

**SECTION 23 05 11
COMMON WORK RESULTS FOR HVAC**

SPEC WRITER NOTES:

1. Use this section only for NCA projects.
2. Delete between // // if not applicable to project. Also delete any other item or paragraph not applicable in the section and renumber the paragraphs.
3. References to pressure in this section are gage pressure unless otherwise noted.
4. The spec writer shall review the Physical Security Design Manual for VA Facilities to determine and include any Life Safety requirements called out.

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this Section apply to all sections of Division 23.
- B. Definitions:
 1. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
- C. Abbreviations/Acronyms:
 1. ABS: Acrylonitrile Butadiene Styrene
 2. AC: Alternating Current
 3. ACR: Air Conditioning and Refrigeration
 4. AI: Analog Input
 5. AISI: American Iron and Steel Institute
 6. AO: Analog Output
 7. AWG: American Wire Gage
 8. BACnet: Building Automation and Control Network
 9. BAG: Silver-Copper-Zinc Brazing Alloy
 10. BAS: Building Automation System
 11. BCuP: Silver-Copper-Phosphorus Brazing Alloy
 12. BSG: Borosilicate Glass Pipe
 13. BTU: British Thermal Unit
 14. BTUH: British Thermal Unit Per Hour
 15. CDA: Copper Development Association
 16. C: Celsius
 17. CD: Compact Disk

18. CFM: Cubic Foot Per Minute
19. CLR: Color
20. CO: Carbon Monoxide
21. COR: Contracting Officer's Representative
22. CPVC: Chlorinated Polyvinyl Chloride
23. CRS: Corrosion Resistant Steel
24. CWP: Cold Working Pressure
25. CxA: Commissioning Agent
26. db(A): Decibels (A weighted)
27. DDC: Direct Digital Control
28. DI: Digital Input
29. DO: Digital Output
30. DVD: Digital Video Disc
31. DN: Diameter Nominal
32. DWV: Drainage, Waste and Vent
33. ECC: Engineering Control Center
34. EPDM: Ethylene Propylene Diene Monomer
35. EPT: Ethylene Propylene Terpolymer
36. ETO: Ethylene Oxide
37. F: Fahrenheit
38. FAR: Federal Acquisition Regulations
39. FD: Floor Drain
40. FED: Federal
41. FG: Fiberglass
42. FNPT: Female National Pipe Thread
43. GPM: Gallons Per Minute
44. HDPE: High Density Polyethylene
45. Hg: Mercury
46. HOA: Hands-Off-Automatic
47. hp: Horsepower
48. ID: Inside Diameter
49. in. wc: Inches of Water Column
50. IPS: Iron Pipe Size
51. Kg: Kilogram
52. kPa: Kilopascal
53. lb: Pound
54. lb/hr: Pounds Per Hour
55. L/s: Liters Per Second

- 56. L/min: Liters Per Minute
- 57. MAWP: Maximum Allowable Working Pressure
- 58. MAX: Maximum
- 59. MBH: 1000 BTUH
- 60. MBTU: 1000 BTU
- 61. MED: Medical
- 62. m: Meter
- 63. MFG: Manufacturer
- 64. mg: Milligram
- 65. mg/L: Milligrams Per Liter
- 66. ml: Milliliter
- 67. mm: Millimeter
- 68. MIN: Minimum
- 69. NC: Normally Closed
- 70. NF: Oil Free Dry (Nitrogen)
- 71. NO: Normally Open
- 72. NPTF: National Pipe Thread Female
- 73. NPS: Nominal Pipe Size
- 74. NPT: Nominal Pipe Thread
- 75. OD: Outside Diameter
- 76. OSD: Open Sight Drain
- 77. OS&Y: Outside Stem and Yoke
- 78. PLC: Programmable Logic Controllers
- 79. PP: Polypropylene
- 80. PPM: Parts Per Million
- 81. PSIA: Pounds Per Square Inch Absolute
- 82. PSIG: Pounds Per Square Inch Gage
- 83. PTFE: Polytetrafluoroethylene
- 84. PVC: Polyvinyl Chloride
- 85. PVDF: Polyvinylidene Fluoride
- 86. RAD: Radians
- 87. RO: Reverse Osmosis
- 88. RPM: Revolutions Per Minute
- 89. RTRP: Reinforced Thermosetting Resin Pipe
- 90. SCFM: Standard Cubic Feet Per Minute
- 91. SPEC: Specification
- 92. SPS: Sterile Processing Services
- 93. STD: Standard

- 94. SDR: Standard Dimension Ratio
- 95. SUS: Saybolt Universal Second
- 96. SWP: Steam Working Pressure
- 97. TAB: Testing, Adjusting, and Balancing
- 98. TDH: Total Dynamic Head
- 99. TEFC: Totally Enclosed Fan-Cooled
- 100. TFE: Tetrafluoroethylene
- 101. THERM: 100,000 BTU
- 102. THHN: Thermoplastic High-Heat Resistant Nylon Coated Wire
- 103. THWN: Thermoplastic Heat & Water Resistant Nylon Coated Wire
- 104. T/P: Temperature and Pressure
- 105. USDA: U.S. Department of Agriculture
- 106. V: Volt
- 107. VAC: Vacuum
- 108. VA: Veterans Administration
- 109. VAMC: Veterans Administration Medical Center
- 110. VAC: Voltage in Alternating Current
- 111. WOG: Water, Oil, Gas

1.2 RELATED WORK

SPEC WRITER NOTE: Retain one of two paragraphs below.

- A. //Section 01 00 01, GENERAL REQUIREMENTS (Major NCA Projects).//
- B. //Section 01 00 02, GENERAL REQUIREMENTS (Minor NCA Projects).//
- C. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- D. Section 01 42 19, REFERENCE STANDARDS.
- E. Section 01 81 13, SUSTAINABLE DESIGN REQUIREMENTS.
- F. //Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.//

SPEC WRITER NOTE: If Section 02 82 11 is included in this project the section shall be obtained from VA Masters.

- G. //Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT. //
- H. Section 05 31 00, STEEL DECKING.
- I. Section 05 36 00, COMPOSITE METAL DECKING.
- J. Section 05 50 00, METAL FABRICATIONS.
- K. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations.
- L. Section 07 84 00, FIRESTOPPING.
- M. Section 07 92 00, JOINT SEALANTS.

N. Section 09 91 00, PAINTING.

SPEC WRITER NOTE: If Section 13 05 41 is included in this project the section shall be obtained from VA Masters.

O. //Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//

P. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.

Q. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

R. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.

S. Section 23 07 11, HVAC INSULATION.

T. //Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//

U. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

V. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW).

W. Section 26 29 11, MOTOR STARTERS.

X. Section 31 20 00, EARTH MOVING: Excavation and Backfill.

1.3 APPLICABLE PUBLICATIONS

SPEC WRITER NOTE: Make material requirements agree with requirements specified in the referenced Applicable Publications. Verify and update the publication list to that which applies to the project, unless the reference applies to all mechanical systems. Publications that apply to all mechanical systems may not be specifically referenced in the body of the specification, but, shall form a part of this specification.

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

B. Air Movement and Control Association (AMCA):
410-1996.....Recommended Safety Practices for Users and
Installers of Industrial and Commercial Fans

C. American Society of Mechanical Engineers (ASME):
ASME Boiler and Pressure Vessel Code -
BPVC Section IX-2015....Welding, Brazing, and Fusing Qualifications

D. American Society for Testing and Materials (ASTM):
A36/A36M-2014.....Standard Specification for Carbon Structural
Steel

- A575-1996(2013)e1.....Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
- E. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc.:
 - SP-58-2009.....Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation
 - SP-127-2014a.....Bracing for Piping Systems: Seismic-Wind-Dynamic Design, Selection, and Application
- F. National Electrical Manufacturers Association (NEMA):
 - MG 1-2014.....Motors and Generators
- G. National Fire Protection Association (NFPA):
 - 70-2014.....National Electrical Code (NEC)

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and with requirements in the individual specification sections.
- B. Submit welder certificates.
- C. Make all necessary field measurements and investigations to ensure that the equipment and assemblies will meet contract requirements.
- D. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- E. Prior to submitting shop drawings for approval, certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls as to provide a complete and efficient installation.
- F. Coordination Drawings: Indicate the proposed locations of equipment, ductwork, piping, and materials by preparing floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations. The sheet metal drawing shall be the Base Sheet. Other drawings produced shall be coordination drawing overlays, so interferences can be detected.

Prepare coordination drawings to a scale of 1/4" = 1'-0" or larger clearly indicating the following:

1. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
 2. Clearances for installing and maintaining insulation.
 3. Clearances for installing and maintaining valves, dampers, and their actuators.
 4. Equipment connections and support details.
 5. Exterior wall and foundation penetrations.
 6. Fire-rated wall and floor penetrations.
 7. Sizes and location of required concrete pads and bases.
 8. Indicate locations where space is limited for installation and maintenance.
 9. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
 10. Indicate location of existing utilities, ducts, piping and equipment that are to remain.
 11. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.
 12. //Fire Protection drawings shall be coordinated with other trades.//
- G. Upon request by COR, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with telephone numbers and e-mail addresses.
- H. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group as to provide a completely compatible and efficient installation. Final review and approvals will be made only by groups.
- I. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
1. Belt drive with the driven equipment.
 2. Electric motor data and variable speed drive data with the driven equipment.
 3. Equipment and materials identification.
 4. Fire-stopping materials.

5. Hangers, inserts, supports, and bracing.
 6. Wall, floor, and ceiling plates.
- J. HVAC Maintenance Data and Operating Instructions: Maintenance and operating manuals in accordance with //Section 01 00 01, GENERAL REQUIREMENTS (Major NCA Projects)// //Section 01 00 02, GENERAL REQUIREMENTS (Minor NCA Projects)//, paragraph, INSTRUCTIONS, for systems and equipment.
- K. Provide copies of approved HVAC equipment submittals to the testing, adjusting, and balancing subcontractor.

1.5 QUALITY ASSURANCE

- A. Mechanical, electrical, and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products, of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in institutional HVAC construction.
- B. Contractor to ensure the flow rate tolerance for HVAC equipment is consistent with Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- C. Equipment Vibration Tolerance:
1. Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT. Equipment shall be factory-balanced to this tolerance and be re-balanced on site, as necessary.
 2. After HVAC air balance work is completed and permanent drive sheaves are in place, perform field mechanical balancing and adjustments required to meet the specified vibration tolerance.
- D. Products Criteria:
1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years. The design, model, and size of each item shall have been in satisfactory and efficient operation on at least three installations for at least three years. However, digital electronics devices, software, and systems such as controls, instruments, and computer work stations shall be the current generation of technology and basic design that has a proven

- satisfactory service record of at least three years. See other specification sections for any exceptions.
2. All items furnished shall be free from defects that would adversely affect the performance, maintainability, and appearance of individual components and overall assembly.
 3. Conform to codes and standards as required by the specifications. Conform to local codes, if required by local authorities such as the natural gas supplier, if the local codes are more stringent than those specified. Refer any conflicts to the COR.
 4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
 5. Assembled Units: Ensure manufacturers of equipment assemblies, which use components made by others, that the manufacturer will assume complete responsibility for the final assembled unit.
 6. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
 7. Do not use asbestos containing products, equipment, or materials.
- E. HVAC Equipment Service Organizations: Products and systems shall be supported by service organizations that maintain a complete inventory of repair parts and are located reasonably close to the site.
- F. HVAC Mechanical Systems Welding: Before any welding is performed, submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME BPVX Section IX.
 2. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
- G. Execution (Installation, Construction) Quality:
1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions and the contract drawings and specifications to the COR for resolution. Provide written hard copies or computer files of manufacturer's installation instructions to the COR at least two weeks prior to commencing installation of any item. Installation of

the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations is a cause for rejection of the material.

2. All items that require access, such as for operating, cleaning, servicing, maintenance, and calibration, shall be easily and safely accessible by persons standing at floor level, or standing on permanent platforms, without the use of portable ladders. Examples of these items include, but are not limited to, all types of valves, filters and strainers, transmitters, and control devices. Prior to commencing installation work, refer conflicts between this requirement and contract drawings to the COR for resolution.
3. Provide complete layout drawings required by Paragraph, SUBMITTALS. Do not commence construction work on any system until the layout drawings have been approved.

1.6 DELIVERY, STORAGE AND HANDLING

A. Protection of Equipment:

1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
2. Place damaged equipment in new operating condition; or, replace same as determined and directed by the COR. Such repair or replacement shall be at no additional cost to the Government.
3. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected as required for new work.

B. Cleanliness of Piping and Equipment Systems:

1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading, and welding of piping.
2. Piping systems shall be flushed, blown, or pigged as necessary to deliver clean systems.
3. Clean interior of all tanks prior to delivery for beneficial use by the Government.

4. Contractor is fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

- A. Provide maximum standardization of components.
- B. Ensure manufacturers of equipment assemblies, which use components made by others, that the manufacturer assumes complete responsibility for the final assembled unit.
 1. All components of an assembled unit need not be products of same manufacturer.
 2. Constituent parts that are alike shall be products of a single manufacturer.
 3. Components shall be compatible with each other and with the total assembly for intended service.
 4. Guarantee performance of assemblies of components, and repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number, and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped, or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment, which serve the same function, shall be the same make and model. Exceptions will be permitted only with the approval of the COR and if performance requirements are met.

2.2 COMPATIBILITY OF RELATED EQUIPMENT

- A. Equipment and materials installed shall be compatible with other items being furnished and with existing items so that the result will be a complete and fully operational plant that conforms to contract requirements.

2.3 BELT DRIVES

- A. Drive Types:
 1. Provide adjustable-pitch or fixed-pitch drive as follows:
 - a. Fan speeds up to 1800 RPM: 7.5 kW (10 horsepower) and smaller.
 - b. Fan speeds over 1800 RPM: 2.2 kW (3 horsepower) and smaller.
 2. Provide fixed-pitch drives for drives larger than those listed above.

3. The final fan speeds required to meet the system CFM and pressure requirements, without throttling, shall be determined by adjustment of a temporary adjustable-pitch motor sheave, or by fan law calculation if a fixed-pitch drive is used initially.

2.4 DRIVE GUARDS

- A. For machinery and equipment, provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears, and other moving parts regardless of height above the floor as to prevent damage to equipment and injury to personnel. Drive guards may be excluded where motors and drives are inside factory-fabricated air handling unit casings.
- B. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16 gage sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 6 mm (1/4 inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.

2.5 LIFTING ATTACHMENTS

- A. Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

SPEC WRITER NOTE: Verify that special motor requirements when required, such as two-speed or explosion proof, are shown on the drawings in the equipment schedules.

2.6 ELECTRIC MOTORS

- A. All material and equipment furnished and installation methods shall conform to the requirements of Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC EQUIPMENT; Section 26 29 11, MOTOR STARTERS; and, Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW). Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection, and operation of the systems. Provide special energy efficient motors as scheduled. Unless otherwise specified for a particular application, use electric motors with the following requirements.

- B. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal fans and pumps may be permanent split capacitor (PSC).
- C. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type.
- D. Electronically Commutated Motors: Brushless DC motors. Provide with equipment where indicated on drawings. //Provide with 6 mH inductor on line side of motor.//
- E. Rating: Continuous duty at 100 percent capacity in an ambient temperature of 40 degrees C (104 degrees F) and sea level; minimum horsepower as shown on drawings; when operating maximum horsepower, not to exceed nameplate rating without service factor.
- F. Special Requirements:
1. Where motor power requirements of equipment furnished deviate from power shown on plans, provide electrical service designed under the requirements of NFPA 70 without additional time or cost to the Government.
 2. Assemblies of motors, starters, controls, and interlocks on factory assembled and wired devices shall be in accordance with the requirements of this specification.
 3. Wire and cable materials specified in the electrical division of the specifications shall be modified as follows:
 - a. Provide shielded conductors or wiring in separate conduits for all instrumentation and control systems where recommended by manufacturer of equipment.
 4. Select motor sizes so that the motors do not operate into the service factor, at maximum required loads, on the driven equipment. Motors on pumps and fans shall be sized for non-overloading at all points on the pump and fan performance curves.
 5. Motors utilized with variable frequency drives shall be rated "inverter-ready" per NEMA MG 1. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.
- G. Motor Efficiency and Power Factor: All motors, when specified as "high efficiency" by the project specifications on driven equipment, shall conform to efficiency and power factor requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC EQUIPMENT, with no consideration of annual service hours. Motor manufacturers generally define these efficiency requirements as "NEMA premium efficient" and

the requirements generally exceed those of the Energy Policy Act of 1992 (EPACT). Motors not specified as "high efficiency" shall comply with EPACT.

- H. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.

2.7 VARIABLE SPEED MOTOR CONTROLLERS

- A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 26 29 11, MOTOR STARTERS for specifications.
- B. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, such as pumps and fans, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. air handlers, fans, pumps, shall be the products of a single manufacturer.
- C. Motors shall be energy efficient type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor/fan sheaves shall be fixed pitch.
- D. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, etc., nor shall be affected from other devices on the AC power system.

2.8 EQUIPMENT AND MATERIALS IDENTIFICATION

SPEC WRITER NOTE: Retain one of the two following paragraphs.

- A. //Use symbols, nomenclature, and equipment numbers specified, shown on the drawings, and shown in the maintenance manuals. Identification for piping is specified in Section 09 91 00, PAINTING.//
- B. //Use symbols, nomenclature, and equipment numbers specified, shown on the drawings, and shown in the maintenance manuals. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section 09 91 00, PAINTING.//
- C. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 4.8 mm (1-7/8 inches) high of brass with black-filled letters, or rigid black plastic with white letters as specified in Section 09 91 00, PAINTING permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.

- D. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 4.8 mm (1-7/8 inches) high, riveted or bolted to the equipment.
- E. Control Items: Label all temperature and humidity sensors, controllers, and control dampers. Identify and label each item as they appear on the control diagrams.
- F. Valve Tags and Lists:
 - 1. Valve tags: Engraved black-filled numbers and letters not less than 15 mm (1/2 inch) high for number designation, and not less than 6 mm (1/4 inch) for service designation on 19 gage 40 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
 - 2. Valve lists: Typed or printed plastic coated card(s), sized 215 mm (8-1/2 inches) by 275 mm (11 inches) showing tag number, valve function, and area of control for each service or system. Punch sheets for a 3-ring notebook.

2.9 FIRESTOPPING

- A. Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke, and gases where penetrations occur for piping and ductwork. Refer to Section 23 07 11, HVAC INSULATION, for firestop pipe and duct insulation.

2.10 GALVANIZED REPAIR COMPOUND

- A. Green Seal Standard GC-03, paint form.

2.11 HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

- A. Vibration Isolators: Refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- B. Supports for Roof Mounted Items:
 - 1. Equipment: Equipment rails shall be galvanized steel, minimum 1.3 mm (18 gage), with integral baseplate, continuous welded corner seams, factory installed 50 mm by 100 mm (2 inch by 4 inch) treated wood nailer, 1.3 mm (18 gage) galvanized steel counter flashing cap with screws, built-in cant strip (except for gypsum or tectum deck), with minimum height 275 mm (11 inches). For surface insulated roof deck, provide raised cant strip starting at the upper surface of the insulation.
 - 2. Pipe/duct pedestals: Provide a galvanized Unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.

- C. Pipe Supports: Comply with MSS SP-58. Type numbers specified refer to this standard. For selection and application, comply with MSS SP-58. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting requirements.
- D. Attachment to Concrete Building Construction:
1. Concrete insert: MSS SP-58, Type 18.
 2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 100 mm (4 inches) thick, when approved by the COR for each job condition.
 3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 100 mm (4 inches) thick, when approved by the COR for each job condition.
- E. Attachment to Steel Building Construction:
1. Welded attachment: MSS SP-58, Type 22.
 2. Beam clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23 mm (7/8 inch) outside diameter.
- F. Attachment to Metal Pan or Deck: As required for materials specified in //Section 05 31 00, STEEL DECKING// //Section 05 36 00, COMPOSITE METAL DECKING//.
- G. Attachment to Wood Construction: Wood screws or lag bolts.
- H. Hanger Rods: Hot-rolled steel, ASTM A36/36M or ASTM A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 40 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- I. Hangers Supporting Multiple Pipes (Trapeze Hangers): Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (12 gage), designed to accept special spring held, hardened steel nuts.
1. Allowable hanger load: Manufacturers rating less 91 kg (200 pounds).
 2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4 inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 15 mm (1/2 inch) galvanized steel bands, or pre-insulated calcium silicate shield for insulated piping at each hanger.
- J. Supports for Piping Systems: Select hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC

INSULATION, for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or pre-insulated calcium silicate shields. Provide Type 40 insulation shield or pre-insulated calcium silicate shield at all other types of supports and hangers, including those for pre-insulated piping.

- K. //Seismic Restraint of Piping and Ductwork: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS. Comply with MSS SP-127.//

2.12 PIPE PENETRATIONS

- A. Install sleeves during construction.
- B. Penetrations are prohibited through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements shall be made only after receipt of prior approval from the COR.
- C. Sheet Metal, Plastic, or Moisture Resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- D. Cast Iron or Zinc-Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.
- E. Galvanized Steel or an Alternate Black Iron Pipe with Asphalt Coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for.
- F. Brass Pipe Sleeves: Provide for pipe passing through quarry tile, terrazzo, or ceramic tile floors. Connect sleeve with floor plate.
- G. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- H. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.
- I. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

2.13 SPECIAL TOOLS AND LUBRICANTS

- A. Furnish, and turn over to the COR, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.

2.14 WALL, FLOOR AND CEILING PLATES

- A. Material and Type: Chrome-plated brass or chrome-plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe or sleeve. Use plates that fit tight around pipes, cover openings around pipes, and cover the entire pipe sleeve projection.
- B. Thickness: Not less than 2.4 mm (3/32 inch) for floor plates. For wall and ceiling plates, not less than 0.64 mm (0.025 inch) for up to 75 mm (3 inch) pipe, 0.89 mm (0.035 inch) for larger pipe.
- C. Locations: Use where pipe penetrates floors, walls, and ceilings in exposed locations, in finished areas only. Use also where insulation ends on exposed water supply pipe drop from overhead. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

2.15 ASBESTOS

- A. Materials containing asbestos are prohibited.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.

3.2 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- A. Coordinate location of piping, sleeves, inserts, hangers, ductwork, and equipment. Locate piping, sleeves, inserts, hangers, ductwork, and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Prepare equipment layout drawings to coordinate proper location and personnel access to all facilities. Submit the drawings for review as required by Part 1. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access, without use of portable ladders, for maintenance and operation of all devices including, but not limited to, all equipment items, valves, filters, strainers, transmitters, sensors, and control devices.

All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the drawings.

- C. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- D. Location of pipe sleeves, trenches, and chases shall be accurately coordinated with equipment and piping locations.
- E. Cutting Holes:
 - 1. Cut holes through concrete and masonry by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill is prohibited, except as permitted by the COR where working area space is limited.
 - 2. Locate holes to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by COR. If the Contractor considers it necessary to drill through structural members, refer to the COR for approval.
 - 3. Do not penetrate membrane waterproofing.
- F. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but shall be provided.
- G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but shall be provided.
- H. Electrical Interconnection of Controls and Instruments: Generally, not shown but shall be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments, and computer workstations. Comply with NFPA 70.
- I. Protection and Cleaning:
 - 1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations, and as approved by the COR. Damaged or defective items, in the opinion of the COR, shall be replaced.
 - 2. Protect all finished parts of equipment, such as shafts and bearings, where accessible, from rust prior to operation by means of

- protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical, or mechanical injury. At completion of all work, thoroughly clean fixtures, exposed materials, and equipment.
- J. Concrete and Grout: Use concrete and shrink compensating grout 21 MPa (3000 psig) minimum.
- K. Install gages, thermometers, valves, and other devices with due regard for ease in reading or operating and maintaining devices. Locate and position thermometers and gages to be easily read by operator or staff standing on floor or on walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- L. Work in Existing Building:
1. Perform as specified in paragraphs, OPERATIONS AND STORAGE AREAS, ALTERATIONS, and RESTORATION of //Section 01 00 01, GENERAL REQUIREMENTS (Major NCA Projects)// //Section 01 00 02, GENERAL REQUIREMENTS (Minor NCA Projects)// for relocation of existing equipment, alterations and restoration of existing building(s).
 2. As specified in paragraph, OPERATIONS AND STORAGE AREAS of //Section 01 00 01, GENERAL REQUIREMENTS (Major NCA Projects)// //Section 01 00 02, GENERAL REQUIREMENTS (Minor NCA Projects)//, make alterations to existing service piping at times that will least interfere with normal operation of the facility.
 3. Cut required openings through existing masonry and reinforced concrete using diamond core drills. Use of pneumatic hammer type drills, impact type electric drills, and hand or manual hammer type drills will be permitted only with approval of the COR. Locate openings that will least effect structural slabs, columns, ribs, or beams. Refer to the COR for determination of proper design for openings through structural sections and for opening layouts approval prior to cutting or drilling into structures. After COR's approval, carefully cut opening through construction no larger than necessary for the required installation.
- M. Switchgear Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints.

N. Inaccessible Equipment:

1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the Government.
2. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

3.3 TEMPORARY PIPING AND EQUIPMENT

- A. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.
- B. Provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress, and shall be insulated where injury can occur to personnel by contact with operating facilities. The requirements of paragraph, ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING apply.

3.4 RIGGING

- A. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Government if allowed under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.
- B. Close all openings in the building when not required for rigging operations, to maintain proper environment in the facility for Government operation, and maintenance of service.
- C. Provide all facilities required to deliver specified equipment, and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's responsibility. Upon request, the Government will check structure adequacy and advise Contractor of recommended restrictions.
- D. Check all clearances, weight limitations, and provide a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement, shall be at Contractor's cost, time, and responsibility.
- E. Rigging plan and methods shall be referred to COR for evaluation prior to actual work.
- F. Restore building to original condition upon completion of rigging work.

SPEC WRITER NOTE: Review the following paragraph with the project structural engineer and confirm that the structural system is adequate for piping and equipment support.

3.5 PIPE AND EQUIPMENT SUPPORTS

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the COR.
- B. Use of chain, wire, or strap hangers; wood for blocking, stays, and bracing; or, hangers suspended from piping above is prohibited. Replace or thoroughly clean rusty products and paint with zinc primer.
- C. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 15 mm (1/2 inch) clearance between pipe or piping covering and adjacent work.
- D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP-58. Provide additional supports at valves, strainers, in-line pumps, and other heavy components. Provide a support within one foot of each elbow.
- E. Overhead Supports:
 - 1. The basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
 - 2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
- F. Floor Supports:
 - 1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Anchor and dowel concrete bases and structural systems to resist forces under operating and seismic conditions without excessive displacement or structural failure.
 - 2. Do not locate or install bases and supports until equipment mounted thereon has been approved. Size bases to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Refer to structural drawings. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.

3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.
4. //For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.//

3.6 MECHANICAL DEMOLITION

- A. //Rigging access, other than indicated on the drawings, shall be provided by the Contractor after approval for structural integrity by the COR. Such access shall be provided without additional cost or time to the Government. Where work is in an occupied building or an operating plant, provide approved protection from dust and debris at all times for the safety of personnel, maintenance of operation, and environment of the facility.//
- B. In an occupied building, maintain the operation, cleanliness, and safety. Government personnel will be carrying on their normal duties or normal duties of operating, cleaning, maintaining equipment, and building operation. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Allowing debris to accumulate in the area to the detriment of operations is prohibited. Perform all flame cutting to maintain the fire safety integrity of the building and occupants. Adequate fire extinguishing facilities shall be available at all times. Perform all work in accordance with recognized fire protection standards. Inspection will be made by personnel of the VA //Cemetery//, and Contractor shall follow all directives of the COR with regard to rigging, safety, fire safety, and maintenance of operations.
- C. Completely remove all piping, wiring, conduit, and other devices associated with the equipment not to be re-used in the new work. This includes all pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment, pipes, ducts, and other penetrations in roof, walls, and floors in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the drawings and specifications of the other disciplines in the project for additional facilities to be demolished or handled.

- D. All valves including gate, globe, ball, butterfly, and check, and all pressure gages and thermometers with wells shall remain Government property and shall be removed, delivered to COR, and stored as directed. Remove all other material and equipment, devices, and demolition debris under these plans and specifications. Such material shall be removed from Government property expeditiously and is prohibited to accumulate.

SPEC WRITER NOTE: Delete the following paragraph if there is no asbestos removal.

- E. //Asbestos Insulation Removal: Conform to Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.//

3.7 CLEANING AND PAINTING

- A. Prior to final inspection and acceptance of the equipment rooms and facilities for beneficial use by the Government, the facilities, equipment, and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING. Use cleaning materials and methods recommended by the manufacturers for the specific tasks. Remove all rust prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.
- B. In addition, the following special conditions apply:
1. Material and Equipment Not to Be Painted Includes:
 - a. Motors, controllers, control switches, and safety switches.
 - b. Control and interlock devices.
 - c. Regulators.
 - d. Pressure reducing valves.
 - e. Control valves and thermostatic elements.
 - f. Lubrication devices and grease fittings.
 - g. Copper, brass, aluminum, stainless steel, and bronze surfaces.
 - h. Valve stems and rotating shafts.
 - i. Pressure gages and thermometers.
 - j. Glass.
 - k. Name plates.
 2. Control and instrument panels shall be cleaned, damaged surfaces repaired, and touched-up with matching paint obtained from panel manufacturer.

3. Pumps, fans, motors, steel and cast iron bases, and coupling guards shall be cleaned, and touched-up with the same color as utilized by the pump and fan manufacturer
4. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary.

3.8 IDENTIFICATION SIGNS

- A. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, and performance.
- B. Pipe Identification: Refer to Section 09 91 00, PAINTING.

3.9 MOTOR AND DRIVE ALIGNMENT

- A. Belt Drive: Set driving and driven shafts parallel, and align so that the corresponding grooves are in the same plane.
- B. Direct-connect Drive: Securely mount motor in accurate alignment so that shafts are free from both angular and parallel misalignments when both motor and driven machine are operating at normal temperatures.

3.10 LUBRICATION

- A. Lubricate all devices requiring lubrication prior to initial operation, and field-check all devices for proper lubrication.
- B. Equip all devices with required lubrication fittings or devices.
- C. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

3.11 STARTUP AND TEMPORARY OPERATION

- A. Startup equipment per manufacturer's instructions. Verify that vibration is within specified tolerance prior to extended operation. Temporary use of equipment is specified in //Section 01 00 01, GENERAL REQUIREMENTS (Major NCA Projects)// //Section 01 00 02, GENERAL REQUIREMENTS (Minor NCA Projects)//, paragraph, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

3.12 OPERATING AND PERFORMANCE TESTS

- A. Prior to the final inspection, perform required tests as specified in //Section 01 00 01, GENERAL REQUIREMENTS (Major NCA Projects)// //Section 01 00 02, GENERAL REQUIREMENTS (Minor NCA Projects)//, paragraph, TESTS, and submit the test reports and records to the COR.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of

tests, make proper corrections, repairs, or replacements and repeat tests at no additional cost to the Government.

- C. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then make performance tests for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work.

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