall provide on-site, on-call maintenance services by Contractor's personnel on the following basis: The service shall be on a per-call basis with 36 hour response. Contractor shall support the maintenance of all hardware and software of the system. Various personnel of different expertise shall be sent on-site depending on the nature of the maintenance service required. Costs shall include travel, local transportation, living expenses, and labor rates of the service personnel while responding to the service request. The provisions of this Section are not in lieu of, nor relieve the Contractor of, warranty responsibilities covered in this specification. Should the result of the service request be the uncovering of a system defect covered under the warranty provisions, all costs for the call, including the labor necessary to identify the defect, shall be borne by the Contractor.

PART 2 PRODUCTS

2.1 VARIABLE FREQUENCY DRIVES (VFD)

Provide frequency drive to control the speed of induction motor(s). The VFD shall include the following minimum functions, features and ratings.

a. Input circuit breaker per UL 489 with a minimum of 10,000 amps symmetrical interrupting capacity and door interlocked external operator.

b. A converter stage per UL 508C shall change fixed voltage, fixed frequency, ac line power to a fixed dc voltage. The converter shall utilize a full wave bridge design incorporating diode rectifiers. Silicon Controlled Rectifiers (SCR) are not acceptable. The converter shall be insensitive to three phase rotation of the ac line and shall not cause displacement power factor of less than .95 lagging under any speed and load condition.

c. An inverter stage shall change fixed dc voltage to variable frequency, variable voltage, ac for application to a standard NEMA design B squirrel cage motor. The inverter shall be switched in a manner to produce a sine coded pulse width modulated (PWM) output waveform.

d. The VFD shall be capable of supplying 120 percent of rated full load current for one minute at maximum ambient temperature.

e. The VFD shall be designed to operate from a 480 volt, plus or minus 10 percent, three phase, 60 Hz supply, and control motors with a

corresponding voltage rating.

f. Acceleration and deceleration time shall be independently adjustable from one second to 60 seconds.

g. Adjustable full-time current limiting shall limit the current to a preset value which shall not exceed 120 percent of the controller rated current. The current limiting action shall maintain the V/Hz ratio constant so that variable torque can be maintained. Short time starting override shall allow starting current to reach 175 percent of controller rated current to maximum starting torque.

h. The controllers shall be capable of producing an output frequency over the range of 3 Hz to 60 Hz (20 to one speed range), without low speed cogging. Over frequency protection shall be included such that a failure in the controller electronic circuitry shall not cause frequency to exceed 110 percent of the maximum controller output frequency selected.

i. Minimum and maximum output frequency shall be adjustable over the following ranges: 1) Minimum frequency 3 Hz to 50 percent of maximum selected frequency; 2) Maximum frequency 40 Hz to 60 Hz.

j. The controller efficiency at any speed shall not be less than 96 percent.

k. The controllers shall be capable of being restarted into a motor coasting in the forward direction without tripping.

l. Protection of power semiconductor components shall be accomplished without the use of fast acting semiconductor output fuses. Subjecting the controllers to any of the following conditions shall not result in component failure or the need for fuse replacement:

    1. Short circuit at controller output

    2. Ground fault at controller output

    3. Open circuit at controller output

    4. Input undervoltage

    5. Input overvoltage

    6. Loss of input phase

    7. AC line switching transients

    8. Instantaneous overload

    9. Sustained overload exceeding 115 percent of controller rated current

    10. Over temperature

    11. Phase reversal

m. Solid state motor overload protection shall be included such that current exceeding an adjustable threshold shall activate a 60 second

timing circuit. Should current remain above the threshold continuously for the timing period, the controller will automatically shut down.

n. A slip compensation circuit shall be included which will sense changing motor load conditions and adjust output frequency to provide speed regulation of NEMA B motors to within plus or minus 0.5 percent of maximum speed without the necessity of a tachometer generator.

o. The VFD shall be factory set for manual restart after the first protective circuit trip for malfunction (overcurrent,undervoltage, overvoltage or overtemperature) or an interruption of power. The VFD shall be capable of being set for automatic restart after a selected time delay. If the drive faults again within a specified time period (adjustable 0-60 seconds), a manual restart will be required.

p. The VFD shall include external fault reset capability. All the necessary logic to accept an external fault reset contact shall be included.

q. Provide critical speed lockout circuitry to prevent operating at frequencies with critical harmonics that cause resonant vibrations. The VFD shall have a minimum of three user selectable bandwidths.

r. Provide the following operator control and monitoring devices mounted on the front panel of the VFD:

1. Manual speed potentiometer.

2. Hand-Off-Auto (HOA) switch.

3. Power on light.

4. Drive run power light.

5. Local display.

s. Provide properly sized NEMA rated by-pass and isolation contactors to enable operation of motor in the event of VFD failure. Mechanical and electrical interlocks shall be installed between the by-pass and isolation contactors. Provide a selector switch and transfer delay timer.

2.2 ENCLOSURES

Provide equipment enclosures conforming to NEMA 250, NEMA ICS 7, NEMA ICS 6.

2.3 WIRES AND CABLES

All wires and cables shall conform to NEMA 250, NEMA ICS 7, NFPA 70.

2.4 NAMEPLATES

Nameplates external to NEMA enclosures shall conform with the requirements of Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS. Nameplates internal to enclosures shall be manufacturer's standard, with the exception that they must be permanent.

2.5 SOURCE QUALITY CONTROL

2.5.1 VFD Factory Test Plan

To ensure quality, each VFD shall be subject to a series of in-plant quality control inspections before approval for shipment from the manufacturer's facilities. Provide test plans and test reports.

PART 3 EXECUTION

3.1 INSTALLATION

Per NEMA ICS 3.1, install equipment in accordance with the approved manufacturer's printed installation drawings, instructions, wiring diagrams, and as indicated on project drawings and the approved shop drawings. A field representative of the drive manufacturer shall supervise the installation of all equipment, and wiring.

3.2 FIELD QUALITY CONTROL

Specified products shall be tested as a system for conformance to specification requirements prior to scheduling the acceptance tests. Contractor shall conduct performance verification tests in the presence of Government representative, observing and documenting complete compliance of the system to the specifications. Contractor shall submit a signed copy of the test results, certifying proper system operation before scheduling tests.

3.2.1 VFD Test

A proposed test plan shall be submitted to the contracting officer at least 28 calendar days prior to proposed testing for approval. The tests shall conform to NEMA ICS 1, NEMA ICS 7, and all manufacturer's safety regulations. The Government reserves the right to witness all tests and review any documentation. The contractor shall inform the Government at least 14 working days prior to the dates of testing. Contractor shall provide video tapes, if available, of all training provided to the Government for subsequent use in training new personnel. All training aids, texts, and expendable support material for a self-sufficient presentation shall be provided, the amount of which to be determined by the contracting officer.

3.2.2 Performance Verification Tests

"Performance Verification Test" plan shall provide the step by step procedure required to establish formal verification of the performance of the VFD. Compliance with the specification requirements shall be verified by inspections, review of critical data, demonstrations, and tests. The Government reserves the right to witness all tests, review data, and request other such additional inspections and repeat tests as necessary to ensure that the system and provided services conform to the stated requirements. The contractor shall inform the Government 14 calendar days prior to the date the test is to be conducted.

3.2.3 Endurance Test

Immediately upon completion of the performance verification test, the endurance test shall commence. The system shall be operated at varying rates for not less than 192 consecutive hours, at an average effectiveness

level of .9998, to demonstrate proper functioning of the complete PCS. Continue the test on a day-to-day basis until performance standard is met. During the endurance test, the contractor shall not be allowed in the building. The system shall respond as designed.

3.3 DEMONSTRATION

3.3.1 Training

Coordinate training requirements with the Contracting Officer.

3.3.1.1 Instructions to Government Personnel

Provide the services of competent instructors who will give full instruction to designated personnel in operation, maintenance, calibration, configuration, and programming of the complete control system. Orient the training specifically to the system installed. Instructors shall be thoroughly familiar with the subject matter they are to teach. The Government personnel designated to attend the training will have a high school education or equivalent. The number of training days of instruction furnished shall be as specified. A training day is defined as eight hours of instruction, including two 15-minute breaks and excluding lunch time; Monday through Friday. Provide a training manual for each student at each training phase which describes in detail the material included in each training program. Provide one additional copy for archiving. Provide equipment and materials required for classroom training. Provide a list of additional related courses, and offers, noting any courses recommended. List each training course individually by name, including duration, approximate cost per person, and location of course. Unused copies of training manuals shall be turned over to the Government at the end of last training session.

3.3.1.2 Operating Personnel Training Program

Provide one 2 hour training session at the site at a time and place mutually agreeable between the Contractor and the Government. Provide session to train 4 operation personnel in the functional operations of the system and the procedures that personnel will follow in system operation. This training shall include:

a. System overview

b. General theory of operation

c. System operation

d. Alarm formats

e. Failure recovery procedures

f. Troubleshooting

3.3.1.3 Engineering/Maintenance Personnel Training

Accomplish the training program as specified. Training shall be conducted on site at a location designated by the Government. Provide a one day training session to train 4 engineering personnel in the functional operations of the system. This training shall include:

a. System overview

b. General theory of operation

c. System operation

d. System configuration

e. Alarm formats

f. Failure recovery procedures

g. Troubleshooting and repair

h. Maintenance and calibration

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INTERIOR LIGHTING

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 A580/A580M	(2012a) Standard Specification for Stainless Steel Wire
ASTM A641/A641M	(2009a) Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

CALIFORNIA ENERGY COMMISSION (CEC)

CEC Title 24	(1978; R 2005) California's Energy Efficiency Standards for Residential and Nonresidential Buildings

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IES)

IES HB-10	(2011) IES Lighting Handbook

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2012; Errata 2012; INT 1 2012; INT 2 2012) National Electrical Safety Code
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
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C78.1381	(1998) American National Standard for Electric Lamps - 250-Watt, 70 Watt, M85 Metal-Halide Lamps
ANSI C82.11	(2002) American National Standard for High-Frequency Fluorescent Lamp Ballasts--Supplements

ANSI C82.4	(2002) American National Standard for Ballasts for High-Intensity-Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)
ANSI/ANSLG C78.43	(2007) American National Standard for Electric Lamps - Single-Ended Metal-Halide Lamps
ANSI/IEC C78.81	(2010) American National Standard for Electric Lamps--Double-Capped Fluorescent Lamps--Dimensional and Electrical Characteristics
ANSI/IEC C78.901	(2005) American National Standard for Electric Lamps - Single Base Fluorescent Lamps--Dimensional and Electrical Characteristics
ANSI/NEMA C78.LL 1256	(2003) Procedures for Fluorescent Lamp Sample Preparation and the Toxicity Characteristic Leaching Procedure (TCLP)
NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System

UNDERWRITERS LABORATORIES (UL)

UL 1029	(1994; Reprint May 2011) High-Intensity-Discharge Lamp Ballasts
UL 1598	(2008; Reprint Jan 2010) Luminaires
UL 844	(2006; Reprint Sep 2011) Standard for Luminaires for Use in Hazardous (Classified) Locations
UL 935	(2001; Reprint Nov 2011) Standard for Fluorescent-Lamp Ballasts

1.2 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

b. Average life is the time after which 50 percent has failed and 50 percent has survived under normal conditions.

c. Total harmonic distortion (THD) is the root mean square (RMS) of all the harmonic components divided by the total fundamental current.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Employ the terminology, classifications, and methods prescribed by the IES HB-10, as applicable, for the lighting system specified in data, drawings, and reports.

SD-02 Shop Drawings

Submit Fabrication Drawings for the following items consisting of fabrication and assembly details to be performed in the factory.
Enclosed and Gasketed Vapor-Tight Fixtures

SD-03 Product Data

Fluorescent lighting fixtures; G

Fluorescent electronic ballasts; G

Fluorescent lamps; G

High-intensity-discharge (HID) lighting fixtures; G

HID ballasts; G

Metal-halide lamps; G

Energy Efficiency

Submit Equipment and Performance Data for incandescent lighting fixtures in accordance with paragraph entitled, "Related Requirements," of this section.

Submit Manufacturer's catalog data for the following items:

Enclosed and Gasketed Vapor-Tight Fixtures

SD-04 Samples

Lighting fixtures, complete with lamps and ballasts; G

SD-06 Test Reports

Operating test

Submit test results as stated in paragraph entitled "Field Quality Control."

SD-10 Operation and Maintenance Data

Lighting Control System, Data Package 5

Submit operation and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein, showing all light fixtures, control modules, control zones, occupancy sensors, light level sensors, power packs, dimming ballasts, schematic diagrams and all interconnecting control wire, conduit, and associated hardware.

Operational Service

Submit 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.

1.4 QUALITY ASSURANCE

1.4.1 Fluorescent Electronic Ballasts

Submit ballast catalog data as required in the paragraph entitled "Fluorescent Lamp Electronic Ballasts" contained herein. As an option, submit the fluorescent fixture manufacturer's electronic ballast specification information in lieu of the actual ballast manufacturer's catalog data. Include published specifications and sketches, which cover the information required by the paragraph entitled "Fluorescent Lamp Electronic Ballasts" herein. This information may be supplemented by catalog data if required, containing a list of vendors with vendor part numbers.

1.4.2 Lighting Fixtures, Complete With Lamps and Ballasts

Submit one sample of each fixture type indicated for inspection, review, and approval. Retain the sample for comparison against the remainder of the fixtures. The sample may be used in the final fixture installation.

1.4.3 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory 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.

1.4.4 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,which have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period includes applications of equipment and materials under similar circumstances and of similar size, 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, 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.

1.4.4.1 Alternative Qualifications

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 manufacturers' factory or laboratory tests, is furnished.

1.4.4.2 Material and Equipment Manufacturing Date

Do not use products manufactured more than 3 years prior to date of delivery to site, unless specified otherwise.

1.4.4.3 Energy Efficiency

Comply with National Energy Policy Act and Energy Star requirements for lighting products. Submit data indicating lumens per watt efficiency and color rendition index of light source.

1.5 WARRANTY

Support the equipment items with 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.

1.5.1 Electronic Ballast Warranty

Furnish the electronic ballast manufacturer's warranty, for not less than 5 years from the date of manufacture of the electronic ballast. Ballast assembly in the lighting fixture, transportation, and on-site storage is not to exceed 12 months, thereby permitting 4 years of the ballast 5 year warranty to be in service and energized. State in the warranty that the manufacturer agrees to exchange a malfunctioning ballast and promptly ship the replacement to the using Government facility,said replacement ballast being identical to, or an improvement upon, the original design of the malfunctioning ballast.

1.6 OPERATIONAL SERVICE

Coordinate with manufacturer for maintenance agreement and take-back program for services which reclaim materials for recycling and/or reuse. Collect information from the manufacturer about maintenance agreement options, and submit to Contracting Officer. Placement into landfills or burning of reclaimed materials is not allowed. Indicate procedures for compliance with regulations governing disposal of mercury. When such a service is not available, seek out local recyclers to reclaim the materials.

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

Provide incandescent lighting fixtures conforming to UL 1598. Provide fixtures in hazardous areas conforming to UL 844.

Furnish lighting fixtures completely assembled with wiring and mounting devices and ready for installation at the locations noted. Design and equip recessed fixtures in suspended ceilings for installation in the type

of ceiling in which the fixture is to be installed. Design fixtures to be supported independent of the ceiling. Equip fixtures with the lamps required.

2.2 FLUORESCENT LIGHTING FIXTURES

Provide fluorescent fixtures, conforming to UL 1598 with electronic ballasts unless specifically indicated otherwise.

2.2.1 Fluorescent Lamp Electronic Ballasts

Provide electronic ballasts, meeting as a minimum, the following characteristics:

a. Provide ballasts complying with UL 935, ANSI C82.11, NFPA 70, and CEC Title 24 unless specified otherwise. Provide 100 percent electronic high frequency type ballasts with no magnetic core and coil components, which provide transient immunity as recommended by IEEE C62.41.1 and IEEE C62.41.2. Design ballast for the wattage of the lamps used in the indicated application. Design ballasts to operate on the voltage system to which they are connected.

b. A power factor of 0.95 (minimum).

c. Operates at a frequency of 20,000 Hertz (minimum), and is compatible with and not cause interference with the operation of occupancy sensors or other infrared control systems. Provide ballasts operating at or above 40,000 Hertz where available.

d. Light regulation of plus or minus 10 percent lumen output with a plus or minus 10 percent input voltage regulation. Ensure ballasts have 10 percent flicker (maximum) using any compatible lamp.

e. A ballast factor between 0.85 (minimum) and 1.00 (maximum). Current crest factor - 1.7 (maximum).

f. UL listed Class P with a sound rating of "A."

g. Include circuit diagrams and lamp connections displayed on the ballast.

h. Provide instant start ballasts unless otherwise indicated, with programmed start where indicated. Provide instant start ballasts which operate lamps in a parallel circuit configuration that permits the operation of remaining lamps if one or more lamps fail or are removed.

i. Provide programmed start ballasts for compact fluorescent fixtures.

j. Provide ballasts for T-5 and smaller lamps with end-of-life protection circuits as required by ANSI/IEC C78.81 and ANSI/IEC C78.901 as applicable.

k. Provide ballasts capable of starting and maintaining operation at a minimum of 0 degrees F unless otherwise indicated.

l. Provide electronic ballasts with a full replacement warranty of 5 years from date of manufacture as specified in paragraph entitled "Electronic Ballast Warranty" herein.

2.2.1.1 T-8 Lamp Ballast

a. Total harmonic distortion (THD): 20 percent (maximum).

b. Input wattage.

1. 32 watts (maximum) when operating one F32T8 lamp

2. 62 watts (maximum) when operating two F32T8 lamps

3. 92 watts (maximum) when operating three F32T8 lamps

4. 114 watts (maximum) when operating four F32T8 lamps

c. Ballast efficacy factor.

1. 2.54 (minimum) when operating one F32T8 lamp

2. 1.44 (minimum) when operating two F32T8 lamps

3. 0.93 (minimum) when operating three F32T8 lamps

4. 0.73 (minimum) when operating four F32T8 lamps

d. Provide three and four lamp fixtures with two ballasts per fixture where multilevel switching is indicated.

2.2.1.2 F17T8 Lamp Ballast

Provide F17T8 ballasts with:

a. Total harmonic distortion (THD): 25 percent (maximum).

b. Input wattage:

1. 34 watts (maximum) when operating two F17T8 lamps.

2.2.1.3 T-5 Long Twin Tube Lamp Ballast

a. Total harmonic distortion (THD): No greater than 25 percent when operating one lamp, 15 percent when operating two lamps, and 20 percent when operating three lamps.

b. Input wattage:

1. 45 watts (maximum) when operating one F40 T-5 lamps

2. 74 watts (maximum) when operating two F40 T-5 lamps

3. 105 watts (maximum) when operating three F40 T-5 lamps

c. Provide three and four lamp fixtures with two ballasts per fixture where multilevel switching is indicated.

2.2.1.4 F96T8 Lamp Ballast

a. Total harmonic distortion (THD): No greater than 30 percent when operating one lamp and 20 percent when operating two lamps.

b. Input wattage:

1. 56 watts (maximum) when operating one F96T8 lamps

2. 102 watts (maximum) when operating two F96T8 lamps

2.2.2 Fluorescent Lamps

a. Provide T-8 rapid start low mercury lamps rated 32 watts (maximum), 2800 initial lumens (minimum), CRI of 75 (minimum), color temperature of 3500 K, with an average rated life of 20,000 hours. Provide low mercury lamps which have passed the EPA Toxicity Characteristic Leachate Procedure (TCLP) for mercury by using the lamp sample preparation procedure described in ANSI/NEMA C78.LL 1256.

g. Provide compact fluorescent lamps: CRI 80, minimum, 3500 K, 10,000 hours average rated life, and as follows:

1. T-4, twin tube, rated as indicated.

2. T-4, double twin tube, rated as indicated.

Average rated life is based on 3 hours operating per start.

2.2.3 Compact Fluorescent Fixtures

Provide compact fluorescent fixtures manufactured specifically for compact fluorescent lamps with ballasts integral to the fixture. Providing assemblies designed to retrofit incandescent fixtures is prohibited except when specifically indicated for renovation of existing fixtures. Provide fixtures using lamps as indicated, with a minimum CRI of 80.

2.2.3.1 Bare Bulb Retrofits

Replace 40-watt incandescent bulbs (495plus lumens) with 11- to 14-watt compact fluorescent bulbs (45 plus lumens per watt). Replace 60-watt incandescent bulbs (900 plus lumens) with 15- to 19-watt compact fluorescent bulbs (60 plus lumens per watt). Replace 75-watt incandescent bulbs (1200 plus lumens) with 20- to 25-watt compact fluorescent bulbs (60 plus lumens per watt). Replace 100-watt incandescent bulbs (1750 plus lumens) with 29-watt or greater compact fluorescent bulbs (60 plus lumens per watt).

2.2.3.2 Reflector Type Bulb Retrofits

Replace 50-watt incandescent bulbs (550 plus lumens) with 17- to 19-watt compact fluorescent bulbs (33 plus lumens per watt). Replace 60-watt incandescent bulbs (675 plus lumens) with 20- to 21-watt compact fluorescent bulbs (40 plus lumens per watt). Replace 75-watt incandescent bulbs (875 plus lumens) with 22-watt or greater compact fluorescent bulbs (40 plus lumens per watt).

2.3 HIGH-INTENSITY-DISCHARGE (HID) LIGHTING FIXTURES

UL 1598. Provide HID fixtures with tempered glass lenses when using metal-halide lamps.

2.3.1 HID Ballasts

Provide HID ballasts conforming to UL 1029 and ANSI C82.4, with constant wattage autotransformer (CWA) or regulator, high power factor type (minimum 90 percent). Provide single-lamp ballasts which have a minimum starting temperature of minus minus 22 degrees F. Provide ballasts:

a. Designed to operate on the voltage system to which they are connected.

b. Designed for installation in a normal ambient temperature of 105 degrees F.

c. Constructed so that open circuit operation will not reduce the average life.

Provide high-pressure sodium (HPS) ballasts with a solid-state igniter/starter with an average life in the pulsing mode of 3500 hours at the intended ambient temperature. Igniter case temperature is not to exceed 195 degrees F in any mode.

2.3.2 Metal-Halide Lamps

a. Double-ended, 70 watt, conforming to ANSI C78.1381

b. Single-ended, wattage as indicated, conforming to ANSI/ANSLG C78.43

2.3.2.1 Luminaire Efficiency Rating (LER)

a. Upward efficiency of 0 percent

1. 150-399 watts: Minimum 41 LER for closed fixture

2. 400-999 watts: Minimum 53 LER for closed fixture; minimum 59 for open fixture

3. 1000 plus watts: Minimum 77 LER for closed fixture

b. Upward efficiency of 1 percent-10 percent

1. 150-399 watts: Minimum 56 LER for closed fixture

2. 400-999 watts: Minimum 62 LER for closed fixture; minimum 64 for open fixture

3. 1000 plus watts: Minimum 88 LER for open fixture

c. Upward efficiency greater than 20 percent

1. 150-399 watts: Minimum 62 LER for closed fixture; minimum 77 for open fixture

2. 400-999 watts: Minimum 65 LER for closed fixture

2.4 INCANDESCENT LIGHTING FIXTURES

Use of incandescent lamps and fixtures is prohibited, unless specifically indicated otherwise. UL 1598.

2.5 RECESS- AND FLUSH-MOUNTED FIXTURES

Provide type that can be relamped from the bottom, with access to ballast from the bottom, with trim for the exposed surface of flush-mounted fixtures as indicated.

2.6 SUSPENDED FIXTURES

Provide hangers capable of supporting twice the combined weight of fixtures supported by hangers. Provide with swivel hangers to ensure a plumb installation, cadmium-plated steel with a swivel-ball tapped for the conduit size indicated. Provide hangers which allow fixtures to swing within an angle of 45 degrees. Brace pendants 4 feet or longer provided in shops or hangers to limit swinging. Provide single-unit suspended fluorescent fixtures with twin-stem hangers. Provide multiple-unit or continuous row fluorescent fixtures with 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 with a minimum 0.18 inch diameter.

2.7 FIXTURES FOR HAZARDOUS LOCATIONS

In addition to requirements stated herein, provide fixtures for hazardous locations which conform to UL 844 or which have Factory Mutual certification for the class and division indicated. Provide fixtures also conforming to UL 1598 for marine environments as indicated.

2.8 AUXILIARY INSTANT-ON SYSTEM

UL listed, automatically switched instant-on quartz lamp. Quartz lamp is to come on when luminaire is initially energized and following a momentary power outage and remain on until HID lamp reaches approximately 60 percent light output. Design wiring for quartz lamp internal to the ballast and independent of the incoming line voltage to the ballast. Provide instant-on quartz system as indicated.

2.9 SUPPORT HANGERS FOR LIGHTING FIXTURES IN SUSPENDED CEILINGS

2.9.1 Wires

ASTM A641/A641M, galvanized regular coating, soft temper, 0.1055 inches in diameter (12 gage).

2.9.2 Wires, for Humid Spaces

ASTM A580/A580M, composition 302 or 304, annealed stainless steel 0.1055 inches in diameter (12 gage).

2.9.3 Rods

Threaded steel rods, 3/16 inch diameter, zinc or cadmium coated.

2.10 EQUIPMENT IDENTIFICATION

2.10.1 Manufacturer's Nameplate

Provide each item of equipment with 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.

2.10.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements. Clearly mark all for operation of specific lamps and ballasts according to proper lamp type. Note the following lamp characteristics:

a. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.

b. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.

c. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.

d. ANSI ballast type (M98, M57, etc.) for HID luminaires.

e. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

Provide all markings related to lamp type clear and located to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Provide ballasts with clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.11 FACTORY APPLIED FINISH

Provide electrical equipment with factory-applied painting systems which , as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.

2.12 ENCLOSED AND GASKETED VAPOR-TIGHT FIXTURES

Provide enclosed and gasketed vapor-tight fixtures suitable for wet or damp locations consisting of a cast-aluminum body, cap or matching outlet box, porcelain lampholder, glass enclosing globe, cork gaskets, and cast-aluminum guards for wall, ceiling, or pendant mounting in accordance with UL 1598 and NFPA 70.

Furnish exposed cast aluminum outlet boxes for wall- and ceiling-mounted fixtures with four tapped hubs 90 degrees apart circumferentially, with three cast-aluminum threaded pipe plugs to fit the tapped holes. Provide boxes with ears or lugs for surface mounting to wall or ceiling. Provide body with mounting screws and gasket to ensure a vapor-tight joint between the body and outlet box.

Concealed outlet boxes for wall- and ceiling-mounted fixtures may be standard sheet metal boxes. Provide fixture body with mounting screws and gasket to ensure a vapor-tight joint between the body and outlet box.

Seal body and cap for pendant-mounted fixtures with a gasket at the joint. Provide cast aluminum cap with top hub tapped for 1/2 inch tapered iron pipe threads.

Furnish cast aluminum exposed outlet boxes for pendant-mounted fixtures with the fixtures with four tapped hubs 90 degrees apart circumferentially, with three cast-aluminum threaded pipe plugs to fit the tapped holes.

Supply boxes with ears or lugs for surface mounting to the ceiling. Provide cast aluminum outlet-box covers for concealed and exposed outlet boxes with the center hub tapped for 1/2 inch tapered iron pipe threads. Provide cover and outlet box with mounting screws and gasket to ensure a vapor-tight joint between the cover and outlet box. Also provide 1/2 inch galvanized rigid steel conduit stem.

Provide clear nondiffusing heat-resistant glass enclosing globe molded in one piece into a cylindrical shape with a closed bowl-shaped bottom and an open molded top bead or thread. Make edges of the open end either ground or molded to a smooth, true surface that will ensure a vapor-tight joint when the globe is fastened to the gasketed body.

Provide a cast-aluminum guard of the same shape as the glass enclosing globe which is affixed to the fixture body with threads or setscrews.

PART 3 EXECUTION

3.1 INSTALLATION

Ensure all electrical installations conform to IEEE C2, NFPA 70, and to the requirements specified herein.

3.1.1 Lamps

Deliver lamps of the type, wattage, and voltage rating indicated to the project in the original cartons and installed just prior to project completion. Replace lamps installed and used for working light during construction prior to turnover to the Government if more than 15 percent of their rated life has been used. Test the lamps for proper operation prior to turn-over and replace if necessary with new lamps from the original manufacturer. Provide 10 percent spare lamps of each type from the original manufacturer.

3.1.2 Lighting Fixtures

Set lighting fixtures plumb, square, and level with ceiling structure and walls, in alignment with adjacent lighting fixtures, and secure in accordance with manufacturers' directions and approved drawings, in conformance with the requirements of NFPA 70. Mounting heights specified or indicated are to the bottom of fixture for ceiling-mounted fixtures and to center of fixture for wall-mounted fixtures. Obtain approval of the exact mounting for lighting fixtures on the job before commencing installation and, where applicable, after coordinating with the type, style, and pattern of the ceiling being installed. Independently support recessed and semi-recessed fixtures from the building structure by a minimum of four wires or rods per fixture and located near each corner of each fixture. Ceiling grid clips are not allowed as an alternative to independently supported light fixtures. Independently support round fixtures smaller in size than the ceiling grid from the building structure by a minimum of four wires or rods per fixture spaced approximately equidistant around the fixture. Do not support fixtures by ceiling acoustical panels. Where fixtures of sizes less than the ceiling grid are indicated to be centered in the acoustical panel, support such fixtures independently and provide at least two 3/4 inch metal channels spanning, and secured to, the ceiling tees for centering and aligning the fixture. Provide wires or rods for lighting fixture support in this section.

3.1.3 Ballasts

3.1.3.1 Remote Ballasts

Mount remote type ballasts or transformers, where indicated, in a well ventilated, easily accessible location, within the maximum operating distance from the lamp, as designated by the manufacturer.

3.2 FIELD APPLIED PAINTING

Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria. Specify painting in Section 09 90 00.00 98 PAINTING AND COATING.

3.3 FIELD QUALITY CONTROL

Upon completion of installation, verify that equipment is properly installed, connected, and adjusted. Conduct an operating test to show that equipment operates in accordance with requirements of this section.

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DIVISION 26 - ELECTRICAL

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EMERGENCY LIGHTING

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.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2012; Amendment 1 2012) Life Safety Code
NFPA 70	(2011; Errata 2 2012) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 924	(2006; Reprint Feb 2011) Standard for Emergency Lighting and Power Equipment

1.2 ADMINISTRATIVE REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

1.2.1 Pre-Installation Meetings

No later than 60 days after contract award, submit installation drawings for the Central Emergency Lighting Systems indicating location of installed fixtures.

Submit Material, Equipment, and Fixture Lists showing manufacturer's style or catalog numbers, specification and drawing reference numbers, sample warranty, and fabrication site location. Also submit manufacturer's catalog data and Certificates of Conformance for the following items:

a. Emergency Lighting Egress Units
b. Emergency Fluorescent Lighting
c. Central Emergency Lighting Systems
d. Accessories

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists; G
sample warranty; G

SD-02 Shop Drawings

Central Emergency Lighting Systems; G

SD-03 Product Data

Emergency Lighting Egress Units; G
Emergency Fluorescent Lighting; G
Central Emergency Lighting Systems; G
Accessories; G

SD-06 Test Reports

System Operational Tests; G

SD-07 Certificates

Certificates of Conformance; G
Warranty; G

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Furnish emergency lighting units completely assembled with wiring and mounting devices, ready for installation at the locations indicated. Equip fixtures with lamps. Ensure emergency lighting units are suitable for operation on the ac supply circuit to which they are to be electrically connected.

2.1.1 Performance Requirements

Provide emergency lighting units conforming to UL 924 and NFPA 101.

2.2 MANUFACTURED UNITS

2.2.1 Emergency Lighting Egress Units

Provide complete self-contained emergency lighting units with batteries, battery charger, one or more local or remote lamp heads with lamps, under-voltage relay, indicator lights, on/off switch, and test switch, in accordance with UL 924 for Type I (emergency light set), Class I, Style D, as indicated.

2.2.1.1 Batteries

Provide batteries rated not less than 6-12 volts. Provide batteries with the capacity and rating to supply the lamp load with maintained 87.5-percent power, minimum, for 1.5 hours, or the battery-lamp combination maintaining 60-percent, minimum, illumination. Provide maintenance-free nickel-cadmium type batteries, with a minimum normal life of 10 years.

2.2.1.2 Battery Charger

Include in battery charger a dry-type full-wave rectifier with two charging rates, one to automatically maintain the battery in a fully charged state under normal conditions and the other to automatically recharge the battery to a fully charged state within 12 hours after continuous discharge of

1-1/2 hours through the connected lampload.

2.2.1.3 Unit Enclosure

Fabricate the unit enclosure from sheet steel not less than 18 gage. Design of cover is to provide access to the battery and battery-charger compartments and have a full-length piano hinge and a latching device. Protect component parts within the enclosure from dust, moisture, and oxidizing fumes from the battery. Coat interior and exterior surfaces of enclosure with a corrosion-resistant gray baked-enamel finish.

2.2.1.4 Lampheads, Lamps, and Indicating Lights

Mount the lampheads on the top of the unit enclosure, or wall mount, except where otherwise indicated and fully adjustable in the horizontal and vertical planes. Provide steel lamp head assembly with nickel plating. Form the exterior housing of the lamp from nickel -plated sheet steel.

Provide sealed-beam type lamps, halogen, rated not less than 12 watts at the specified dc voltage.

Mount an amber "ready-for-use on alternating current" indicating light, a red "recharging on alternating current" indicating light, and a momentary-contact pushbutton test switch on the cover of the unit enclosure. The amber light indicates, when illuminated, that the unit is electrically connected to the normal ac supply source and that the battery is fully charged. The red light indicates, when illuminated, that the battery is being recharged. The momentary-contact pushbutton test switch transfers the unit from normal supply to battery supply and tests operation of equipment under simulated ac source power failure.

2.2.1.5 Relays and Switches

Provide an under-voltage relay of the self-clearing type which automatically connects the lampload to the battery supply upon failure of the alternating current supply. Mount an on-off toggle switch inside the unit enclosure to disconnect the battery from the lampload when the unit is taken out of service for maintenance purposes. The relay energizes when the ac supply falls to 70 percent of normal voltage.

2.2.1.6 Mounting Shelves

Provide emergency lighting units with angle iron mounting shelves and with a protective screen designed by the equipment manufacturer for this purpose. Coat the mounting shelf and screen with a corrosion-resistant finish in accordance with manufacturer's standard practice.

2.2.2 Emergency Fluorescent Lighting

Provide each unit with an automatic power failure device, test switch, pilot light, and fully automatic high/low trickle charger in a self-contained solid-state, temperature-compensated power-pack. Provide gelled-electrolyte type battery with capacity as required to supply power to provide a minimum of 600 lumens using a 40-watt rapid start lamp. Provide a sealed and maintenance-free battery, with an active life of not less than 10 years under normal operating conditions.

2.2.3 Central Emergency Lighting Systems

Provide a central power system providing emergency power at voltages as indicated, 60 hertz, for a minimum period of 90 minutes. Design the system to handle surges during loss and recovery of the voltage, and to deliver its full rated output to designated lamp load. Provide backup ac source for power.

2.2.3.1 Operation

Upon loss of normal supply voltage, design the system to automatically disengage itself from the normal input line, switching to a self-contained inverter with built-in protection when the output is shorted or overloaded. When normal line voltage resumes, the emergency system automatically switches back to normal operation. Size the transfer switch for this function to handle 125 percent of full load. Battery systems are to include self-contained inverters with overload protection.

2.2.3.2 Charger

Provide a completely automatic battery charger, which maintains the batteries in a fully charged condition, and recharges the batteries to full capacity within 24 hours after full discharge in accordance with UL 924.

2.2.3.3 Batteries

Provide sealed nickel-cadmium type batteries, maintenance-free for a period of not less than 10 years under normal operating conditions.

2.2.3.4 Accessories

Provide visual indicators to indicate normal power, inverter power, and battery charger operation. Provide low-voltage test switch to simulate power failure by interrupting the input line, voltage meter, electrolyte level detector to automatically disable the charging circuit in the event of a fault, and low voltage cutoff to prevent extreme battery power dissipation.

2.2.3.5 Enclosure

Provide a free-standing cabinet with floor stand and constructed of 12-gauge sheet steel with baked-on enamel finish and locking type latch.

2.2.4 Self-Testing Module

Provide self-testing module for exit signs and emergency lighting equipment which performs the following functions:

a. Continuous monitoring of charger operation and battery voltage with visual indication of normal operation and of malfunction.

b. Monthly discharge cycling of battery with monitoring of transfer circuit function, battery capacity and emergency lamp operation with visual indication of malfunction. Conduct the battery capacity test using a synthetic load.

c. Manual test switch to simulate a discharge test cycle.

d. Provide module with low voltage battery disconnect (LVD) and brown-out

protection circuit.

PART 3 EXECUTION

3.1 INSTALLATION

Permanently fix in place the emergency lighting unit and install wiring for each unit in accordance with NFPA 70. Use the same panel bus or branch circuit as that serving the normal lighting in the area for the branch circuit feeding the unit equipment, and connect ahead of area switches. Keep remotely connected emergency lighting circuit wiring independent of all other wiring and equipment and do not enter the same conduit, cable, box, or cabinet with other wiring unless the fixture is supplied from two sources.

Mount emergency lighting units and remote lamps at a minimum of 7 feet above the finished floor.

3.2 FIELD TESTING

Demonstrate emergency lighting units to operate satisfactorily in the presence of the Contracting Officer.

Perform and submit System Operational Tests in accordance with referenced standards in this section.

3.3 WARRANTY

Submit warranty, signed by an authorized representative, designating the Government as warrantee, to the Contracting Officer, 5 days prior to project closeout.

-- End of Section --

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EXIT SIGNS

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.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2012; Amendment 1 2012) Life Safety Code

U.S. DEPARTMENT OF ENERGY (DOE)

DOE LT-4	(2000) How to Buy Energy-Efficient Exit Signs

UNDERWRITERS LABORATORIES (UL)

UL 924	(2006; Reprint Feb 2011) Standard for Emergency Lighting and Power Equipment

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Material, Equipment, and Fixture Lists shall be submitted for the following showing manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Material, Equipment, and Fixture Lists shall be submitted for the following in accordance with paragraph entitled, "General Requirements," of this section.

Exit Lighting Units
Contemporary Fixtures

SD-02 Shop Drawings

Installation drawings shall be submitted for Exit Lighting Units in accordance with the paragraph entitled, "Installation," of this section.

Outline drawings shall be submitted for Exit Lighting Units indicating overall physical features, dimensions, ratings, service requirements, and weights of equipment.

SD-03 Product Data

Manufacturer's catalog data shall be submitted for the following items:

Exit Lighting Units
Contemporary Fixtures

SD-06 Test Reports

Test reports shall be submitted showing results of Operational Tests of exit lighting systems.

SD-07 Certificates

Certificates shall be submitted showing compliance with the following requirements.

Efficiencies

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

Emergency exit lighting fixtures shall conform to UL 924, NFPA 101, and as specified.

Exit lighting fixtures shall be furnished completely assembled with wiring and mounting devices and ready for installation at the locations indicated. Ceiling-mounted fixtures shall be designed to be supported independent of the ceiling. Fixtures shall be equipped with lamps.

2.1.1 Efficiencies

Exit lighting fixtures shall have efficiencies in accordance with the recommended levels specified in DOE LT-4.

2.2 CONTEMPORARY FIXTURES

Contemporary exit lighting fixture shall have a fixture body with edge-lighted plastic exit-sign panels, face trims, lamps, lampholders, and mounting brackets for top, back, and end mounting to walls and ceilings in accordance with NFPA 101, as indicated.

Fixtures shall be single or double face with thin wedge-shaped vertical cross sections. Top edge of double-face fixtures shall be not more than 2-3/4-inches thick. Top edge of single-face fixtures shall be not more than 2-inches thick. Bottom edge of double-face fixtures shall be not more than 1-3/4-inches thick. Bottom edge of single-face fixtures shall be not more than 1-1/4-inches thick.

Plastic sign panels shall be acrylic with green translucent letters and directional arrows, as required. Letters shall be 6-inches high with stroke not less than 3/4 inch wide.

Wireway cover and plastic sign backup plate shall be anodized sheet aluminum with a matte finish. Face trims shall be formed from sheet aluminum and shall have a brushed-satin finish. Fixture bodies formed from sheet steel shall be not less than20 gauge and painted.

Plastic sign panels shall be edge-lighted from the top with at least two low-voltage miniature incandescent lamps that will illuminate the plastic sign panels and floor. Exit signs shall be wired for two-circuit service at voltage indicated and shall include a diode circuit that will provide a minimum of 50,000 hours of lamp life.

Mounting plates and brackets formed from sheet aluminum or plate shall have a brushed-satin finish. Mounting plates shall be not less than 4-1/2 inches square and designed to secure the fixture to a 4 inch square outlet box.

2.3 EMERGENCY POWER LOSS EXIT LIGHTING UNITS

Each self-contained unit shall have an automatic power failure device, test switch, pilot light, and fully automatic high/low solid-state trickle charger in a self-contained power pack. Battery shall be the gelled-electrolyte type and shall be maintenance-free for a period of not less than 10-years under normal operating conditions. Normal operation shall be with voltage indicated. Emergency lighting panel shall be used.

2.4 LIGHT EMITTING DIODES (LEDs) EXIT LIGHTING FIXTURES

Exit lighting fixtures shall include sheetmetal enclosures with frames, battery charger, batteries, green light emitting diodes (LEDs) and mounting brackets. Fixtures shall be single or double faced as indicated. Mounting plates shall be suitable for securing the fixture to a 4 inchoutlet box. Fixture features shall include continuous charging, automatic switching to standby batteries upon loss of power, overload protection, short circuit protection, test switch, low voltage disconnect, switch controlled left and right LED directional arrows, and shall be field connectable to operate from voltage indicated. Minimum operating time of the battery system shall be three (3) hours for double faced fixtures and seven (7) hours for single faced fixtures. Brightness shall not be less than ten (10) candlepower. All components shall have a five year warranty.

PART 3 EXECUTION

3.1 INSTALLATION

Fixtures shall be connected to the main panel bus through overcurrent protection. Emergency lighting panel shall be used where available.

3.2 FIELD TESTING

Exit lighting shall be demonstrated to operate satisfactorily in the presence of the Contracting Officer.

Operational Tests shall be performed in accordance with referenced standards in this section.

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FLOOD LIGHTING

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.

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IES)

IES HB-10	(2011) IES Lighting Handbook

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2	(2012; Errata 2012; INT 1 2012; INT 2 2012) National Electrical Safety Code
IEEE Stds Dictionary	(2009) IEEE Standards Dictionary: Glossary of Terms & Definitions

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI C78.379	(2006) American National Standard for Electric Lamps--Classification of the Beam Patterns of Reflector Lamps
ANSI C82.4	(2002) American National Standard for Ballasts for High-Intensity-Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type)
NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA ICS 6	(1993; R 2011) Enclosures
NEMA LSD 25	(2008) Best Practices for Metal Halide Lighting Systems, Plus Questions and Answers about Lamp Ruptures in Metal Halide Lighting Systems

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 1029	(1994; Reprint May 2011) High-Intensity-Discharge Lamp Ballasts
UL 1598	(2008; Reprint Jan 2010) Luminaires

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Submit Certificates showing compliance with the following requirements:

Lighting-distribution curves for each type of fixture in accordance with the Illuminating Engineering Society and ANSI C78.379.

Certification that Floodlighting Fixtures conform to structural, electrical, and photometric requirements.

Submit Equipment and Performance Data for floodlighting systems consisting of life, test, system functional flows, safety features, mechanical automated details, automatic interlocks, and such features as electrical system protective device ratings.

1.3 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE Stds Dictionary.

b. Average life is the time after which 50 percent will have failed and 50 percent will have survived under normal conditions.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Equipment and Performance Data for floodlighting systems in accordance with paragraph entitled, "General Requirements," of this section.

Manufacturer's catalog data for the following Luminaires:

Floodlighting Fixtures
Floodlighting Luminaires

High-Intensity-Discharge (HID) Luminaires

Lamp Ballasts

SD-02 Shop Drawings

Installation Drawings for the Floodlighting Systems (including luminaire drawings)in accordance with the paragraph entitled "Installation," of this section.

SD-04 Samples

Luminaires; G

Submit one sample of each luminaire type, complete with lamp and ballast. Submit one sample for each item other than luminaires. Sample will be returned to the Contractor for installation in the project work.

SD-05 Design Data

Design Data for luminaires; G

SD-06 Test Reports

Test reports for Operational Tests on incandescent lighting fixtures in accordance with the paragraph entitled, "Field Testing," of this section.

SD-07 Certificates

Certificates in accordance with paragraph entitled, "General Requirements," of this section.

Floodlighting Fixtures

SD-10 Operation and Maintenance Data

Operational Service

Submit 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.

1.5 QUALITY ASSURANCE

1.5.1 Drawing Requirements

1.5.1.1 Luminaire Drawings

Include dimensions, accessories, and installation and construction details. Accompany shop drawings with photometric data, including zonal lumen data, average and minimum ratio, aiming diagram, and candlepower distribution data.

1.5.2 Design Data for Luminaires

a. Distribution data according to IES classification type as defined in IES HB-10.

b. Computerized horizontal illumination levels in footcandles at ground level, taken every 10 feet. Include average maintained footcandle level and maximum and minimum ratio.

c. Amount of shielding on luminaires.

1.5.3 Standard Products

Provide materials and equipment, conforming to IEEE C2, that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship, which have been in

satisfactory commercial or industrial use for 2 years prior to bid opening 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, 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.

1.5.3.1 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.

1.5.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 3 years prior to date of delivery to site are not allowed, unless specified otherwise.

1.6 WARRANTY

Provide support for the 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.

PART 2 PRODUCTS

2.1 PRODUCT STANDARDS

Floodlighting fixtures shall conform to IES HB-10.

Provide floodlighting fixtures complete with wiring, enclosures conforming to NEMA ICS 6, and mounting devices ready for installation at the locations. Equip all fixtures with the proper lamps.

2.2 FLOODLIGHTING LUMINAIRES

Provide floodlighting luminaires which are enclosed and gasketed vaportight fixtures in accordance with IES HB-10 and UL 1029.

2.3 HIGH-INTENSITY-DISCHARGE (HID) LUMINAIRES

Include with HID luminaires, with base-down vertical-lamp burning positions, a housing with glass lens and cover, reflector, lampholder, ballast compartment, terminal block, fuses, fuseholders, and fixture mounting devices in a completely sealed optical system.

Provide cast aluminum housing with hinged cast-aluminum cover, heat-resistant clear plain glass lens not less than 3/16-inch thick, gasket, and cover clamps. Include with housing a weatherproof seal against moisture and foreign material, and an integral cast-aluminum ballast compartment with built-in ballast and terminal block.

Provide detachable reflector, formed anodized sheet aluminum with diffuse or specular finish designed for a rectangular wide-beam spread.

2.3.1 Mounting Devices

Include with fixture mounting devices a galvanized-steel trunnion adaptable to pole, wall, pipe, or crossarm mounting as indicated and required, with fixture positioning devices that will permit horizontal and vertical adjustment over a 180-degree range.

2.3.2 Focusing, Fusing,and Connecting

Provide fixture with lamp focusing adjustments, fixture aiming and leveling devices, fuses, and fuseholders accessible from the outside of the fixture, and replaceable lamps from the top or front.

Make electrical connections with Type AFS cord.

2.4 LAMP BALLASTS

Provide lamp ballasts which maintain correct lamp operation over a voltage-input range of plus or minus 13 percent of rated voltage, with capacitors providing a power-factor lamp load of not less than 95 percent. Provide ballasts conforming to ANSI C82.4

Provide ballasts voltage rated for operation on voltage as indicated, single-phase, 60-hertz lighting-distribution systems.

Design ballasts for a minimum lamp starting temperature of minus 20 degrees F and a maximum ambient temperature of 105 degrees F.

2.5 LAMPS

2.5.1 Metal Halide

Provide Metal Halide lamps conforming to NEMA LSD 25.

2.6 EQUIPMENT IDENTIFICATION

2.6.1 Manufacturer's Nameplate

Provide each item of equipment with 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.

2.6.2 Labels

Provide labeled luminaires in accordance with UL 1598 requirements, clearly marked for operation of specific lamps and ballasts according to proper lamp type. Note the following lamp characteristics:

a. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.

b. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.

c. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.

d. ANSI ballast type (M98, M57, etc.) for HID luminaires.

e. Correlated color temperature (CCT) and color rendering index (CRI) for all luminaires.

Make markings related to lamp type clear and locate to be readily visible to service personnel, but unseen from normal viewing angles when lamps are in place. Provide ballasts with clear markings indicating multi-level outputs and indicate proper terminals for the various outputs.

2.7 FACTORY APPLIED FINISH

Factory apply painting system to electrical equipment which as a minimum, meets the requirements of NEMA 250 corrosion-resistance test.

PART 3 EXECUTION

3.1 INSTALLATION

Install floodlighting fixtures in accordance with NFPA 70, with lamps of the proper type, voltage, and wattage in each fixture.

Install new lamps immediately prior to completion of the project. Install lamps with the light center at the focal point in the reflector and in the proper burning position. Aim fixtures at night to provide optimum light coverage.

Submit Installation Drawings for Floodlighting Systems. Indicate on drawings overall physical features, dimensions, ratings, service requirements, and weights of equipment.

3.2 FIELD TESTING

Demonstrate that floodlighting fixtures installation operates satisfactorily in the presence of the Contracting Officer.

Perform Operational Tests in accordance with referenced standards in this section. Provide written documentation and point of contact for operational service.

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SECTION 26 60 13.00 40

LOW-VOLTAGE MOTORS

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 BEARING MANUFACTURERS ASSOCIATION (ABMA)

ABMA 11	(1990; R 2008) Load Ratings and Fatigue Life for Roller Bearings
ABMA 9	(1990; R 2008) Load Ratings and Fatigue Life for Ball Bearings

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 112	(2004) Standard Test Procedure for Polyphase Induction Motors and Generators

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

NETA ATS	(2009) Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems
NETA MAINT	(2011) Standard for Maintenance Testing Specifications for Electric Power Distribution Equipment and Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 1940-1	(2003; Cor 2005) Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA MG 1	(2011) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

U.S. DEPARTMENT OF ENERGY (DOE)

DOE CI-1	(2001) How to Buy a Premium Energy-Efficient Electric Motor

1.2 ADMINISTRATIVE REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

1.2.1 Pre-Installation Meeting

The Contracting Officer will schedule a pre-installation meeting within 60 days of Contract Award. Provide the following for review and approval:

a. Submit informational drawings for Low-Voltage Motors indicating the overall physical features, dimensions, ratings, service requirements, and weights of equipment.

b. Submit equipment and performance data for Low-Voltage Motors consisting of:

(1) Use life

(2) System functional flows

(3) Safety features

(4) Mechanical automated details

(5) Data curves indicating tested and certified equipment response and performance characteristics

(6) Sample warranty with submittal for review and approval by the Contracting Officer

c. For Electric Motors rated over 10 hp and those specified to meet a special vibration class in accordance with NEMA MG 1indicate number of:

(1) Rotor bars

(2) Stator slots

(3) Rotational speed

(4) Cooling fan blades

(5) Bearing manufacturer

(6) Bearing style

(7) Bearing type

(8) Balls/Elements

(9) Commutator bars

(10) Commutator brushes

(11) SCR firing frequencies (for variable speed motors)

d. Submit manufacturer's instructions for Low-Voltage Motors including special provisions required to install equipment components and system packages. Include all special notices regarding detail impedances,

hazards and safety precautions.

e. Submit certificates for the following tests showing conformance with the referenced standards contained in this section. Certified copies of previous test reports on identical Low-Voltage Motors may be submitted in lieu of factory test reports.

(1) Factory test results

(2) Efficiency

(3) Power-Factor

(4) Service factor

(5) Temperature rating

(6) Noise

(7) Full-Load

(8) Locked-Rotor

(9) Insulation resistance

(10) Winding resistance

(11) High-Potential tests

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Sample Warranty; G

Equipment and Performance Data; G

Manufacturer's Instructions; G

SD-02 Shop Drawings

Informational Drawings; G

SD-03 Product Data

Motor Enclosures; G

Rotor Bars; G

Stator Slots; G

Rotational Speed; G

Cooling Fan Blades; G

Bearing Manufacturer; G

Bearing Style; G

Bearing Type; G

Balls/Elements; G

Commutator Bars; G

Commutator Brushes; G

SCR Firing Frequencies; G

SD-07 Certificates

Factory Test Results; G

Efficiency; G

Power-Factor; G

Service Factor; G

Temperature Rating; G

Noise; G

Full-Load; G

Locked-Rotor; G

Insulation Resistance; G

Winding Resistance; G

High-Potential Tests; G

SD-08 Manufacturer's Instructions

Motors; G

SD-10 Operation and Maintenance Data

Operating and Maintenance Manual; G

SD-11 Closeout Submittals

Warranty; G

1.4 QUALITY ASSURANCE

1.5 DELIVERY, STORAGE, AND HANDLING

Ensure all motors and related equipment are packaged and protected to prevent any damage during shipping, after acceptance of delivery, storage, and handling at the project site. Include manufacturer's instructions for proper handling and uncrating with the shipment of the Low-Voltage Motor(s).

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide Low-Voltage Motors of a sufficient size for the duty to be performed not exceeding the full-load rating when the driven equipment is operating at specified capacity under the most severe loading conditions.

2.1.1 Motor Types

Mark Low-Voltage Motor with an index letter, from the letters shown below or a letter that indicates a higher efficiency.

Provide Low-Voltage Motors of the following types:

a. 1/3 HP and smaller, single phase - capacitor start

b. 1/2 HP and larger, three-phase - induction squirrel-cage type, NEMA Design B, having normal starting torque and low starting current

2.1.2 Design Requirements

Provide Low-Voltage Motors (LVM) designed for across-the-line starting with torque characteristics to carry the specified rated starting load. Ensure LVM have factory-sealed ball bearings with an L-10 rated life of not less than 50,000 hours in accordance with ABMA 9 or ABMA 11.

Ensure design, fabrication, testing, allowable balance limits and performance of polyphase induction motors are in accordance with NEMA MG 1 and ISO 1940-1 and meets or exceeds the requirements as specified herein.

Provide the following motor design data prior to final turnover:

a. Number of motor rotor bars

b. Stator slots

c. Rotational speed

d. Number of cooling fan blades

e. RPM of motor

f. Bearing manufacturer

g. Bearing type

h. Bearing style

i. Number of balls/elements

j. Number of commutator bars

k. Commutator brushes

l. SCR firing frequencies

2.1.2.1 Sizes Of Motors

Provide motors of a sufficient size for the duty to be performed, and not exceeding the full-load rating when the driven equipment is operating at specified capacity under the most severe loading conditions.

2.1.2.2 Efficiency

Ensure motors have efficiencies in accordance with the recommended levels specified in DOE CI-1.

Ensure efficiency labeling is in accordance with NEMA MG 1.

2.1.3 Electrically Driven Equipment

When electrically driven equipment differs from that indicated, ensure adjustments have been made to the motor size, wiring and conduit systems, disconnect devices, and circuit protection to accommodate the equipment actually installed, at no additional cost to the Government. Provide control and protective devices in accordance with Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.2 VOLTAGE RATINGS

Provide motors with the following minimum voltage ratings:

MOTOR SIZE			MOTOR
MOTOR TYPE	HORSEPOWER	SERVICE	VOLTAGE RATING
Fractional horsepower, single-phase	1/3 and smaller	120/208-volt, 3-phase, 4-wire	115-volt, 60-hertz
Fractional and integral horsepower, 3-phase	1/2 and larger	120/208-volt, 3-phase, 4-wire	200-volt, 3-phase 60-hertz
Fractional and integral horsepower, 3-phase	1/2 and larger	480-volt, 3-phase, 3-wire	230/460-volt, 3-phase, 60-hertz

2.3 TEMPERATURE RATING AND INSULATION

Provide motors designed for continuous operation at the rated full load in an ambient temperature of 104 degrees F, with an insulation level of at least Class F.

2.4 MOTOR HOUSINGS

Provide a smooth surface motor housing in the vertical, horizontal, and axial directions at each bearing housing for attaching a magnet mounted accelerometer in order to monitor the motor vibration. Ensure the smooth surface is on the bearing housing, with the axial surface as close to the motor centerline as possible. Provide a motor housing with a surface finish of 63 micro-inch minimum, corrosion resistant, with a minimum

diameter finished surface of 2 inch. As an option sound disks with a minimum thickness of 3/8 inch can be used to meet the smooth surface requirement.

Ensure surface is level within 1 degree or .001 inch.

Identify the smooth surface using a printed label or embossed plate stating "Vibration data collection point - Do Not Paint".

2.5 MOTOR ENCLOSURES

2.5.1 Indoor Type Enclosures

For motors installed in indoor, clean, dry, nonhazardous locations, provide the following:

a. Open-type drip-proof enclosures

b. Hinged access cover, large enough to enable the placement of a magnet/accelerometer data collection instrument, at each vibration collection point

For motors installed in indoor, wet, nonhazardous locations, provide the following:

a. Open splash-proof enclosures

b. Hinged access cover, large enough to enable the placement of a magnet/accelerometer data collection instrument, at each vibration collection point

For motors installed in indoor, nonhazardous locations where it is necessary to protect the motor from dirt, moisture, chemical fumes, or other harmful ingredients in the surrounding atmosphere, provide either of the following type of enclosure:

a. Totally enclosed, not fan-cooled, enclosures not equipped for cooling by means external to the enclosing parts, with a hinged access cover at each vibration collection point, large enough to enable the placement of a magnet/accelerometer data collection instrument.

b. Totally enclosed fan-cooled enclosures for exterior cooling by means of a fan or fans integral with the machine but external to the enclosing parts, with a hinged access cover at each vibration collection point, large enough to enable the placement of a magnet/accelerometer data collection instrument.

2.5.2 Outdoor Type Enclosures

For motors installed in outdoor, nonhazardous locations, provide waterproof enclosures.

For motors installed in hazardous locations for Classification I, Division 1 or Division 2, meet or exceed the minimum requirements of NFPA 70, Article 501.8, using the type of enclosure approved by the Contracting Officer prior to fabrication for the class and group of hazard in which the motors are located.

Provide all motors with weatherproof/waterproof enclosures with permanent

accelerometers installed in the horizontal, vertical, and axial directions. Ensure the enclosure has a penetration installed to enable the accelerometer cables to be routed to outside the enclosure. Include a NEMA 4R rated data collection box mounted to the outside of the motor enclosure in a location that is easily accessible.

2.6 SERVICE FACTOR

Ensure service factor of general purpose and other open ac motors is in accordance with NEMA MG 1.

Provide totally enclosed ac motors with a service factor of 1.15.

2.7 FACTORY TESTS

Factory test all motors in accordance with the requirements of NEMA MG 1. Ensure polyphase induction motors are factory-tested in accordance with IEEE 112, Method B, consisting of measurements of voltage, frequency, speed, and current under no-load conditions; voltage, frequency, and current under locked-rotor conditions; and efficiency, noise, power factor, and thermal protection. Verify routine tests on wound-rotor induction motors include the measurement of wound-rotor open-circuit voltage across the slip rings under locked-rotor conditions. Provide written documentation of electrical tests including winding resistance, insulation resistance, and high-potential tests. Submit certified copies of factory test results for approval prior to shipment from the factory. Previous test reports on identical motors are not acceptable for these tests.

PART 3 EXECUTION

3.1 INSTALLATION

Install, align, and connect motors in accordance with the equipment manufacturer's instructions.

Mount motors with bolts. Ensure motor feet are coplanar within 0.001 inch, and base mounting points are accessible and adjustable to enable machine alignment. For motors over 7.5 hp, provide alignment jack bolts installed to enable alignment.

Recheck alignment of motors and adjust as required after the motor has been in operation for not less than 48 hours.

3.2 ALIGNMENT

Before attempting alignment, demonstrate that the load does not have any load/force imposed by the piping system. Minimum alignment values (below) are for motor and load at normal running temperatures. Ensure values are compensated for thermal growth. Correct limited movement of the motor or load (commonly known as bolt-bound) to ensure alignment capability. Do not undercut hold down bolts in order to perform adjustment.

Provide commercially die-cut shims, without seams or folds, made of corrosion resistant stainless steel. Use no more than four shims at any single point.

Align motor and load to the following minimum specifications:

Speed(RPM)	Close-Coupled Offset (mils)	Close-Coupled Angle(mils/in.)	Spool Piece Angle (mils/in. @ coupling pt.)
600	6.0	2.0	3.0
900	5.0	1.5	2.0
1200	4.0	1.0	1.5
1800	3.0	0.5	1.0
3600	1.5	0.4	0.5
7200	1.0	0.3	0.4

Perform motor/load alignment under the direction of the manufacturer's representative.

Provide written final alignment settings as part of the final test data.

3.3 ELECTRICAL TESTS

Perform continuity test on all phases.

Perform insulation resistance and polarization index test on each phase of motor. Conduct insulation tests on 480-volt and 600-volt motors using a 1000-volt insulation test set. For insulation tests on motors rated less than 480-volts, use a 500-volt insulation test set.

Include in test data the location and identification of motors and megohm readings versus time. Record test data at 15, 30, 45 seconds, and in 1 minute increments thereafter up to 10 minutes. Ensure Megohm readings are not be less than 25 megohms for each phase; and each phase reading is within 10 percent of the other two.

Perform inspections and test procedures on all motors in accordance with NETA ATS and NETA MAINT 7.15.1 for rotating machinery, AC motors.

Calculate the polarization index of each phase by dividing the 10 minute reading by the 1 minute reading. Verify that the polarization index is than 1.25. Reject any lower values and return the motor to the factory.

3.4 VIBRATION TESTS

3.4.1 Vibration Analyzer

To measure vibration levels, use a Fast Fourier Transformer (FFT) analyzer having the following characteristics:

a. A dynamic range greater than 70 dB; a minimum of 400 line resolution

b. A frequency response range of 5 Hz-10 KHz(300-600000 cpm)

c. The capacity to perform ensemble averaging

d. The capability to use a Hanning window

e. Auto-ranging frequency amplitude

f. A minimum amplitude accuracy over the selected frequency range of plus or minus 20 percent or plus or minus 1.5 dB

Use an accelerometer, either stud-mounted or mounted using a rare earth, low mass magnet and sound disk (or finished surface) with the FFT analyzer

to collect data. Ensure the mass of the accelerometer and its mounting have minimal influence on the frequency response of the system over the selected measurement range.

3.4.2 Vibration Data

Collect vibration data in the axial, vertical, and horizontal direction for each motor bearing.

Obtain two narrowband spectra for each data collection point in the following manner:

a. For all machines regardless of operating speed, obtain a 5 to 500 Hz spectrum with a minimum of 400 lines of resolution.

b. Acquire an additional spectrum of 5 to 2500 or 5 to 5000 Hz for machines operating at or below 1800 RPM or greater than 1800 RPM, respectively.

Ensure vibration limits conform to the following:

Frequency Range(CPM)	Vibration limit(inch/sec)
0.3xRPM to 0.8xRPM	0.04
0.8xRPM to 1.2xRPM	0.75
1.2xRPM to 3.5xRPM	0.04
3.5xRPM to 120,000cpm	0.03

Provide final test reports to the Contracting Officer. Include with reports a cover letter/sheet clearly marked with the System name, Date, and the words "Final Test Reports - Forward to the Systems Engineer/Condition Monitoring Office/Predictive Testing Group for inclusion in the Maintenance Database."

3.5 OPERATION AND MAINTENANCE DATA

No later than 10 days prior to final acceptance, submit manufacturer's operating and maintenance manual to the Contracting Officer.

3.6 WARRANTY

No later than 10 days prior to final acceptance, submit manufacturer's warranty to the Contracting Officer.

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CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

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.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA VE 2 (2006) Cable Tray Installation Guidelines

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2011; Errata 2 2012) National Electrical Code

1.2 ADMINISTRATIVE REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

1.2.1 Pre-Installation Meetings

The Contracting Officer will schedule a pre-installation meeting within 30 days of Contract Award. Submit the following for review and approval:

a. Fabrication Drawings

b. Installation Drawings

Submit manufacturer's product data for the following items:

a. Cable Trays

b. Supports

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fabrication Drawings; G

Installation Drawings; G

SD-03 Product Data

Cable Trays; G

Supports; G

SD-08 Manufacturer's Instructions

Manufacturer's Instructions; G

1.4 QUALITY ASSURANCE

Comply with NEMA Standards Publication Number VE1, "Cable Tray Systems."

Comply with NEC, as applicable to construction and installation of cable tray and cable channel systems (Article 392 NEC).

Provide products that are UL-classified and labeled.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide ladder cable trays consisting of two longitudinal side members connected by individual transverse members.

Provide solid bottom trays consisting of two longitudinal side members connected by one-piece bottom section.

2.2 MATERIAL

Provide cable trays constructed of high-strength corrosion-resistant aluminum Alloy No. 5052-H32.

2.3 FABRICATION

Submit fabrication drawings for cable trays consisting of fabrication and assembly details to be performed in the factory.

Prior to assembly, coat contact surfaces of trays with an antioxidant compound. Finish edges, fittings, and hardware free from burrs and sharp edges. Include splice and end plates, dropouts, and miscellaneous hardware.

2.4 COMPONENTS

2.4.1 Supports

Permit both vertical and horizontal adjustment, where possible on supports and hangers. Provide an adequate bearing surface for the tray on the horizontal and vertical tray supports and have provisions for holddown clamps or fasteners. Provide a secure means other than friction for fastening cable trays to supports.

Support cable trays at not more than 6-foot intervals. Place supports for horizontal-elbow tray fittings within 2 feet of each fitting extremity and as recommended by the cable-tray manufacturer.

When supported at 6-foot intervals, the cable trays shall be capable of carrying not less than 150 pounds per linear foot. Tray fittings shall have not less than the load-carrying ability of straight tray sections and have the manufacturer's minimum standard radius.

PART 3 EXECUTION

Comply with NEMA VE 2 for cable tray installation.

3.1 INSTALLATION

3.1.1 Manufacturer's Instructions

Submit manufacturer's instructions for cable trays including special provisions required to install equipment components and system packages. Detail impedances, hazards and safety precautions.

3.1.2 Installation Drawings

Thirty calendar days prior to shipment, submit installation drawings to the Contracting Officer for approval. Coordinate drawings with all other work in the immediate area that could come in conflict with the installation. Include layout of cable tray work and details of both horizontal and vertical supports as specified in paragraph entitled, "Supports," of this section.

3.1.3 Grounding

Properly grounded cable trays by means of a low-resistance conductor of sufficient capacity, but in no case smaller than No. 3/0 AWG aluminum. Bond grounding conductor to cable-tray sections and fittings by compatible bolted connections. Consider cable tray sections in tandem assembly as having electrical continuity when these sections are bonded with appropriate high-strength bolts. Provide permanent and continuous effective grounding with an impedance sufficiently low to limit the potential above ground and to facilitate operation of overcurrent devices in the circuit. Provide grounding and bonding of cable trays in accordance with NFPA 70.

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BUILDING TELECOMMUNICATIONS CABLING SYSTEM

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 D709	(2001; R 2007) Laminated Thermosetting Materials

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA S-83-596	(2011) Indoor Optical Fiber Cables
ICEA S-90-661	(2008) Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables for Use in General Purpose and LAN Communications Wiring Systems Technical Requirements

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA/BICSI 568	(2006) Standard for Installing Building Telecommunications Cabling

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA WC 66	(2001; Errata 2003) Performance Standard for Category 6 and Category 7 100 Ohm Shielded and Unshielded Twisted Pairs

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

TIA J-STD-607	(2002a) Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
TIA-1152	(2009) Requirements for Field Test Instruments and Measurements for Balanced

	Twisted-Pair Cabling
TIA-455-21	(1988; R 2012) FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices
TIA-526-14	(2010b) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
TIA-526-7	(2002; R 2008) OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
TIA-568-C.0	(2009; Add 1 2010) Generic Telecommunications Cabling for Customer Premises
TIA-568-C.1	(2009; Add 2 2011; Add 1 2012) Commercial Building Telecommunications Cabling Standard
TIA-568-C.2	(2009; Errata 2010) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
TIA-568-C.3	(2008; Corrections 2008) Optical Fiber Cabling Components Standard
TIA-569	(2012c) Commercial Building Standard for Telecommunications Pathways and Spaces
TIA/EIA-598	(2005c) Optical Fiber Cable Color Coding
TIA/EIA-604-10	(2002a) FOCIS 10 Fiber Optic Connector Intermateability Standard - Type LC
TIA/EIA-604-12	(2000) FOCIS 12 Fiber Optic Connector Intermateability Standard Type MT-RJ
TIA/EIA-604-2	(2004b) FOCIS 2 Fiber Optic Connector Intermateability Standard
TIA/EIA-604-3	(2000b) Fiber Optic Connector Intermateability Standard (FOCIS), Type SC and SC-APC, FOCIS-3
TIA/EIA-606	(2002a; Errata 2007; R 2007; Adm 1 2008) Administration Standard for the Telecommunications Infrastructure

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 68	Connection of Terminal Equipment to the Telephone Network (47 CFR 68)

UNDERWRITERS LABORATORIES (UL)

UL 1863	(2004; Reprint Aug 2008) Communication Circuit Accessories

UL 444	(2008; Reprint Apr 2010) Communications Cables
UL 467	(2007) Grounding and Bonding Equipment
UL 514C	(1996; Reprint Novy 2011) Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 969	(1995; Reprint Nov 2008) Standard for Marking and Labeling Systems

1.2 RELATED REQUIREMENTS

Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL, apply to this section with additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in this specification shall be as defined in TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-569, TIA/EIA-606 and IEEE 100 and herein.

1.3.1 Campus Distributor (CD)

A distributor from which the campus backbone cabling emanates. (International expression for main cross-connect (MC).)

1.3.2 Building Distributor (BD)

A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect (IC).)

1.3.3 Floor Distributor (FD)

A distributor used to connect horizontal cable and cabling subsystems or equipment. (International expression for horizontal cross-connect (HC).)

1.3.4 Telecommunications Room (TR)

An enclosed space for housing telecommunications equipment, cable, terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and the horizontal cabling.

1.3.5 Entrance Facility (EF) (Telecommunications)

An entrance to the building for both private and public network service cables (including wireless) including the entrance point at the building wall and continuing to the equipment room.

1.3.6 Equipment Room (ER) (Telecommunications)

An environmentally controlled centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity.

1.3.7 Open Cable

Cabling that is not run in a raceway as defined by NFPA 70. This refers to cabling that is "open" to the space in which the cable has been installed and is therefore exposed to the environmental conditions associated with that space.

1.3.8 Open Office

A floor space division provided by furniture, moveable partitions, or other means instead of by building walls.

1.3.9 Pathway

A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.4 SYSTEM DESCRIPTION

The building telecommunications cabling and pathway system shall include permanently installed backbone and horizontal cabling, horizontal and backbone pathways, work area pathways, telecommunications outlet assemblies, conduit, raceway, and hardware for splicing, terminating, and interconnecting cabling necessary to transport telephone and data (including LAN) between equipment items in a building. The horizontal system shall be wired in a star topology from the KITS enclosures at the center or hub of the star to the floor MUTOAS. The backbone cabling and pathway system includes intrabuilding and interbuilding interconnecting cabling, pathway, and terminal hardware. The intrabuilding backbone provides connectivity from the MUTOAS to the KITS enclosure as required. Provide telecommunications pathway systems referenced herein as specified in Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

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. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Telecommunications drawings; G

In addition to Section 01 33 00 SUBMITTAL PROCEDURES, provide shop drawings in accordance with paragraph SHOP DRAWINGS.

SD-03 Product Data

Telecommunications cabling (backbone and horizontal); G

Telecommunications outlet/connector assemblies; G

Spare Parts; G

Submittals shall include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Include performance and characteristic curves. Submittals shall also include applicable federal, military, industry, and technical

society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information shall be submitted as specified in paragraph REGULATORY REQUIREMENTS and as required in Section 01 33 00 SUBMITTAL PROCEDURES.

SD-06 Test Reports

Telecommunications cabling testing; G

SD-07 Certificates

Telecommunications Contractor Qualifications; G

Key Personnel Qualifications; G

Manufacturer Qualifications; G

Test plan; G

SD-09 Manufacturer's Field Reports

Factory reel tests; G

SD-10 Operation and Maintenance Data

Telecommunications cabling and pathway system Data Package 5; G

SD-11 Closeout Submittals

Record Documentation; G

1.6 QUALITY ASSURANCE

1.6.1 Shop Drawings

In exception to Section 01 33 00 SUBMITTAL PROCEDURES, submitted plan drawings shall be a minimum of 11 by 17 inches in size using a minimum scale of 1/8 inch per foot, except as specified otherwise. 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. Submittals shall include the nameplate data, size, and capacity. Submittals shall also include applicable federal, military, industry, and technical society publication references.

1.6.1.1 Telecommunications Drawings

Provide registered communications distribution designer (RCDD) approved, drawings in accordance with TIA/EIA-606. The identifier for each termination and cable shall appear on the drawings. Drawings shall depict final telecommunications installed wiring system infrastructure in accordance with TIA/EIA-606. The drawings should provide details required to prove that the distribution system shall properly support connectivity from the KITS enclosures and MUTOAS to the telecommunications work area

outlets. The following drawings shall be provided as a minimum:

a. T1 - Layout of complete building per floor - Building Area/Serving Zone Boundaries, Backbone Systems, and Horizontal Pathways. Layout of complete building per floor. The drawing indicates location of building areas, serving zones, vertical backbone diagrams, telecommunications rooms, access points, pathways, grounding system, and other systems that need to be viewed from the complete building perspective.

b. T2 - Serving Zones/Building Area Drawings - Drop Locations and Cable Identification (ID'S). Shows a building area or serving zone. These drawings show drop locations, telecommunications rooms, access points and detail call outs for common equipment rooms and other congested areas.

c. T4 - Typical Detail Drawings - Faceplate Labeling, Firestopping, Americans with Disabilities Act (ADA), Safety, Department of Transportation (DOT). Detailed drawings of symbols and typicals such as faceplate labeling, faceplate types, faceplate population installation procedures, detail racking, and raceways.

1.6.2 Telecommunications Qualifications

Work under this section shall be performed by and the equipment shall be provided by the approved telecommunications contractor and key personnel. Qualifications shall be provided for: the telecommunications system contractor, the telecommunications system installer, and the supervisor (if different from the installer). A minimum of 30 days prior to installation, submit documentation of the experience of the telecommunications contractor and of the key personnel.

1.6.2.1 Telecommunications Contractor

The telecommunications contractor shall be a firm which is regularly and professionally engaged in the business of the applications, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor shall demonstrate experience in providing successful telecommunications systems within the past 3 years of similar scope and size. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor.

1.6.2.2 Key Personnel

Provide key personnel who are regularly and professionally engaged in the business of the application, installation and testing of the specified telecommunications systems and equipment. There may be one key person or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel shall demonstrate experience in providing successful telecommunications systems within the past 3 years.

Supervisors and installers assigned to the installation of this system or any of its components shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level. Submit documentation of current BICSI certification for each of the key personnel.

In lieu of BICSI certification, supervisors and installers assigned to the

installation of this system or any of its components shall have a minimum of 3 years experience in the installation of the specified copper and fiber optic cable and components. They shall have factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for each of the key personnel. Documentation for each key person shall include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications systems and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems. All of the existing telecommunications system installations offered by the key persons as successful experience shall have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity.

Indicate that all key persons are currently employed by the telecommunications contractor, or have a commitment to the telecommunications contractor to work on this project. All key persons shall be employed by the telecommunications contractor at the date of issuance of this solicitation, or if not, have a commitment to the telecommunications contractor to work on this project by the date that the bid was due to the Contracting Officer.

Note that only the key personnel approved by the Contracting Officer in the successful proposal shall do work on this solicitation's telecommunications system. Key personnel shall function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires approval from The Contracting Officer.

1.6.2.3 Minimum Manufacturer Qualifications

Cabling, equipment and hardware manufacturers shall have a minimum of 3 years experience in the manufacturing, assembly, and factory testing of components which comply with TIA-568-C.1, TIA-568-C.2 and TIA-568-C.3.

1.6.3 Test Plan

Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the components and accessories for each cable type specified, 60 days prior to the proposed test date. Include procedures for certification, validation, and testing.

1.6.4 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.

1.6.5 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.

1.6.5.1 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.

1.6.5.2 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.

1.7 DELIVERY AND STORAGE

Provide protection from weather, moisture, extreme heat and cold, dirt, dust, and other contaminants for telecommunications cabling and equipment placed in storage.

1.8 ENVIRONMENTAL REQUIREMENTS

Connecting hardware shall be rated for operation under ambient conditions of 32 to 140 degrees F and in the range of 0 to 95 percent relative humidity, noncondensing.

1.9 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.

1.10 MAINTENANCE

1.10.1 Operation and Maintenance Manuals

Commercial off the shelf manuals shall be furnished for operation, installation, configuration, and maintenance of products provided as a part of the telecommunications cabling and pathway system, Data Package 5. Submit operations and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein not later than 2 months prior to the date of beneficial occupancy. In addition to

requirements of Data Package 5, include the requirements of paragraphs TELECOMMUNICATIONS DRAWINGS, TELECOMMUNICATIONS SPACE DRAWINGS, and RECORD DOCUMENTATION. Ensure that these drawings and documents depict the as-built configuration.

1.10.2 Record Documentation

Provide T5 drawings including documentation on cables and termination hardware in accordance with TIA/EIA-606. T5 drawings shall include schedules to show information for cut-overs and cable plant management, patch panel layouts and cover plate assignments, cross-connect information and connecting terminal layout as a minimum. T5 drawings shall be provided in hard copy format. Provide the following T5 drawing documentation as a minimum:

a. Cables - A record of installed cable shall be provided in accordance with TIA/EIA-606. The cable records shall include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility in accordance with TIA/EIA-606. Include manufacture date of cable with submittal.

b. Termination Hardware - A record of installed patch panels, cross-connect points, distribution frames, terminating block arrangements and type, and outlets shall be provided in accordance with TIA/EIA-606. Documentation shall include the required data fields as a minimum in accordance with TIA/EIA-606.

1.10.3 Spare Parts

In addition to the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking.

PART 2 PRODUCTS

2.1 COMPONENTS

Comments shall be UL or third party certified. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations, submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard. Provide a complete system of telecommunications cabling and pathway components using star topology. Provide support structures and pathways, complete with outlets, cables, connecting hardware and telecommunications cabinets/racks. Cabling and interconnecting hardware and components for telecommunications systems shall be UL listed or third party independent testing laboratory certified, and shall comply with NFPA 70 and conform to the requirements specified herein.

2.2 TELECOMMUNICATIONS PATHWAY

Provide telecommunications pathways in accordance with TIA-569.

2.3 TELECOMMUNICATIONS CABLING

Cabling shall be UL listed for the application and shall comply with TIA-568-C.0, TIA-568-C.1, TIA-568-C.2, TIA-568-C.3 and NFPA 70. Provide a labeling system for cabling as required by TIA/EIA-606 and UL 969. Ship cable on reels or in boxes bearing manufacture date for for unshielded twisted pair (UTP) in accordance with ICEA S-90-661 and optical fiber cables in accordance with ICEA S-83-596 for all cable used on this project. Cabling manufactured more than 12 months prior to date of installation shall not be used.

2.3.1 Horizontal Cabling

Provide horizontal cable in compliance with NFPA 70 and performance characteristics in accordance with TIA-568-C.1.

2.3.1.1 Horizontal Copper

Provide horizontal copper cable, UTP, 100 ohm in accordance with TIA-568-C.2, UL 444, ANSI/NEMA WC 66, ICEA S-90-661 . Provide four each individually twisted pair, minimum size 24 AWG conductors, Category 6, with a blue thermoplastic jacket. Cable shall be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) and length marking at regular intervals in accordance with ICEA S-90-661. Provide plenum (CMP), riser (CMR), or general purpose (CM or CMG) communications rated cabling in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70. Cables installed in conduit within and under slabs shall be UL listed and labeled for wet locations in accordance with NFPA 70.

2.3.1.2 Horizontal Optical Fiber

Provide optical fiber horizontal cable in accordance with ICEA S-83-596 and TIA-568-C.3. Cable shall be tight buffered, as indicated. Cable shall be imprinted with manufacturer, flammability rating and fiber count at regular intervals not to exceed 40 inches.

Provide plenum (OFNP), riser (OFNR), or general purpose (OFN or OFNG) rated non-conductive, fiber optic cable in accordance with NFPA 70. Substitution of a higher rated cable shall be permitted in accordance with NFPA 70.Cables installed in conduit within and under slabs be UL listed and labeled for wet locations in accordance with NFPA 70. The cable jacket shall be of single jacket construction with color coding of cordage jacket, fiber, unit, and group in accordance with TIA/EIA-598.

2.4 TELECOMMUNICATIONS OUTLET/CONNECTOR ASSEMBLIES

2.4.1 Outlet/Connector Copper

Outlet/connectors shall comply with FCC Part 68, TIA-568-C.1, and TIA-568-C.2. UTP outlet/connectors shall be UL 1863 listed, non-keyed, 8-pin modular, constructed of high impact rated thermoplastic housing and shall be third party verified and shall comply with TIA-568-C.2 Category 6 requirements. Outlet/connectors provided for UTP cabling shall meet or

exceed the requirements for the cable provided. Outlet/connectors shall be terminated using a Type 110 IDC PC board connector, color-coded for both T568A and T568B wiring. Each outlet/connector shall be wired as indicated. UTP outlet/connectors shall comply with TIA-568-C.2 for 200 mating cycles.

2.4.2 Optical Fiber Adapters(Couplers)

Provide optical fiber adapters suitable for duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves, duplex SC in Accordance with TIA/EIA-604-3 with zirconia ceramic alignment sleeves, MT-RJ in accordance with TIA/EIA-604-12 with thermoplastic alignment sleeves, and ST in accordance with TIA/EIA-604-2 with metallic alignment sleeves as indicated. Provide dust cover for adapters. Optical fiber adapters shall comply with TIA-455-21 for 500 mating cycles.

2.4.3 Optical Fiber Connectors

Provide in accordance with TIA-455-21. Optical fiber connectors shall be duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves, ferrule, epoxyless compatible with8/125 single-mode fiber. The connectors shall provide a maximum attenuation of 0.3 dB at 850 nm with less than a 0.2 dB change after 500 mating cycles.

2.4.4 Cover Plates

Telecommunications cover plates shall comply with UL 514C, and TIA-568-C.1, design constructed as indicated. Provide labeling in accordance with the paragraph LABELING in this section.

2.5 MULTI-USER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

Provide MUTOA(s) in accordance with TIA-568-C.1.

2.6 TERMINAL CABINETS

Construct of zinc-coated sheet steel, as indicated. Trim shall be fitted with hinged door and locking latch. Doors shall be maximum size openings to box interiors. Boxes shall be provided with 5/8 inch backboard with two-coat varnish finish. Match trim, hardware, doors, and finishes with panelboards. Provide label and identification systems for telecommunications wiring and components consistent with TIA/EIA-606.

2.7 GROUNDING AND BONDING PRODUCTS

Provide in accordance with UL 467, TIA J-STD-607, and NFPA 70. Components shall be identified as required by TIA/EIA-606. Provide ground rods, bonding conductors, and grounding busbars as specified in Section 28 05 26.00 40 GROUNDING AND BONDING.

2.8 FIRESTOPPING MATERIAL

Provide as specified in Section 07 84 00 FIRESTOPPING.

2.9 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.

2.10 FIELD FABRICATED NAMEPLATES

ASTM D709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified 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 inches 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 one by 2.5 inches. Lettering shall be a minimum of 0.25 inches high normal block style.

2.11 TESTS, INSPECTIONS, AND VERIFICATIONS

2.11.1 Factory Reel Tests

Provide documentation of the testing and verification actions taken by manufacturer to confirm compliance with TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-526-7 for single mode optical fiber, and TIA-526-14 for multimode optical fiber cables.

PART 3 EXECUTION

3.1 INSTALLATION

Install telecommunications cabling and pathway systems, including the horizontal and backbone cable, pathway systems, telecommunications outlet/connector assemblies, and associated hardware in accordance with NECA/BICSI 568, TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, TIA-569, NFPA 70, and UL standards as applicable. Provide cabling in a star topology network. Pathways and outlet boxes shall be installed as specified in Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL. Install telecommunications cabling with copper media in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment. The interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling.

3.1.1 Cabling

Install UTP, and optical fiber telecommunications cabling system as detailed in TIA-568-C.1, TIA-568-C.2, and TIA-568-C.3. Screw terminals shall not be used except where specifically indicated on plans. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations. Do not exceed manufacturers' cable pull tensions for copper and optical fiber cables. Provide a device to monitor cable pull tensions. Do not exceed 25 pounds pull tension for four pair copper cables. Do not chafe or damage outer jacket materials. Use only lubricants approved by cable manufacturer. Do not over cinch cables, or crush cables with staples. For UTP cable, bend radii shall not be less than four times the cable diameter. Cables shall be terminated; no cable shall contain unterminated elements. Cables shall not be spliced. Label cabling in accordance with paragraph LABELING in this section.

3.1.1.1 Open Cable

Use only where specifically indicated on plans for use in cable trays, or below raised floors. Install in accordance with TIA-568-C.1, TIA-568-C.2

and TIA-568-C.3. Do not exceed cable pull tensions recommended by the manufacturer.

3.1.1.2 Horizontal Cabling

Install horizontal cabling as indicated on drawings Do not untwist Category 6 UTP cables more than one half inch from the point of termination to maintain cable geometry. Provide slack cable in the form of a figure eight (not a service loop) on each end of the cable, 10 feet in the telecommunications room, and 12 inches in the work area outlet..

3.1.2 Pathway Installations

Provide in accordance with TIA-569 and NFPA 70.

3.1.3 Cable Tray Installation

Install cable tray as specified in Section 27 05 28.36 40 CABLE TRAYS FOR COMMUNICATIONS SYSTEMS.

3.1.4 Work Area Outlets

3.1.4.1 Terminations

Terminate UTP cable in accordance with TIA-568-C.1, TIA-568-C.2 and wiring configuration as specified. Terminate fiber optic cables in accordance with TIA-568-C.3

3.1.4.2 Cover Plates

As a minimum, each outlet/connector shall be labeled as to its function and a unique number to identify cable link in accordance with the paragraph LABELING in this section.

3.1.4.3 Cables

Unshielded twisted pair and fiber optic cables shall have a minimum of 12 inches of slack cable loosely coiled into the telecommunications outlet boxes. Minimum manufacturer's bend radius for each type of cable shall not be exceeded.

3.1.4.4 Pull Cords

Pull cords shall be installed in conduit serving telecommunications outlets that do not have cable installed.

3.1.4.5 Multi-User Telecommunications Outlet Assembly (MUTOA)

Run horizontal cable and terminate each cable on a MUTOA in each individual zone. MUTOAs shall not be located in any obstructed area. MUTOAs shall be located so that each platform is served by at least one MUTOA. Maximum work area cable length requirements shall also be taken into account. MUTOAs must be labeled to include the maximum length of work area cables. MUTOA labeling is in addition to the labeling described in TIA/EIA-606, or other applicable cabling administration standards. Work area cables extending from the MUTOA to the work area device must also be uniquely identified and labeled.

3.1.5 Telecommunications Space Termination

Install termination hardware required for Category 6 and optical fiber system. An insulation displacement tool shall be used for terminating copper cable to insulation displacement connectors.

3.1.5.1 Connector Blocks

Connector blocks shall be cabinet mounted in orderly rows and columns. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks. Install in accordance with industry standard wire routing guides in accordance with TIA-569.

3.1.5.2 Patch Panels

Patch panels shall be mounted in equipment cabinets with sufficient ports to accommodate the installed cable plant plus 25 percent spares.

a. Copper Patch Panel. Copper cable entering a patch panel shall be secured to the panel with cable ties to prevent movement of the cable.

b. Fiber Optic Patch Panel. Fiber optic cable loop shall be 3 feet in length. The outer jacket of each cable entering a patch panel shall be secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

3.1.6 Electrical Penetrations

Seal openings around electrical penetrations through fire resistance-rated wall, partitions, floors, or ceilings as specified in Section 07 84 00 FIRESTOPPING.

3.1.7 Grounding and Bonding

Provide in accordance with TIA J-STD-607, NFPA 70 and as specified in Section 28 05 26.00 40 GROUNDING AND BONDING..

3.2 LABELING

3.2.1 Labels

Provide labeling in accordance with TIA/EIA-606. Handwritten labeling is unacceptable. Stenciled lettering for voice and data circuits shall be provided using thermal ink transfer process.

3.2.2 Cable

Cables shall be labeled using color labels on both ends with identifiers in accordance with TIA/EIA-606.

3.2.3 Termination Hardware

Workstation outlets and patch panel connections shall be labeled using color coded labels with identifiers in accordance with TIA/EIA-606.

3.3 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 00.00 98 PAINTING AND COATING.

3.3.1 Painting Backboards

If backboards are required to be painted, then the manufactured fire retardant backboard must be painted with fire retardant paint, so as not to increase flame spread and smoke density and must be appropriately labeled. Label and fire rating stamp must be unpainted.

3.4 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.

3.5 TESTING

3.5.1 Telecommunications Cabling Testing

Perform telecommunications cabling inspection, verification, and performance tests in accordance with TIA-568-C.1, TIA-568-C.2, TIA-568-C.3. Test equipment shall conform to TIA-1152. Perform optical fiber field inspection tests via attenuation measurements on factory reels and provide results along with manufacturer certification for factory reel tests. Remove failed cable reels from project site upon attenuation test failure.

3.5.1.1 Inspection

Visually inspect UTP and optical fiber jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for T568A or T568B pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1, TIA-568-C.2, TIA-568-C.3, . Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.

3.5.1.2 Verification Tests

UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after termination but prior to being cross-connected.

For multimode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568-C.3 and TIA-526-14 using Method B, OTDR for multimode optical fiber. For single-mode optical fiber, perform optical fiber end-to-end attenuation tests in accordance with TIA-568-C.3 and TIA-526-7 using Method B, OTDR for single-mode optical fiber. Perform verification acceptance tests.

3.5.1.3 Performance Tests

Perform testing for each outlet and MUTOA as follows:

a. Perform Category 6 link tests in accordance with TIA-568-C.1 and TIA-568-C.2. Tests shall include wire map, length, insertion loss,

NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.

b. Optical fiber Links. Perform optical fiber end-to-end link tests in accordance with TIA-568-C.3.

3.5.1.4 Final Verification Tests

Perform verification tests for UTP and optical fiber systems after the complete telecommunications cabling and workstation outlet/connectors are installed.

a. Voice Tests. These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and DSN telephone call.

b. Data Tests. These tests assume the Information Technology Staff has a network installed and are available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

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SECTION 27 21 00.00 40

PAGING AND AREA WARNING SYSTEM

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 S3.2	(2009) Method for Measuring the Intelligibility of Speech Over Communication Systems (ASA 85)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 50	(2007; Reprint Apr 2012) Enclosures for Electrical Equipment, Non-environmental Considerations
UL 6	(2007; reprint Nov 2010) Electrical Rigid Metal Conduit-Steel
UL 797	(2007) Electrical Metallic Tubing -- Steel

1.2 RELATED REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS, applies to this section, with the additions and modifications specified herein.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Paging system equipment

Cables and raceways

SD-10 Operation and Maintenance Data

Submit in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA.

PART 2 PRODUCTS

2.1 EQUIPMENT AND COMPONENTS

Equipment and components shall conform to applicable requirements of NFPA 70. Units of the same type of the equipment shall be product of single manufacturer. Units to be mounted outside or subject to inclement conditions shall be weatherproof or to be mounted in weatherproof enclosures.

2.1.1 Paging System

Provide paging system including speakers, and interconnecting cables. Amplifiers, control panels and control enclosures are provided by others. Coordinate cabling connections at the designated plans terminal cabinet with the Government.Operate all speakers from a 70 volt distribution system. System shall be solid state, and integrated design of a single supplier.

2.1.1.1 Cone Speaker

Provide ceiling, wall or pendant-mounted cone type speakers as indicated. Include rust-proof back boxes of acoustically damped construction, provide for relief of back pressure. Include suitable recessed mounted speaker grille, made of 20 gauge minimum steel or aluminum. Speaker assembly shall as a minimum conform to the following specifications:

a. Sensitivity (sound pressure level): Minimum of 92 dB, measured at 1 watt input, 4 feet on axis (250 Hz to 4kHz speech range)

b. Frequency response ratio: Plus or minus 5 dB from 80 Hz to 20 kHz

c. Dispersion angle: 90 degrees

d. Transformer with 4 level taps: 60W, 30W, 15W, 7.5W and low impedance @ 70V

e. Voice coils: one inch

2.1.1.2 Horn-Type Loudspeakers

Provide horn-type loudspeakers with line transformers, mounting brackets and all hardware, mount at heights indicated on drawings, and as a minimum conform to the following specifications:

a. Max input rating: 200W continuous

b. Operating Range: Plus or minus 3 dB from 160 Hz to 12.5 kHz

c. Horizontal dispersion angle: 90 degrees

d. Vertical dispersion angle: 40 degrees

e. Sensitivity (sound pressure level): Minimum of 97 dB measured at 1 watt input, 4 feet on axis (250 Hz to 4 kHz speech range).

f. Power taps: 200W, 70V autoformer

2.2 CABLES AND RACEWAYS

Cable and raceways shall conform to UL 6 and UL 797. Cabinets and boxes shall conform to UL 50. Cables for use in air plenums shall be UL classified low smoke and low flame in accordance with NFPA 70.

2.2.1 Speaker Cable

Basic cables shall be single twisted pair shielded cables, 22 gage, stranded tinned copper with vinyl insulation aluminum polyester shield, stranded tinned copper wire with overall vinyl jacket. Multi-conductor shielded pair cables conforming to basic speaker cable specifications are acceptable.

2.3 TERMINALS

Terminals shall be solderless, tool-crimped pressure type.

2.4 SPEAKER ENCLOSURES

Speaker enclosures shall be compatible with the speakers specified and shall comply with UL 50.

PART 3 EXECUTION

3.1 INSTALLATION

3.1.1 General

Install all system components and appurtenances in accordance with the manufacturer's instructions and as specified herein.

3.1.2 Wiring

Install wiring in rigid metal conduit, intermediate metal conduit, cable tray, or electric metallic tubing as specified in Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL. Wiring for signal circuits shall terminate on identified terminal blocks in cabinets and master station enclosures. Terminate audio circuits on identified terminal blocks in cabinets and master stations. Ground cable shield at all points of termination.

3.1.2.1 Signal Wiring and Control Wiring

Install signal and control circuits in accordance with NFPA 70. Provide type of signal and control wires and number of conductors as recommended by the intercommunication system manufacturer, and as necessary to provide a complete and operable system.

3.1.3 Grounding

NFPA 70. Ground and distribution ground buses shall be solid copper wire with insulating covering.

3.2 FIELD QUALITY CONTROL

3.2.1 Acceptance Tests

Contractor shall be responsible for system speaker operation only. Testing

shall be done in support of the entire system.

After installation has been completed, Contractor shall conduct an acceptance test in the presence of the Contracting Officer or its representative and with paws system engineers, to demonstrate that the equipment operates in accordance with specification requirements. Contractor shall notify the Contracting Officer 2 weeks prior to performance of tests. The acceptance tests shall include originating and accepting messages at specified stations, at proper volume levels, without cross-talk or noise from other links or non-designated units. Test shall utilize the phonetically balanced monosyllabic work intelligibility test in accordance with ASA S3.2. In order to be acceptable a score of at least 75 percent must be obtained for each system test.

3.2.2 Retesting

Rectify deficiencies in speaker/horn operations indicated by tests and completely retest work affected by such deficiencies at Contractor's expense.

3.3 INSPECTION

Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals identified.

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SECTION 28 05 26.00 40

GROUNDING AND BONDING

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 WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2011; Amendment 2012) Specification for Filler Metals for Brazing and Braze Welding

ASTM INTERNATIONAL (ASTM)

ASTM B3	(2001; R 2007) Standard Specification for Soft or Annealed Copper Wire

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

RCBEA GUIDE	(2004) NASA Reliability Centered Building and Equipment Acceptance Guide

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2011; Errata 2 2012) National Electrical Code

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-STD-889	(1976; Rev B; Notice 2 1988; Notice 3 1993) Dissimilar Metals

UNDERWRITERS LABORATORIES (UL)

UL 467	(2007) Grounding and Bonding Equipment

1.2 GENERAL REQUIREMENTS

Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS applies to work specified in this section.

Section 05 05 23.00 98 METAL, FASTENINGS applies to work specified in this section.

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit material, equipment, and fixture lists for Grounding Systemsincluding manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

SD-02 Shop Drawings

Submit Record Drawings in accordance with paragraph entitled, "Drawings," of this section.

SD-03 Product Data

Submit equipment and performance data for the following items including life, test, system functional flows, safety features, and mechanical automated details.

Submit Manufacturer's catalog data for the following items:

Ground Wires

Connectors and Fasteners

Bonding

SD-06 Test Reports

Submit Test Reports for the following tests on grounding systems in accordance with the paragraph entitled, "Field Tests," of this section. Within the report include certified record of ground-resistance tests on each driven ground rod, ground rod assembly, and other grounding electrodes. Include within the record the number of rods driven and their depth at each location to meet the required resistance-to-ground measurements specified. Include a statement describing the condition of the soil at the time of measurement.

Bond Resistance Test

Ground Isolation Test

Continuity Isolation Test

SD-08 Manufacturer's Instructions

Submit Manufacturer's instructions for the Grounding Systems including special provisions required to install equipment components and system packages. Within special notices, detail impedances, hazards and safety precautions.

1.4 DRAWINGS

Record Drawings must indicate the location of ground rods, mats, grids, building ground bus, supplementary grounding electrodes, steel building columns, and other metal structures connected to the grounding system.

Identify the location of each ground rod and ground-rod assembly and other grounding electrodes by letter in alphabetical order and keyed to the

record of ground-resistance tests.

1.5 PREDICTIVE TESTING AND INSPECTION TECHNOLOGY REQUIREMENTS

This section contains systems and/or equipment components regulated by NASA's Reliability Centered Building and Equipment Acceptance Program. This program requires the use of Predictive Testing and Inspection (PT&I) technologies in conformance with RCBEA GUIDE to ensure building equipment and systems installed by the Contractor have been installed properly and contain no identifiable defects that shorten the design life of a system and/or its components. Satisfactory completion of all acceptance requirements is required to obtain Government approval and acceptance of the Contractor's work.

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

PART 2 PRODUCTS

2.1 GROUND WIRES

Ground wires must be in accordance with Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

Ground and bond wires for substations, main panels and distribution points must be annealed bare copper conforming to ASTM B3, stranded, with 98 percent conductivity. Wire size must be in accordance with the grounding requirements of NFPA 70.

Ground wires for equipment receptacles for noncurrent carrying hardware, installed in conduit must be soft drawn copper, in accordance with ASTM B3, stranded, with green insulation. Note wire size.

2.2 CONNECTORS AND FASTENERS

Grounding and bonding fasteners and connectors must conform to the requirements of UL 467, and Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

Grounding and bonding fasteners must be copper or bronze.

Bonding straps and jumpers must be copper and have a cross-sectional area of not less than No. 6 AWG. Bonding straps and jumpers for shock-mounted devices with pivot, hinged or swivel joints must be made of woven-wire braid wire.

PART 3 EXECUTION

3.1 BONDING AND GROUNDING

Bonding and grounding requirements must be in accordance with NFPA 70.

3.2 BUILDING GROUNDS

Steel framework of the VAB is considered to be grounded to an existing counteroise grounding grid. Existing system includes electrically connected grounding conductor from steel columns and extending around the perimeter of the building.

3.3 EQUIPMENT GROUNDING

In addition to the green colored equipment grounding conductor required in each raceway and sized in accordance with Table 250.122 of the NEC, each panelboard/ switchboard enclosure, transformer housing, motor housing, disconnect, starter, and other electrical equipment, addressed under this contract, must be bonded to the grounding system with a stranded copper conductor, routed external to the feeder raceway.

Metallic raceway systems must have electrical continuity with equipment individually and be directly connected to the building ground, independent of the raceway system.

Individually and directly connect enclosures for panelboards to the building ground. Grounding conductor must not be less than No. 2 AWG and be connected from the building ground to a copper ground-bus terminal strip located in each panelboard.

Polarized receptacles, lighting fixtures, and equipment enclosures must be grounded with an identified (green color) insulated conductor, not smaller than No. 12 AWG, connected to the branch circuit ground-bus terminal strip. Ground-bus terminal strip in each panelboard enclosure must be isolated and independent of the system neutral terminal strip.

Indoor substations, transformers, switchboard frames, switchgear assemblies, motors, motor control centers, air compressors, air handlers, refrigerated air dryers, generators, frames and tracks of cranes, and platforms must be individually and directly connected to the building ground. Current-carrying capacity of the grounding conductor must be the same as the current-carrying capacity of the power conductors for circuits utilizing power lines size No. 2 AWG and smaller. For circuits with power wiring larger than No. 2 AWG, the grounding conductor must be in accordance with NFPA 70, except that the grounding conductor must not be smaller than No. 2 AWG.

Noncurrent carrying metallic parts of electrical equipment, including metallic cable sheaths, conduit, raceways, and electrical structural members, must be bonded together and connected to the ground grid or ground connection rods.

Install secure ground systems for power and instrumentation. Independently connect each system to the building counterpoise as shown.

Secure ground systems must consist of unspliced ground wires in individual welded or epoxied conduit runs from the secure area to the building counterpoise. Welding and epoxying must conform to Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL.

3.4 GROUNDING CONNECTIONS

Ground connections must be bonded connections in accordance with paragraph entitled, "Bonding," of this section.

Weld ground connections that are buried or in inaccessible locations.

Bolt connections in accessible locations. Connections to steel building columns in accessible locations must be cast-copper-alloy clamp lugs bolted or exothermically fusion-welded to the structure.

Clean, grease, and remove foreign matter from ground connection surfaces. Do not penetrate clad material in the cleaning process. Make connection between like metals where possible. Where dissimilar metals are welded, brazed, or clamped, follow the weld kit manufacturer's instructions. Connections between dissimilar metals must not produce galvanic action in accordance with MIL-STD-889.

3.5 BONDING

3.5.1 Type of Bonds

Accomplish bonding of metal surfaces by brazing, welding, clamping or structural joining methods.

3.5.1.1 Brazing

Brazing solder must conform to AWS A5.8/A5.8M.

3.5.1.2 Welding

Welding must be by the exothermic process. Within the welding procedure, include the proper mold and powder charge and conform to the manufacturer's recommendations.

Welding processes must be of the exothermic fusion type that will make a connection without corroding or loosening. Process must join all strands and not cause the parts to be damaged or weakened. Completed connection or joint must be equal or larger in size than the conductors joined and have the same current-carrying capacity as the largest conductor. Paint buried ground connections with a bitumastic paint.

3.5.1.3 Clamping

In external locations, use clamping only where a disconnect type of connection is required. Connection device may utilize spring-loaded jaws or threaded fasteners. Construct device such that positive contact pressure is maintained at all times. Use machine bolts with spring-type lockwashers.

3.5.1.4 Structural Joining Methods

Consider joints made with high-strength structural bolts, and clean unpainted faying surfaces sufficiently bonded. Install a jumper across the joint in the form of a No. 4 AWG bare copper wire exothermically welded at each end to the surfaces involved spanning the connection wire jumpers used across joints employing miscellaneous machine bolts.

3.5.2 Cleaning of Bonding Surfaces

Thoroughly clean surfaces that comprise the bond before joining. Apply an appropriate abrasive with gentle and uniform pressure to ensure a smooth and uniform surface. Do not remove excessive metal from the surface. Clean clad metals in such a manner that the cladding material is not penetrated by the cleaning process. Then clean bare metal with an appropriate solvent to remove any grease, oil, dirt, corrosion preventives, and other contaminants. Bond to the cleaned area must be made within one hour after cleaning. Seal joint and refinish the exposed surfaces within two hours of exposure to prevent oxidation. When additional time is required, apply a corrosion preventive compound until the area can be

refinished.

3.5.3 Bonding Straps and Jumpers

Install jumpers such that the vibration by the shock-mounted device will not change its electrical characteristics.

Braze or Weld bonds for outdoor locations unless a disconnect type of connection is required. When a disconnect is required, use clamping with bolts. Insert a tooth-type lockwasher between the strap and metallic member for each bolt.

Bond straps directly to the basic structure and do not penetrate any adjacent parts. Install straps in an area that is accessible for maintenance.

Use single straps for the bonds and install such that they will not restrict movement of structural members. Do not connect two or more straps in series.

Install straps such that they will not weaken structural members to which they are attached.

3.5.4 Equipment and Enclosure Bonding

Each metallic enclosure and all electrical equipment must be bonded to ground. At least one copper connection must be made from the system ground point to one or more enclosures in the area such that all enclosures and equipment provide a low-impedance path to ground when properly bonded together.

3.5.5 Bonding of Conduit and Raceway Systems

Bond all metal conduit, fittings, junction boxes, outlet boxes, armored and metal sheathed cable, and other raceways. Take care to ensure adequate electrical contact at the joints and terminations.

3.5.5.1 Rigid Metal Conduit and Terminations

Threaded connections must be wrench-tight and there must be no exposed threads. Ream all ends of the conduit to remove burrs and rough edges. Conduits entering boxes and enclosures must be bonded to the box with locknuts and grounding-type bushings. Locknuts that gouge into the metal box when tightened are not acceptable.

Conduit systems that are interrupted by PVC dielectric links must be bonded separately on either side of the link. Dielectric link must not be jumpered.

3.5.5.2 Flexible Metal Conduit

Flexible conduit must have an integral grounding conductor.

3.5.6 Cable Tray Bonding

Bond cable tray sections together. Cable tray sections in tandem assembly must be considered as having electrical continuity when these sections are bonded with the appropriate bolts. Install bond straps across expansion joints. Bond cable trays to the building ground system.

3.5.7 Protection of Finished Bonds

Protect finished bonds by painting to match the original finish after the bond is made.

3.6 FIELD TESTS

Perform PT&I tests and provide submittals as specified in Section 01 86 26.07 40 RELIABILITY CENTERED ACCEPTANCE FOR ELECTRICAL SYSTEMS.

Perform the following tests in the presence of the Contracting Officer.

3.6.1 Bond Resistance Test

Resistance of any bond connection must not exceed 0.5 milliohm. Rework bonds that exceed this resistance at no additional cost to the Government.

3.6.2 Ground Isolation Test

Test ground systems for isolation from other ground systems.

3.6.3 Continuity Isolation Test

Perform continuity test on all power receptacles to ensure that the ground terminals are properly grounded to the facility ground system.

-- End of Section --

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FIRE DETECTION AND ALARM

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 S1.4a	(R2006) American National Standard Specification for Sound Level Meters
ANSI S3.41	(1990, R2008) American National Standard Audible Emergency Evacuation Signal

ASME INTERNATIONAL (ASME)

ASME A17.1	(2010) 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	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 101	(2012; Amendment 1 2012) Life Safety Code
NFPA 70	(2011; Errata 2 2012) National Electrical Code
NFPA 72	(2013) National Fire Alarm and Signaling Code
NFPA 75	(2009; TIA 12-1) Standard for the Protection of Information Technology Equipment
NFPA 90A	(2012) Standard for the Installation of Air Conditioning and Ventilating Systems

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES (NICET)

NICET 1016-2	(2007) Program Detail Manual Fire Alarm Systems, 8th Edition

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-595	(Rev C; Notice 1) Colors Used in Government Procurement

UNDERWRITERS LABORATORIES (UL)

UL 1449	(2006; Reprint Feb 2011) Surge Protective Devices
UL 1480	(2003; Reprint Jun 2010) Standard for Speakers for Fire Alarm, Emergency, and Commercial and Professional Use
UL 1971	(2002; Reprint Oct 2008) Signaling Devices for the Hearing Impaired
UL 268	(2009) Smoke Detectors for Fire Alarm Systems
UL 268A	(2008; Reprint Sep 2009) Smoke Detectors for Duct Application
UL 346	(2005; Reprint Nov 2009) Waterflow Indicators for Fire Protective Signaling Systems
UL 38	(2008; Reprint Dec 2008) Manual Signaling Boxes for Fire Alarm Systems
UL 497B	(2004; Reprint Oct 2008) Protectors for Data Communication Circuits
UL 1711	(2006) UL Standard for Amplifiers for Fire Protective Signaling Systems, 4th Edition
UL 2196	(2008) UL Standard for Tests for Fire Resistive Cables, 1st Edition
UL Fire Prot Dir	(2012) Fire Protection Equipment Directory

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. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Submit Evidence of the Contractor's State Certification; G to the Contracting Officer for approval, prior to any work being started on the Fire Alarm System, in accordance with paragraph entitled

"Services of a Certified Fire Alarm Specialist".

SD-02 Shop Drawings

Submit the following in accordance with the paragraph entitled, "General Requirements," of this section:

Connection Drawings; G

Module Schematic Drawings; G

Software Programs; G

Fire Service Floor Plans; G

Record Drawings; G (As-Built Drawings after completion of the final acceptance test)

SD-03 Product Data

Where multiple types of the same item are required (Example: indoor, weatherproof, and explosion-proof types) provide separate Catalog Data for each type of device. Submit Manufacturer's Catalog Data for the following items:

Fire Alarm Control Panel; G

CFMS Reporting Equipment; G

Addressable Modules/Devices; G

Flame Detectors; G

Smoke Detectors; G

Duct Smoke Detectors; G

Manual Alarm/Push Button Stations; G

Strobe Units; G

Speakers; G

Fire Resistive Cables; G

Water Flow Alarm Devices; G

Valve Tamper Switches; G

Remote Auxiliary Control Relays; G

Power Source; G

Line Voltage Surge Suppressors; G

Low Voltage Surge Suppressors; G

Wiring (Wire and Multi-Conductor Cable); G

SD-05 Design Data

Design Analysis and Battery Calculations; G

Flame Detectors; G

Submit list of parts and components; G for the installed system by manufacturer's name, part number, and nomenclature, and recommended stock level required for normal maintenance and unscheduled repairs.

SD-06 Test Reports

Fire Alarm System Acceptance Test Procedures; G (For Both Preliminary and Final Tests)

SD-07 Certificates

Submit Quality Assurance Plan; G consisting of the following in accordance with the paragraph entitled, "Quality Assurance Plan," of this section:

Submit listing and/or approval documentation; G that all components are Underwriter Laboratory (UL) UL Fire Prot Dir listed or Factory Mutual (FM) FM APP GUIDE approved for their intended use and function.

Submit Contractor Readiness Affirmation - For Preliminary Fire Alarm Testing; G in accordance with the paragraph entitled, "Field Testing" of this section.

Submit KSC - Transfer of Responsibility; G for the designated portion of the Fire Alarm System; in accordance with the paragraph entitled, "Installation," of this section.

Submit NFPA 72 Fire Alarm System Record of Completion; G in accordance with paragraph entitled, "Field Testing" of this section.

SD-10 Operation and Maintenance Data

Submit Operation and Maintenance Manuals; G bound in manual format and grouped by technical sections consisting of manufacturer's standard brochures, schematics, procedures, recommended spare parts, recommended test equipment, and safety precautions. Submit this information prior to acceptance tests being performed. Provide one single .pdf format of the O&M Manual on a single CD.

1.3 GENERAL REQUIREMENTS

Section 26 05 00.00 40 COMMON WORK RESULTS FOR ELECTRICAL and Section 26 00 00.00 20 BASIC ELECTRICAL MATERIALS AND METHODS apply to work specified in this section.

Submit submittals for approval in the following sequence with each approved prior to the next submittal:

a. Sign and submit the KSC Transfer of Responsibility form no later than

30 days after notice to proceed.

b. Submit Product Data (Catalog Data), Contractor's Certifications, and Quality Assurance Plan, within 30 days after notice to proceed.

c. Submit Connection Drawings, Module Schematic Drawings, Design Analysis and Battery Calculations within 60 days after notice to proceed.

d. Submit new and revised Fire Alarm Control Panel (FACP) and Network Software Program information no later than 60 days prior to the scheduled preliminary test. Provide two completed sets minimum of the Record Drawings and documentation and make available for reference at the preliminary test.

e. Submit Acceptance Test Procedures no later than 60 days prior to the scheduled preliminary test.

f. Sign and submit the Readiness Affirmation form no later than 5 days prior to the scheduled preliminary test.

g. Submit Record Shop Drawings, Panel and Network software programs, and Battery Calculations for approval no later than 30 days prior to the scheduled final acceptance test. Provide two completed sets minimum of the Record drawings (As-built condition) and documentation and the NFPA 72 Fire Alarm System Record of Completion Form and make available for reference at the final test. Include submittal of listing and/or approval documentation

h. Submit Operation and Maintenance Manuals 14 days after the final test has been complete and approved.

i. Include in the Record drawing submittal all Shop Drawings, Panel and Network software programs, Battery Calculations, Completed Final Test Procedures, NFPA 72 Fire Alarm System Record of Completion Form and submit within 14 days after completion of the final acceptance test. Include in this submittal two (2) sets of CD ROM digital media of all the record drawings, Design Analysis, Battery Calculations and Program software information.

Prepare and submit all drawings generated by computer aided design (CAD). Include in digital media compact disc (CD) submittals .DWG or .DXF format files for all drawings: Connection Diagrams, Module Schematics, Battery Calculations, Floor plans and Fire Service Floor Plans. Also on this CD provide a complete copy of the aforementioned drawings in PDF format.

Provide Connection drawings consisting of point-to-point wiring diagrams of internal and external wiring including, but not limited to, all fire alarm field devices, panel wiring, and interconnection between other building systems and components and the fire alarm system. Indicate wire label designations matching the field installation on these drawings.

Include in Connection drawings Floor Plan Drawings that indicate equipment locations, device locations with address designation, and conduit/wiring routing from the FACP(s) to all field devices including looped Class A circuit routing requirements. Also include typical mounting requirements for each type of initiation, signaling, notification and control device. Show on Record drawings (as-built) for installations with flame detectors horizontal and vertical field of views for each detector and aiming point of detector with clear dimensions from fixed and readily identifiable

structural references. Include riser diagram and sequence of operations in an input/output matrix format that clearly shows interaction of system components.

Provide Module schematic drawings minimum size 8-1/2 by 11 inch prior to system acceptance testing.

Include in Record Drawings connection drawings, floor plan drawings, module schematics, software programs, fire service floor plans, design and battery calculations, and all other data required to fully document the completed system. After final testing is complete, submit Record Drawings including digital media and hard copies of all new and revised software, drawings, and analysis/calculations incorporating approved comments and any changes. Document final system configuration in Record Drawings including, but not limited to, geographic monitor zone boundaries, location of the FACP, all initiating and auxiliary control devices, signaling line devices, notification appliances, additional cabinets, wet and dry pipe sprinkler risers, dry pipe control panel, smoke and fire dampers, magnetic door holders, and all other equipment associated with the fire alarm system(s). Also, annotate the location and address setting for each multiplexed addressable device (when used), deviations from and amendments to the record drawings, and field installation changes, concealed and visible.

Provide software programs, both hard copy and compact disc, for all new and/or existing programmable FACP(s) affected by the project. Provide system executable file and report file on the compact disc. Program information for FACP including program listings, system point summary, and addressable device switch settings. Include in corrected program information panel and network programs and sequence of operations in matrix format that clearly shows interaction of system components.

Conduct tests in accordance with approved Fire Alarm System Acceptance Test Procedures, and in accordance with the paragraph entitled "Field Testing" in this specification. Prepare a test procedure and test record form for conducting complete tests on control panels, reporting systems, wiring systems, and field devices installed in accordance with the manufacturer's requirements and these specifications. Identify each device and circuit to be tested in the test procedure, describe the initial condition, each step or function in the test, required test result, and equipment to be employed. Test procedures are to be written to minimally disrupt facility operations (minimize activation of evacuation notification appliances, AHU shutdown, etc.) in support of testing requirements. Ensure test forms have suitable space for recording test results on all equipment, devices, and wiring to be tested. Provide test record forms with identified spaces for verification signatures of official witnesses and dates of the test.

Clearly indicate on Fire Service Floor Plans the location of the FACP, all initiating and auxiliary control devices, signaling line devices, notification appliances, additional cabinets, detection systems, wet and dry pipe sprinkler risers, dry pipe control panel, smoke and fire dampers, magnetic door holders and all other equipment associated with the fire alarm system(s). Also, annotate the location and address setting for each multiplexed addressable device (when used). Do not place borders or title blocks on the Fire Service Floor Plan. Provide a symbol legend, which clearly identifies each device shown on the Fire Service Floor Plan. Install a copy of the Fire Service Floor Plan, minimum size18 by 24 inch in a painted metal frame with a Plexiglas cover. Submit the floor plan and it's location for approval, to the Contracting Officer, prior to installation.

Submit Design Analysis and Battery Calculations for approval for the Fire Alarm and Detection Systems consisting of the battery capacity and loading calculations in accordance with the paragraphs entitled, "Fire Alarm Control Panel," and "Flame Detectors," of this section.

Submit list of parts and components in accordance with the paragraph entitled "System Requirements," of this section.

1.4 SYSTEM REQUIREMENTS

Provide a fully addressable, modular type, microprocessor based, supervised, non-coded electrical fire alarm and deluge control system with NFPA 72 Class A initiating device circuits,notification appliance circuits, and auxiliary control circuits. Provide NFPA 72 Class A signaling line circuits, Style 6, and Central Fire Monitoring System (CFMS) network reporting circuits, Style 7. Ensure all styles of Class A initiating device, signaling line, network, notification appliance, and control circuits use diverse routing in accordance with NFPA 72. Do not run the outgoing and return redundant circuit conductors in the same cable assembly, enclosure or raceway.

Electrically connect the fire alarm system to report alarm, trouble, and supervisory signals to the CFMS; to sound the general alarm continuously; and to control auxiliary equipment such as dampers, air handling units, magnetic door latches, elevator recall, etc., upon operation of one or more initiating devices. For initiating, notification, signal, and auxiliary control circuits, use 24 V(DC). Ensure duct smoke detectors transmit to the CFMS as a silent alarm unless otherwise directed by the Authority Having Jurisdiction (AHJ).

Ensure the system conforms to all the applicable requirements of NFPA 70, NFPA 72, NFPA 75, NFPA 90A, and NFPA 101.

Ensure fire alarm and deluge control systems contain all of the equipment, devices, programming and circuits required for system operation in accordance with NFPA Codes and KSC requirements, including remote reporting to and remote control from existing Simplex based equipment.

Provide all additional equipment, cabinets, conduit, and labor to meet the requirements and intent of this specification.

Components installed under this contract can not be more than one (1) year older than the date of installation.

Fire alarm and deluge control system simplified scope of work consist of:

1. Install/replace existing simplex 4100 FACPS in Tower "E" and "F", with simplex 4100ES units.
2. Install new 4100ES and 4010ES units as shown for Quad value assemblies and platform operations.
3. Modify the existing software to the VAB Simplex Network Display Unit (NDU) for reporting and annuciation functions associated with the fire alarm and deluge systems.
4. Suppliment existing devices as shown for adequate coverage and monitoring.

The Contractor shall provide all associated equipment, components, wiring, software and testing required for a fully functioning system. This

simplified scope of work is intended to only capture the overall intent of this portion of the design.

1.5 QUALITY ASSURANCE PLAN

Provide manufactured fire-alarm equipment which meets the requirements of the paragraph entitled, "System Requirements," of the latest standard design, and listed by Underwriters' Laboratories or approved by Factory Mutual and be suitable for it's intended service. Ensure all devices installed function with the control panel without interference of the operation of the control panel.

1.6 SERVICES OF A CERTIFIED FIRE ALARM SPECIALIST

Provide Services of a Certified Specialist thoroughly experienced in fire detection and alarm work on site, to perform or directly supervise the installation, make all necessary adjustments, and perform all tests on the fire alarm system at the site.

A Fire Alarm specialist is considered certified when the specialist holds a valid Fire Alarm System, Level III Certification from the National Institute for Certification in Engineering Technologies NICET 1016-2; or a valid Level III Fire Alarm Engineering Technician Certification from the International Municipal Signal Association (IMSA); or is licensed by the State of Florida as a Fire Alarm Contractor I in accordance with Florida State Statute, Chapter 489, Part II.

Certification of other recognized agencies with equivalent requirements will be considered. Provide Evidence of the Contractor's State Certification and the basis of certification to the Contracting Officer and secure Contracting Officer approval prior to any work being performed at Kennedy Space Center.

PART 2 PRODUCTS

2.1 FIRE ALARM CONTROL PANEL

Provide fully addressable Fire Alarm Control Panel (FACP), of modular construction with solid state, microprocessor based electronics. Include non-volatile programmable operating system memory for all operating requirements in the panel. Addressable components are to include, but not be limited to, addressable monitor modules, control modules, signal modules, addressable notification appliance power supplies and addressable input/output relays. Equip modules with transient surge suppression.

Ensure (FACP) contains power-on, alarm, supervisory, and trouble indicating lights plainly visible when the cabinet is closed; and also contains the following functions accessible only by unlocking and opening the unit:

Alarm Silence
Trouble Silence
Supervisory Silence
Power On-Off (If standard by the manufacturer)
Alarm/Trouble Acknowledge
Auxiliary Devices (AHU shutdown relay) Maintenance By-pass Switches
System Reset

Ensure FACP contains all components necessary to monitor and supervise all

initiating device circuits, and when any detector, manual alarm station (pull box), water flow switch, pressure switch, etc., connected to the fire alarm control panel is activated, the control panel's visual alarm, alarm indicator and audible signal are activated. This causes all notification appliances to be activated, including all associated auxiliary control functions. Verify that the control panel visually indicates the addressable device or zone in alarm and transmits an alarm condition to the remote Central Fire Monitoring System. Provide separate audible and visual notification appliance circuits, with sufficient capacity to operate all devices connected, plus 25 percent minimum spare capacity.

Verify that the FACP includes all components and modules required for installation of a multiple addressable device network. Utilize network polling methods and provide two-way Class A, Style 6 supervised communications between the FACP and addressable smoke detectors and monitor, signal, or control addressable modules. Ensure that the FACP contains all components necessary to monitor and supervise all supervisory device circuits. Verify that when any valve tamper switch, low air pressure switch, water level indicator, or other supervisory device connected to the control panel is activated, the control panel supervisory visual indication and supervisory audible device is activated; and that control panel visually indicates the addressable device or zone in supervisory alarm and transmit a supervisory condition to the remote Central Fire Monitoring System.

Provide FACP with all components necessary to operate and supervise the circuits for annunciator panels indicated, auxiliary power supplies indicated, and auxiliary devices controlling equipment such as ventilating fans, air handling units, fan coil units, damper motors, solenoids, magnetic door holders, elevator recall, etc. Ensure circuits for auxiliary control relays are supervised to within 3 feet of the device to be controlled in accordance with NFPA 101. Include maintenance by-pass switches for all auxiliary control devices in the FACP. Ensure by-pass switches are supervised to report supervisory signal when in the maintenance (by-pass) position. Provide switches used for by-pass functions which are either toggle or soft key type, and listed for use with the control panel. In addition, provide each switch with a positive visual indication to show the function is ON.

Provide panel which monitors and reports any trouble open supervised circuits, ground faulted supervised circuits, removal of detector or device, removal or failure of control panel module, maintenance by-pass switch activated, loss of primary power, power supply trouble, low battery voltage, loss of battery voltage, FACP enclosure open, and activation of the alarm silence switch. Ensure all trouble signals are identified by initiating, notification appliance, auxiliary control, or signaling line circuit; and that trouble signals activate the control panel trouble visual indication and trouble audible devices, and send a trouble signal to the remote Central Fire Monitoring System.

Provide alarm, supervisory, and trouble reset switches which reset a cleared device in alarm, supervisory, or trouble condition. Ensure alarm, supervisory, and trouble signals do not self-restore without activating the switch.

Ensure that alarm, supervisory, and trouble silence switches silence the alarm, supervisory, and trouble audibles, and that either switch placed in other than the normal position provides the following:

a. Report as an alarm, supervisory, or a trouble to the Central Fire Monitoring System.

b. Transfer audible signal to a panel lamp visual indication.

c. Re-ring the trouble audible if the problem has been cleared, but the switch has been left in the silence position.

When the alarm silencing switches are in the silence position, ensure subsequent alarms reactivate the notification appliances, and the strobes remain operational until the FACP is reset.

Provide FACP suitable for use with UL listed or FM approved detectors and manual alarm stations and other fire alarm devices specified in this section.

Provide FACP with an individual set of Form C dry contacts which activate for alarm, trouble and supervisory conditions for connection to the Central Fire Monitoring System. Provide additional other fire monitoring or special function relay contacts as indicated.

Deluge control panel shall have multiple sets of dry relay contacts as required to interface with KCCS PLC equipment (by others) for remote deluge monitoring and control.

Ensure all relays are continuous duty and have self-cleaning contacts of silver or an alloy of equivalent performance, and supervisory relays are suitably protected against dust by individual covers. Provide all relays with external functions, such as remote reporting, control device activation, and notification appliance activation, with at least one set of spare contacts. Permanently mark relays with the coil resistance, operating-current range, and internal pin connections using standard pin numbers.

Install a separate terminal cabinet adjacent to the FACP for interfacing device field wiring to the control panel. Provide outdoor cabinets of stainless steel construction rated NEMA 4X. Install terminal strips for all field wiring circuits plus 25 percent spare. Where a terminal cabinet is installed, install terminal strips to accommodate remote reporting circuits and associated surge suppressors. Provide copper ground bus within this terminal cabinet for termination of equipment ground conductors.

Provide steel FACP, terminal cabinets, surge suppression cabinets and battery cabinets (when used), with a hinged cover and an integral pin-tumbler cylinder lock (mortise or standard rim cylinder from Best Access Systems) with removable core that accepts the key presently in use with other control units existing in the area. Lock core will be provided by the government. Paint cabinets with a prime coat and one or more finish coats of scratch-resistant baked enamel red finish coat unless otherwise indicated.

Include in FACP all components and modules required for a local facility maintenance and fire fighters phone system. Install a master telephone set at the control panel with remote phone jacks installed in the facility as indicated on the contract drawings, expandable to 6 separate Style B supervised telephone circuits. Include in telephone control switching capabilities with visual indication for phone circuit activation.Provide system which operates from a power supply with 120 grounded V(AC) input and 24 V(DC) output, and functions satisfactorily with power input voltage

varying from 85 to 110 percent of nominal value. Ensure power supply output is capable of powering all initiation, signaling, annunciation, and control devices during alarm condition with 25 percent minimum spare capacity.

Provide all FACPs and auxiliary power supplies with a DC power input and with a DC disconnect switch integral with the equipment provided (2P 30A switch), or provide a separate safety switch. If supplied within the cabinet, ensure the power on-off switch disconnects all power sources to the control panel. Provide the on-off switch with DC rated contacts.

Provide the means of automatically supplying the entire fire alarm system with backup power with batteries, charger, and power transfer equipment alarm system with battery backup power in event of a primary power system failure. Ensure system switches to battery power in event of AC power failure, and switches back to AC power upon return of primary power. Ensure control panel(s) and auxiliary power supplies are able to operate when the backup batteries are disconnected for any reason. Also ensure system controls charging currents and floating voltage levels to maintain batteries in optimum condition. Provide capability to recharge batteries in event of discharge. Fuse wiring to protect against battery over-current and polarity reversal. Confirm primary power, battery, or charging equipment failure results in a FACP trouble signal and visual indication.

Use sealed, spill-proof battery modules to prevent any corrosive fumes. Provide batteries listed for fire alarm service and suitable for high discharge currents required under alarm conditions. Size batteries to operate the fire alarm and detection system (including triple IR flame detectors), in normal supervisory condition for 24 hours, minimum, then operate the system in the alarm mode for 10 minutes, minimum.

2.1.1 Large Capacity Fire Alarm Control Panel (With Voice)

Provide Simplex 4100ES FACP(s) with initiation, notification appliance, auxiliary control, and local auxiliary relay circuits necessary for system requirements indicated. Include a minimum of 25-percent spare circuit capacity, rounded up based on circuits provided at each location (FACP, auxiliary power supply), for the following circuit types: initiation zones, addressable device zones, notification appliance circuits, auxiliary control circuits and local auxiliary relays. Ensure unit is expandable to 2000 addressable devices. Use modular construction with solid-state, microprocessor based electronics. Equip modules with transient suppression. Include in system non-volatile programmable operating system memory for all operating requirements.

Include in FACP all components and modules required for network communication interface with the existing VAB simplex fire alarm control panel network system, including style 7 module. Communication interface shall perit customized remote reporting of monitoring zones and addressible devices, remote control panel alarm silence and system reset, and remote control of control panel outputs from the central fire monitoring system or other panels on the VAB simplex fire alarm control panel network system.

2.2 CFMS REPORTING EQUIPMENT

2.2.1 Existing VAB Reporting

Provide FACP(s) which are compatible with the existing VAB network configuration. Currently each of the six (6) VAB towers use simplex 4100+

FACPs, configured in a mini-network that reports to the Tower 'A' NDU. Tower 'A' NDU is connected to a Tower 'D' FACP (Data Tap FACP). This Data Tap FACP reports the VAB point data as summarized at Tower 'A' NDU through redundant radio transmitters.

New FACP(s) shall be capable of replacing existing while maintaining this network reporting scheme.

2.3 ADDRESSABLE MODULES/DEVICES

Provide solid-state addressable modules compatible with the FACP. Provide modules which are suitable for individual outlet box mounting or group mounting within a control enclosure. Install outdoor modules in weatherproof enclosures with a neoprene gasket protected from corrosion.

Provide field addressable modules to individually communicate with the FACP using multiplexed communication techniques. Provide communication circuit wiring connections suitable for supervised Class A, Style 6 operation. Derive module power from the communication circuit or 24 V(DC) power supply supervised by the FACP. Ensure invalid address setting, component failure, or power failure initiates a trouble signal at the FACP.

Provide manufacturer's standard outlet box for enclosure housing a single isolated module (not grouped with other modules or no other modules nearby).

Provide enclosures housing more than one addressable module with hinged door type with back panel for module mounting. Provide hinged cover(s) with an integral pin-tumbler cylinder lock (Mortise or Standard Rim Cylinder from Best Access Systems) with removable core that accepts the key presently in use with other fire alarm control units at KSC; lock core will be provided by the government. Provide adequately sized enclosure to allow a minimum of 2-inch wiring space around the cabinet perimeter to include all module termination points. Provide additional spare space for 2 future modules. Provide terminal strips with 25-percent spare capacity for interfacing all module connections to field wiring. Paint enclosures with a prime coat and one or more finish coats of red enamel to provide a smooth, hard, and durable finish. Provide enclosures with an engraved phenolic nameplate labeled, "FIRE ALARM MODULE TYPE, Address."

Provide supervised addressable modules for initiation circuits, 4-wire Class A type, unless otherwise indicated. Two-wire Class B modules are acceptable when installed in the same box or enclosure as the connected initiating device.

Provide supervised addressable modules for notification appliance circuits with parallel wired Class A type unless otherwise indicated. Ensure module is suitable for use with bells, strobes, and relays.

Provide addressable relay modules for control and/or remote reporting circuits (addressable relays), including 2 separate fused Form-C contacts rated at 2 Amperes for 28 V(DC) or 120 V(AC).

Provide addressable modules for suppression system releasing service, if used, which are UL listed for use with the fire alarm control panel and the suppression system releasing device. Include in module all necessary circuitry to supervise the suppression system release device coil.

2.4 FLAME DETECTORS

2.4.1 Triple IR Detectors

Provide unitized Triple IR flame detectors incorporating all sensory, signal processing, and alarm system interfacing components to provide fire detection by sensing within the CO2 emission band for IR radiation. Ensure detector logic requires IR signal from all three (3) sensors present in the proper spectral signature as emitted by a hydrocarbon fire, and retains alarm-initiating capability in the presence of modulated false alarm sources. Ensure detector is not activated by single sources of UV and IR radiation including sunlight (direct, intermittent, or reflected), quartz halogen lighting, electric discharge lighting, arc welding, lightning, radiant heat, hot engine exhaust, heating coils, etc, as well as being immune from radio frequency interference and electromagnetic frequency interference. Detectors using guard band technology are not acceptable.

Ensure detector has a minimum field of view of 90 degrees along the horizontal axis and 70 degrees along the vertical axis, and is capable of detecting a 1 foot gasoline fire at a distance of 210 feet on axis, and 150 feet off axis. Ensure detector can detect a 2 foot JP5 pan fire at 100 feet on axis, and off axis, as well as an atomized type fire at 50 feet on and off axis. Ensure detector response time is selectable to 500 msec with typical response under 5 seconds for initiating fire signal, and includes self-diagnostic features to monitor its sensors, power source, and internal circuitry.

Provide a detector which incorporates separate single pole, double throw (SPDT) alarm and trouble contacts rated 5 amperes minimum at 30 V(DC), with alarm contacts which activate upon fire detection and are programmable for latching or non-latching operation; program for non-latching operation unless otherwise indicated. Ensure cycling detector power or momentarily (10ms) activating the manual test line resets latching alarm contacts. Provide non-latching trouble contacts which activate upon loss of unit power or internal diagnostic failure. Provide wiring connections for all contacts suitable for Class A wiring and made on screw terminals capable of accepting No. 18 through No. 12 AWG solid copper conductors. Ensure detectors are individually addressable for alarm and trouble conditions by connection to addressable modules. Provide addressable modules in accordance with the paragraph entitled, "Addressable Modules/Devices," of this section.

Power detector from a 24 V(DC) source. Where a power source other than the FACP is used, ensure the power source incorporates power supply, battery backup and power transfer equipment in accordance with the paragraph entitled, "Fire Alarm Control Panel," of this section. Ensure detector power wiring connections are made on screw terminals suitable for No. 16 through No. 10 AWG diameter solid copper conductors. Include 25 percent spare capacity on the power circuit.

Ensure enclosures and detectors mounted in hazardous locations conform to the requirements of Underwriter's Laboratory or Factory Mutual for the hazardous location classification indicated. Install conduit seal-off fittings suitable for the hazardous location classification at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70. Provide stainless steel, rated NEMA 4X enclosures, and include threaded conduit connection. Mount enclosure on a stainless steel swivel base, which allows 180 degree horizontal and vertical rotation from the pivot point.

Provide detector with a calibrated integral optical integrity test feature, including individual test lamps for each IR sensor and generate a fault when 50 percent of the detection range is lost. Include calibrated self-test capabilities that generate an alarm when more than 50 percent of the detection range is retained.

Provide remote optical integrity test capability for each Triple IR detector from the addressable FACP. Ensure the optical integrity test is activated, manually or automatically, when the addressable control module is activated from the FACP, and each control circuit activates the internal IR test lamps simultaneously for each Triple IR detector connected to the control circuit. Include 25 percent spare capacity on each optical integrity test control circuit. Ensure activation of the control circuit via the control addressable module causes all of the associated Triple IR detectors to go into an alarm condition. Also ensure that when the optical integrity test switch is restored to it's normal position all the affected Triple IR detectors self restore. Provide the addressable device monitoring the Triple IR detector which is a latching type so as to provide alarm identification.

2.5 SMOKE DETECTORS

Provide alarm initiating smoke detectors designed for use with automatic/manual fire alarm systems in accordance with UL 268.

Provide 2.5 percent per foot nominal obscuration (photo-electric) type smoke detectors, listed for use with FACP installed, including all required accessories, rust and corrosion resistant. Ensure detector head is a plug-in unit, that detector contains no moving parts, nor requires read justment or removal to resume normal operation after an alarm. Provide all detector openings with screen to prevent the entry of insects and debris.

Provide detector head that plugs into a separate receptacle type base, with base screw terminals suitable for No. 18 through No. 14 AWG diameter solid copper conductors for all wiring connections required. Ensure base is supervised to initiate a trouble signal at the fire alarm control panel if the detector is removed, and a light emitting diode indicator to provide a visual indication when the detector initiates an alarm.

Provide detectors in areas subject to moisture or exterior atmospheric conditions that are UL listed or FM approved for such locations.

Provide addressable detector(s), bases where indicated or used in lieu of remote annunciator panels with detector or bass which includes circuitry and used selectable switching required for assigning each detector a unique address on the FACP communication bus. Ensure invalid address switch settings or component failure initiates a trouble signal at the FACP.

Provide detectors with terminals suitable for Class A wiring powered from the panel alarm initiation or communication bus circuit; separate power sources are not acceptable.

2.5.1 Duct Smoke Detectors

Provide alarm-initiating smoke detector devices designed for use with automatic/manual fire alarm systems in accordance with UL 268A.

Provide addressable type duct smoke detectors connected to an addressable

FACP, unless otherwise indicated, with the ability to perform sensitivity testing from the FACP in accordance with NFPA 72.

Provide photoelectric type duct smoke detectors listed by UL Fire Prot Dir or FM approval guide, including duct housings, mounted exterior to the duct, and perforated sampling tubes extending across the width of the duct. Ensure activation of duct smoke detectors causes shutdown of the associated air-handling unit, annunciation at the FACP, and transmits a silent alarm to the Central Fire Monitoring Station, but does not activate the building evacuation notification appliances. Provide a single maintenance by-pass switch to isolate each air handling unit's duct smoke detectors. Ensure activation of any maintenance by-pass switch inhibits reporting and causes a supervisory condition at the FACP, and when the maintenance by-pass switch is restored to it's normal configuration, the supervisory signal at the FACP self restores. Where duct smoke detectors are installed outdoors, in unconditioned mechanical or electrical rooms, or in areas with high ambient temperatures and humidity, or in high ambient temperature areas, install the detector housing in an additional PVC enclosure with an additional set of supply and exhaust sampling tubes to prevent condensation from forming within the detector housing.

Provide duct smoke detectors with terminals suitable for Class A wiring powered from the panel alarm initiation or communication bus circuit; separate power sources are not acceptable.

Install a separate remote test/light assembly for each duct smoke detector. Where multiple duct smoke detectors are installed, group the remote test switches together at a common location.

2.6 MANUAL ALARM/PUSHBUTTON STATIONS

Provide non-coded, manual alarm stations designed for use with automatic/manual fire alarm systems in accordance with UL 38.

Manual alarm/pushbutton stations shall be labeled appropriately for the purpose intended - "Fire", "Deluge Arm", "Deluge Activate".

Ensure wiring terminals are suitable for Class A wiring and capable of accepting No. 18 through No. 14 AWG diameter solid copper conductors. Make manual stations individually addressable by connection to addressable modules, provided in accordance with the paragraph entitled, "Addressable Modules/Devices," of this section.

Ensure manual alarm station door has a protected, pull-down operating lever with recessed finger grip. When operated, ensure the station mechanically latches, breaks a glass or plastic rod, closes one or more sets of contacts, and locks the contacts in the operated position until reset. Stations with a pushbutton which depends upon a spring-loaded device to close the contacts when the handle is pulled are not acceptable, nor are stations which are resettable without the use of a key or tool.

Each manual pushbutton station shall consist of an arm circuit and activation circuit. Each circuit shall consist of a pushbutton assembly and a pilot light assembly with red pilot light above green pilot light/both LED type.

Paint all exposed metal surfaces of enclosing cases with a prime coat and one or more finish coats of red enamel to produce a smooth, hard, durable finish. Provide identification and directions for operating fire-alarm

stations on the cover in raised or depressed white-enameled letters. Manual stations constructed of plastics or composite material are not acceptable.

Furnish surface-mounted stations with matching cast-iron or cast-aluminum back boxes with top and bottom threaded-conduit connections. For stations mounted outdoors, provide weatherproof type, with a neoprene gasket, and protect against corrosion. Provide a molded polycarbonate clear protective cover with the provision for a lead seal or plastic supervisory seal in all areas open to the general public. Ensure the protective cover does not have an integral warning horn.

For hazardous locations, provide manual stations that are UL listed, FM approved, or approved by a recognized testing laboratory for the hazardous location classification indicated. Ensure unit consists of a complete manufactured explosion-proof manual station assembly. Provide conduit seal-off fittings suitable for the hazard classification at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70.

2.7 STROBE UNITS

Provide strobe units designed for use with automatic/manual fire alarm systems, in accordance with UL 1971

Provide UL listed or FM approved strobe units including red cast metal housing, dome polycarbonate white lens with white "FIRE" lettering on two sides , and a zenon flash tube with solid state circuitry. Ensure unit brightness is 15, 30, 75, or 110 candela in accordance with NFPA 72, producing a minimum flashing frequency of 1 Hz and a maximum of 3 Hz. Synchronize all strobes. Ensure strobes remain flashing until the FACP is reset. Ensure visual notification appliance circuits have sufficient capacity to operate all devices connected, plus 25 percent minimum spare capacity per circuit.

Provide units which operate from polarized 24 V(DC), Class A, parallel wired supervised notification appliance circuits, with an operating current not exceeding 0.1 amperes and capability of operating over a 20 percent variation in nominal input voltage. Ensure wiring connection terminal blocks are suitable for No. 16 through No. 12 AWG diameter solid copper conductors.

Provide flush mounted interior units using standard electrical back boxes, and surface mounted units in cast iron or cast aluminum boxes with threaded conduit hubs. Provide weatherproof units with a neoprene gasket, protected from corrosion, in exterior or wet locations. Paint all metal exposed surfaces with a prime coat and one or more finish coats of red enamel paint to provide a smooth, hard durable finish.

If mounted in hazardous locations, provide strobes UL listed or FM approved for the hazardous location classification indicated. When the unit is not factory sealed, provide conduit seal-off fittings suitable for the hazardous location classification indicated at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70.

2.8 SPEAKERS

Provide speakers UL listed or FM approved for audible signal use, designed for use with automatic/manual fire alarm systems in accordance with UL 1480 and UL 1711, capable of clearly reproducing voice messages and bell tones

in a three-pulse temporal pattern over a 400 to 4000 Hz range. Ensure speaker output at 1000 Hz for 1 watt input power is no less than 87 dB at 10 feet.

Provide Notification Appliance mechanism consisting of sealed speaker and multiple-tap impedance matching transformer suitable for 24 V(DC), Class A parallel-wired, supervised audio signaling systems. Include with transformer settings 0.25, 0.5, 1.0, and 2.0 watt taps unless otherwise indicated. Ensure Wiring connections for 4 wire operation are screw terminals suitable for No. 16 through No. 12 AWGdiameter conductors.

Provide speaker housings made of red impact resistant polycarbonate or cast metal construction. Mount flush mounted interior speakers using standard electrical back boxes. Mount surface mounted speakers using red cast iron or cast aluminum boxes with threaded conduit hubs. If mounted in exterior or wet locations, provide weather-proof type with a neoprene gasket, protected from corrosion. Paint all metal exposed surfaces with a prime coat and one or more finish coats of red enamel paint to provide a smooth, hard, durable finish.

Ensure strobe portion of a combination audible/visual notification appliance is in accordance with the applicable provisions of the paragraph entitled, "Strobe Units," of this section.

If mounted in hazardous locations, provide speakers UL listed or FM approved for the hazardous location classification indicated. When the unit is not factory sealed, provide conduit seal-off fittings suitable for the hazardous location classification indicated at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70.

2.9 WATER FLOW ALARM DEVICES

Provide alarm-initiating water flow devices designed for use with automatic/manual fire alarm systems, in accordance with UL 346, conforming to UL or FM requirements for the particular type of sprinkler system being specified.

Ensure contact have a minimum of 2 single pole, double throw contacts rated 5 amps at 28 V(DC) or 250 V(AC). Make water flow devices individually addressable by connection to addressable modules, and provide in accordance with the paragraph entitled, "Addressable Modules/Devices," of this section. Provide weatherproof and corrosion protected flow devices for outdoor installations.

If installed in hazardous locations, provide water flow devices UL listed or FM approved for the hazardous location classification indicated. When the switch is not factory sealed, provide conduit seal-off fittings suitable for the hazardous location classification indicated at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70.

2.9.1 Pressure Switch

Wire alarm pressure switch to make or break an alarm circuit depending on rise or fall of water pressure. Provide an alarm pressure switch with an instant-recycle pneumatic-retard, or electronic adjustable setting time delay, settable from 45 to 90 seconds.

2.9.2 Vane-Type Flow Switch

Provide vane-type alarm flow switch which makes or breaks an alarm circuit upon deflection by a volume of flowing water that equals or exceeds the capacity of a single sprinkler. Ensure alarm flow switch has an instant-recycle pneumatic-retard, or electronic adjustable setting time delay, settable from 45 to 90 seconds.

2.10 VALVE TAMPER SWITCHES

Provide supervisory initiating valve tamper switches designed for use with automatic/manual fire alarm systems, in accordance with UL 346, conforming to UL or FM requirements of use on the specified valve.

Provide contacts with a minimum of 2 single pole, double throw contacts rated 5 amps at 28 V(DC) or 250 V(AC). Ensure valve tamper switches are individually addressable by connection to addressable modules, in accordance with the paragraph entitled, "Addressable Modules/Devices," of this section. Provide weatherproof, corrosion-protected switches for outdoor installations. In hazardous locations, provide valve tamper switches UL listed or FM approved for the hazardous location classification indicated. If the tamper switch is not factory sealed, provide conduit seal-off fittings suitable for the hazardous location classification indicated, at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70.

2.11 REMOTE AUXILIARY CONTROL RELAYS

Provide remote control relays with continuous duty coils rated 24 V(DC). Where relays are used on Class A parallel wired supervised circuits, ensure coils incorporate supervisory current blocking diode. Provide relays with a minimum of 2 single pole, double throw contacts rated 5 amps at 28 V(DC) or 250 V(AC). Where auxiliary control circuits connected to the relay are protected at a higher ampacity than the relay contacts are rated, provide fusing rated to protect the relay contacts in the relay enclosure.

Provide addressable type relays, where indicated, in accordance with the paragraph entitled, "Addressable Modules/Devices," of this section.

Mount remote auxiliary control relays in enclosures indicated, or if not indicated, in manufacturer's required enclosure. Install outdoor relays in a weatherproof enclosure with a neoprene gasket and protection against corrosion.

In hazardous locations, install relays with enclosures UL listed or FM approved for the hazardous location classification indicated. Provide seal-off conduit fittings at each conduit connection to the explosion-proof enclosure in accordance with NFPA 70.

Paint enclosures with a prime coat and one or more finish coats of red enamel to provide a smooth, hard, and durable finish. Label enclosure with an engraved phenolic nameplate stating, "F/A RELAY."

Mount remote auxiliary control relays and supervise within 3 feetof the controlled device in accordance with NFPA 101.

2.12 POWER SOURCE

Ensure normal power to the local systems for all purposes, including

separately powered notification appliances and initiating devices, is 120 volts 60 hertz. Ensure system operates satisfactorily between 85 and 110 percent of normal voltage. Provide fire-alarm-system disconnect/protective device as a fused switch with a red factory finish as specified herein for manual alarm stations. Mount this disconnect switch adjacent to the FACP. Mark as FIRE-ALARM DISCONNECT FED FROM (indicate supply circuit) with 1/2-inch high letters in white paint or engraved phenolic identification plates fastened with sheetmetal screws. Ensure switch is capable of being locked in the "on" or "off" position, a feature which can not interfere with the circuit protection capability of the device. Equip switch with surge suppression for all phase and neutral conductors. Install current limiting Class RK1 fuses properly sized to protect the fire alarm equipment.

When power is supplied from a single 20 amp circuit breaker, provide an adjustable set screw type clamping device over the circuit breaker handle to prevent handle operation. Paint only the locking device red.

2.13 WIRING

Provide copper conductor wiring in accordance with NFPA 70 and NFPA 72. Connect all devices to Class A, parallel-wired circuits, per NFPA 72, with the wire types specified in this section, unless specifically noted otherwise in the paragraph entitled, "Wiring (Wire and MultiConductor Cable)", of this section. For 120 V(AC) circuits, use No. 12 AWG minimum.

Ensure all conductors installed on fire alarm systems are solid copper with an insulation rating of not less than 300 volts, permanently marked with the size, voltage rating and manufacturer's name on the conductor jacket at no less than 2 feet intervals. Conductor sizes are listed below.

Where modifications are made to existing systems, match the new or added conductors to the size and color-coding of the existing system. Conductor AWG diameter and Insulation Type are listed below. Required wire colors are listed in the paragraph entitled, "Wiring (Wire and Multi-Conductor Cable)," of this section.

Provide solid copper, shielded, twisted pairs, meeting UL 2196 requirements, for conductors in multiplexed communication circuits, signaling line circuits, speaker audio circuits, remote phone circuits, and remote reporting circuits. Ensure cable is listed as Type FPL, Power-Limited Fire Protective Signaling Cable, with conductor size less than No. 16 AWG diameter for data circuits and No. 14 AWG diameter for audio circuits.

Air sampling detection units are permitted to use No. 18 AWG for connection to addressable modules with maximum conductor length not to exceed 25 ft.

Provide direct current initiating device (manual pull station) circuit conductor size of not less than No. 16 AWG diameter, with insulation Type TFN for No. 16 AWG diameter, and Type THHN/THWN for No. 14 AWG diameter and larger.

Size power leads from the control panel for product-of-combustion detectors accordingly, but not less than No. 14 AWG diameter, with insulation Type THHN/THWN for No. 14 AWG diameter and larger.

Provide direct current notification appliance circuit (strobes, bells) conductor size of not less than No. 14 AWG diameter, with insulation Type THHN/THWN for No. 14 AWG diameter and larger.

Provide direct current auxiliary control device (AHU shut down relay) circuit conductor size of not less than No. 14 AWG diameter, with insulation Type THHN/THWN for No. 14 AWG diameter and larger.

Provide solenoid valve control circuit conductor size of not less than No. 14 AWG diameter, with insulation type THHN/THWN for No. 14 AWGdiameter and larger.

2.13.1 Fire Resistive Cables

Provide fire resistive cables for notification appliance circuits designed for use with automatic/manual fire alarm systems in accordance with UL 2196.

Provide UL Fire Prot Dir listed Type FPL-CI fire alarm cable for use with power limited fire alarm notification appliance circuits. Ensure the CI cable has a minimum 2 hour fire resistance rating by having passed the applicable testing requirements of UL 2196. Install this cable in locations required to meet NFPA 72 survivability requirements.

2.14 SURGE SUPPRESSORS

Provide line voltage and low voltage surge suppression devices to suppress all voltage transients which might damage the control panel components.

Install surge suppression in accordance with UL 497B on each conductor of fire alarm circuits which extend beyond a building. Locate protection as close as practical to the point where the circuits leave the building. Install protectors in surge suppression cabinets of adequate size with terminal strips for all wiring connections plus 25 percent spare. Paint enclosures with a prime coat and one or more coats of red baked enamel finish to provide a smooth, hard, and durable finish. Where installed outdoors, provide stainless steel NEMA 4X rated cabinets. Provide a copper ground bus inside the cabinet and connect protectors to an earth ground electrode system in accordance with the manufacturer's requirements and NFPA 70. Ensure an etched metal or engraved laminated plastic identification plate labeled, "Fire Alarm Cabinet," is affixed to the cabinet door of the alarm control unit to identify the cabinet as a fire alarm cabinet. For cabinets painted black, ensure the identification plate has white letters on a black background, and for cabinets not painted red, the identification plate has white letters on a red background.

2.14.1 Line Voltage Surge Suppressors

Provide suppressor UL 1449 listed with a maximum 330 volt clamping level and a maximum response time of 5 nanoseconds, and also meets IEEE C62.41, category B tests for surge capacity. Ensure suppressor is a multi-stage construction type which includes inductors and silicon avalanche zener diodes. Provide suppressor which has a long-life indicating lamp (light emitting diode or neon lamp) which extinguishes upon failure of protection components, with externally accessible fuses. Wire in series with the incoming power source to the protected equipment using screw terminations.

2.14.2 Low Voltage Surge Suppressors

Provide for all circuits which leave the building shell and as shown on the contract drawings. When circuits interconnect two (2) or more buildings, provide an arrestor at the circuit entrance to each building. Ensure suppressor is UL 497B listed, with a maximum 30 volt clamping level and a

maximum response time of 5 nanoseconds, with multi-stage construction and both differential/common mode protection.

PART 3 EXECUTION

3.1 SYSTEM SEQUENCE OF OPERATION

3.1.1 Normal Operation

Ensure all switches are in the normal position; available power lamp is on, the trouble and detector identification lamps are off, and all circuits are electrically supervised.

3.1.2 Supervisory Condition

Per system conditions identified in the paragraph entitled, "Fire Alarm Control Panel," of this section, ensure that a supervisory signal is transmitted to the Central Fire Monitoring System, device indication is provided, a supervisory signal is activated in the FACP, and input is provided to remote annunciators (when used). Ensure supervisory signal in the alarm control unit is comprised of visual and audible indications and is self-restoring.

3.1.3 Trouble Condition

Per system conditions identified in the paragraph entitled, "Fire Alarm Control Panel," of this section, ensure that a trouble signal is transmitted to the remote reporting device of the Central Fire Monitoring System, providing zone indication, activating a trouble signal in the FACP, and providing input to remote annunciators (when used). Ensure trouble signal in the alarm-control unit provides visual and audible indications.

3.1.4 Alarm Condition

Ensure activation of any detectors, manual alarm stations, water flow switches, or other initiating devices closes a contact that activates the appropriate FACP. FACP transmits a signal to the remote reporting device of the Central Fire Monitor System, activates the facility indicating appliances, provides zone identification, controls air handling and ventilating units, provides an input to remote annunciators (when used), and provides indication or control to devices or other systems.

3.2 INSTALLATION

Prior to performing any installation or modification work to existing Fire Alarm system(s), secure a Transfer of Responsibility Form completed by the COTR and signed by the Contractor and Institutional Services Contractor (ISC) Fire Protective Systems designee. The completed form will be turned over to the Contracting Officer by the COTR. Permanently affix a copy of the completed "Transfer of Responsibility" Form to the affected FACP throughout the construction period.

Install all equipment in accordance with manufacturer's recommendations and requirements of this Section.

3.2.1 Fire Alarm Control Panel(s) and Reporting Equipment

Install equipment in each protected building, located where indicated, and complete with all indicated accessories and devices. Install equipment in

accessible locations in such a manner as to prevent damage from vibration or jarring. Equipment requires a minimum of 3 feet clearance directly in front of the panel for maintenance per NFPA 70. With multiple equipment, the 3 feet clearance is required directly in front of the complete configuration. In addition, provide a 28 inch clear aisle way for access to the equipment.

Ensure wiring within FACP(s) and reporting equipment is in accordance with the paragraph entitled, "Installation in Cabinets and Boxes," of this section.

Install conductors in accordance with the paragraph entitled, "Wiring," from the FACP to a new 8 point terminal strip labeled "FATB" in the indicated telephone terminal cabinet.

When FACP(s) and reporting equipment are installed flush or semi-flush, provide three spare 1-inch conduits in accordance with the paragraph entitled, "Conduit and Raceways," of this section, from the FACP wiring termination cabinet to an accessible location.

3.2.2 Addressable Modules and/or Devices

Install zone addressable modules at accessible locations indicated. Configure module address switches to settings indicated on approved shop submittals. Individually identify modules adjacent to their mounting.

Mount control zone addressable modules used for smoke control, AHU shutdown, etc. in accessible locations within 3 feet of the device to be controlled. Do not install control modules connected to separately energized control wiring from auxiliary systems in the same enclosure with initiation and signal zone addressable modules.

Where zone addressable modules are grouped within an enclosure, wire in accordance with the paragraph entitled, "Installation in Cabinets and Boxes," of this section.

3.2.3 Flame Detectors

Provide flame detector location and general arrangement as indicated. Adjust location as required to prevent obstruction of the detector field of view, and provide coverage in all protected areas by at least one detector.

Where detectors are installed outdoors, arrange conduit systems to drain away from the detector. Aim detectors to accurately cover the field specified using a laser aimer recommended by the detector manufacturer. Point the aiming spot on the floor for each detector and include the measurements of this spot from fixed structural elements on the shop drawings and record (as-built) drawings.

3.2.4 Smoke Detectors

Provide smoke detector location, number, and general arrangement as indicated. Ensure field installation in accordance with NFPA 72. Do not install detectors until the work of other trades is complete.

Utilize 'T' bar corner plate bracket for devices mounted in acoustical, lay-in type ceilings. Cut ceiling tile as required to accommodate mounting plate and device wiring.

Install duct smoke detectors in accordance with the manufacturer's requirements and NFPA 90A. Seal all duct penetrations air and water-tight.

Configure addressable smoke detector address switch settings as approved on shop drawings and submittals.

Locate detectors no closer than 6 feet from a fluorescent light fixture. Locate detectors no closer than 3 feet from any return air diffuser and no closer than 6 feet from any supply diffuser. Ensure detectors installed in areas subject to moisture or exterior atmospheric conditions are UL listed or FM approved for such locations.

3.2.5 Manual Pull Stations (Fire Alarm Boxes)

Mount manual pull stations at locations indicated within 18-inch of the latch side of the door. Ensure mounting height is 48-inch above the finished floor measured from the top of the device.

Where manual pull stations are installed outdoors, arrange conduit systems to drain away from the manual pull stations.

3.2.6 Alarm Bells/Speakers

Mount bells and/or audio speaker notification appliances at the approximate locations indicated. Ensure mounting height is 90-inch above the finished floor measured from the top of the bell/speaker, but no less than 6-inch below the ceiling.

Where bells or speakers are installed outdoors, arrange conduit systems to drain away from the bells or speakers.

3.2.7 Strobe Units/Combination Audio Visual

Mount strobe notification appliances at the approximate locations indicated. Ensure locations are unobstructed and allow viewing by area occupants in accordance with NFPA 70. Ensure mounting height is 80-inch above the finished floor measured from the bottom of the strobe, but no less than 6-inch below the ceiling.

Where strobes are installed outdoors, arrange conduit systems to drain away from strobes. Ensure visual and audible appliances are capable of operating independently via separate and independent circuits for both the audible and strobe portions.

3.2.8 Auxiliary Control Relays

Install and supervise remote control relays in accessible locations within 3 feet of the device to be controlled.

3.2.9 Wiring (Wire and Multi-Conductor Cable)

Provide wiring conforming to the requirements of NFPA 70 and the following special requirements:

Install fire alarm system circuits in a separate raceway system. Route each circuit type (Initiating, Notification, Signaling, and Control) through a dedicated separate conduit or raceway system configured to comply with NFPA 72 Class "A" conduit system requirements. Do not allow 60-Hertz power circuits to enter enclosures containing fire alarm

circuits except where required to connect to the fire alarm system.

Provide continuous conductors from a terminal point at one device to a terminal point at the next device and from a device to the FACP. Break wires at each terminal; do not loop wires over a terminal. Terminate approved explosion proof devices, provided with pigtail wiring connection leads, on a field installed terminal strip installed in the box on which the device is mounted. Install solderless ring tongue terminal lugs with manufacturer's required tooling on the device wiring connection leads. Use this ring type lug on stranded wire only. Terminate solid wire on compression or screw type terminals. When screw type terminals are used, capture the conductor under 80 percent of the screw head surface. Identify all circuit conductors within each enclosure where a tap, splice, or termination is made. Provide conductor identification by heat-shrink-type sleeves or other approved method. Use point destination type conductor labels to indicate cabinet, circuit board, terminal block and screw terminal location for each individual conductor.

Provide conductor colors as listed below and in accordance with FED-STD-595. Where modifications are made to existing systems, match the new or added conductors to the size and color-coding of the existing system.

Mark conductors for multiplexed communication circuits, speaker audio circuits, remote phone circuits, and remote station signaling circuits with circuit designation, and maintain consistent color-coding for the positive and negative loops throughout the cable system.

Install direct current initiating device circuits (heat detectors, manual pull station) as Class A, parallel-wired circuits per NFPA 72. Ensure the positive loop conductor is colored blue, Color No. 15102, and the negative loop conductor is colored black, Color No. 17038.

Install power leads from the control panel for product-of-combustion detectors as Class A, parallel-wired circuits per NFPA 72. Ensure the positive conductor is be colored white, Color No. 17877, and the negative conductor is colored black, Color No. 17038.

Install direct current notification appliance (bells, strobes) circuits as Class A, parallel-wired circuits per NFPA 72. Ensure the positive conductor is colored red, Color No. 11105, and the negative conductor is colored orange, Color No. 12473.

Install direct current auxiliary device control device circuits (AHU shutdown relay) as Class A, parallel-wired circuits per NFPA 72. Ensure the positive conductor is colored yellow, Color No. 13591, and the negative conductor is colored brown, Color No. 10055.

Install solenoid valve control circuits as Class B circuits per NFPA 72. Ensure the positive conductor is colored yellow, Color No. 13591, and the negative conductor is colored violet, Color No. 37100.

3.2.9.1 60-Hertz Power

Provide 60-hertz power to FACP(s) or separately powered devices of 120 volts. Provide one black phase conductor, one white or gray solidly grounded neutral conductor, and one green equipment grounding conductor. Size conductor as shown on the drawing with the minimum size No. 12 AWG

copper. Install surge arrestors in accordance with NFPA 72 and NFPA 70.

Clearly identify Circuit Breakers used to supply AC power to the FACP. Provide a permanent label with white background and red lettering adjacent to the circuit breaker.

3.2.9.2 Installation in Cabinets and Boxes

Install wiring in control cabinets and boxes in a neat and orderly manner with wire properly grouped, tie-wrapped, or laced parallel and perpendicular to the major axis, supported and identified. Provide continuous control wiring from device to device with no splices unless otherwise indicated. Permanently mark all wires entering or leaving control cabinets, boxes, and devices and terminate on screw terminals. Ensure marking is consistent throughout the fire alarm system and is the same as the identification shown on the connection drawings.

Ensure wire labels correspond to the approved connection drawings and use a method indicating the destination of the other end of the wire. Provide labels in control panel equipment or between fire alarm terminal cabinets which indicate the destination of the other end by cabinet designation-terminal strip designation-terminal number. Provide labels in fire alarm terminal cabinets indicating connection in control panel equipment by fire alarm cabinet designation-module identifier-module terminal strip identifier-terminal number. Provide conductor labels with legible machine-printed black lettering on white background using indelible ink. Ensure labels are heat shrink or wrap around type.

3.2.10 Conduit and Raceways

Minimum size for fire alarm system initiating, notification, signaling line and control circuit conduits and raceways is 3/4-inch. Install in accordance with NFPA 70. Ensure all Class A initiating device, signaling line, notification appliance and control circuits use diverse routing in accordance with NFPA 72. Do not run outgoing and return redundant circuit conductors in the same cable assembly, enclosure or raceway. The outgoing and return circuit conductors are only permitted to be run in a single conduit or raceway for drops that enter or exit an initiating device, notification appliance, or control unit enclosure.

Install rigid galvanized steel conduit in all hazardous (classified) locations, exterior locations where the conduit is exposed above grade, interior exposed locations from finished floor to 1 foot above finished ceiling unless otherwise shown on the drawings. EMT with hexnut expansion gland-type fittings can be installed in all other locations. Use flexible metal conduit, maximum length 6 feet, as the final connecting raceway to a fire alarm device mounted on vibrating equipment or on a suspended ceiling.

Where devices, junction boxes, and cabinets are installed outdoors, arrange conduit systems to drain away from the box; ensure conduit enters the box side or bottom only and drain type fittings are installed.

Use schedule 80 PVC for conduit direct buried in earth. Ensure that portions of underground raceway systems that penetrate above finished grade are rigid, galvanized, heavy-wall steel conduit with a 40-mil PVC coating or painted with a bitumastic compound.

Conceal all conduit in interior finished areas. Fire-stop all conduit passing through fire-resistant rated walls, floors, ceilings, in a manner

that maintains the fire-resistant rating of the wall, floor or ceiling.

Ensure conduit installed in a vertical position is parallel with walls and perpendicular with the floor and ceiling, and that conduit installed in a horizontal position is parallel with the floor and ceiling and perpendicular to the walls. Make changes in direction of runs with symmetrical bends. For bends of over 1-inch in diameter, provide factory made elbows.

3.2.11 Water Flow Alarm and Valve Tamper Switches

Install switches in accordance with the manufacturer's requirements and make final connections using liquid-tight flexible metallic conduit. Adjust time delays on water flow/pressure switches to between 45 and 90 seconds to prevent false alarms due to momentary water movement.

3.2.12 Elevators

Ensure initiating devices to effect control of the elevator(s) in an alarm condition report through the facility fire alarm system and initiate the following actions in the elevator controls in accordance with ASME A17.1 and NFPA 72:

a. Primary Fire Fighter Recall.

b. Secondary Fire Fighter Recall.

c. Power Feed Shunt-Trip.

d. "Do Not Use Elevator" Warning.

e. Coordinate elevator actions with existing conditions. By the addition of new FA devices, the elevator functions as currently configured shall not change.

3.3 FIELD TESTING

After complete installation of the equipment and at such time as directed by the Contracting Officer, conduct tests to demonstrate that the installation requirements of this specification have been met and that the sequential functions of the system comply with the requirements specified herein. Perform the Tests covered in the following paragraphs in two parts:

a. Contractor Checkout - Perform this test to remove all troubles, ground faults, ensure all devices are fully functional and operational, and test the programming to ensure the installation meets the contract drawings and specifications.

For modification and rehabilitation work, the Contractor is not responsible for existing troubles and ground faults that are not in contract scope. Clearly convey the existing troubles and ground faults that are not in contract scope in the Transfer of Responsibility form. Upon successful completion of Contractor Checkout, submit Contractor Readiness Affirmation - For Preliminary Fire Alarm Testing prior to requesting the preliminary test. Also submit KSC - Transfer of Responsibility; and draft of NFPA 72 Fire Alarm System Record of Completion. Contractor Readiness Affirmation - For Preliminary Fire Alarm Testing and KSC - Transfer of Responsibility forms can be found in the "Special Conditions" documentation associated with this project.

b. Preliminary - Perform this test using the approved test procedure and witnessed by the Government construction inspectors. Verify Record (as-built) fire alarm system drawings against the system installed, annotate all red-lines, and summarize on a single set of record (as-built) drawings. Follow the test procedures as written and annotate all red-lines on a single Test Procedure. Secure the initials and date on the summarized set of drawings and test procedures from the construction inspector and the fire alarm vendor. The Preliminary test is not considered complete until all steps in the test procedure have been satisfactorily completed. This includes any additional steps required to complete 100 percent testing of the fire alarm system and its associated functionality.

c. Final Acceptance - After the successful completion of the preliminary test, schedule a Final Acceptance test. Incorporate the final acceptance test procedure and record (as-built) drawings including all red lines from the preliminary test. Provide a copy of the consolidated redlines for the record (as-built) drawings and preliminary test procedures from the preliminary test. Ensure the Contracting Officer and the Authority Having Jurisdiction or their designee(s) witness the final acceptance test for the fire alarm system. During the Final Acceptance Test, provide two corrected as-built drawings and Final Acceptance Test Procedures for use in conducting the final acceptance test. Upon completion of the Final Acceptance Test, provide the following documentation to the Contracting Officer; a copy of the Final Acceptance Test procedure (with all steps annotated as complete), a corrected set of as-built drawings and a signed and completed NFPA 72 Fire Alarm System Record of Completion form.

On both preliminary and final tests, follow the approved testing procedures.

3.3.1 External System Wiring

Perform the following tests on the external system wiring before connection to the control panel:

Check continuity of circuits with an ohmmeter. Insert temporary jumpers in appropriate sockets of missing detectors and install the end-of line resistor when this test is performed. Verify resistance reading for each circuit is the value of the end-of-line resistor, plus or minus 10 percent.

Check each wire for grounds with 300-volt and 500-volt insulation resistance test set. Ensure resistance to ground is not less than 20 megohms. Isolate each wire tested from ground, with all other wires within the same conduit grounded. Verify that the conduit system is grounded prior to insulation resistance testing by verifying a short circuit between the conduit and earth ground.

3.3.2 Fire Alarm System Acceptance Test Procedures (For Both Preliminary and Final Tests)

After completion of the above tests, connect the external system wires to the appropriate terminals in the control panel and perform the following tests:

With the control panel energized, demonstrate the proper operation of

all indicating lights and alarms.

Demonstrate each annunciator panel lamp to operate when its associated device or zone is activated.

Activate each manual pull station to demonstrate proper operation.

Activate each smoke detector in accordance with the manufacturer's instructions, to demonstrate proper operation; both alarm and trouble.

Perform a static pressure differential test on each duct smoke detector to verify the pressure differential between the inlet and outlet tubes is within the manufacturer's specifications for acceptable operation. For air handling units with variable speed drives, test at both the minimum and maximum operating speeds.

Activate each flame detector in accordance with the manufacturers recommendation; verify both alarm and trouble indications at the FACP.

Activate each optical integrity test switch and verify that each flame detector on this circuit went into alarm and that all the addressable interface modules latched in the alarm condition. Restore the test switch and visually verify the flame detectors returned to normal operation.

Each time an initiating or supervisory circuit is activated, verify that the associated device address, notification appliances circuits, auxiliary control circuits, and alarm reporting to the Central Fire Monitoring System is activated and the correct information is displayed by the color graphics units.

Remove and ground one lead at each alarm initiating device, (manual pull station, smoke detector, flame detector, heat actuated detector etc.), to demonstrate circuit trouble, ground fault, and then alarm over ground fault with an open circuit. Alternate between positive (plus) and negative (minus) leads during the device testing process.

Turn off power to each separately powered panel or device to simulate loss of power and to demonstrate operation of the trouble alarm.

Test the rate-of-rise function on each heat-actuated detector in each zone by application of heat from a heat lamp or hand held hot air blower. Ensure detectors initiate an alarm to the system, sustain repeated tests of the rate-of-rise function without damage to the fixed temperature function. Replace heat-actuated detectors (HADS) subject to operation from body temperature.

Open and close water suppression system valves requiring tamper switches, to demonstrate proper operation.

Activate water flow/pressure switches by water flow at the inspector's test valve to demonstrate proper operation. Set water flow time delay between 45 and 90 seconds.

Verify discharge of electrically activated suppression systems. Verify each initiation device that activates the suppression system to activate the solenoid valve. Fully discharge the overall system at least once.

Demonstrate each alarm initiating circuit to operate its associated alarm-control and auxiliary control units and remote reporting.

Remove and ground one lead at each notification appliance and auxiliary control device to demonstrate open circuit trouble, ground fault trouble, and then operation over ground fault with an open circuit. Alternate between positive (plus) and negative (minus) leads during the device testing process.

Measure and record sound pressure level with a sound level meter meeting ANSI S1.4a, Specifications for Sound Level Meters, Type 2 requirements. Measure and record sound pressure Levels and ambient background levels throughout the protected area. Set the sound level meter in accordance with ANSI S3.41, American National Standard Audible Evacuation Signal, using the time-weighted characteristic F (FAST). Record the maximum output when the audible emergency evacuation signal is on. Verify audible information to be distinguishable and understandable. In locations where voice intelligibility is required, verify by one of the NFPA 72 approved methods. Ensure Acceptable Sound pressure level differentials comply with NFPA 72.

Demonstrate each alarm control unit to operate in all modes.

Demonstrate capacity and the operation of the battery backup system to operate as required by these specifications by disconnecting the 120 volt, 60 Hz power from the fire alarm (control) panel and operating the system as specified for backup operation.

Demonstrate all circuits interconnecting with other systems fire protection, smoke control, HVAC, security and safety, elevators, etc., to operate as specified on alarm from the associated zone or zones.

Verify all maintenance bypass functions operate as specified. Independently verify each device or circuit controlled by the bypass function.

Test multiplex equipment, devices, and wiring in accordance with NFPA 70 and manufacturer's requirements. Remove and ground one lead at each addressable device to demonstrate open circuit trouble, ground fault trouble, and then operation over ground fault with an open circuit. Alternate between positive (plus) and negative (minus) leads during the device testing process.

Test Style 7 network wiring configuration and fault tolerance to verify proper operation.

3.3.3 Reacceptance System Tests

Perform reacceptance testing after system components are added or deleted; after any modification, repair, or adjustment to system hardware or wiring; or after any change to software. Test all components, circuits, systems operations, or site specific software functions known to be affected by the change or identified by a means that indicates the system operational changes are 100 percent tested. In addition, also test 10 percent of the initiating devices that are not directly affected by the change and verify proper system operation.

Changes to all control units connected or controlled by the system executive software require a 10 percent functional test of the system,

including a test of at least one device on each input and output circuit to verify proper system operation.

Upon completion of the modification, functionally test the existing devices that were reinstalled and test the devices that are on both sides of the point of connection of the new devices. Test all newly installed devices in accordance with the paragraph entitled, "Fire Alarm System Acceptance Test Procedures (For Both Preliminary and Final Tests)," of this section.

After final acceptance testing has been successfully completed, submit test data under the terms of the "GENERAL REQUIREMENTS" clause of this contract.

3.4 OPERATION AND MAINTENANCE MANUALS

Submit Operation and Maintenance Manuals. Bind information in manual format and group by technical sections consisting of manufacturer's standard brochures, schematics, procedures, recommended spare parts, recommended test equipment, and safety precautions. Submit this information prior to acceptance tests being performed.

3.5 PAINTING

Bring all manufacturer's standard finish equipment surfaces, damaged during construction, to as-new condition by touchup or repainting to the satisfaction of the Contracting Officer, or replace with new undamaged equipment at no additional cost to the Government.

Paint all fire alarm conduit fittings, junction boxes, and junction box covers red, Color No. 11105 in accordance with FED-STD-595. Mark conduit with a minimum 1-inch wide band every 20 feet. Alternative compliant method is to use red-colored EMT conduit that is hot-galvanized for durability with a red top coat. If the alternative method is selected, none of the conduit fittings, junction boxes, or junction box covers are required to be painted.

-- End of Section --

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SECTION 31 99 99

MICROPILES

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 T26	Standard Method of Test for Quality of Water to Be Used in Concrete

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7	(2010; Change 2010; Change 2011; Errata 2011; Change 2011) Minimum Design Loads for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM A 252	(1998; R 2002) Welded and Seamless Steel Pipe Piles
ASTM A 36	(2005) Standard Specification for Carbon Structural Steel
ASTM A 572	(2006) High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A 615	(2006a) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 722	(2006) Uncoated High-Strength Steel Bar for Prestressing Concrete
ASTM C 150	(2007) Standard Specification for Portland Cement
ASTM C 494	(2005a) Standard Specification for Chemical Admixtures for Concrete
ASTM D 1143	(1981; R 1994e1) Piles Under Static Axial Compressive Load
ASTM D 3966	(1990; R 1995) Piles Under Lateral Loads

JOHN F. KENNEDY SPACE CENTER (KSC)

KSC-STD-Z-0004	Standard for Structural Design

U.S. FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA-SA-97-070	Ground Improvement, Micropile Design and Construction Guidelines - Implementation Manual

1.2 DEFINITIONS

Admixture: Substance added to the grout to either control bleed and/or shrinkage, improve flowability, reduce water content, retard setting time, or resist washout.

Alignment Load (AL): A nominal load applied to a micropile during testing to keep the testing equipment correctly positioned.

Apparent Free Micropile Length: The length of pile which is apparently not bonded to the surrounding ground, as calculated from the elastic load extension data during testing.

Bond Breaker: A sleeve or coating placed over the steel reinforcement to prevent load transfer.

Bonded Length: The length of the micropile that is bonded to the ground and which is conceptually used to transfer the applied axial loads to the surrounding soil or rock. Also known as the load transfer length.

CASE 1 Micropile: A pile designed to accept load (either axial or lateral) directly, and transfer it to an appropriate bearing stratum. Usually comprises significant steel reinforcement.

CASE 2 Micropile: One of a network of low capacity piles used to delineate and internally reinforce a volume of composite, reinforced pile/soil material.

Casing: Steel pipe introduced during the drilling process to temporarily stabilize the drill hole. Depending on the details of the micropile construction and composition, this casing may be fully extracted during or after grouting, or may remain partially or completely in place, as part of the final pile configuration.

Centralizer: A device to centrally locate the reinforcing element(s) within the borehole.

Core Steel: Reinforcing bars or pipes used to strengthen or stiffen the pile, excluding any left-in drill casing.

Corrosion Inhibiting Compound: Material used to protect against corrosion (and/or lubricate the reinforcing steel inside a bond breaker).

Coupler: The means by which the load can be transmitted from one partial length of reinforcement to another.

Creep Movement: The movement that occurs during the creep test of a micropile under a constant load.

Design Load (DL): Anticipated final maximum service load in the micropile.

Duplex Drilling: A drilling system involving the simultaneous advancement of (inner) drill rod and (outer) drill casing. Flush from the inner drill rod is permitted to exit the borehole via the annulus between rod and casing.

Elastic Movement: The recoverable movement measured during a micropile test.

Encapsulation: A corrugated tube protecting the reinforcing steel against corrosion.

Free (unbonded) length: The designed length of the micropile that is not bonded to the surrounding ground or grout during testing.

Micropile: A small diameter, bored, cast-in-place pile, in which most of the applied load is resisted by the steel reinforcement.

Overburden: Non-lithified material, natural or placed, which normally requires cased drilling methods to provided an open borehole to underlying strata.

Post Grouting: The injection of additional grout into the load transfer length of a micropile after the Primary grout has set. Also known as regrouting or secondary grouting.

Preloading: The principle whereby load is applied to the micropile, prior to the micropile's connection to the structure, to minimize any structural movement in service.

Primary Grout: Portland cement based grout that is injected into the micropile hole prior to or after the installation of the reinforcement to provide the load transfer to the surrounding ground along the micropile and affords a degree of corrosion protection in compression.

Proof Test: Incremental loading of a micropile, recording the total movement at each increment.

Reinforcement: The steel component of the micropile which accepts and/or resists applied loadings.

Residual Movement: The non-elastic (non-recoverable) movement of a micropile measured during load testing.

Safety Factor: The ratio of the ultimate capacity to the working load used for the design of any component or interface.

Single Tube Drilling: The advancement of a steel casing through overburden usually aided by water flushing through the casing. Also known as "external flush." The fluid may or may not return to the surface around the casing, depending largely on the permeability of the overburden.

Test Load (TL): The maximum load to which the micropile is subjected during testing.

Tremie Grouting: The placing of grout in a borehole via a grout pipe introduced to the bottom of the hole. During grouting, the exit of the pipe is kept at least 10 feet below the level of the grout in the hole.

Type A-D: Classification of micropiles based on method and pressure of grouting according to FHWA-SA-97-070.

Working Load: Equivalent term for Design Load.

1.3 SCOPE

This specification, along with the drawings, encompasses the furnishing of all designs, materials, products, accessories, tools, equipment, services, transportation, labor and supervision, and installation techniques required for testing and installing of micropiles and pile-top attachments.

The work consists of furnishing all necessary engineering and design services, supervision, labor, materials, and equipment to perform all work necessary to install and test the micropiles, at LC39 Vertical Assembly Building, Kennedy Space Center per the specifications described herein, and as shown on the design drawings. The micropile contractor shall install a micropile system that will develop the load capacities indicated on the drawings. The micropile load capacities and measurements shall be verified by testing as specified herein.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Installation Procedures; G

Testing Procedures; G

Contractor Qualifications; G

SD-02 Shop Drawings

Micropile Foundations; G

SD-03 Product Data

Admixtures; G

SD-05 Design Data

Design Calculations; G

Grout Mix Design; G

SD-06 Test Reports

Calibration Reports; G

Testing Reports; G

SD-07 Certificates

Steel; G

SD-08 Manufacturer's Instructions

Admixtures; G

SD-11 Closeout Submittals

Installation Records; G

1.5 QUALIFICATIONS

The micropile contractor shall be fully experienced in all aspects of micropile design and construction, and shall furnish all necessary plant, materials, skilled labor, and supervision to carry out the contract. The contractor will have successfully completed at least five projects in the previous five years of similar scope and size. He must also provide resumés of key personnel who will be present on site (and will be materially involved) and who will each have at least three years of relevant experience. These personnel include superintendent, driller, and project engineer/manager.

1.6 ALLOWABLE TOLERANCES

Centerline of micropile shall not be more than 3 in. from indicated plan location.

Micropile-hole alignment shall be within 2% of design alignment.

Top elevation of micropile shall be within +2 in. to -2 in. of the design vertical elevation.

Centerline of core reinforcement shall not be more than 1 in. from centerline of piling.

1.7 DESIGN CRITERIA

The micropile and jet grout combined foundation shall be designed to meet the specified loading and movement conditions as shown on the drawings. The calculations and drawings required from the Contractor shall be submitted to the Owner for review and acceptance in accordance to SD-01 "Pre-construction Submittals".

Lateral Load and Bending: Where lateral loads are indicated on the plans, the bending moment from these lateral loads shall be determined using COM624 or equal. The soil parameters for use with COM624, or equal, shall be clearly identified in the submitted design calculations. The combined bending and axial load factor of safety of the micropile shall be as follows for each load combination (per ASCE 7 and KSC-STD-Z-0004):

Compression	2.0
Uplift	1.5

The micropile top attachment shall effectively distribute the design load (DL) to the concrete footing, such that the concrete bearing stress does not exceed those in the ACI Building Code and the bending stress in the steel plates does not exceed AISC Allowable stresses for steel members.

The overall length of a micropile will be selected such that the required

geotechnical capacity is developed by skin friction between grout and ground and/or jet grouted "soilcrete" over a suitable length in an appropriate stratum.

1.7.1 Allowable Working Loads

The allowable working load on the pile shall be calculated in accordance with FHWA-SA-97-070.

1.8 GROUND CONDITIONS

The borings provided in as-built drawing 203-28-304, volume 2 are believed to be representative of the conditions likely to be encountered on the site, and are to be used as the basis for micropile design. The drawing is available from KSC Electronic Document Center.

If, during installation of a pile, an obstruction is encountered that prevents the practical advancement of the hole, the hole shall be abandoned and filled with grout. A new pile shall be drilled at a location to be determined by the Contracting Officer.

1.9 INSTALLATION PROCEDURES

Submit a detailed description of the construction procedures for review and approval.

1.10 TESTING PROCEDURES

Submit a detailed description of the load testing procedures for review and approval. This submittal shall include all necessary drawings and details to clearly describe the test method and equipment to be used.

1.11 CONTRACTOR QUALIFICATIONS

Submit resumes of key personnel and evidence of qualifications as described in 1.5 Qualifications.

1.12 MICROPILE FOUNDATIONS

Submit shop drawings for all structural steel, including the micropile components, pile top attachment, and bond length details for review and approval. Shop drawings shall include micropile installation details including, but not limited to: micropile number, location, and pattern; micropile design load; type and size of reinforcing steel; minimum total bond length; total micropile length; grouting volumes and maximum pressures; micropile top attachment; micropile cut off elevation.

1.13 DESIGN CALCULATIONS

Submit structural design calculations for the micropile and jet grout foundation sealed by a registered Professional Engineer, currently licensed in the State of Florida.

1.14 GROUT MIX DESIGN

Submit grout mix design, including details of all materials to be incorporated and the procedure for mixing and placing the grout. This submittal shall include test results certified by a registered Professional Engineer, currently licensed in the State of Florida verifying the

acceptability of the proposed mix design.

1.15 CALIBRATION REPORTS

Submit calibration reports for each test jack, pressure gauge and master pressure gauge to be used. Calibration tests shall be performed within six months of the date submitted. Testing shall not commence until the calibration submittals have been approved.

1.16 TESTING REPORTS

Submit a detailed report of the load testing for review and approval. This submittal shall also include one of the following:

- Certification by a registered Professional Engineer, currently licensed in the State of Florida verifying the acceptability of the micropile foundation design submitted under SD-05 with the capacities obtained by the testing procedure.
- Or, if the capacities obtained by the testing procedure do not verify the acceptability of the design, then the submittal shall include new structural design calculations sealed by a registered Professional Engineer, currently licensed in the State of Florida for a revised design using the capacities obtained by the testing procedure.

1.17 STEEL

Submit certified mill test reports, properly marked, for the reinforcing steel. The ultimate strength, yield strength, elongation, material properties, and composition shall be included. For steel pipe used as permanent casing, or core steel, the contractor shall submit a minimum of two representative coupon tests or mill certifications on each load delivered to the project.

PART 2 PRODUCTS

2.1 WATER

Water for mixing grout shall be potable, clean and free from substances which may be in any way deleterious to grout or steel. If water is not potable, it shall be tested in accordance with AASHTO T26 for acceptability.

2.2 ADMIXTURES

Admixtures shall conform to the requirements of ASTM C 494 (AASHTO M194). Admixtures which control bleed, improve flowability, reduce water content, and retard set may be used in the grout subject to the review and acceptance by the Government. Expansive admixtures shall only be added to the grout used for filling sealed encapsulations. Accelerators will not be permitted. Admixtures shall be compatible with the grout and mixed in accordance with the manufacturer's recommendations. Their use will only be permitted after appropriate field tests on fluid and set grout properties. Admixtures with chlorides shall not be permitted.

2.3 CEMENT

All cement shall be Portland cement conforming to ASTM C 150 (AASHTO M85) Type I, Type II, or Type III, and shall be the product of one manufacturer. If the brand or type of cement is changed during a project, additional grout mix tests shall be conducted to ensure consistency of

quality and performance in situ.

2.4 FILLERS

Inert fillers such as sand may be used in the grout in special situations (e.g., presence of large voids in the ground, when grout take and travel are to be limited) as approved by the Government.

2.5 BAR REINFORCEMENT

Reinforcing steel shall be deformed bars in accordance with ASTM A 615 (AASHTO M31) Grade 60 or Grade 75 or ASTM A 722 (AASHTO M275) Grade 150.

For cases of tensile loading, bar couplers, if required, shall develop the ultimate tensile stress of the bar, without any evidence of failure. For compressive loading, the coupler shall be compatible with efficient load transfer and overall reinforcement performance requirements.

2.6 PIPE/CASING

If the casing is to be relied upon to carry loads or reduce deflection, the permanent steel casing/pipe:

1. Shall meet the tensile requirements of ASTM A 252, Grade 3, except the yield strength shall be a minimum of 50,000 psi to 80,000 psi as used in the design submittal and minimum elongation shall be 15%.

2. May be new "Structural Grade" (a.k.a. "Mill Secondary") steel pipe meeting above but without Mill Certification, free from defects (dents, cracks, tears) and with two coupon tests per truckload.

2.7 PLATES AND SHAPES

Structural steel plates and shapes for pile top attachments shall conform to ASTM A 36 (AASHTO M183) or ASTM A 572 Grade 50 (AASHTO M183).

2.8 CENTRALIZERS

Centralizers shall be fabricated from plastic, steel, or material that is non-detrimental to the reinforcing steel. Wood shall not be used.

PART 3 EXECUTION

3.1 INSTALLATION

The micropile installation technique shall be such that it is consistent with the geotechnical, logistical, environmental, and load carrying conditions of the project. The Contractor shall submit installation procedures for approval in accordance with SD-01. Installation of micropiles into soil improved by jet grouting shall begin no earlier than 5 calendar days after the completion of jet grouting operations.

The drilling equipment and methods shall be suitable for drilling through the conditions to be encountered, with minimal disturbance to these conditions or any overlying or adjacent structure or service. The borehole must be open to the defined nominal diameter, full length, prior to placing grout and reinforcement.

All installation techniques shall be determined and scheduled such that

there will be no interconnection or damage to piles in which grout has not achieved final set.

Centralizers shall be provided at 10-ft center maximum spacing on central reinforcement. The uppermost centralizer shall be located a maximum of 5 ft from the top of the micropile. Centralizers shall permit the free flow of grout without misalignment of the reinforcement.

The central reinforcement steel with centralizers shall be lowered into the stabilized drill holes to the desired depth without difficulty. Partially inserted reinforcing bars shall not be driven or forced into the hole such that there will be no interconnection or damage to piles in which the grout has not achieved final set.

The grout shall be injected as per Section 3.2.

The Contractor shall check pile top elevations and adjust all installed micropiles to the planned elevations.

3.1.1 Installation Records

Submit a detailed record of micropile installation, including: micropile installation (drilling, jetting or driving)duration and observations, description of strata and water encountered, final tip elevation, cut-off elevation, rated load capacities, description of any unusual installation behavior or conditions, description of any deviation from intended parameters, grout pressures obtained, and grout quantities pumped.

3.2 GROUTING

The Contractor shall provide systems and equipment to measure the grout quality, quantity, and pumping pressure during the grouting operations.

After drilling, the hole shall be flushed with water and/or air to remove drill cuttings and/or other loose debris. The Contractor shall provide a stable, homogenous neat cement grout or a sand cement grout with a minimum 28-day unconfined compressive strength of 4000 psi. The grout shall not contain lumps or any other evidence of poor or incomplete mixing. Admixtures, if used, shall be mixed in accordance with manufacturer's recommendations. The pump shall be equipped with a pressure gauge to monitor grout pressures. The pressure gauge shall be capable of measuring pressures of at least 150 psi or twice the actual grout pressures used by the Contractor, whichever is greater. The grouting equipment shall be sized to enable the grout to be pumped in one continuous operation. The grout should be kept in constant agitation prior to pumping.

The grout shall be injected from the lowest point of the drill hole (by tremie methods) until clean, pure grout flows from the top of the micropile. The tremie grout may be pumped through grout tubes, hollow stem augers, or drill rods. Subsequent to tremie grouting, all grouting operations associated with , for example, extraction of drill casing and pressure grouting, must ensure complete continuity of the grout column. The use of compressed air to directly pressurize the fluid grout is not permissible. The grout pressures and grout takes shall be controlled to prevent excessive heave in cohesive soils or fracturing of soil or rock formations. The entire pile shall be grouted to the design cut-off level.

Upon completion of grouting of Type A and B micropiles, the grout tube may remain in the hole, but it shall be filled with grout. For Type C and D

micropiles, grout tubes shall be installed prior to the tremie grouting.

Grout within the micropiles shall be allowed to attain the minimum design strength prior to being loaded.

If the Contractor uses a post-grouting system, all relevant details including grouting pressure, volume, location and mix design, shall be submitted as part of Section SD-05.

3.3 MICROPILE SPLICES

Micropile splices shall be constructed to develop the required design strength of the micropile section.

Lengths of casing and reinforcing steel to be spliced shall be secured in proper alignments and in such a manner that no eccentricity between the axes of the two lengths spliced or angle between them results.

3.4 PRE-PRODUCTION PILE TESTS

Load tests shall be performed to verify the adequacy of the design of the foundation system submitted in SD-05 and the proposed construction procedures prior to installation of production piles.

The test section of jet grouted columns shall be used for the tests specified in this section. A single test micropile shall be installed at the center of each jet grout column constructed in the test section, for a minimum of two test piles. Construction methods, including the drilling and grouting methods, casing and other reinforcement details, and depth of embedment for the test pile shall be identical to the production piles, except where approved otherwise by the Contracting Officer. Reaction piles and/or ground anchors shall be constructed as required to accomplish the load testing specified herein.

The Contractor shall submit for review and acceptance the proposed load testing procedure to verify the design parameters of the micropile and jet grouting foundation. Approval shall be obtained in writing from the Contracting Officer prior to beginning the testing program. This verification load testing proposal shall be in general conformance with ASTM D 1143 and ASTM D 3966, and shall indicate the minimum following information:

- Type and accuracy of apparatus for measuring vertical load
- Type and accuracy of apparatus for applying vertical load
- Type and accuracy of apparatus for measuring lateral load
- Type and accuracy of apparatus for applying lateral load
- Type and accuracy of apparatus for measuring the pile deformation
- Type and capacity of reaction load system, including sealed design drawings by a Professional Engineer currently licensed in the State of Florida
- Hydraulic jack and/or load cell calibration report, verifying calibration within the previous 90 days

Results of the testing program shall be used by the contractor's engineer to verify the design parameters of the micropile and jet grouting foundation submitted in the design calculations required by SD-05. Design calculations shall be re-analyzed using the results of the testing program to verify the capacity of the combined micropile and jet grouting foundations to withstand the design loads provided on the construction

drawings and the design criteria provided in Paragraph 1.7 DESIGN CRITERIA of this section.

A detailed report shall be submitted within 7 working days after the completion of the pre-production tests in accordance with SD-06 for review and approval confirming micropile geometry and construction details.

-- End of Section --

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WELDING PROCESS PIPING

PART 1 GENERAL

1.1 REFERENCES

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

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ASNT SNT-TC-1A	(2011) Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing
ASNT SNT-TC-1A Q&A Bk A	(2010) Supplement to Recommended Practice No. SNT-TC-1A (Q&A Book): Radiographic Testing Method

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS A3.0M/A3.0	(2010) Standard Welding Terms and Definitions
AWS B2.1/B2.1M	(2009) Specification for Welding Procedure and Performance Qualification
AWS QC1	(2007) Standard for AWS Certification of Welding Inspectors
AWS Z49.1	(2012) Safety in Welding and Cutting and Allied Processes

ASME INTERNATIONAL (ASME)

ASME B31.3	(2010) Process Piping
ASME BPVC SEC I	(2010) BPVC Section I-Rules for Construction of Power Boilers
ASME BPVC SEC II-C	(2010) BPVC Section II-Materials Part C-Specifications for Welding Rods Electrodes and Filler Metals
ASME BPVC SEC IX	(2010) Boiler and Pressure Vessel Code; Section IX, Welding and Brazing Qualifications
ASME BPVC SEC V	(2010) BPVC Section V-Nondestructive

Examination

1.2 DEFINITIONS AND SYMBOLS

Definitions shall be in accordance with AWS A3.0M/A3.0. Symbols shall be in accordance with AWS A2.4.

1.3 PERFORMANCE REQUIREMENTS

Quality of all joint preparation, welding, and examination is the Contractor's responsibility. Clearly identify and record all materials used in the welding operations. The inspection and testing defined in this specification are minimum requirements. Additional inspection and testing shall be the responsibility of the Contractor when it is deemed necessary to achieve the quality required.

1.4 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Pressure Piping; G

SD-03 Product Data

Welding Operations

SD-07 Certificates

Qualifications

1.5 QUALIFICATIONS

Welding procedures, welders, and welding operators previously qualified by test may be accepted for the work without requalification, provided that all of the following conditions are fulfilled:

a. Copies of the welding procedures, the procedure qualification test records, and the welder and welding operator performance qualification test records are submitted and approved in accordance with paragraph SUBMITTALS.

b. Testing was performed by an approved testing laboratory or technical consultant or by the Contractor's approved quality assurance organization.

c. The welding procedures, welders, and welding operators were qualified in accordance with ASME BPVC SEC IX, or AWS B2.1/B2.1M, AR-2 level; and base materials, filler materials, electrodes, equipment, and processes conformed to the applicable requirements of this specification.

d. The requirements of paragraph "Renewal of Qualification" below are met and records showing name of employer and period of employment using the process for which qualified are submitted as evidence of conformance.

1.5.1 Welding Procedures Qualification

Record in detail and qualify the Welding Procedure Specifications for every proposed welding procedure. Qualification for each welding procedure shall conform to the requirements of ASME B31.3, and to this specification. The welding procedures shall specify end preparation for butt welds including cleaning, alignment, and root openings. Preheat, interpass temperature control, and postheat treatment of welds shall be as required by approved welding procedures, unless otherwise indicated or specified. The type of backing rings or consumable inserts, if used, shall be described and if they are to be removed, the removal process shall be described. Copies of the welding procedure specifications and procedure qualification test results for each type of welding required shall be submitted in accordance with paragraph SUBMITTALS. Approval of any procedure does not relieve the Contractor of the sole responsibility for producing acceptable welds. Welding procedures shall be identified individually and shall be referenced on the detail drawings or keyed to the contract drawings.

1.5.2 Welder and Welding Operator Performance

Each welder and welding operator assigned to work shall be qualified in accordance with ASME B31.3,.

1.5.2.1 Certification

Before assigning welders or welding operators to the work, provide the Contracting Officer with their names together with certification that each individual is performance-qualified as specified. The certification shall state the type of welding and positions for which each is qualified, the code and procedure under which each is qualified, date qualified, and the firm and individual certifying the qualification tests.

1.5.2.2 Identification

Identify each particular weld with the personal number, letter, or symbol assigned to each welder or welding operator. To identify welds, written records indicating the location of welds made by each welder or welding operator shall be submitted, and each welder or welding operator shall apply the personal mark adjacent to the welds using a rubber stamp or felt-tipped marker with permanent, weatherproof ink or other methods approved by the Contracting Officer that do not deform the metal. For seam welds, identification marks shall be placed adjacent to the welds at 3 foot intervals. Identification by die stamps or electric etchers will not be allowed.

1.5.2.3 Renewal of Qualification

Requalification of a welder or welding operator is required under any of the following conditions:

a. When a welder or welding operator has not used the specific welding process for a period of 3 months; the period may be extended to 6 months if the welder or welding operator has been employed on some other welding process.

b. When a welder or welding operator has not welded with any process during a period of 3 months, all the personal qualifications shall be considered expired, including any extended by virtue of a., above.

c. There is specific reason to question the person's ability to make welds that will meet the requirements of the specifications.

d. 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 preceding 12 months.

e. Renewal of qualification for a specific welding process under conditions a., b., and d., above, needs to be made on only a single test joint or pipe of any thickness, position, or material to reestablish the welder's or welding operator's qualification for any thickness, position, or material covered under previous qualification.

1.5.3 Inspection and NDE Personnel

All inspection and NDE personnel shall be qualified in accordance with the following requirements.

1.5.3.1 Inspector Certification

Welding inspectors shall be qualified in accordance with AWS QC1.

1.5.3.2 NDE Personnel

NDE personnel shall be certified, and a written procedure for the control and administration of NDE personnel training, examination, and certification shall be established. The procedures shall be based on appropriate specific and general guidelines of training and experience recommended by ASNT SNT-TC-1A and ASNT SNT-TC-1A Q&A Bk A.

1.6 REGULATORY REQUIREMENTS

This section covers the welding of pressure piping systems. Submit detail drawings showing location, length, and type of welds; and indicating postweld heat treatment and NDE as required. Deviations from applicable codes, approved procedures, and approved detail drawings will not be permitted without prior written approval. Materials or components with welds made offsite will not be accepted if the welding does not conform to the requirements of this specification, unless otherwise specified. Develop procedures for welding all metals included in the work. Welding shall not be started until welding procedures, welders, and welding operators have been qualified. Qualification testing shall be performed by an approved testing laboratory, or by the Contractor if approved by the Contracting Officer. Notify the Contracting Officer at least 24 hours in advance of the time and place of the tests. When practicable, perform the qualification tests at or near the worksite. Maintain current records of the test results obtained in the welding procedure, welding operator, welder performance qualifications, and nondestructive examination (NDE) procedures readily available at the site for examination by the Contracting Officer. The procedures for making transition welds between different materials or between plates or pipes of different wall thicknesses shall be qualified. ASME B31.3, requirements for branch connections may be used in lieu of detailed designs. Unless otherwise specified, the choice of welding process shall be the responsibility of the Contractor. Safety precautions shall conform to AWS Z49.1.

1.7 DELIVERY, STORAGE, AND HANDLING

All filler metals, electrodes, fluxes, and other welding materials shall be

delivered to the site in manufacturers' original packages and stored in a dry space until used. Packages shall be properly labeled and designed to give maximum protection from moisture and to insure safe handling.

1.7.1 Material Control

Materials shall be stored in a controlled access and clean, dry area that is weathertight and is maintained at a temperature recommended by the manufacturer. The materials shall not be in contact with the floor and shall be stored on wooden pallets or cribbing.

1.7.1.1 Damaged Containers

Low-hydrogen steel electrodes shall be stored in their sealed shipping container. If the seal is damaged during shipment or storage, and the damage is not immediately detected, the covered electrodes in that container shall be rebaked in accordance with the manufacturer's instructions prior to issuance or shall be discarded. If a container is damaged in storage and the damage is witnessed, the electrodes from that container shall be immediately placed in a storage oven. The storage oven temperature shall be as recommended by the manufacturer or the welding material specification.

1.7.1.2 Partial Issues

When a container of covered electrodes is opened and only a portion of the content is issued, the remaining portion shall, within 1/2 hour, be placed in a storage oven.

1.7.2 Damaged Materials

Materials which are damaged shall be discarded. Covered electrodes which are oil or water-soaked, dirty, or on which the flux has separated from the wire shall be discarded.

PART 2 PRODUCTS

2.1 MATERIALS

Provide welding materials which comply with ASME BPVC SEC II-C. Welding equipment, electrodes, welding wire, and fluxes shall be capable of producing satisfactory welds when used by a qualified welder or welding operator using qualified welding procedures.

PART 3 EXECUTION

3.1 WELDING OPERATIONS

Perform welding in accordance with qualified procedures using qualified welders and welding operators. Submit detailed procedures which define methods of compliance to contract drawings and specifications. Inspection and material procurement records. System and material testing and certification records. Written records and drawings indicating location of welds made by each welder or welding operator.

Welding shall not be done when the quality of the completed weld could be impaired by the prevailing working or weather conditions. The Contracting Officer will determine when weather or working conditions are unsuitable for welding. Welding of hangers, supports, and plates to structural

members shall conform to Section 05 05 23.00 98 METAL FASTENERS.

3.1.1 Base Metal Preparation

Oxy-fuel cutting shall not be used on austenitic stainless steel or nonferrous materials.

3.1.2 Weld Joint Fit-Up

Parts that are to be joined by welding shall be fitted, aligned, and retained in position during the welding operation by the use of bars, jacks, clamps, or other mechanical fixtures. Welded temporary attachments shall not be used except when it is impractical to use mechanical fixtures. When temporary attachments are used, they shall be the same material as the base metal, and shall be completely removed by grinding or thermal cutting after the welding operation is completed. If thermal cutting is used, the attachment shall be cut to not less than 1/4 inch from the member and the balance removed by grinding. After the temporary attachment has been removed, the area shall be visually examined.

3.1.3 Preheat and Interpass Temperatures

Preheat temperatures shall meet the requirements specified by ASME B31.3,. However, in no case shall the preheat be below 50 degrees F for ferritic steel or austenitic stainless steel, or 32 degrees F for nonferrous alloys. The maximum interpass temperatures shall not exceed 300 degrees F for austenitic stainless steels, nickel alloys, and copper alloys; and 500 degrees F for carbon steels. Preheat techniques shall be such as to ensure that the full thickness of the weld joint preparation and/or adjacent base material, at least 3 inches in all directions, is at the specified temperature. Preheating by induction or resistance methods is preferred. When flame heating is used, only a neutral flame shall be employed. Oxy-fuel heating shall not be used on austenitic stainless steel or nickel-alloy materials; however, air-fuel heating is acceptable if controlled to insure that the surface temperature does not exceed 150 degrees F. Interpass temperatures shall be checked on the surface of the component within 1 inch of the weld groove and at the starting location of the next weld pass, and for a distance of about 6 inches ahead of the weld, but not on the area to be welded.

3.1.4 Production Welding Instructions

a. Welding shall not be done when the ambient temperature is lower than 0 degree F.

b. Welding is not permitted on surfaces that are wet or covered with ice, when snow or rain is falling on the surfaces to be welded, or during periods of high winds, unless the welders and the work are properly protected.

c. Gases for purging and shielding shall be welding grade and shall have a dew point of minus 40 degrees F or lower.

d. Back purges are required for austenitic stainless steels and nonferrous alloys welded from one side and shall be set up such that the flow of gas from the inlet to the outlet orifice passes across the area to be welded. The oxygen content of the gas exiting from the purge vent shall be less than 2 percent prior to welding.

e. The purge on groove welds shall be maintained for at least three layers or 3/16 inch.

f. Removable purge dam materials shall be made of expandable or flexible plugs, such as plexiglass, plywood (which shall be dry when used), etc. Wood dams shall be kiln-dried quality. Nonremovable purge dams and purge dam adhesives shall be made of water soluble materials. Purge dams shall not be made of polyvinyl alcohol.

g. Any welding process which requires the use of external gas shielding shall not be done in a draft or wind unless the weld area is protected by a shelter. This shelter shall be of material and shape appropriate to reduce wind velocity in the vicinity of the weld to a maximum of 5 mph (440 fpm).

h. Welding of low-alloy and hardenable high-alloy steels may be interrupted provided a minimum of at least 3/8 inch thickness of weld deposit or 25 percent of the weld groove is filled, whichever is greater, and the preheat temperature is maintained during the time that welding is interrupted. If the temperature falls below the minimum preheat temperature before all welding has been completed on a joint, or, where required, before post weld heat treatment, a liquid penetrant or magnetic particle examination shall be performed to insure sound deposited metal before reheating. Welding of other materials may be interrupted without restriction provided a visual inspection is performed before welding is resumed.

i. Tack welds to be incorporated in the final welds shall have their ends tapered by grinding or welding technique. Tack welds that are cracked or defective shall be removed and the groove shall be retacked prior to welding. Temporary tack welds shall be removed, the surface ground smooth, and visually inspected. For low-alloy and hardenable high-alloy steels, the area shall be magnetic particle examination inspected.

j. When joining ferritic steel pressure piping components to austenitic stainless steel pressure piping components and postweld heat treatment is required, the following requirements apply:

(1) The weld-end preps of ferritic steel components, which are to be welded to austenitic stainless steel, shall be buttered with one of the following weld filler metals and shall conform to the specified requirements: ASME BPVC SEC II-C, SFA 5.14, Classification ERNiCr-3; or ASME BPVC SEC II-C, SFA 5.11, Classification ENiCrFe-2.

(2) The ferritic steel weld-end prep shall be buttered, receive a postweld heat treatment as required by ASME B31.3, and then be machined with the applicable weld-end preparation. After machining, the buttered layer shall be a minimum of 1/4 inch thick.

(3) Pressure piping transition joints shall be completed using ERNiCr-3 or ENiCrFe-2 weld filler metals. No further postweld heat treatment shall be performed.

k. When joining ferritic steel pressure piping components to austenitic stainless steel pressure piping components and postweld heat treatment is not required, prepare and weld the joint using either ERNiCr-3 or ENiCrFe-2 filler metals. For service temperatures of 200 degrees F or

less, stainless filler metal 309 ASME BPVC SEC II-C, SFA 5.4 or 5.9 is permissible in lieu of the nickel-based alloys.

l. Grinding of completed welds is to be performed only to the extent required for NDE, including any inservice examination, and to provide weld reinforcement within the requirements of ASME B31.3,. If the surface of the weld requires grinding, reducing the weld or base material below the minimum required thickness shall be avoided. Minimum weld external reinforcement shall be flush between external surfaces.

3.1.5 Postweld Heat Treatment

a. Postweld heat treatment shall be performed in accordance with ASME B31.3. Temperatures for local postweld heat treatment shall be measured continuously by thermocouples in contact with the weldment.

b. Postweld heat treatment of low-alloy steels, when required, shall be performed immediately upon completion of welding and prior to the temperature of the weld falling below the preheat temperature. However, postweld heat treatment may be postponed after the completion of the weld, if, immediately after the weld is completed, it is maintained at a minimum temperature of 300 degrees F or the preheat temperature, whichever is greater, for 2 hours per inch of weld thickness.

c. For low-alloy steels, the cooling rates shall be such that temper embrittlement is avoided.

3.2 EXAMINATIONS, INSPECTIONS, AND TESTS

Visual and NDE shall be performed by the Contractor to detect surface and internal discontinuities in completed welds. The services of a qualified commercial inspection or testing laboratory or technical consultant, approved by the Contracting Officer, shall be employed by the Contractor. All tack welds, weld passes, and completed welds shall be visually inspected. Radiographic examination shall be required as specified in paragraph 3.2.1 Random NDE Testing. When inspection and testing indicates defects in a weld joint, the weld shall be repaired by a qualified welder in accordance with paragraph CORRECTIONS AND REPAIRS.

3.2.1 Random NDE Testing

When random radiographic examination is required, test a minimum of 10 percent of the total length or number of piping welds. The welds inspected shall be selected randomly, but the selection shall include an examination of welds made by each welding operator or welder. If the random testing reveals that any welds fail to meet minimum quality requirements, an additional 10 percent of the welds in that same group shall be inspected. If all of the additional welds inspected meet the quality requirements, the entire group of welds represented shall be accepted and the defective welds shall be repaired. If any of the additional welds inspected also fail to meet the quality requirements, that entire group of welds shall be rejected. The rejected welds shall be removed and rewelded, or the rejected welds shall be 100 percent inspected and all defective weld areas removed and rewelded.

3.2.2 Visual Inspection

Weld joints shall be inspected visually as follows:

a. Before welding - for compliance with requirements for joint preparation, placement of backing rings or consumable inserts, alignment and fit-up, and cleanliness.

b. During welding - for cracks and conformance to the qualified welding procedure.

c. After welding - for cracks, contour and finish, bead reinforcement, undercutting, overlap, and size of fillet welds.

3.2.3 NDE Testing

NDE shall be in accordance with written procedures. Procedures for radiographic tests and methods shall conform to ASME BPVC SEC V. The approved procedure shall be demonstrated to the satisfaction of the Contracting Officer. In addition to the information required in ASME BPVC SEC V, the written procedures shall include the timing of the NDE in relation to the welding operations and safety precautions.

3.2.4 Inspection and Tests by the Government

The Government will perform inspection and supplemental nondestructive or destructive tests as deemed necessary. The cost of supplemental NDE will be borne by the Government. The correction and repair of defects and the reexamination of weld repairs shall be performed by the Contractor at no additional cost to the Government. Inspection and tests will be performed as required for visual inspection and NDE, except that destructive tests may be required also. When destructive tests are ordered by the Contracting Officer and performed by the Contractor, and the specimens or other supplemental examinations indicate that the materials and workmanship do not conform to the contract requirements, the cost of the tests, corrections, and repairs shall be borne by the Contractor. When the specimens or other supplemental examinations of destructive tests indicate that materials or workmanship do conform to the specification requirements, the cost of the tests and repairs will be borne by the Government. When destructive tests are made, repairs shall be made by qualified welders or welding operators using welding procedures which will develop the full strength of the members cut. Welding shall be subject to inspection and tests in the mill, shop, and field. When materials or workmanship do not conform to the specification requirements, the work may be rejected at any time before final acceptance of the system containing the weldment.

3.3 ACCEPTANCE STANDARDS

3.3.1 Visual

The following indications are unacceptable:

a. Cracks.

b. Undercut on surface which is greater than 1/32 inch deep.

c. Weld reinforcement greater than 3/16 inch.

d. Lack of fusion on surface.

e. Incomplete penetration (applies only when inside surface is readily accessible).

f. Convexity of fillet weld surface greater than 10 percent of longest leg plus 0.03 inch.

g. Concavity in groove welds.

h. Concavity in fillet welds greater than 1/16 inch.

i. Fillet weld size less than indicated or greater than 1.25 times the minimum indicated fillet leg length.

3.3.2 Radiography

Welds that are shown by radiography to have any of the following discontinuities are unacceptable:

a. Porosity in excess of that shown as acceptable in ASME BPVC SEC I, Appendix A-250.

b. Any type of crack or zone of incomplete fusion or penetration.

c. Any other elongated indication which has a length greater than:

(1) 1/4 inch for "t" up to 3/4 inch inclusive. Where "t", here and below, pertains to the thickness of the weld being examined; if a weld joins two members having different thickness at the weld, "t" is the thinner of these two thicknesses.

(2) 1/3 "t" for "t" from 3/4 inch to 2-1/4 inch, inclusive.

(3) 3/4 inch for "t" over 2-1/4 inch.

d. Any group of indications in line that have an aggregate length greater than "t" in a length of "12t", except where the distance between the successive indications exceeds 6L where L is the longest indication in the group.

3.4 CORRECTIONS AND REPAIRS

Defects shall be removed and repaired as specified in ASME B31.3, unless otherwise specified. Disqualifying defects discovered between weld passes shall be repaired before additional weld material is deposited. Wherever a defect is removed, and repair by welding is not required, the affected area shall be blended into the surrounding surface eliminating sharp notches, crevices, or corners. After defect removal is complete and before rewelding, the area shall be examined by the same test method which first revealed the defect to ensure that the defect has been eliminated. After rewelding, the repaired area shall be reexamined by the same test method originally used for that area. Any indication of a defect shall be regarded as a defect unless reevaluation by NDE or by surface conditioning shows that no disqualifying defects are present. The use of any foreign material to mask, fill in, seal, or disguise welding defects will not be permitted.

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SECTION 40 34 10

STAINLESS STEEL TUBING

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 A 167	(2004) Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
ASTM A 36/A 36M	(2008) Standard Specification for Carbon Structural Steel
ASTM A 576	(1990b; R 2006) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
ASTM F 402	(2005) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings

JOHN F. KENNEDY SPACE CENTER (KSC)

KSC-C-123	(1995) Surface Cleanliness of Ground Support Equipment Fluid Systems, Specification for
KSC-SPEC-P-0027	Tubing, Superaustenitic Steel, Corrosion Resistant, UNS N08367 and UNS S31254, Seamed, Bright Annealed, Passivated, Specification for
KSC-SPEC-Z-0008	Fabrication and Installation of Flared Tube Assemblies and Installation of Fittings and Fitting Assemblies, Specification for
NASA-SPEC-5004	Welding of Aerospace Ground Support Equipment and Related Nonconventional Facilities
KSC-STD-SF-0004	(Rev B) Safety Standard for Ground Piping Systems Color Coding and Identification

MARSHALL SPACE FLIGHT CENTER (MSFC)

MSFC-SPEC-384	Leak Test Compound, LOX Compatible

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 704	(2006) Identification of the Hazards of Materials for Emergency Response

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

29 CFR 1910	Occupational Safety and Health Standards

1.2 SYSTEM DESCRIPTION

This specification covers the requirements for stainless steel tubing and fittings.

1.2.1 Design Requirements

Support systems shall be selected and designed in accordance with KSC-SPEC-Z-0008 within the specified spans and component requirements. The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing supports throughout facility.

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. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Qualifications; G

A statement certifying that the Contractor has the specified experience.

Welders; G

The names of all qualified welders, their identifying symbols, and the qualifying procedures for each welder including support data such as test procedures used, standards tested to, etc.

Waste Water Disposal; G

The method proposed is for disposal of waste water from hydrostatic tests and all required permits, prior to performing hydrostatic tests.

Delivery, Storage and Handling; G

Material safety data sheets.

Materials and Equipment; G

List of all tubing and fittings required for complete

installation of tubing subsystems shown in contract drawings.

Tubing Schedule; G

A list of tubing systems, pressure ratings and source of supply for each tubing system broken out by material, size and application as indicated on the contract drawings. A list of any special tools necessary for each tubing system and appurtenances furnished for adjustment, operation, maintenance and disassembly of the system.

Tube Welding; G

The Contractor shall submit for approval prior to the start of fabrication the names of all qualified tube welding operators, the qualifying procedures for each operator including support data such as test procedures used, test specimens etc.

Tube Flaring; G

The Contractor shall submit for approval prior to the start of fabrication the names of all qualified tube flaring operators, the qualifying procedures for each operator including support data such as test procedures used, test specimens etc.

Tube Cleanliness; G

The Contractor shall submit for approval prior to the start of fabrication a cleaning procedure to show compliance with KSC-C-123. The Contractor is also responsible for maintaining and preserving the cleanliness of all existing precision cleaned components, GFE and tubing in accordance with the cleanliness level indicated on the drawing. A certification of cleanliness shall be submitted in the final data package.

Detailed weights shall be provided for all equipment, components, materials and products which will be installed on the ML during construction/fabrication as a permanent part of the facility; G

SD-06 Test Reports; G

Provide for all tests on all systems.

SD-10 Operation and Maintenance Data

Appurtenances; G

Six copies each of operation and maintenance manuals in indexed booklet form. The O&M Manual to include the manufacturer's name, model number, parts list and brief description of system equipment such as valves and other appurtenances and their basic operating features. List in the Maintenance Manuals routine maintenance procedures and troubleshooting guides for the equipment, and include piping layout and valve locations.

1.4 QUALIFICATIONS

1.4.1 Contractor

Contractor shall have successfully completed at least 3 projects of the same scope and size or larger within the last 6 years. Contractor shall demonstrate specific experience in regard to the system installation to be performed.

1.4.2 Welders

The welding of tubing systems shall be in accordance with qualifiedprocedures using performance qualified welders and operators. Procedures and welders shall be qualified in accordance with the requirements of 40 05 13.96 WELDING PROCESS PIPING. Structural members shall be welded in accordance with Section 05 05 23.00 98 METAL FASTENINGS.

1.5 DELIVERY, STORAGE, AND HANDLING

Materials delivered and placed in storage shall be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged shall be replaced at the Contractor's expense. During installation, tubing shall be capped to keep out dirt and other foreign matter. A material safety data sheet in conformance with 29 CFR 1910 Section 1200(g) shall accompany each chemical delivered for use in tube installation. At a minimum, this includes all solvents, solvent cements, glues and other materials that may contain hazardous compounds. Handling shall be in accordance with ASTM F 402. Storage facilities shall be classified and marked in accordance with NFPA 704. Materials shall be stored with protection from puncture, dirt, grease, moisture, mechanical abrasions, excessive heat, ultraviolet (UV) radiation damage, or other damage. Tubing and fittings shall be handled and stored in accordance with the manufacturer's recommendation.

1.6 PROJECT/SITE CONDITIONS

1.6.1 Existing Conditions

The Contractor shall be responsible for the verification of existing piping, tubing and penetrations. Prior to ordering materials, expose all existing pipes which are to be connected to new pipelines. Verify the size, material, joint types, elevation, horizontal location, and pipe service of existing pipes, and inspect size and location of structure penetrations to verify adequacy of wall sleeves, and other openings before installing connecting pipes.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

Provide tubing materials and appurtenances as specified and as shown on the drawings, and suitable for the service intended. Tubing materials, appurtenances, and equipment supplied as part of this contract shall be of equal material and ratings as the connecting tube, new and unused except for testing equipment. Components that serve the same function and are the same size shall be identical products of the same manufacturer. The general materials to be used for the tubing systems shall be in accordance

with contract drawings. Tube fittings shall be compatible with the applicable tube materials.

2.1.1 Standard Products

Provide material and equipment which are the standard products of a manufacturer regularly engaged in the manufacturing of the products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Nominal sizes for standardized products shall be used. Tubing, valves, fittings and appurtenances shall be supported by a service organization that is, in the opinion of the Contracting Officer, reasonably convenient to the site.

2.2 STAINLESS STEEL TUBING SYSTEM

Stainless steel tubing shall be fabricated and installed per KSC-SPEC-Z-0008. Tube material shall be AL6XN per KSC-SPEC-P-0027. Tubing thickness requirements are shown on the drawings. Tubing and tube fittings shall be GFE.

NOTE: KSC-SPEC-Z-0008 does not address the use of AL6XN tube material. All requirements in KSC-SPEC-Z-0008 shall apply to AL6XN tubing except the following:

The test ball size used for checking the tube inside diameter after bending shall be 0.344" for 1/2"x0.049" wall tube and 0.250" for 3/8"x0.035" wall tube.

Flared fittings shall be per KSC GP-425.

A schedule showing all tubing sizes and thicknesses shall be developed by the Contractor.

2.3 VALVES

Valves shall be as indicated on the drawings.

2.4 TUBE SUPPORTS AND PENETRATIONS

Provide auxiliary steel where the support of tubing systems and equipment is required between building structural elements. Light gauge and structural steel shapes shall conform to the requirements of ASTM A 36/A 36M. The Contractor has the option to use pre-engineered support systems of electrogalvanized steel products. However, a mixture of support system manufacturers products is not permitted. Where auxiliary steel is indicated as stainless steel, provide TP304 stainless steel conforming to ASTM A 167.

2.4.1 Tube Supports

Tube supports shall be provided as shown on the drawings. Where tube supports contact bare tubing or in-line devices, provide supports of compatible material so that neither shall have a deteriorating action on the other.

2.4.1.1 Brackets

Where tubing is run adjacent to walls or steel columns, provide welded ASTM A 36/A 36M steel brackets, pre-punched with a minimum of two fastener

holes.

2.4.1.2 Hangers

Hangers shall be fabricated of ASTM A 36/A 36M carbon steel. All hangers shall be of a uniform type and material for a given tube run and application. Coated or plated hangers shall be used to isolate steel hangers from dissimilar metal tube.

2.4.1.3 Hanger Rods

Hanger rods shall be carbon steel conforming to ASTM A 576. The diameter of the rods for tubing system support shall conform to the contract drawings.

2.4.1.4 Preformed Channel Systems

Preformed channel systems, where permitted shall be made of 304 stainless steel and all hardware shall be stainless steel and vibration resistant. Spring nuts shall not be used. In lieu of spring nuts, stud nuts shall be used with double nuts to lock nuts in place. Preformed channel system shall be Unistrut or approved equal. Unistrut shall be permitted in interior locations only. See Section 26 05 00.00 40 paragraph 2.9 for additional restrictions.

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 before performing the work.

3.2 PREPARATION

3.2.1 Protection

Tube and equipment openings shall be closed with caps or plugs during installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.

3.2.2 System Preparation

3.2.2.1 Damaged Coatings

Repair damaged coating areas in the field with material equal to the original coating.

3.2.2.2 Field Fabrication

Notify the Contracting Officer at least 2 weeks prior to the field fabrication of tubing and at least 3 days prior to the start of any surface preparation or coating application work. Tube welding shall be performed in accordance with the requirements of NASA-SPEC-5004 as applicable. Tube weld inspection shall be per KSC-STD-Z-0005 with an additional requirement to perform random radiographic testing of 5 per cent of the welds.

3.3 TUBING INSTALLATION AND TEST REQUIREMENTS

Tubing shall be run as straight as practical along the alignment shown on the contract drawings and with a minimum of joints. Tubing and appurtenances shall be installed in conformance with reviewed shop drawings, manufacturer's instructions and KSC-SPEC-Z-0008. Tubing shall be installed without springing or forcing.

Tube flaring shall be in accordance with KSC-SPEC-Z-0008.

See drawing sheet M-809 for additional tubing installation and test requirements.

3.3.1 Anchors and Fasteners

Impact expansion (hammer and explosive charge drive-type) anchors and fastener systems are not acceptable. Lead shields, plastic or fiber inserts, and drilled-in plastic sleeve/nail drive systems are also not acceptable.

3.3.2 Valve Locations

Valves shall be located in accordance with the drawings.

3.4 TUBING SUPPORT SYSTEMS INSTALLATION

The absence of pipe supports and details on the contract drawings shall not relieve the Contractor of responsibility for providing supports throughout the installation.

3.4.1 General Support Requirements

Tubing support systems shall be provided as shown on the drawings. Tubing connections to equipment shall be supported by supports and not off the equipment. Large or heavy valves, fittings, and/or equipment shall be supported independently of associated tubing. Tubes shall not be supported off other tubes. Supports shall be provided at tubing changes in direction or in elevation, adjacent to flexible joints and couplings, and where otherwise shown on the contract drawings. Tubing supports and hangers shall not be installed in equipment access areas. Hanging tubing shall be braced against horizontal movement by both longitudinal and lateral sway bracing. At each channel type support, every tube shall be provided with an intermediate guide, except where tube anchors are required. Existing support systems may be used to support additional new tubing only if the Contractor can demonstrate that the existing support systems are adequate for the additional loads, or if the existing systems are strengthened to support the additional loads. Pedestal type tube supports shall be provided under base flanges adjacent to rotating equipment and where required to isolate vibration. Lateral supports for seismic loads shall be installed at all changes in direction.

3.4.2 Support Spacing

3.4.2.1 Acceptable Limits for Tubing

See drawings for support spacing requirements. Also, support spacing shall meet the requirements of KSC-SPEC-Z-0008.

3.4.3 Support Methods

Tubing support shall be provided as specified and as shown in the contract drawings. Single horizontal suspended tubing shall be supported by adjustable swivel-ring, split-ring, or clevis hangers. Vertical tubing shall be supported by wall brackets or riser clamps on floor penetrations.

3.4.4 Supports and Hangers for Stainless Steel Tubing

All hanger-pipe contact surfaces shall have a dielectric barrier consisting of chloroprene rubber wrapping or plastic coated hangers.

3.5 TUBING HYDROSTATIC/PNEUMATIC TEST

Tubing shall be pressure tested in accordance with KSC-SPEC-Z-0008, Table 7.

Submit the testing procedure for Government review prior to implementation.

3.6 LEAK TEST

Leak testing shall be performed after completion of the pressure test. The pneumatic leak test shall be performed at the system maximum operating pressure (MOP) using the following:
GN2 for the Gaseous Nitrogen (GN2) System, Gaseous Oxygen (GO2), Breathing Air(BA), and Gaseous Helium (GHe) for the Gaseous Helium (GHe) system.

The surface temperature shall be between 5°C and 51°C (40°F and 125°F) and the MOP shall be maintained for 15 minutes prior to the testing (refer to ASME B31.3 and ASME Boiler and Pressure Vessel Code, Section V, Article 10). All welds and mechanical joints shall be visually bubbletight when tested with MSFC-SPEC-384 leak test solution.

Test records shall be taken, including date of test, identification of tubing system, test gas, and description of test method. The test results shall be certified by a qualified examiner serving as an independent test observer.

Submit the testing procedure for Government review prior to implementation.

3.7 CLEANING

Tube cleanliness shall be verified in accordance with KSC-C-123, flushing media shall be per KSC-C-123.

Required Cleanliness Levels:

Fluid Type Cleanliness Level (per KSC-C-123)

Gaseous Nitrogen (GN2) 300A, Gaseous oxygen (GO2) 100A, Breathing Air (BA) 100A, and Gaseous Helium (GHe) 300A.

Submit the cleaning Procedure to the Government prior to cleaning implementation.

Waste water shall be disposed per Contractors submitted plan.

3.8 DRAIN, DRY AND PURGE

After cleaning the tubing assembly shall be drained and dried using clean

GN2. The assembly shall be thoroughly purged until a dewpoint reading of minus 63.5 degree F is reached. A positive GN2 blanket, of at least 5 PSIG shall then be applied to the inner tube and blanked off.

3.9 PAINTING

See specification section 09 97 13.00 40 for Coating Requirements.

3.9.1 Identification

All tubing shall be permanently and legibly marked with identification per KSC-STD-SF-0004.

-- End of Section --

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SECTION 40 50 00

PNEUMATICS SYSTEMS (GN2, GHE, GO2, and BREATHING AIR)

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 WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination

ASME INTERNATIONAL (ASME)

ASME B16.5	(2009) Standard for Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24
ASME B31.3	(2010) Process Piping

ASTM INTERNATIONAL (ASTM)

ASTM A 182/A 182M	(2009a) Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A 193	(2008b) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A 194	(2008b) Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A 312/A 312M	(2008a) Standard Specification for Seamless, Welded, and Heavily Worked Austenitic Stainless Steel Pipes
ASTM A 403/A 403M	(2007a) Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings

JOHN F. KENNEDY SPACE CENTER (KSC)

KSC-STD-SF-0004B	(1982) Safety Standard for Ground Piping Systems Color Coding and Identification
KSC-GP-425g	(2007, Amendment 1) Fluid Fitting Engineering Standards, NASA KSC Engineering Development Directorate

KSC-C-123 (1995) Surface Cleanliness of Ground Support Equipment Fluid Systems, Specification for

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58 (2009) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

MARSHALL SPACE FLIGHT CENTER (MSFC)

MSFC-SPEC-384 Leak Test Compound, LOX Compatible

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA-SPEC-5004a (2003) Welding of Aerospace Ground Support Equipment and Related Nonconventional Facilities

1.2 SCOPE

This section covers requirements for installation of pneumatics panels and equipment and installation in pneumatic systems.

1.3 DESCRIPTION

The Contractor shall provide the labor and materials for the fabrication, installation, supporting, cleaning, testing and identification of the following pneumatic systems:

a. Gaseous Nitrogen (GN2)
b. Gaseous Oxygen (GO2)
c. Gaseous Helium (GHE)
d. Breathing Air (BA)

1.4 WORK AREA

The Contractor shall visit the premises to thoroughly familiarize himself with all details of the work and working conditions, verify all dimensions in the field, and indicate verified dimensions on the shop drawings. The Contractor shall be responsible for the coordination and proper relation of his work to the existing structures and to other work.

1.5 SUBMITTALS

The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop drawings, fabrication/erection/installation drawings shall be submitted for approval in accordance with the Contract Schedule. No work shall begin until the approved shop drawings have been return to the Contractor.

Shop drawings shall include drawings or sketches, descriptive literature, and any other data necessary to completely identify

each item specified. Shop drawings shall include detailed fabrication and installation plans of the piping systems including location of fittings, bends, welds, and all other details necessary to fabricate and install the system. All welds shall be indicated in accordance with NASA-SPEC-5004a and AWS A2.4 and shall reflect conformance to the referenced specification herein. Proposes deviations from contract specifications and drawings shall be submitted for approval in accordance with the Contract Schedule; G.

SD-03 Product Data

Manufacturer's catalog data shall include catalog cuts, brochures, circulars, specifications, and other product data and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents; G.

Detailed weights shall be provided for all equipment, components, materials and products which will be installed on the ML during construction/fabrication as a permanent part of the facility; G

SD-06 Test Reports

Except as otherwise specified, an independent testing agency shall prepare reports of inspections and laboratory tests, including analysis and interpretation of test results where applicable. Each report shall be properly identified and, where required, the testing agency's certification of the test results shall be provided. Test methods used and compliance with recognized test standards shall be described; G.

SD-07 Certificates

As specified in the Contract Schedule and for proposed piping and tubing materials.

No materials shall be installed or delivered to the site until approval has been obtained.

Welders; G

1.6 PAINTING

Where mechanical equipment is the manufacturer's standard product, it shall be furnished with the manufacturer's standard finish coat, unless otherwise specified. Equipment damaged during construction shall be brought to "as new" condition by touchup, or repainting, to the satisfaction of the Contracting Officer.

Pipe hangers, supports, equipment and other uncoated steel work shall be thoroughly cleaned and painted in accordance with Section 09 97 13.00 98 "STEEL COATINGS".

1.7 EXCEPTIONS

If the proposed equipment and work differ in any manner from that specified in the contract drawings, the Contractor shall submit a request for deviation or waiver for approval in accordance with the Contract Schedule.

1.8 ITEMS OF WORK INCLUDED

Items of work to be provided by the Contractor include, but are not limited to, the following:

Install panels with supplementary steel and fasteners for panel mounting.

Install piping and tubing; flanges and bolts; fittings; pipe hangers; pipe supports; pipe anchors; support saddles; sway braces and all connections

Install all supplemental structural steel indicated for pipe hangers, pipe supports, pipe anchors, support saddles and anchors for the proper installation and erection of the piping systems

All materials and labor for welding and cutting operations

Cleaning of mill scale, sand, rust and other undesirable matter from the interior piping prior to erection

Pressure and leak testing of all piping systems installed by the Contractor

Cutting of holes in grating, plate, walls, structures, etc., in only those cases where required for the passage of only that piping shown on the drawings and only then with prior approval of Contracting Officer

Final adjustment of all hangers and supports

1.9 INTERFERENCES

The Contractor shall coordinate the work of the different trades so that interference between piping, equipment, structural, and electrical work will be avoided. All necessary offsets in piping and all fittings, etc., required to properly install the work shall be furnished complete in place without additional cost to the Government. If interference develops, the Contracting Officer will decide which equipment shall be relocated, regardless of which apparatus was installed first.

1.10 BONDING AND GROUNDING

Piping shall be bonded and grounded in accordance with Section 28 05 26.00 40 "GROUNDING AND BONDING".

1.11 MAINTAINING CLEANLINESS LEVELS

Where equipment or components have been chemically cleaned, the Contractor shall take necessary precautions to maintain the cleanliness levels. If these cleanliness levels are degraded, the Contractor shall be responsible for recleaning at no cost to the Government.

1.12 CUTTING

Cutting of construction or work done by others shall be done only with the written permission of the Contracting Officer. Any damage to the structure, piping, wiring or equipment as a result of cutting for installation shall be repaired by skilled mechanics of the trade involved,

at no additional expense to the Government.

1.13 DISSIMILAR METALS

Where dissimilar metals are assembled together, a material compatible with each material shall be interposed between them.

1.14 GOVERNMENT-FURNISHED EQUIPMENT (GFE) TUBING AND FITTINGS

GFE tubing and fittings will be furnished by the Government at a storage area located on Kennedy Space Center. The Contractor shall accept delivery and load, transport, and unload at his own expense. The Contractor shall perform all operations necessary for installing or incorporating the GFE in the work.

1.15 QUALIFICATIONS

1.15.1 Contractor

Contractor shall have successfully completed at least 3 projects of the same scope and size or larger within the last 6 years. Contractor shall demonstrate specific experience in regard to the system installation to be performed.

1.15.2 Welders

The welding of piping and tubing systems shall be in accordance with qualified procedures using performance qualified welders and operators. Procedures and welders shall be qualified in accordance with the requirements of 40 05 13.96 WELDING PROCESS PIPING. Structural members shall be welded in accordance with Section 05 05 23.00 98 METAL FASTENINGS.

PART 2 PRODUCTS

All materials shall be new and compatible with the specified fluid or gas media. Pipe sizes shall be indicated on the drawing.

2.1 PIPE

ASTM A 312/A 312M, Type 304 or Type 316, seamless, cold drawn

2.2 TUBING

Type AL6XN in accordance with Section 40 34 10, "STAINLESS STEEL TUBING".

2.3 FITTINGS

Welded, flanges	Weldneck, 300 psig, ASTM A 182/A 182M Grade F 304 and ASME B16.5 (to match pipe wall thickness)
Welded, fittings, weldolets and threadolets	ASTM A 403/A 403M, Grade WP304 or WP316 (to match pipe material)

Tube Fittings - See Section 40 34 10 "STAINLESS STEEL TUBING"

2.4 FASTENERS

Bolts and nuts required for installation shall be in accordance with ASTM A 193, Grade B8M Class 2 and ASTM A 194 Grade 8M.

2.5 INSULATION

No pipe, tubing or components covered by this specification section require insulation.

2.6 COMPONENTS, PANELS AND OTHER EQUIPMENT

All other components, panels, and equipment shall be as shown on the drawings.

PART 3 EXECUTION

3.1 WORKMANSHIP

The Contractor shall demonstrate the satisfactory quality of representative tubing flares by means of tests under paragraph entitled "Quality Provisions" herein prior to any stainless steel tubing fabrication or installation.

Personnel whose workmanship is found to be unsatisfactory shall have their certification revoked and shall be requalified or removed from the project and replaced with qualified personnel at no additional cost to the Government.

All piping and tubing shall be installed as shown on the drawings. See Section 40 34 10 "STAINLESS STEEL TUBING" for tubing requirements. Where detailed dimensions are not given, the Contractor shall "field run" the lines in a neat and substantial manner. The Contractor shall reroute any field run lines contacting insulation on other piping or ductwork, pipe, tubing, equipment, steel work, etc. at no additional cost to the Government. No piping or tubing shall be run in such a manner as to block access. Where any line conflicts with other work, resolution will be made by the Contracting Officer prior to routing of line(s).

Installation of tube runs and pipe in stacks shall require detailed planning and scheduling of same to utilize the automatic welding machine in the most productive fashion. The removal or loosening of installed tube or pipe to accommodate the automatic welding head shall be the Contractor's responsibility and shall be done at no additional cost to the Government.

3.2 PIPING

The provisions of referenced codes and standards shall constitute minimum requirements for system materials, installation, and workmanship. Where the drawings and specification require better material and methods of installation than the minimum requirements set forth in the code or standard, the drawings and specifications shall supersede code standard requirements.

Piping shall be fabricated and installed in accordance with the methods described herein and in accordance with ASME B31.3.

All straight runs of piping measuring less than 10 feet in length shall be continuous without transverse butt welds.

Pipe shall be carefully worked into place without springing or forcing. Adequate provision shall be made for absorbing all expansion and contraction without undue stress in any part of the system.

All pipe, fittings, valves, equipment and accessories shall be clean and free of all extraneous foreign material before being installed into their respective systems. Immediately prior to erection, all piping shall be checked for cleanliness and, if found otherwise, shall be thoroughly cleaned of visible contaminants. During the progress of construction, open ends of pipe, fittings and valves shall be properly protected at all times by plugs.

Piping shall be installed straight and true with approved offsets around obstructions as may be necessary to increase headroom or to avoid interference with construction, electric conduit, or equipment, and as approved by the Contracting Officer.

Unless otherwise noted, standard long-sweep pipe fittings shall be used for changes in direction. No mitered joints or pipe bends will be permitted, unless indicated on the drawings.

Tee connections shall be made with tee fittings or, where pipe is being welded, branch connections may be made with branch outlet fittings if noted on drawings. Branch outlet fittings, where used, shall be reinforced against external strains and designed to withstand pipe-bursting strength requirements.

3.3 PIPE JOINTS

Pipe ends shall be reamed before joint connections are made.

Stainless steel pipe shall be welded in accordance with NASA-SPEC-5004a. See Section 40 05 13.96 WELDING PROCESS PIPING for welding requirements.

All KSC standard pipe joints (Grayloc) shall be assembled and torqued in accordance with KSC-GP-425g. After final tightening, torque putty shall be applied to the nuts. Allowance shall be made for disengagement of all mechanical joints. Two-bolt clamps shall not be used.

3.4 STAINLESS STEEL TUBING

Tubing installation shall be in accordance with Section 40 34 10, "STAINLESS STEEL TUBING SYSTEMS".

3.5 INSULATION

The ground cooling system tubing shall be insulated. That system is covered in Section 40 34 10, "STAINLESS STEEL TUBING".

3.6 SUPPORTING ELEMENTS INSTALLATION

Supporting elements shall be provided in accordance with the referenced codes, standards and requirements specified herein, and shown on the drawings.

Piping shall be hung from the structure, not from other pipe.

Piping hangers, supports, anchors and guides shall be provided by the

Contractor. Where detailed on the drawings, these items shall be fabricated and provided by the Contractor as detailed.

Except where detailed on the contract drawings, the Contractor shall select pipe and tubing hangers and supports as best suited for the installation. Components shall be as specified in MSS SP-58.

Refer to paragraph 2.4.1.4 of Section 40 34 10, "Stainless Steel Tubing" for use of unistrut and other preformed channels.

Conventional standard stock or production parts shall be utilized wherever possible.

Rigid hangers shall be designed in accordance with this section. All pipe supports shall be designed to avoid interferences with insulation, other piping hangers, electrical conduit and supports, structures and equipment. All nuts on rods and clamps shall be of the self-locking type or shall have jam nuts and shall be torqued tight. Hanger rods shall not at any time be subjected to bending or stresses other than tension. Hangers at locations where lateral or axial movement is anticipated shall be provided with suitable linkage to permit swing. Hangers shall be designed, fabricated, and assembled so that they cannot become disengaged by any movement of the supported pipe. Pipe hangers and supports shall be spaced as indicated on the drawings.

All piping shall run parallel to structural steel. Unless otherwise indicated, piping and components shall be spaced and installed so that a threaded pipe fitting may be removed between adjacent pipes and so that there will be no less than 1/2 inch of clear space between the finished surface and other work and between the finished surface of parallel adjacent piping. Hangers on different adjacent service lines running parallel with each other shall be arranged to be in line with each other and parallel to the lines of the structural steel.

Hangers and supports shall be painted in accordance with 09 97 13.00 40 "GENERAL REQUIREMENTS FOR COATINGS".

3.7 PROTECTIVE COATING OF STAINLESS STEEL PIPE

All stainless steel pipe, except within the MLB and enclosures, shall be cleaned and coated per specification Section 09 97 13.00 40, "GENERAL REQUIREMENTS FOR COATINGS".

3.8 PIPING SYSTEMS TESTING

All pressure tests specified herein shall be made prior to concealment of piping. Tests shall be made in the presence of the Contracting Officer's Technical Representative (COTR) or his alternate. A proposed test schedule and actual field test procedure shall be submitted for approval prior to the actual test. All test procedures shall be essentially as specified herein unless job conditions require a modification to the method of performing the test; however, any changes shall have prior approval of the Contracting Officer. In no case will reductions of the test pressures be permitted.

Testing of stainless steel tubing shall be in accordance with Section 40 34 10, "STAINLESS STEEL TUBING".

Testing of welded pipe shall be as specified in Section 40 05 13.96 WELDING

PROCESS PIPING.

Only experienced personnel of the Contractor shall conduct the tests. All material, labor, test connections, gages and test equipment shall be furnished by the Contractor without additional cost to the Government. Unless otherwise approved by the Contracting Officer, all temporary test connections, materials or equipment shall be removed from the permanent system following final testing.

Each individual length or fabricated assembly shall be identified (after proof test) by an attached band. The marking shall be with permanent-type letters and shall indicate the pipe size, schedule, test pressure, date of test and part number.

3.8.1 Proof Pressure Testing

Testing shall take place during steady state ambient temperature conditions.

Each welded and threaded joint shall be pressure tested at one and one-half times the maximum operating pressure for 30 minutes. The maximum allowable pressure drop shall be 2 psi or as approved by the Contracting Officer.

Portions of the system to be tested shall be defined as that length of line between mechanical terminations or as otherwise approved by the Contracting Officer. The full test pressure shall be placed on the system at least 15 minutes prior to the start of the test period. Vents, plugs or valves shall be provided at high points to bleed trapped air and ensure an air-free, solid hydrostatic test. During the test period, all joints and connections shall be inspected for leaks and distortions. Following the repair of all leaks, the pressure test period shall again commence.

Hydrostatic tests of systems shall be made with deionized water furnished by the Contractor.

The Contractor may conduct tests for his own purposes, but the acceptance proof pressure test shall be conducted as specified herein.

Other than standard piping flanges, plugs, caps, and valves, only commercially manufactured expandable elastomer plugs shall be used for sealing off piping for test purposes. The safe test pressure rating of any plug used shall be not less than two times the actual test pressure being applied.

The Contractor shall take all necessary precautions to vent the expansive force of compressed air trapped during high pressure hydrostatic testing to preclude injury and damage. The Contracting Officer may require the removal of any system component such as plugs and caps to ascertain whether or not the water has reached all parts of the system if adequate purging or vent valves are not provided to ensure removal of compressed air cushion.

Piping system components such as valves shall be checked for functional operation under system test pressure, where practical.

The Contractor shall assure that the temperature of water used for testing shall not cause condensation of atmospheric moisture on system surfaces.

If leak test is not performed within 48 hours after draining of water from proof pressure test the lines shall be dried using filtered gaseous nitrogen until dew point reading of minus 63.5 degrees F is obtained.

3.8.2 Leak Test for Pneumatic Lines

The leak test shall be conducted after successful performance of the proof pressure tests, cleaning, and final adjustment of pipe supports has been accomplished. The test shall be at the maximum operating pressure for a minimum of 15 minutes with a maximum of 24 hours, unless otherwise specified. Each joint shall be tested with a leak detection solution conforming to MSFC-SPEC-384, Type I, with no visible leakage. The test may be terminated by direction of the Contracting Officer at any point during this period.

3.8.3 Test Records

Test records shall be prepared and maintained of all system tests. Records shall show Governmental and Contractor test personnel responsibilities, dates, test gage identification numbers, pressure ranges, rates of pressure drop, leakage rates, and other system characteristics. Test records shall be submitted to the Contracting Officer for approval.

3.9 CLEANING

Refer to 40 34 10, "STAINLESS STEEL TUBING" for tubing cleaning. All piping shall be cleaned and verified clean, in accordance with KSC-C-123 as follows:

The Contractor shall prepare cleaning procedures and submit Contracting Officer's approval.

All piping systems shall be cleaned using the flushing media specified in the following listing.

All piping systems shall be verified clean to the levels shown below.

All flushing operations shall be toward the system low point and shall be continued until the effluent is visually clean.

Prior to visual examination, the piping systems shall be purged dry using gaseous nitrogen.

Visual examination of piping surfaces shall be performed at locations specified by the Government.

KSC-C-123

PIPING SYSTEMS	CLEANLINESS LEVELS	*FLUSHING MEDIUM
GN2	300A	T or V
GHe	300A	T or V
BA	100A	T or V
GO2	100A	T or V

* T=Trichloroethylene
V=Ventrel MCA

3.10 PIPE SYSTEMS IDENTIFICATION

The Contractor shall provide coordinated system of pipe identification that

includes metal tags for components, color coding and service labeling. Tubing shall be identified in accordance with Section 40 34 10 "STAINLESS STEEL TUBING".

3.10.1 Metal Tags

Identification tags shall be installed on all components (valves, regulators, gages, etc.). The tags shall be 3 inches by 1 inch, stainless steel, and permanently marked with the assigned mechanical "A" number, electrical reference designator and matching drawing or control diagram designation. Tags shall be wired to component with No. 14 AWG (0.06408-inch-diameter) stainless steel wire and securely attached at top and bottom to prevent a swinging action.

3.10.2 Color Coding and Identification

All pipe and tubing shall be color coded. Color coding consists of titles, primary color warnings and flow direction arrows as described in KSC-STD-SF-0004B.

Titles shall be lettered on the two lower quarters of the tube or pipe or covering. Titles shall be visible from operating positions, especially those adjacent to control valves and panels. Titles shall be permanently fastened adhesive labels. Letters shall be upper case and numbers shall be arabic. Letter size shall be 1/2" for pipe diameters less than 1-1/2" and shall be 3/4" for tube and pipe diameters greater than 1-1/2".

Primary color warnings shall consist of 1" wide bands which completely encircle the pipe. Bands shall be painted on and shall be applied no less than 40' apart on straight runs. Immediately adjacent to and upstream of all operating accessories such as valves, regulators and flow checks, all coded systems shall be painted on and all coded systems shall be painted with primary color. In addition, primary color warnings shall be painted throughout the system at convenient intervals (e.g. at branch lines, penetrations, and other conspicuous places.

Secondary color warning arrows are used to identify the directions of flow within the pipe and appear adjacent to the color warning bands. Arrows shall be dimensioned per KSC-STD-SF-0004B, Figure 2-1.

Primary and Secondary warning colors are based on the medium in the pipe or tube system and are identified below:

MEDIUM	PRIMARY WARNING (BAND COLOR)	SECONDARY WARNING (ARROW COLOR)
Breathing Air	Green	Black
Helium	Gray	Black
Nitrogen	Gray	Black
Oxygen	Green	Black

Those sections of piping that are concealed by inclusion in walls or partitions are not subject to these requirements.

Each panel-mounted component shall be identified on the face of the panel

by a plate mounted adjacent to the component (beneath the component if practicable).

The legend on the plate shall provide clear, concise and positive component identification, including the component's name, find number, medium, and pressure. The plate shall be 1/8-inch thick (nominal) laminated phenolic surface. The plate shall be rectangular in shape, with beveled edges, and shall be securely mounted to the panel with a suitable adhesive. Each complete panel containing components (valves, gages, bulkhead connection points, etc.) shall be identified on its face by a plate which clearly defines the purpose of the panel (3/16-inch letter size).

3.11 QUALITY PROVISIONS

3.11.1 Inspection Requirements

The Contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the Contractor may utilize his own or any other inspection facilities and services acceptable to the Government. Inspection and test records shall be kept complete and provided to the Contracting Officer or his designated representative. The Contracting Officer, or his designated representative, reserves the right to perform (at Government expense and without any increase in contract price) any or all of the inspections set forth in this specification to ensure that the end item conforms to the prescribed requirements.

-- End of Section --

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SECTION 41 22 23.19

PLATFORM HOISTS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

It is not the intent to specify herein all details of design and construction. It shall be the responsibility of the hoist manufacturer to ensure that the equipment has been designed and constructed in accordance with all engineering codes, standards, Government regulations, and as a minimum in accordance, guidance and recommendations of applicable portions of CMAA 70 specifications for Class C services.

The contractor shall have full responsibility for compliance with the requirements of the specifications. Review of drawings, catalog, or specifications by Designated NASA Representative with regard to general design and controlling dimensions does not constitute acceptance of any design, material, or equipment that will not fulfill the function or performance requirements established herein.

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.

ASME INTERNATIONAL (ASME)

ASME B30.7	(2011) Winches
ASME B30.10	(2009) Hooks
ASME NOG-1	(2010) Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 70	(2010) Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes, No. 70

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 519	(1992; R 1993; Errata 2004) Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2008) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA ICS 6 (1993; R 2011) Enclosures

NEMA MG 1 (2011) Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2011; Errata 2 2012) National Electrical Code

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

29 CFR 1910.179 Overhead and Gantry Cranes

UNDERWRITERS LABORATORIES (UL)

UL 1004 (2012) Standard for Safety Rotating Electrical Machines

UL 508C (2002; Reprint Nov 2010) Power Conversion Equipment

WIRE ROPE TECHNICAL BOARD (WRTB)

WRTB (2005) Wire Rope Users Manual 4th Edition

1.3 SYSTEM DESCRIPTION

1.3.1 General

This specification describes the performance requirements for the design, construction, installation and testing of four (4) new hoisting systems used for raising and lowering large work platforms located in VAB High Bay 3. Each hoist within a single hoist system shall be capable of independent operation or in syncronized combination with other hoists in the same system.

Two hoist systems will be lifting main extensible platforms. Each system will have four hoists rated for 34 tons for a total of eight (8) 34 ton hoists.

Two hoist systems will be lifting elevator access platforms. Each system will have four hoists rated for 7.5 tons for a total of eight (8) 7.5 ton hoists. Understand this is not an elevator. This is an adjustable access platform located at various elevator landings.

These towers are located inside an existing 525' tall enclosed building, VAB, that processes aerospace vehicles in preparation for movement to a launch pad. The towers contain new platforms stacked at multiple levels within each of the two separate towers.

1.3.1.1 Hoist Capacity and Special Proof Load

The hoist capacity was selected based on enhanced safety needs to accommodate NASA critical lift requirements. These are requirements related to special safety requirements needed to support platform operations and the need to have personnel on the platform during movement.

Safety rational dictated requirements to accommodate the failure of any one of the four hoists during tandem platform lifting operations. During this

failure scenario the platform is assumed to tip (based on worst case center-of-gravity location of the platform) and resulting in only two hoists to support the platform. The tipping platform is designed to safely wedge itself into building columns. Personnel on the moving platform will be safe based on this limited tipping (and they will be tethered to the platform with safety harnesses).

Based on this enhanced safety design the platform hoists will comply with the following:

- hoists are rated for twice the normal capacity needed to lift a platform. This accomodates two hoists holding the platform should one hoist fail.
- hoist holding brakes shall be designed for 150 percent of the torque needed to lift the rated load (special testing for the hoist brakes is required)
- a special 150 percent proof load test will be completed on all hoists

1.3.2 Platform Operation

Platforms shall be normally fixed in place and pinned to structural columns of the building. The platforms serve to provide access to various work stations around the launch vehicle by personnel. During normal work activities, the platforms hoist slings are detached and withdrawn. Periodically it is necessary to raise or lower a platform to a different elevation within the stack.

Platforms within the stack can be repositioned within the elevation limits of the platform directly above or directly below. Repositioning of a platform within the stack shall be accomplished by attaching slings from the four overhead hoists to four corners of the platform to pick up the platform. After the slings are securely attached to the platform, the hoist control system energizes the four hoists to lift the platform and relieve the pin pressure at the platform connections to the columns. After the pins are removed from the column connections, the platform load is supported by the hoist slings. The platform is free to be repositioned by the hoisting system.

At the new location, the platform is reconnected to the building structure and the hoisting slings disconnected and withdrawn from the platform. The hoist control system shall provide normal speed and inching speeds for the four hoists synchronized operation and individual hoist operation for final positioning and pin alignment or removal at individual platform corners. A no-load or empty hook speed is provided for rapid hook positioning. Each tower contains platforms installed at varying elevations in the tower and stacked on top of each other and attached to the same building columns. During platform hoisting and positioning operations, a limited number of personnel will be riding the platforms to disconnect, align and connect the platform to the building columns before removing the hoisting cables.

1.3.3 Extensible Platforms

There are two (2) extensible platform towers having a stack of ten (10) platforms in each tower one at a time. Each platform is approximately 38'-0" by 76'-0" wide with a total weight of 132,000 pounds.

The platforms have similar shapes and geometry but have differences in total weight and center of gravity.

The physical differences in weight and center of gravity will necessitate differences in hoist line pull during platform movements. Each independent control system shall synchronize speeds between each of the four hoists regardless of actual hoist line pull. In this manner the four hoists attached to the four corners of each platform will raise and lower the platform and maintain the platform in a level state.

1.3.4 Elevator Access Platforms

There are two (2) elevator access platform towers having a stack of ten (10) platforms in each. Each platform is approximately 19'-0" by 24'-0" wide with a total weight of 30,000 pounds.

The platforms have similar shapes and geometry but have differences in total weight and center of gravity. The physical differences in weight and center of gravity will necessitate differences in hoist line pull during platform movements. Each independent hoist control system shall synchronize speeds between each of the four hoists regardless of hoist line pull. In this manner the four hoists attached to the four corners of each platform will raise and lower the platform and maintain the platform in a level state.

1.4 SUBMITTALS

The submittal requirements for the 34 ton hoists include engineering details needed for design and fabrication of a custom engineered and manufactured hoists. The submittals are specific to provide approval of structural and mechanical items for detailed components. The submittal requirements for the commercial electric 7-1/2 ton hoists include standard manufacturers literature needed for selection and approval of commercial equipment.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings; G

General Arrangement Drawings shall show capacities, duty class, and details for all of the main components of the hoist including parts descriptions, manufacturer's model numbers, and shall include clearances and interfaces within the facility, lifts, speeds, and weight breakdown. Weights shall be shown for: hoist and load block; total net weight. The hoist shall be shown in plan, side and end elevation.

Submit shop drawings showing all principal mechanical components, principal dimensions, details of structural connections, and related component details. Include complete schematic wiring diagram with description of operation. Manufacturer's catalog data will suffice for items of standard manufacturer.

Electrical Schematics

The drawings shall integrate all control equipment to provide clear and contiguous control logic between sheets. The compiling of individual manufacturers drawings as a substitute for

integrated drawings will not be acceptable. All electrical schematics shall be provided such that a functional analysis can be performed.

Documentation for microprocessor-based control systems

Documentation for Microprocessor-Based Control Systems, if provided, shall include complete manufacturer's catalog data which shall include definitions of their functions and their relation to the integrated control system. Programmed parameters shall be provided, along with complete instruction on programming method.

As-Built Drawings

On or before completion date of the contract, the Contractor shall submit to the designated NASA representative a complete set of as-built drawings in accordance with the Contract which incorporates all comments, annotations, conditions of approval and corrections. The set shall include assembly drawings with part list, detail drawings on custom engineered components, and electrical drawings including electrical schematics and wiring diagrams.

SD-03 Product Data; G

Product data shall be provided for all assemblies and subassemblies including but not limited to the following:

Commercial Electric Wire Rope Hoist (7-1/2 ton hoist only)
Application software
Drive Controllers
Control Parameter Settings
Control Components
Electrification
Control Panels
AC Motors
Brakes
Couplings
UPS
Capacity Overload Protective Device
Limit Switches
Master Switches
Wire Rope

Batteries - The Contractor shall submit a list of devices that contain batteries. This list shall indicate the estimated life of each individual battery, location of each battery, and the procedure for replacement of each battery. This can be supplied by the devices cut sheets.

SD-05 Design Data; G

Hoist Structural Support Calculations

Submit floor loading structural design calculations verifying the size of structural members, structural supports and components for the hoist drive assembly as imposed to the concrete floor slabs. Include stress and loading diagrams.

34 ton hoist only - Hoist Frame Load and sizing calculations

Hoist mechanical calculations to component level

SD-06 Test Reports; G

Shop Test Procedure
Post-Erection Inspection
150 percent Rated Load test
No-Load Test

Operational Tests
Rated Load Speed Test
Hook NDT Report
Acceptance Test Procedure

SD-07 Certificates; G

Hazardous Material
Brake Settings

Loss of Power Tests
Hook Proof Test
Wire Rope Test

SD-10 Operation and Maintenance Data; G

Hoist system, all mechanical and electrical components, Data Package 5

Submit Data Package 3 as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA.

1.5 QUALITY ASSURANCE

All structural, machine shop and assembly work shall be neat, accurate and equal in all respects to the best heavy machine tool practice and shall conform to the best practice of modern fabrication shops.

Where two or more units of the same class of equipment are required under this section and other sections of the specifications, these units shall be products of a single manufacturer.

Metal fits, tolerances, and finishes shall conform to those indicated on the approved drawings.

1.5.1 Inspections

All parts shall be inspected to ensure compliance with the finishes and tolerances established by the approved shop drawings. The material to be furnished shall be subject to inspection and tests in the mill, shop and field by Government Inspectors. When materials and 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 hoists. Parts which fail to conform to the approved shop drawings shall be replaced with acceptable parts unless a specific method of repair is authorized in writing by the designated NASA representative.

Certification and inspection test reports shall be submitted to the designated NASA representative for approval on the following items. Approved certification and inspection test reports shall be submitted in the Acceptance Data Package.

1.5.2 Hooks, Proof Load and Throat Spread Measurement

Prior to acceptance testing, hooks shall be individually proof load tested in accordance with ASME B30.10.

A throat dimension base measurement shall be established by installing two tram points and measuring the distance between these tram points (+/- 1/32 inch). This base dimension shall be recorded. The distance between tram points shall be measured after load test. The hook shall be able to withstand the proof load without permanent deformation.

As part of acceptance testing, the hoist shall be proof load tested to 150 percent. The hooks shall be measured for hook throat spread before and after testing at 150 percent proof load tests. An increase in the hook throat opening from the base measurement is cause for rejection.

1.5.3 Non-Destructive Examination of Mechanical Components

Prior to assembly, all hooks, hook nuts and sheave pins, hoist drum shafts, upper block sheave pins, and hoist shafts shall receive non-destructive examination (NDE) in accordance with ASME NOG-1 Section 7100 and Table 7210-1. Acceptance criteria shall be in accordance with ASME NOG-1 Section 7100.

1.5.4 Welders Certification and NDT of Welding

Welders certifications and NDT reports on welds shall be completed and available for inspection by Government Inspectors. All welder certification and NDT reports shall be submitted with the hoist data manual, at the end of the contract.

Inspection on the hoist welding shall be in accordance with the hoist manufacturers standards.

1.5.5 Certificates of Compliance

Certificates of Compliance shall be provided on the following items:

a. Electrical Components and Controls

b. Motors - Hoist motors, wiring, contract drawings, over-current protection, and grounding conform to NFPA 70, and to UL standards; the label or listing with re-examination of the UL will be accepted as evidence that the materials conform to this requirement and to NFPA 70.

1.5.6 Certificates

a. Certification of actual wire rope breaking strength for each supplied wire rope, with traceable identification to the wire rope manufacturer.

b. Certification that the hoist systems contains no hazardous material, asbestos, cadmium, lead, elemental mercury, or PCBs.

c. Certification of brake settings, including the allowable range of and the initial setting of each.

d. Certification and acceptance of NDE of components in accordance with requirements herein.

1.6 DELIVERY, STORAGE, AND HANDLING

1.6.1 Delivery and Storage

Inspect materials delivered to site for damage; unload and store with minimum handling. Store materials on-site in weather-proof enclosures.

1.6.2 Handling

Handle materials in such a manner as to ensure delivery to final location in undamaged condition. Make repairs to damaged materials at no cost to Government.

PART 2 PRODUCTS

2.1 HOISTING SYSTEM COMPONENTS

The 34-ton extensible platform hoists shall be a built-up unit generally made from commercially available or made to order motors, brakes, couplings and gear reducers. These components are engineered together as an assembly mounted on a custom designed and built equipment frame with custom drums and shafts.

The 7-1/2 ton elevator access platform hoists shall be a pre-engineered, built to order unit.

All equipment shall be built and equipped to accommodate the exceptions, features and capabilities specified herein and on the accompany contract drawings.

2.1.1 General

The hoisting systems shall be comprised of four (4) hoists operated by an electrical control system for raising and lowering a work platform while occupied by a limited number of personnel and equipment. The hoisting system shall incorporate the following features:

FEATURE	EXTENSIBLE PLATFORMS	ELEVATOR PLATFORMS
Hoist Load Rating	34 tons	7-1/2 tons
Duty Service Class	CMAA Class C	CMAA Class C
Rope Type	Python Super 8C	Python Class 38 X 7 non-rotating wire rope
Drum Surface	Lebus Grooved for multiple layers of wire rope	Ground; single layer of wire rope
Normal Hook Speed	Variable 0-15 FPM	Variable 0-15 FPM

FEATURE	EXTENSIBLE PLATFORMS	ELEVATOR PLATFORMS
Inching Hook Speed	variable 0-1.5 fpm	variable 0-1.5 fpm
No-Load Hook Speed	2 ½ x Normal Speed	2 ½ x Normal Speed
Controls	AC flux vector drives Electromotive Impulse VG+, Series 4, Closed Loop, or equal	AC flux vector drives Electromotive Impulse VG+, Series 4, Closed Loop, or equal
Brakes	Elect. @150% Rated Torque	Elect. @ 150% Rated Torque
Safety Switches	Two Upper-limit switches Control & Final power sw. Gear-opr. Lower-limit sw.	Two Upper-limit switches Control & Final power sw. Gear-opr. Lower-limit sw.
Sheaves	20:1 Diamter of rope with tie-off	20:1 Diameter of rope with tie-off

2.2 COMMON REQUIREMENTS

2.2.1 Identification Plates

Provide manufacturer installed identification plates of non-corrosive metal showing, in clearly legible permanent lettering, the manufacturer's name, model number, capacity rating in pounds, and other essential information.

All electrical enclosures shall be labeled with PPE requirements per Section 26 05 71.00 40, LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

**2.2.2 Miscellaneous Equipment Features

Drip pans will be provided under new components installed under contract that contains oils or grease that has the capability to leak out.

All couplings with setscrews shall have loctite applied to them and marking putty applied to indicate any loosening.

All belts, chains, and rotating equipment shall have proper covers to prevent inadvertent contact from personnel.

All new Zirk fittings shall be pressure relief fittings.

No plastic tie wraps are permissible on the hoist exterior.

NASA will define any passwords and receive four keys for every lock.

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2.3 HOIST SYSTEM

2.3.1 Material and Design Requirements

Hoist system shall include the following design requirements:

a. Powered hoists shall include a brake and a controlled braking means, and an overload limiting device.

b. Design the mainline contactor, along with the power-off/power-on circuitry to remove power from the drive motors, brakes and control circuit. The control circuit shall not operate unless a power-on button is depressed.

c. Overcurrent protection for the control circuit and control circuit transformer; fuse or circuit breaker protection for branch circuit short circuit and ground fault protection; and overload protection for each motor, motor controller, and branch circuit conductor shall all conform to the NFPA 70.

**The Contractor is to provide metal safety guards over the hoist brake wheels. These guards shall be shaped to provide close fitting protection so moving parts are guarded from contact with personnel and they shall protect against debris from falling onto the brake wheel. These covers shall be easily removable to accommodate maintenance.

The Contractor shall provide a hoist holding brake release indication for control verification. This may include adding a proximity switch or other device to the brake shoe linkage. This must indicate a physical movement of the brake linkage, not energizing the brake coil. This brake release information will be provided to the control system to assure brake release occurs correctly, to enable hoist run commands.

The brake system shall be able to accommodate manual lowering operations upon loss of a drive. The contractor shall verify the brake can be manually release to allow the lowering of the load at a slow controlled manner to allow operators to safe the load upon a loss of drive capability.

All electrical enclosures shall be labeled with PPE requirements per Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

The operator input has direct control of the speed. Provisions shall be provided so that the hoist control system can tolerate both actuation of an emergency stop and loss of power or the interruption of over-current protection devices without damage to components under 100 or 125% load. In order to mitigate software corruption due to power transients, provisions shall be made to insure that line power supplied to microprocessor based devices is conditioned to remain within the input specifications of the devices and is monitored by the control system which shall initiate a shutdown upon detection of the out-of-tolerance condition. Provide UPS for these functions with 10% spare capacity and full load run time of 30 minutes.

Performance response to controls shall be instantaneous, except where time delay devices and relays are provided. Operation shall be smooth and quiet. Heat rise in motors, brakes, and transistors during maximum capacity operation shall not exceed the design limitation.

The control system shall include over-current protection, under and over-voltage protection, phase loss protection and line transient protection. The system shall be capable of detecting these conditions before they adversely affect the control system and perform a safe and normal shut-down.

Protective devices shall include a fused circuit disconnect switch for each motor controller. The control system shall provide over-current protections, under-voltage protection, and reverse-phase protection.

On AC motors, overload relays shall be provided for each phase of the motor windings. Operation of any protective device (overload, under voltage, undercurrent, control-circuits fuses, or stopping device) shall safely stop

motions, without any adverse affects on the control circuit.

Safety devices and brakes shall be positive in action without slipping, chattering, or jamming and shall have a fail-safe design.

All hoists shall be capable of simultaneous and independent operation without degradation of control function.

The hoist controls shall not allow inadvertent initiation of a run command. All master switches or motion control devices out of center or neutral position shall prevent any hoist movement

The hoist master switches will be used for normal operation in inching, normal, and empty hook. Pulling the master switch toward the operator will raise the load and pushing the master switch away from the operator will lower the load. Neutral position will bring the load to a stop and set the brakes.

Full load speeds and control shall be maintained to within plus or minus 2 percent.

A standard closed-loop system consisting of an AC induction motor controlled by a flux vector drive shall be used for the hoist motors. Each motion shall have an independent drive for each motor. Selected speeds shall be constant, without any fluctuation within a (+/-) 2% percent error tolerance loaded or unloaded. On a closed loop system the control system shall provide programmable acceleration and deceleration functions. All acceleration shall be continuous with no stepping, and shall follow a linear slope. Controls shall be able to maintain + 0.005 movement of the load upon brake release and brake engagement. Power system harmonic performance shall be per IEEE 519.

Provide static reversing, adjustable frequency flux vector controllers for hoists electric drives. Provide dynamic braking for all electric drives. All electric drives should be sized with dynamic braking resistors capable of bringing the rated load to stop without overheating the drive.

The hoist brakes must set only after the associated controller decelerates the motor to a controlled stop.

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2.3.2 Safety

Comply with the mandatory and advisory safety requirements of ASME B30.7, and 29 CFR 1910.179. The Contractor is responsible for checking the proper operation and condition of safety devices, electrical components, mechanical equipment, and structural assemblies prior to installation. Immediately report any observed defective components and replace.

2.4 ELECTRIC WIRE ROPE HOIST

2.4.1 Hoisting Ropes

Provide the following:

a. Rope lengths shall be sufficient to provide required lift of 85 feet per contract drawings and to maintain a minimum of two full wraps of rope at the dead end(s) of the drum, with the block in the geared lower limit position.

b. Hoisting ropes: See paragraph 2.1.1.

**c. All wire rope shall be inspected prior to installation and post testing. The inspection shall be performed per ASME B30.7 Section 7-2.4.1.

**d. All bolts next to open edges shall be Ny-lock type or equal self locking.

e. The Wire Rope Users Manual shall be used for all aspects of end fitting attachments, seizing of ends, and wire rope handling.

2.4.2 Load Block and Sheaves

The load block shall be an enclosed steel safety type which will shroud the sheave and protect the operator. The sheave assembly shall be mounted on a steel axle and carried on sealed, antifriction bearings. The hook shall be mounted on a lower block trunnion.

Sheave pitch diameters shall be selected based wire rope size in accordance with the requirements on the drawings. Sheave grooves shall be sized properly to support the wire rope circumference.

2.4.3 Hook Assembly

Hooks and hook swivels shall be heat-treated alloy steel forgings marked in accordance with ASME B30.10. Hook assembly shall be carried on antifriction bearings to permit free swivel under rated-capacity load without twisting wire rope.

Hook assembly shall include a machined and threaded shaft and swivel lock-nut with a suitable easily removal locking device to prevent nut from backing off.

Hook shall have a spring-loaded, heavy duty, swinger type safety latch such as Bullard Swinger type gate "Rollox" or "Tip-lok" safety latch as applicable, or equal.

Each load block shall be labeled with its ratings capacity.

2.4.4 Wire Rope Drum

Provide steel or ductile cast iron wire rope drum. Drum shall have accurate, machine-cut grooves, cut to depth of wire-rope diameter as recommended by CMAA specifications, with rounded corners of dimension as required for the indicated lift. Drum shall be flanged at each end and shall have enclosed tops and sides to preclude cable binding and jamming. Drum pitch diameter shall be no less than recommended by CMAA 70 Table 4.6.4-1 "Guide for Minimum Pitch Diameter of Drums".

The 7-1/2 ton hoist drum shall be proportioned to store not more than one layer of rope with the load hook at the upper operating limit and shall have not less than two full turns remaining on the drum at the lowest lift elevations, as defined by the setting of the lower limit switch. Wire rope fleet angle shall not be greater than recommended by CMAA 70.

The 34-ton hoist drum shall be proportioned to store all wire rope needed to provide full travel of the hook with not less than two full turns remaining on the drum at its lowest elevation, as defined by the setting of

the lower limit switch.

The drum shall provide for multiple layers of spooling of the wire rope. Drum shall have flanges at each end of the wire rope spool to a height of not less than two rope diameters above the final layer. Drum grooves shall be LeBus International, Inc., Longview, Texas or equal. Drum grooves must provide correct and repetitive action of layer of wire rope spooling throughout the hoisting range. This wire rope grooving, when combined with proper fleet angle control, will force the cable to conform to the proper spool pattern, and control the position of each succeeding layer to prevent abnormal wire rope spooling such as "cutting in" or skip wrapping.

The wire rope groove radius, depth of and spacing shall be as recommended by LeBus international. In order to accommodate lifting the four corners of the platform in a level manner the tolerance of the drum pitch diameter of each of the four hoists in the four hoist system shall accommodate equal lift speeds by the synchronized hoist motors. The rope length shall be accurately controlled to assure each hoist transition to successive wire rope layers together so the drum pitch diameter and line speed remains constant between the four hoists.

The wire rope fleet angle shall not be greater than 2 degrees.

Wire rope dead ends to the drum shall be by means of rope clamps or a swaged terminal in a keyhole slot. The drum and other parts shall be designed and fabricated to allow convenient inspection of hoist rope termination. Fastener holes shall be located between the clamp grooves. A minimum of two fasteners shall be provided for each rope clamp. When wire rope sockets are used, end grooves of the drum barrel shall be turned into the anchor point with a radius of not less than six rope diameters. The rope socket shall be anchored inside the drum against a rigid surface which is welded in place. The holes in the drum barrel for insertion and removal of the socket and rope shall be closed with pipe plugs or a bolted keeper plate to prevent the rope from coming out should the drum be overdriven in the down direction.

2.4.5 Bearings

All bearing shall be precision, antifriction type. They shall be installed in accordance with the manufacturers recommendations. Bearings shall be fitted with pressure lubrication fitting conforming to industry standard practice or permanently lubricated. Pressure fittings where provided shall be easily accessible from a safe location. Bearings shall be lubricated for their application and shall be shielded or sealed to prevent leakage.

Exposed bearings and load block bearings shall be pre-lubricated and factory sealed.

2.5 MOTORS

Motors shall conform to NEMA MG 1. All motors shall be minimum 60 minute duty rating. Motor insulation shall be Class H with a Class B temperature rise. All motors shall be equipped with thermal trip type over-temperature protection and shall provide warning and over-temperature indications to the operator.

**Motors must meet all applicable requirements of NEMA MG 1 and UL 1004-1. Provide insulated inverter duty motors for Variable Frequency Drives (VFD).

Motor insulation must be Class H, but with a Class B temperature rise. Provide AC squirrel cage induction type motors.

2.5.1 Hoist Motors

Provide AC inverter duty, totally enclosed non-ventilated (TENV), squirrel cage induction type hoist motors.

**2.5.1.1 Motor Starters

Motor starters and contactors shall be per Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

2.5.1.2 Circuit Breakers

Circuit breakers shall be per Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES.

**2.5.2 Adjustable Frequency Drive Controls

2.5.2.1 Hoist Electric Drive

Provide a static reversing, adjustable frequency, speed regulated, closed loop flux vector controller with encoder feedback. The hoist drive shall ensure that adequate motor torque is available to suspend the load before the brakes are released. For a hoist with one brake, two independent drive outputs energizing separate brake contactors, whose contacts are in series with the brake coil, are required to release the brake; or an additional separate brake contactor independent of the drive whose contact is in series with the drive controlled brake contactor. For hoists with two brakes, connect the secondary brake to a different output from the primary brake.

**The hoist controller must enable the drive motor to develop full torque continuously at zero speed. The motor drives shall be Magnetek Electromotive flux vector Impulse VG+ series 4 motor drives or approved equal. The drive shall be listed to UL 508C.

The drive unit shall have the following features:

1. Reverse Plug Simulation function that allows the operator to smoothly and quickly stop and change directions without setting the brake.
2. Encoder loss detection.
3. Phase loss detection.
4. Brake test allowing testing of available brake torque.
5. Snapped Shaft Detection.
6. Provide a redundant hardware safety circuit that guarantees motor and brake power are removed when an E-STOP switch or safety controller opens that drive.
7. Ground Fault protection.
8. Key pad display including diagnostics.
9. Stall Prevention.
10. Static Auto Tune.
11. Load checking that prevents lifting an overload.
12. Output accuracy 0.01% or greater.
13. Braking torque 150%.
14. Thermal Overload UL recognized.
15. Drives shall conform to CENELEC EN 61800-3.

16. Fault reporting capability

2.5.2.2 Hoist Control Stations

The Hoist Control Station shall be provided for each 4 hoist system. Each control station shall consist of a Central Control Station located adjacent to the hoists.

The Central Control Station shall have a selector switch to switch between inching speed, normal speed and empty hook speed. The Central Control Station and Pendant shall each also have an emergency stop button.

The Central Control Station shall be provided with a control to synchronize hoist movement where all four hoists are operating together. The drive shall synchronize hook speed of all four hoists. Speeds shall be regulated regardless of the load on any platform corner to provide level movement of the platform.

The Central Control Station shall be provided with an independent control of each hoist so that any one hoist can be selected and operated. Also control station will provide for all four hoists or two east hoists or two west hoists operated together with synchronized hook speeds regardless of load on the hooks.

**Control Devices

Control devices shall be per Section 26 05 71.00 40 LOW VOLTAGE OVERCURRENT PROTECTIVE DEVICES unless otherwise indicated in this specification section.

Hoist Electrification

Provide enclosures for control panels, controls, and brakes in accordance with NEMA 250 and NEMA ICS 6, Classification Type 12.

The existing building ambient temperature at the location of where the hoists will be located ranges from 40 degrees F to 100 degrees F with 10% to 95% relative humidity. All electronic equipment shall be rated for or above this temperature range for continuous duty. If the electronic equipped cannot meet this temperature requirement then the contractor shall provide environmental equipment on the enclosures to maintain the electronic equipment in proper operating ranges. Provide cooling unit on each control panel. Provide ductwork, etc. inside each enclosure for uniform airflow distribution. The cooling unit shall be designed not to require condensate drain and cool the panel interior to 80 degrees F with all equipment running at full load. Cooling units shall be accessible for regular service and maintenance.
**

The control console will include the following items:

Console Functional Requirements
Power on button
Stop button
Emergency stop
3 position hoist speed selector switch with the following chooses:
Inching speed
Normal speed
No load speed
4 position selector switch with the following choices:

- Four hoists tandem lift
- Two east hoists tandem lift
- Two west hoists
- Independent hoist operation

4 position selector switch with the following choices:

- Hoist 1 NE
- Hoist 2 SE
- Hoist 3 NW
- Hoist 4 SW

Master switch control
Bypass key for final upper limit
Indicator lights as follows:
A run light for each hoist (green)
Power on light (green)
Hoist over temp warning (amber) and cutout light (red) for each hoist

2.5.2.3 Dynamic Braking, Controlled Braking Means

Provide dynamic braking for hoist electric drives. The hoist brakes shall set after the associated controller decelerates motor to a controlled stop. Size the hoist controllers to provide sufficient starting torque to initiate motion of that drive mechanism from standstill with 0 to 150 percent of rated load on the hook. The hoist controller shall enable the drive motor to develop full torque continuously at zero speed. Drive motors shall run smoothly, without torque pulsations at the lowest speed and be energized at a frequency not exceeding 60 HZ for the hoist drive.

2.6 HOIST LIMIT SWITCHES

The hoist shall be furnished with upper and lower control limit switches to prevent hook/load block overtravel in either vertical direction. These limit switches shall cut off control power, causing the brakes to set and the motor to stop, and shall be setup to permit attainment of maximum vertical hook coverage and to provide safe margins for drift at all speed ranges. The control circuitry design shall be such that these limit switches only stop motion in the protected direction, permitting normal operation in the opposite (back-out) direction. A second, higher, block operated upper limit switch is to be provided. This limit switch is to cut off all crane power and shall require manual reset. The block operated switch shall be set at at a sufficient height above the control power limit switch to prevent unwanted actuation of the power switch. When the first upper limit actuates, its position shall also provide safe margins for drift so as to not two-block the hoist and/or cause wire rope damage at all speed ranges.

All limit switches of the four hoist system shall be arranged in series such that one switch actuation will stop all hoists in the four hoist system.

2.7 BRAKES

2.7.1 Hoist Electric Holding Brakes

Each hoist shall be equipped with one electric holding brake electrically released, spring applied. Holding brake capacity shall be capable of stopping and holding the 150 percent proof load.

All brakes shall be adjustable from 50-100 percent of their rated capacity. Brakes shall have thermal capacity for frequency of operation

required by service.

Manual release mechanism, hand lever or other easily actuated release method shall be provided. This feature shall not self-lock in the open position.

All brake shoe friction material shall be non-asbestos type.

2.7.1.1 Brake Safety Guards

Hoist brake shall be enclosed or provided with metal safety guards. These guards shall be shaped to provide close fitting protection so moving parts are guarded from contact with personnel and shall protect against debris from falling onto the brake wheel. These covers shall be easily removable to accommodate inspection and maintenance.

2.8 LOAD BLOCK AND SHEAVES

2.8.1 Gear Assembly

The 34-ton hoists shall have an enclosed gear reducer selected by the hoist manufacturer. AGMA rated certified helical, herringbone spiral bevel type or their combinations may be used for hoist. Worm drive reducers are not acceptable. The reducers shall be base mounted and shall be standard products of manufacturers regularly engaged in production of this type of equipment for commercial applications. Housings shall be ridged and properly shaped to maintain precise alignment of gears and support of bearings under varying loads. Gear orientation and bearing location within the enclosures shall provide a means for oil lubrication of the mating surfaces of the gears and bearings. The housing shall include inspection covers for inspection of gears at meshing points, a breather, a cover or closed filler opening, a pipe plug closed drain opening that is accessible and capable of draining the contents down into a pan or bucket. Reducer shall conform to all applicable CMAA 70 requirements for Class C service and bearing life.

The enclosed gear reducer for the 7-1/2 ton hoist shall be integral to the commercial hoist and equipment frame. Worm drive reducers are not acceptable. The housing shall include a breather, a filler opening, a pipe plug closed drain opening that is accessible and capable of draining the contents down into a pan or bucket.

2.8.2 Couplings

The 34-ton hoist couplings shall be connected between the hoist motor shall be a flexible type, grease lubricated. Coupling rating shall be not less than determined by the coupling manufacture's published selection methods based on operating speed, design horsepower, dynamic effects and brake torque. Couplings shall be located immediately next to bearings. Couplings shall be suitable for its location within the hoist machinery. Machinery arrangements such as three bearings on the same drive shaft are not permitted, they must be separated by an appropriate coupling of a full flexible type or half flexible as needed. Couplings shall be lubricated as recommended by the manufacturer. All couplings shall be press fitted and keyed.

Couplings for the 7-1/2 ton hoists shall be manufacturers standard integral to the commercial hoist.

2.9 PAINTING SYSTEM

All carbon steel surfaces, except factory finished electrical and mechanical components shall be prepared in accordance with Coating System No. 2, specification section 09 97 13.00 40, top coat yellow #13538.

Items not to be painted (protect for shipping only)

Equipment name plates
Drum and sheave grooves
Flexible hose and electrical cables

2.10 SOFTWARE AND HARDWARE

**

Section 2.4 is required only if the contractor chooses to use a control PLC in the design of the hoist controls. At that time all parts of section 2.4 will become applicable.

All communication between electronic systems will be of the speed and data quality such that operations between units appear seamless. Random communication faults will not be acceptable. All software systems shall be tied together with a common clock such that when comparing reported data events within or between systems it shall be discernable to the relative timing sequence of when these events occurred relative to each other.

All hoist communication and software related wiring shall be protected against outside interference and static noise. Any loss of communication between software systems, on either primary or redundant channels, shall be detectable and reported as a system fault. It will be determined whether this loss of communication is sufficient reason to automatically shut down hoist operations or whether the hoist can continue operations. These determinations will be approved by the Contracting Officer.

Two new laptop computers with individual protective carrying cases shall be provided with this contract. Both laptops shall be loaded with identical software containing all the software development platforms used to develop custom software for these hoist systems as well as any software written specifically for these hoist systems. Two back-up copies shall also be provided on non-volatile memory such as a memory stick or card. All software licenses and software code custom written for this crane shall become the property of the Government. Any passwords, keys, locks, etc shall be given to and become property of the Government. There shall be a procedure available to allow for password changes. All interface cables needed for communications between the laptop and hoist devices shall be provided for each laptop. The laptop shall be able to connect to the PLC directly or through Ethernet.

Laptops shall be able to communicate with data systems on the hoists when directly connected to hoist interface components. When the laptop(s) is connected to devices on the hoist through direct connection, there shall be no restrictions except for password protection.

The laptop(s) shall be able to view operating software and operating logic "real-time" to the greatest extent possible. Where individual devices are monitored, such as relays, encoders, brakes, master switches, potentiometers, switches, etc the laptop displays shall show the changes of states of these devices as they occur as well as the internal ladder logic (or equal) state changes within the PES or other software devices.

The control PLC shall monitor communication health.

Lights

All enclosures and cabinets shall be provided with work lighting

Lighting in cabinets shall be on interlock switches so that the light comes on when the door to the panel is opened and goes off when the door is shut.

Miscellaneous

All electronic components and wiring shall be properly labeled to match the drawing. All lights, switches, and components on the hoist control panel shall be properly labeled to designate its purpose. All control panels shall be properly labeled to indicate what components are inside.

The hoist control panel shall have a dust cover to protect the console when not in use.

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2.11 HOIST, ELECTRICAL AND CONTROL REQUIREMENTS

The operator input has direct control of the speed. Provisions shall be provided so that the hoist control system can tolerate both actuation of an emergency stop and loss of power or the interruption of over-current protection devices without damage to components under 150 percent load. In order to mitigate software corruption due to power transients, provisions shall be made to insure that line power supplied to microprocessor based devices is conditioned to remain within the input specifications of the devices and is monitored by the control system which shall initiate a shutdown upon detection of the out-of-tolerance condition. Provide UPS for these functions with 10% spare capacity and full load run of 30 minutes.

Performance response to controls shall be instantaneous, except where time delay devices and relays are provided. Operation shall be smooth and quiet. Heat rise in motors, brakes, and transistors during maximum capacity operation shall not exceed the design limitation.

The control system shall include over-current protection, under and over-voltage protection, phase loss protection and line transient protection. The system shall be capable of detecting these conditions before they adversely affect the control system and perform a safe and normal shut-down.

Protective devices shall include a fused circuit disconnect switch for each motor controller.

Provide enclosed type circuit breaker readily accessible to the hoist operator for hoists disconnect (ability to open and shut breaker without opening the enclosure). Provide for lockout/tagout of all hazardous energy sources.

Each hoist system shall be equipped with an emergency stop function that will remove power to the entire for hoist system. This can be accomplished using a shunt trip on the main isolation breaker or a main contactor just downstream of the main isolation breaker.

On AC motors, overload relays shall be provided for each phase of the motor windings. Operation of any protective device (overload, under voltage, undercurrent, control-circuits fuses, or stopping device) shall safely stop

motions, without any adverse affects on the control circuit.

Safety devices and brakes shall be positive in action without slipping, chattering, or jamming and shall have a fail-safe design.

All hoists shall be capable of simultaneous and independent operation without degradation of control function.

The hoist controls shall not allow inadvertent initiation of a run command. All master switches or motion control devices out of center or neutral position upon power up shall prevent any hoist movement.

The hoist master switches will be used for normal operation in inching, normal and empty hook speed ranges. Pulling the master switches toward the operator will raise the load and pushing the master switch away from the operator will lower the load. Neutral position will bring the load to a controlled stop and set the brakes.

All speeds shall be maintained to within plus or minus 2 percent of commanded speed.

A standard closed-loop system consisting of an AC induction motor controlled by a flux vector drive shall be used for the hoist motors. Each motion shall have an independent drive for each motor. Selected speeds shall be constant, without any fluctuation within a (+/-) 2 percent error tolerance loaded or unloaded. On a closed loop system the control system shall provide programmable acceleration and deceleration functions. All acceleration shall be continuous with no stepping, and shall follow a linear slope. Controls shall be able to maintain (+/-) 0.005 inches movement of the load upon brake release and brake engagement. Power system harmonic performance shall be per IEEE 519.

Provide static reversing, adjustable frequency flux vector controllers for hoists electric drives. Provide dynamic braking for all electric drives. All electric drives should be sized with dynamic braking resistors capable of bringing the rated load to stop without overheating the drive.

The hoist brakes must set only after the associated controller decelerates the motor to a controlled stop.

**2.12 Sub Title

Each hoist shall be furnished with upper and lower control limit switches to prevent hook over travel in either vertical direction. These switches electrical contacts shall be normally closed contacts. These limit switches shall allow the motor to come to a normal stop and allowing the brakes to set, and shall be set to attain maximum vertical hook height at any speed and to provide safe margins for drift.

The lower limit switches shall be a geared type control circuit lower limit switch. The upper control limit switch shall be geared type control circuit upper limit switch. The control circuitry design shall ensure these limit switches stop motion in the protected direction and permit normal operation in the opposite back-out direction. These switches shall be located in accessible areas and shall reset automatically.

Each hoist shall be furnished with a second, higher power type, weight-operated upper limit switch. This switch's electrical contacts shall be a set of normally closed electrical contacts wired into the mainline

circuit, hoist power contactor control circuit such that all hoist motion shall be precluded after the limit switch is encountered. This normally closed contact may be located in the low voltage circuit.

After the upper limit switch has been activated, normal movement of the load will require action (resetting) at the upper limit switch level. A upper limit switch bypass key shall be provide that will allow the operator to bypass the second upper limit switch and travel only in the downward direction for the sole purpose of landing the load safely.

The weighted upper limit shall be adjusted sufficiently low to ensure that the hoist will not two-block (or otherwise damage wire rope) if the hoist actuates the weighted upper limit at full speed with no load. Both limits shall be tested from slow speed to full speed to verify correct operation and clearance.

The geared upper limit switch shall be positioned low enough to prevent initiation of the weighted upper limit switch when travelling into the geared limit switch at no load speed. This limit switch shall be tested for correct operation and clearance.

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PART 3 EXECUTION

3.1 GENERAL

Hoist manufacturer shall provide a qualified erection superintendent to supervise the delivery, unloading, assembly, and erection of the hoist systems to inspect and approve the installation; and to place each system into operation.

Hoist shall be assembled at the factory, properly wired, tested without load, and disassembled only as required for shipment. Each disassembled part shall be match marked for field assembly.

Hoists shall be installed and fully tested prior to using the hoists to install the elevator platforms.

Adequate and safe erection equipment and rigging shall be provided by Contractor as required to install and test the hoists.

The conduits shall not exceed 90% of NFPA 70 required fill capacity allowing 10% left for additions. A non-conductive messenger cable shall be added to each conduit run to provide future wire pulling capability.

The contractor shall not run conduit across the floor if at all possible. Any conduit ran across the floor shall be covered, protected and marked as to not create a tripping hazard.

All crimped lugs shall be ring lugs; forked lugs will not be allowed. No wire splices will be allowed. All termination shall be made at terminal blocks or on electrical devices.

All wiring will be verified upon completion for proper location and labeling. All devices shall be properly marked in accordance with the drawings. No components shall be marked as high/low.

One convenience outlet shall be located on each hoist mounting base. All receptacles shall be 120 VAC.

3.2 ERECTION SERVICES

The hoist systems shall be erected in accordance with the manufacturer's printed and approved instructions and as directed by the manufacturer's erection superintendent and in his presence.

3.3 FIELD QUALITY CONTROL

3.3.1 Post-Erection Inspection

After erection, the Contractor, the Contracting Officer, and a hoisting system manufacturer's representative, shall jointly inspect the hoist systems and components to determine compliance with specifications and approved submittals. Notify the Contracting Officer 10 days before the inspection.

3.4 TESTING

3.4.1 General

The hoist shall be tested in the shop prior to shipment and after installation. The manufacturer shall prepare detailed, step by step, test procedures, with blank space for date, Contractor/Designated NASA Representative acceptance, description of item to be tested, how it will be tested, and acceptance limits. Submit test procedures to the Designated NASA Representative for approval at least 30 days prior to testing and make additions and deletions as noted. The Designated NASA Representative shall be given a minimum of two weeks notice before the start of testing. The Contractor shall not start any Government required testing until he is prepared to conduct all such tests. The Contractor shall repeat any test, or portion of a test at the direction of the Designated NASA Representative where the Designated NASA Representative determines that a subsequent adjustment has affected a previously demonstrated capability. The Government reserves the right to require additional testing on any component or system that shows signs of deficiencies, potential failure or other anomalous performance, until determined acceptable by the Designated NASA Representative. The Contractor shall take immediate action to correct any deficiencies disclosed by test and shall rerun the test as directed by the Designated NASA Representative. The Designated NASA Representative will be given a reasonable period of time to evaluate results before notification of acceptance. The Contractor shall be the test conductor and record time and conditions for each test. A reproducible copy of the completed test, with data, shall be provided in accordance with submittal requirements.

3.4.2 Certification and Inspection Test Reports

Certification and inspection test reports for shop testing and acceptance testing shall be provided as required in paragraph of this section entitled "Certificates of Compliance".

3.4.3 Shop Assembly and Testing

Shop testing will be completed on one four hoist set of 34-ton hoists and its associated control console and one four hoist set of the 7-1/2 ton hoists and its associated control console. Shop testing of the other two four hoist sets and their control consoles will not be witnessed by the government. Testing of these hoist systems is the responsibility of the Contractor. Note full acceptance testing of all units will be completed

during a acceptance testing on site. The Contractor shall be responsible for full compliance with all contract requirements for all equipment.

The hoist and hoist control system shall be fully assembled for shop testing purposes. Assembled panels and hoist control console and four hoists shall be temporarily wired and powered with the motor drive programmed and tuned to the appropriate configuration at the Contractor's plant. Equipment shall be wired and examined visually and dimensionally for fit, quality of material, adjustment, workmanship, finish, etc.

For the purposes of the shop testing "fully assembled" shall mean that all hoist control elements shall be assembled in the shop to permit the demonstration of the full function of the control system performance requirements specified. This will include all control panels (fully assembled) and hoist operator's console (fully assembled) with all systems temporarily wired for full functional testing. Hoist shall be tested for proper operation and clearances. Each hoist shall be assembled for testing on its equipment base, without reeving.

Safety covers and guards, etc. that will be removed for shipment need not be in place. All safety covers shall be present and fit checked prior to shipment. Electrical pull box and junction box covers need not be installed when electrical connections wire numbers, etc. are exposed for inspection, troubleshooting.

The shop test shall demonstrate all control functions the hoist controls are designed to perform. Hoist speeds in both directions shall be checked and recorded. All brakes shall be checked for proper operation and clearance. Hoist brake torque shall be static tested by using a torque wrench and by using the motor drive brake testing feature. This test will show the torque required to slip the brake, as specified.

**The Contractor shall provide a means to test the hoist holding brake independently at full design torque. The brakes shall be statically tested at 150% motor torque for no movement and at 160% for slip. This method may include providing a shaft extension with a lug on the back or the new motor. Then using a torque multiplier manually apply a torque to the shaft extension using a calibrated torque wrench to measure the capacity of the brake. The Contractor shall provide the torque multiplier and all fittings necessary to perform these tests. The torque multiplier and fittings will be provided to the government. The calibrated torque wench will be provided by others.

All special tooling required to perform this test will be turned over to the government at the end of this contract. Other approved methods for brake testing can be provided.

**All bolts next to open edges shall be Ny-lock type or equal self locking.

The drives shall be tested for correct operation. They shall demonstrate the movement and coordination and communication in a tandem operation of four hoists, two individual hoists (east and west groups) and as individual hoists. For all operating speeds and operating operational scenarios. Accurate drum speed and positioning shall be measured for the simulated full range of motion.

Motor voltage and amperage shall be checked and recorded.

All limit switches will be tested individually to assure correct operation

including all limit switch by-pass functions.

Any deficiencies noted shall be corrected and re-tested prior to shipment.

3.4.4 Acceptance Test

3.4.4.1 General

Acceptance testing shall be completed on all four (4) hoist systems (a total of 16 hoists) and their control consoles completely installed and finished.

Acceptance testing shall be per the requirements of the Approved Test Procedure. The Contractors shall provide a competent on site engineer/technician to oversee and assist in the installation and acceptance testing of the hoist systems and their related control systems.

The Government will provide test weights and power for these tests. These tests will be performed after final installation. Prior to testing, the hoist systems shall be inspected for damage during shipment and installation. The hoist systems shall be tested to prove that it meets all operating requirements for which it was designed.

3.4.4.2 Acceptance Test

Acceptance test shall include, but not be limited to the following:

Test all limiting controls and safety devices such as limits switches, and reset features etc. Demonstrate the design lift of each hoist.

Test all operating controls which the hoist is required to perform and other control features which are not otherwise called out in these tests.

Perform a no load test of hoist motions to verify operation in all speed ranges, for all motions.

Load test hoist at 50 and 100 percent of rated load to verify operation in all speed ranges for all motions. Also operate in all hoist speed modes at both loads, at 50 percent and 100 percent rated speed for 10 minutes in each speed and load. Demonstrate variable speed in each speed range.

Demonstrate hoist motions at 0, 50 and 100 percent load are smooth in all speed ranges.

Test each holding brake and then demonstrate the holding capability with the torque wrench and using the motor drive feature.

Proof load test the hoist at 150 percent rated load. Lift and lower the load in normal and inching speeds approximately 6 inches and stop and hold the load for three minutes. Confirm the holding brake does not slip. Raise this load 6 ft. stop hold the load for 3 minutes lower to the floor.

Measure hook for hook throat spread before and after proof load test. Establish a throat dimension base measurement by installing two tram points and measuring the distance between these tram points (plus or minus 1/32 inch). Record this base dimension. Measure the distance

between tram points before and after load test. An increase in the throat opening from the base measurement is cause for rejection. Add hook NDE in acceptance test.

Check for motor overheating during each test. Each load test, at each speed range, shall be run consecutively without a break. If any adjustments are required during performance of the tests, test will be voided and rerun.

Demonstrate accessibility and maintainability features of the Hoist System for lubrication, brake adjustment, and general maintenance by actual field evaluation.

Test to demonstrate the ability to simultaneously operate the four hoist system at no-load. Accurately measure actual hook speeds of all four units. Verify motor drive frequency is the same to each hoist motor. Repeat when loaded at 50 percent load on one hoist and 100 percent on one hoist and two hoists unloaded. Demonstrate 4 hoist tandem operation. Move test weights to other hoist pair and repeat.

Demonstrate operation of the emergency stop control and reset features and test remote emergency stop control and reset features at all remote E-stop locations.

The test procedure shall list all recorded data and acceptance ranges. Three copies of the completed test log shall be delivered to the Designated NASA Representative not later than 48 hours after the completion of each test.

3.5 OPERATOR TRAINING

The Contractor shall provide a person(s) knowledgeable in the mechanical and electrical features, control characteristics, design function, and limitations of the hoist and various hoist control systems. This person shall be knowledgable at the engineering level of the hoist mechanical and electrical control systems. He shall be required to conduct both classroom discussion and hands-on-operation of the hoists for approximately 20 people. These people will be the engineering, operators and maintenance personnel for the hoist system once it is turned over to the Government. Also included shall be discussion covering items in the Contractor furnished operation, service, maintenance and spare parts (O&M) manuals. This classroom activity shall be conducted at the job site after acceptance tests are complete. Class shall provide 1/2 day training to engineering personnel and 1/2 day training to operation and maintenance personnel.

-- End of Section --