

**SECTION 22 13 23**  
**SANITARY WASTE INTERCEPTORS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Sanitary waste interceptors.

**1.2 RELATED WORK**

Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Sand Interceptor.
  - 2. Oil Interceptor.

**1.4 APPLICABLE PUBLICATIONS**

- 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. International Plumbing Code - 2009
- C. American Society for Testing and Materials (ASTM):
  - C913-08.....Standard Specification for Precast Concrete Water and Wastewater Structures
  - C890-06.....Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
  - C923-08.....Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

**PART 2 - PRODUCTS**

**2.2 OIL INTERCEPTOR**

- A. Oil Interceptor: Precast concrete comply with ASTM C 913.
  - 1. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain oil and to permit wastewater flow.
  - 2. Heavy-Traffic Load: Comply with ASTM C 890 load.
  - 3. Resilient Pipe Connectors: ASTM C 923, cast or fitted into interceptor walls, for each pipe connection.

4. Individual steps wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 300- to 400-mm (12- to 16-inch) intervals. Omit steps if total depth from floor of interceptor to finished grade is less than 1500 mm (60 inches).
5. Grade Rings: Reinforced-concrete rings, 150- to 225-mm (6- to 9-inch) total thickness, to match diameter of manhole frame and cover.
6. Manhole Frames and Covers: Ferrous; 610-mm (24-inch) ID by 175- to 225-mm (7- to 9-inch) riser with 100-mm (4-inch) minimum width flange and 660-mm (26-inch) diameter cover.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. General: Comply with the International Plumbing Code.

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SECTION 22 33 00  
ELECTRIC DOMESTIC WATER HEATERS

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Domestic electric water heater system complete, ready for operation including: water heater and accessories, connections and equipment.

**1.2 RELATED WORK**

- A. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING
- B. Circulating Pump: Section 22 11 23, DOMESTIC WATER PUMPS
- C. Insulation: Section 23 07 11, HVAC AND PLUMBING INSULATION.
- D. Piping, Fittings, Valves and Gages: Section 22 05 19, METERS AND GAGES FOR PLUMBING PIPING, 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING, and 22 11 00, FACILITY WATER DISTRIBUTION.

**1.3 QUALITY ASSURANCE**

- A. Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) for efficiency performance:
  - 1. ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, Performance Requirements for Water Heating Equipment.

**1.4 SUBMITTALS**

- A. Submit manufacturer's literature and data pertaining to the water heater in a properly bound package, in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Include the following as a minimum:
  - 1. Water Heater.
  - 2. Pressure and Temperature Relief Valve.
  - 3. Thermometer
  - 4. Pressure Gage
  - 5. Vacuum Breaker

**1.5 APPLICABLE PUBLICATIONS**

- 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. American National Standard Institute (ANSI):
  - Z21.22B-2001.....Relief Valves for Hot Water Supply systems
- C. American Society of Mechanical Engineers (ASME):
  - B1.20.1-83(R 2006).....Pipe Threads, General Purpose (Inch)
  - B16.5-03.....Pipe Flanges and Flanged Fittings

B16.24-2006.....Cast Copper Alloy Pipe Flanges and Flanged  
Fittings: Classes 150, 300, 600, 900, 1500 and  
2500

PTC 25-2008.....Pressure Relief Devices

Section VIII-07.....Rules for Construction of Pressure Vessels  
Division 1

D. National Fire Protection Association (NFPA)

70-08.....National Electrical Code

E. Underwriters Laboratories, Inc. (UL):

174.....Household Electric Storage Tank Water Heaters

## **PART 2 - PRODUCTS**

### **2.1 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS**

A. Thermostat-Control, Electric, Tankless, Domestic-Water Heaters:

1. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.
2. Construction: Copper piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
  - a. Connections: ASME B1.20.1 pipe thread.
  - b. Pressure Rating: 150 psig (1035 kPa).
  - c. Heating Element: Resistance heating system.
  - d. Temperature Control: Thermostat.
  - e. Safety Control: High-temperature-limit cutoff device or system.
  - f. Jacket: Aluminum or steel with enameled finish or plastic.
3. Support: Bracket for wall mounting.
4. Capacity and Characteristics:
  - a. Flow Rate: See schedule on drawings..
  - b. Temperature Setting: 125 deg F (52 deg C).
  - c. Power Demand: See schedule on drawings

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Refer to Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING
- B. Install water heaters level and plumb.
- C. Install and connect water heaters in accordance with manufacturer's written instructions.

### **3.2 PERFORMANCE TEST**

- A. Ensure that all water outlets have minimum 48.8 degrees C (120 degrees F) and maximum of 54.4 degrees C (130 degrees F) water at all times. If necessary, make correction to balance the return water system or reset the thermostat to make the system comply with design requirements.

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**SECTION 22 40 00  
PLUMBING FIXTURES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Plumbing fixtures, associated trim and fittings necessary to make a complete installation from wall or floor connections to rough piping, and certain accessories.

**1.2 RELATED WORK**

- A. Sealing between fixtures and other finish surfaces: Section 07 92 00, JOINT SEALANTS.
- B. Flush panel access doors: Section 08 31 13, ACCESS DOORS AND FRAMES.
- C. Through bolts: Section 10 21 13, TOILET COMPARTMENTS.
- D. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submit plumbing fixture information in an assembled brochure, showing cuts and full detailed description of each fixture.
- C. Submit Operation and Training Manuals including dates of required maintenance in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

**1.4 APPLICABLE PUBLICATIONS**

- 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. The American Society of Mechanical Engineers (ASME):
  - A112.6.1M-08 .....Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
  - A112.18.1-05 .....Faucets
  - A112.18.3-02 .....Backflow Protection Devices for Faucets with Side Spray
  - A112.19.1-08 .....Enameled Cast Iron Plumbing fixtures
  - A112.19.2-08 .....Standard for Vitreous China Plumbing Fixtures and Hydraulic Requirements for Water Closets and Urinals
  - A112.19.5-05 .....Trim for Water-Closet Bowls, Tanks and Urinals
  - A112.19.3-08 .....Stainless Steel Plumbing fixtures (Designed for Residential Use)

- C. American Society for Testing and Materials (ASTM):  
A276-2008a .....Standard Specification for Stainless Steel Bars  
and Shapes
- D. National Association of Architectural Metal Manufacturers (NAAMM): NAAMM  
AMP 500-06  
Metal Finishes Manual (2006)
- E. American Society of Sanitary Engineers (ASSE):  
1001-08 .....Integral, Atmospheric Vacuum Breakers  
1011-04 .....Hose-Connection Vacuum Breakers  
1019-04 .....Vacuum Breaker Wall Hydrants, Freeze Resistant,  
Automatic Draining Type  
1037-90 .....Performance Requirements for Pressurized  
Flushing Devices (Flushometer) for Plumbing  
FixturesF. National Sanitation Foundation  
(NSF)/American National Standards Institute  
(ANSI):  
61-08 .....Drinking Water System Components-Health Effects
- F. American with Disabilities Act (A.D.A) Section 4-19.4 Exposed Pipes and  
Surfaces
- G. Air Conditioning, Heating and Refrigeration Institute (AHRI)  
1010-02 Self-Contained, Mechanically Refrigerated  
Drinking Water Coolers
- H. American Society of Sanitation Engineers (ASSE)  
1002-08 .....Performance Requirements for Anti-Siphon Fill  
Valves for Water Closet Tanks  
1014-05 .....Performance Requirements for Backflow Prevention  
Devices for Hand-Held Showers
- I. Underwriters Laboratory (UL)  
1951-03 .....Sensor Operated Flushometers

## PART 2 - PRODUCTS

### 2.1 STOPS

- A. Provide lock-shield loose key or screw driver pattern angle stops,  
straight stops or stops integral with faucet, with each compression type  
faucet whether specifically called for or not, including sinks in wood  
and metal casework ASME A112.18.1M. Locate stops centrally below fixture  
in an accessible location.
- B. Furnish keys for lock shield stops to Contracting Officers Technical  
Representative (COTR).

## 2.2 ESCUTCHEONS

- A. Heavy type, chrome plated, with set screws. Provide for piping serving plumbing fixtures and at each wall, ceiling and floor penetrations in exposed finished locations and within cabinets and millwork.

## 2.3 LAMINAR FLOW CONTROL DEVICE

- A. Smooth, bright stainless steel or satin finish, chrome plated metal laminar flow device shall provide non-aeration, clear, coherent laminar flow that will not splash in basin. Device shall also have a flow control restrictor and have vandal resistant housing.
- B. Flow Control Restrictor:
  - 1. Capable of restricting flow to 32 mL/s (0.5 gpm) for lavatories; 140 mL/s (1.75 gpm) for sinks; and 155 mL/s (2.5 gpm) for food preparation and rinse sinks.
  - 2. Compensates for pressure fluctuation maintaining flow rate specified above within 10 percent between 170 and 550 kPa (25 and 80 psi).
  - 3. Operates by expansion and contraction, eliminates mineral/sediment build-up with self-clearing action, and is capable of easy manual cleaning.

## 2.4 CARRIERS

- A. Water Closet, ASME A112.6.1M, with adjustable gasket faceplate chair carriers for wall hung closets with auxiliary anchor foot assembly, hanger rod support feet, and rear anchor tie down.
- B. Lavatory, ASME A112.6.1M, carrier for thin wall construction .
- C. Where water closets, lavatories or sinks are installed back-to-back and carriers are specified, provide one carrier to serve both fixtures in lieu of individual carriers. The drainage fitting of the back to back carrier shall be so constructed that it prevents the discharge from one fixture from flowing into the opposite fixture.

## 2.5 SEATS

- A. Water Closet Seat Type 1

Extra heavy duty, chemical resistant, solid plastic, open front less cover for elongated bowls, integrally molded bumpers, concealed check hinge with stainless steel posts. Seat shall be posture contoured body design. Color shall be white.

## 2.6 FLUSH VALVES

- B. Flush Valve Type 1 (Water Closet)

- 1. Flushometer valve, high efficiency, automatic infra-red sensor, hardwired, 4.8 Lpf (1.28 gpf) with maximum 10 percent variance, chloramines resistant exposed fixed volume piston-type flush valve,

38 mm (1-1/2 inch) top spud, 6 VDC hardwired power converter, motorized actuator with over-ride, impact resistant housing, chrome plated metal cover with manual courtesy over-ride button, chrome plated spud coupling, chrome plated cast wall flange with set screw, sweat solder adapter with chrome plated cover tube, chrome plated back check angle stop, vandal resistant stop cap, high back pressure vacuum breaker, ASSE 1037, UL 1951, ANSI/ASME 112.19.6.

2. Provide concealed/accessible 9VDC control transformer capable of supplying up to six sensor valves or fixtures.

E. Flush Valve Type 2 (Urinal)

1. Flushometer valve, ultra high efficiency, automatic infra-red sensor, hardwired, 0.5 Lpf (1/8 gpf) with maximum 10 percent variance, chloramines resistant exposed flush valve, 19 mm (3/4 inch) top spud, 6VDC battery powered exposed motor actuator, adjustable depth sensor, impact resistant housing, chrome plated metal cover with manual courtesy over-ride button, Low Battery indicator light, chrome plated spud coupling, chrome plated cast wall flange with set screw, sweat solder adapter with chrome plated cover tube, chrome plated back check angle stop, vandal resistant stop cap, high back pressure vacuum breaker, ASSE 1037, UL 1951, ANSI/ASME 112.19.6. Provide concealed/accessible 6VDC control transformer capable of supplying up to six sensor valves or fixtures.

## 2.7 WATER CLOSETS

- D. (P-1) Water Closet (handicap accessible, wall mount, high efficiency flushometer valve, 4.8 L (1.28 gallons) per flush, back outlet, top spud, white vitreous china, elongated high efficient siphon action jetted bowl, 50 mm (2 inch) fully glazed trapway, fully glazed exterior concealed trapway, ASME A112.19.2M). Top of water closet shall be 432 to 482 mm (17 inch to 19 inch) above finished floor measured to the top of the toilet seat.

1. Seat: Water Closet Seat Type 1
2. Water Closet Carrier: Adjustable horizontal drain.
3. Flush valve: Flush Valve Type 1, Sensor, Hard Wired/. Flush valve handle shall be located on the wide side of toilet stall.

## 2.8 URINALS

- B. (P-7) Urinal, handicap accessible, Ultra high efficient, 0.5 L (1/8 gallon) per flush, washout flushing action, 19 mm (3/4 inch) top spud, wall mount, 50 mm (2 inch) IPS back outlet flange, integral trap, white vitreous china, pressure compensating internal flow regulator, 355 mm



(14 inch) extended rim, stainless steel vandal resistant outlet strainer, ASME A112.19.2M. Top of urinal flood rim shall be a maximum of 432 mm (17 inch) above finished. Flush handle shall be located on the wide side of toilet stall.

1. Urinal Carrier: Adjustable /horizontal drain.
2. Flush valve: Flush Valve Type 2, Sensor, Hard Wired.

## 2.9 FAUCETS

### A. Faucet Type 1

1. Lavatory Faucet: deck mount, hardwired electronic proximity infrared sensor, dual beam chrome plated solid cast brass construction, vandal resistant, 101 mm (4 inch) centers, 127 mm (5 inch) spout, concealed internal temperature control mixer, 1.9 Lpm F. Faucet Type 2
1. Sink Faucet: deck mount, Double Lever Handle Control with side hand spray, 254 mm (10 inch) spout, chrome plated solid cast brass construction, vandal resistant, heavy-duty single lever handle, center set. Control shall be washerless ceramic disc cartridge type. Provide laminar flow control device, adjustable hot water limit stop, and vandal proof screws, 6.6 Lpm (1.75 gpm) maximum flow, NSF 61, ANSI A112.18.1M.

### G. Faucet Type 3

1. Service Sink Faucet, solid brass construction, combination faucet with replaceable monel seat, removable replacement unit containing all parts subject to wear, integral stops, mounted on wall above sink. Spout shall have a pail hook, 20 mm (3/4-inch) hose coupling threads, vacuum breaker, and top or bottom brace to wall. Four-arm handles on faucets shall be cast, formed, or drop forged copper alloy. Escutcheons shall be either forged copper alloy or CRS. Exposed metal parts, including exposed part under valve handle when in open position, shall have a smooth bright finish.

## 2.10 LAVATORIES

- A. Dimensions for lavatories are specified, Length by width (distance from wall) and depth.
- B. Brass components in contact with water shall contain no more than 3 percent lead content by dry weight.
- D. (P-2) Lavatory handicap accessible, wall mount, 500 by 450 mm (20 by 18 inch) vitreous china, deck mounted faucet, integral 4" backsplash, front overflow, concealed arm carrier system, ASME A112.19.2. Set with flood rim 864 mm (34 inches) above finished floor.
1. Faucet: Electronic Infrared Sensor Lavatory Faucet Type 1/.

2. Drain: Cast or wrought brass with flat grid strainer and offset tailpiece, chrome plated. Provide handicap compliant waste pipe cover in accordance with A.D.A 4-19.4.
3. Stops: Angle type, see paragraph 2.1 Stops. Provide handicap compliant supply riser cover in accordance with A.D.A 4-19.4.
4. Trap: Cast copper alloy, 40 by 32 mm (1-1/2 by 1-1/4 inch) P-trap. Adjustable with connected elbow and 1.4 mm thick (17 gauge) tubing extensions to wall. Exposed metal trap surface and connection hardware shall be chrome plated with a smooth bright finish. Set trap parallel to wall. Provide handicap compliant waste pipe cover in accordance with A.D.A 4-19.4.

## 2.10 SINKS

- A. Dimensions for sinks and laundry tubs are specified, length by width (distance from wall) and depth.
- B. (P-4) Sink handicap accessible, single compartment, counter mount, self rimming with minimum 32 mm (1.25 inch) faucet ledge, seamless Type 304 stainless steel, 482 mm (19 inch) x 533 mm (21 inch) x 203 mm (8 inch) deep, vertical and horizontal radius basin corners, fully undercoated for sound deadening, basin drain center in the rear of the bowl for handicap compliance, ASME A112.19.3M.
  1. Faucet: /Two Lever Lavatory/Sink Faucet Gooseneck Type 5
  2. Drain: Cast or wrought brass with flat grid strainer and offset tailpiece, chrome plated. Provide handicap compliant waste pipe cover in accordance with A.D.A 4-19.4.
  3. Stops: Angle type, see paragraph 2.1 Stops. Provide handicap compliant supply riser cover in accordance with A.D.A 4-19.4.
  4. Trap: Cast copper alloy, 40 by 32 mm (1-1/2 by 1-1/4 inch) P-trap. Adjustable with connected elbow and 1.4 mm thick (17 gauge) tubing extensions to wall. Exposed metal trap surface and connection hardware shall be chrome plated with a smooth bright finish. Set trap parallel to wall. Provide handicap compliant waste pipe cover in accordance with A.D.A 4-19.4.
- C. (P-8) Sink handicap accessible counter mount, self rimming with minimum 32 mm (1.25 inch) faucet ledge, seamless Type 304 stainless steel, 838 mm (33 inch) x 533 mm (21 inch) x 203 mm (8 inch) deep, equal sized basins, vertical and horizontal radius basin corners, fully undercoated for sound deadening, basin drains center in the rear of each bowl for handicap compliance, ASME A112.19.3M.
  1. Faucet: Double Lever Handle Sink Faucet Type 3.

2. Drain: Forged stainless steel basket strainer assembly, and chrome plated copper tailpiece, continuous drain and tee with wall connection and escutcheon. Provide handicap compliant waste pipe cover in accordance with A.D.A 4-19.4.
  3. Stops: Angle type, see paragraph 2.1 Stops. Provide handicap compliant supply riser cover in accordance with A.D.A 4-19.4.
  4. Trap: Cast copper alloy, 40 by 32 mm (1-1/2 by 1-1/4 inch) P-trap with cleanout plug. Adjustable with connected elbow and 1.4 mm thick (17 gauge) tubing extensions to wall. Exposed metal trap surface and connection hardware shall be chrome plated with a smooth bright finish. Set trap parallel to wall. Provide handicap compliant waste pipe cover in accordance with A.D.A 4-19.4.
- F. (P-405) Service Sink (Floor Mounted) stain resistant terrazzo, 609 by 609 mm by 305 mm (24 by 24 by 12 inches) with 152 mm (six-inch) drop front. Terrazzo, composed of marble chips and white Portland cement, shall develop compressive strength of 20 684 kPa (3000 psi) seven days after casting. Provide stainless steel edge guards on front side fixture.
1. Faucet: Service Sink Faucet Type 3.
  2. Drain: 88 mm (3-inch) cast brass drain with nickel bronze strainer.
  3. Trap: P-trap, drain through floor.

#### **2.11 DISPENSER, DRINKING WATER**

- A. Standard rating conditions: 10 degrees C (50 degrees F) leaving water temperature with 18 degrees C (65 degrees F) inlet water temperature and 32 degrees C (90 degrees F) ambient air temperature.
- B. (P-6) Electric Water Cooler, Two Station, Bi-Level water cooler, self contained electric refrigeration with stainless steel basin and cabinet, anti-splash ridge, integral drain strainer, non-squirt bubbler, push bar activation on front and sides of each station, single refrigeration system serving both stations including a high efficient compressor, R-134A, fully insulated stainless steel tank. System shall be capable of providing 30 L (8 gallons) per hour of chilled water, 115 volt, ANSI 117.1, NFS/ANSI 61, ARI Standard 1010.

#### **2.14 HYDRANT, HOSE BIBB AND MISCELLANEOUS DEVICES**

- A. (P-5) Wall Hydrant: Exposed, Cast bronze non-freeze hydrant with detachable T-handle. Brass operating rod within casing of bronze pipe of sufficient length to extend through wall and place valve inside building. Brass valve with coupling and union elbow having metal-to-metal seat. Valve rod and seat washer removable through face of hydrant;

20 mm (3/4-inch) hose thread on spout; 20 mm (3/4-inch) pipe thread on inlet. Finish may be rough; exposed surfaces shall be chrome plated. Set not less than 460 mm (1-1/2 feet) nor more than 920 mm (3-feet) above grade. On porches and platforms, set approximately 760 mm (2-1/2 feet) above finished floor. Provide integral vacuum breaker which automatically drains when shut off.

- B. (P-9) Lawn Faucet: Shall be brass with detachable wheel or T-handle, straight or angle body, and be of compression type 20 mm (3/4-inch) hose threaded on spout; 20 mm (3/4-inch) pipe threaded on inlet. Finish may be rough; exposed surfaces shall be chrome plated, except handle may be painted. Set not less than 460 mm (1-1/2 feet) or more than 920 mm (3-feet) above grade. On porches and platforms, set approximately 760 mm (2-1/2 feet) above finished floor. Provide integral vacuum breaker.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Fixture Setting: Opening between fixture and floor and wall finish shall be sealed as specified under Section 07 92 00, JOINT SEALANTS.
- B. Supports and Fastening: Secure all fixtures, equipment and trimmings to partitions, walls and related finish surfaces. Exposed heads of bolts and nuts in finished rooms shall be hexagonal, polished chrome plated brass with rounded tops.
- C. Through Bolts: For free standing marble and metal stud partitions refer to Section 10 21 13, TOILET COMPARTMENTS.
- D. Toggle Bolts: For hollow masonry units, finished or unfinished.
- E. Expansion Bolts: For brick or concrete or other solid masonry. Shall be 6 mm (1/4-inch) diameter bolts, and to extend at least 75 mm (3-inches) into masonry and be fitted with loose tubing or sleeves extending into masonry. Wood plugs, fiber plugs, lead or other soft metal shields are prohibited.
- F. Power Set Fasteners: May be used for concrete walls, shall be 6 mm (1/4-inch) threaded studs, and shall extend at least 35 mm (1-1/4 inches) into wall.
- G. Tightly cover and protect fixtures and equipment against dirt, water and chemical or mechanical injury.
- H. Where water closet waste pipe has to be offset due to beam interference, provide correct and additional piping necessary to eliminate relocation of water closet.

I. Polished chromium-plated pipe, valves, and fittings shall be provided where exposed to view. Angle stops, straight stops, stops integral with the faucets, or concealed type of lock-shield, and loose-key pattern stops for supplies with threaded, sweat or solvent weld inlets shall be furnished and installed with fixtures.

J. Use manufacturer's roughing-in data if roughing-in data are not indicated.

K. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.

### 3.2 CLEANING

A. At completion of all work, fixtures, exposed materials and equipment shall be thoroughly cleaned.

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SECTION 23 05 11  
COMMON WORK RESULTS FOR HVAC

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.
  - 2. Option or optional: Contractor's choice of an alternate material or method.
  - 3. RE/COTR: Resident Engineer/Contracting Officer's Technical Representative.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- D. Excavation and Backfill: Section 31 20 00, EARTH MOVING.
- E. Building Components for Attachment of Hangers: Section 05 31 00, STEEL DECKING.
- F. Section 05 50 00, METAL FABRICATIONS.
- G. Section 07 84 00, FIRESTOPPING.
- H. Flashing for Wall and Roof Penetrations: Section 07 60 00, FLASHING AND SHEET METAL.
- I. Section 07 92 00, JOINT SEALANTS.
- J. Section 09 91 00, PAINTING.
- L. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
- M. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

1.3 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. Flow Rate Tolerance for HVAC Equipment: 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 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 approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, 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 Contracting Officers Technical Representative (RE/COTR).
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: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
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. Asbestos products or equipment or materials containing asbestos shall not be used.

E. Equipment Service Organizations:



1. HVAC: 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, contractor shall submit a certificate certifying that welders comply with the following requirements:
  1. Qualify welding processes and operators for piping according to ASME Section IX, "Welding and Brazing Qualifications".
  2. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
- H. 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 RE/COTR for resolution. Provide written hard copies or computer files of manufacturer's installation instructions to the RE/COTR 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, control devices. Prior to commencing installation work, refer conflicts between this requirement and contract drawings to the RE/COTR 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.

#### 1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and with requirements in the individual specification sections.

- B. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.
- C. 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.
- D. Prior to submitting shop drawings for approval, contractor shall 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 to provide a complete and efficient installation.
- E. Upon request by RE/COTR, 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.
- F. 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 to provide a completely compatible and efficient installation. Final review and approvals will be made only by groups.
- G. Manufacturer's Literature and Data: Submit under the pertinent section rather than under this section.
  - 1. Submit belt drive with the driven equipment.
  - 2. Submit 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.
- H. HVAC Maintenance Data and Operating Instructions:
  - 1. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS, Article, INSTRUCTIONS, for systems and equipment.
- I. Provide copies of approved HVAC equipment submittals to the Testing, Adjusting and Balancing Subcontractor.

## 1.5 APPLICABLE PUBLICATIONS

- 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 Conditioning and Refrigeration Institute (ARI):  
430-99 (R2002) .....Central Station Air-Handling Units
- C. Rubber Manufacturers Association (ANSI/RMA):  
IP-20-2007 .....Drives Using Classical V-Belts and Sheaves
- D. Air Movement and Control Association (AMCA):  
410-96 .....Recommended Safety Practices for Air Moving  
Devices
- E. American Society of Mechanical Engineers (ASME):  
Boiler and Pressure Vessel Code (BPVC):  
Section IX-2007 .....Welding and Brazing Qualifications
- F. American Society for Testing and Materials (ASTM):  
A36/A36M-08 .....Carbon Structural Steel  
A575-96(2007) .....Steel Bars, Carbon, Merchant Quality, M-Grades  
E84-09 .....Standard Test Method for Burning Characteristics  
of Building Materials  
E119-08a .....Standard Test Method for Fire Tests of Building  
Construction and Materials
- G. Manufacturers Standardization Society (MSS) of the Valve and Fittings  
Industry, Inc:  
SP-58-2002 .....Pipe Hangers and Supports-Materials, Design and  
Manufacture  
SP 69-2003 .....Pipe Hangers and Supports-Selection and  
Application  
SP 127-2001 .....Bracing for Piping Systems, Seismic - Wind -  
Dynamic, Design, Selection, Application
- H. National Electrical Manufacturers Association (NEMA):  
MG 1-2006 .....Motors and Generators
- I. National Fire Protection Association (NFPA):  
70-08 .....National Electrical Code  
90A-09 .....Installation of Air Conditioning and Ventilating  
Systems  
101-09 .....Life Safety Code

## 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 first class, new operating condition; or, replace same as determined and directed by the RE/COTR. 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 shall be 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. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for 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. Contractor shall guarantee performance of assemblies of components, and shall 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, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

## **2.2 COMPATIBILITY OF RELATED EQUIPMENT**

- A. Equipment and materials installed shall be compatible in all respects 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, Based on ARI 435:
  - 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 just 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 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.

## 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; Section 26 29 11, LOW-VOLTAGE 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 split phase or permanent split capacitor (PSC).
- C. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type. Each two-speed motor shall have two separate windings. Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.
- D. Rating: Continuous duty at 100 percent capacity in an ambient temperature of 40 degrees centigrade (104 degrees F); minimum horsepower as shown on drawings; maximum horsepower in normal operation not to exceed nameplate rating without service factor.
- E. 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 shall be sized for non-overloading at all points on the pump performance curves.

5. Motors utilized with variable frequency drives shall be rated "inverter-ready" per NEMA Standard, MG1, Part 31.4.4.2. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.
- F. 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, 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.
- G. 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, LOW-VOLTAGE 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 product 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.

## **2.10 EQUIPMENT AND MATERIALS IDENTIFICATION**

- //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. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 48 mm (3/16-inch) high of brass with black-filled letters, or rigid black plastic with white letters specified in Section 09 91 00, PAINTING permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc.

- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 48 mm (3/16-inch) high riveted or bolted to the equipment.
- D. Control Items: Label all temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.
- E. Valve Tags and Lists:
  - 1. Valve tags: Engraved black filled numbers and letters not less than 13 mm (1/2-inch) high for number designation, and not less than 6.4 mm (1/4-inch) for service designation on 19 gage 38 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 216 mm (8-1/2 inches) by 280 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.

## **2.11 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, PLUMBING INSULATION, for firestop pipe and duct insulation.

## **2.12 GALVANIZED REPAIR COMPOUND**

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

## **2.13 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 gauge), with integral baseplate, continuous welded corner seams, factory installed 50 mm by 100 mm (2 by 4) treated wood nailer, 1.3 mm (18 gauge) galvanized steel counter flashing cap with screws, built-in cant strip, (except for gypsum or tectum deck), minimum height 280 mm (11 inches). For surface insulated roof deck, provide raised cant strip to start 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-58-2002. Type Numbers specified refer to this standard. For selection and application comply with MSS SP-69-



2003. 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-58-2002, Type 18.
2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 102 mm (four inches) thick when approved by the Resident Engineer for each job condition.
3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 102 mm (four inches) thick when approved by the Resident Engineer for each job condition.

E. Attachment to Steel Building Construction:

1. Welded attachment: MSS SP-58-2002, Type 22.
2. Beam clamps: MSS SP-58-2002, Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23mm (7/8-inch) outside diameter.

G. Attachment to Wood Construction: Wood screws or lag bolts.

H. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58-2002. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 38 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 (No. 12 gage), designed to accept special spring held, hardened steel nuts.

1. Allowable hanger load: Manufacturers rating less 91kg (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 13mm (1/2-inch) galvanized steel bands, or preinsulated calcium silicate shield for insulated piping at each hanger.

J. Supports for Piping Systems:

1. Select hangers sized to encircle insulation on insulated piping. Refer to Section 23 07 11, HVAC, PLUMBING INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or preinsulated calcium silicate shields. Provide Type 40 insulation shield or preinsulated calcium silicate shield at all

other types of supports and hangers including those for preinsulated piping.

#### **2.14 PIPE PENETRATIONS**

- A. Install sleeves during construction.
- B. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of RE/COTR.
- 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.

#### **2.15 SPECIAL TOOLS AND LUBRICANTS**

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

#### **2.16 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 80 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.

## 2.17 ASBESTOS

- A. Materials containing asbestos are not permitted.

## PART 3 - EXECUTION

### 3.1 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 of 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, 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 will not be allowed, except as permitted by RE/COTR 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 RE/COTR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to RE/COTR for approval.
  3. Do not penetrate membrane waterproofing.
- F. Interconnection of Instrumentation or Control Devices: Generally, electrical and pneumatic interconnections are not shown but must be provided.
- G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- H. Electrical Interconnection of Controls and Instruments: This generally not shown but must 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 Resident Engineer. Damaged or defective items in the opinion of the Resident Engineer, 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 25 MPa (3000 psi) minimum.
- K. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- L. Work in Existing Building:
1. Perform as specified in Article, OPERATIONS AND STORAGE AREAS, Article, ALTERATIONS, and Article, RESTORATION of the Section 01 00

- 00, GENERAL REQUIREMENTS for relocation of existing equipment, alterations and restoration of existing building(s).
2. As specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, OPERATIONS AND STORAGE AREAS, 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 Resident Engineer. Locate openings that will least effect structural slabs, columns, ribs or beams. Refer to the Resident Engineer for determination of proper design for openings through structural sections and opening layouts approval, prior to cutting or drilling into structure. After Resident Engineer's approval, carefully cut opening through construction no larger than absolutely 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.
- 3.2 TEMPORARY PIPING AND EQUIPMENT**
- A. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.
  - B. The Contractor shall 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 Para. 3.1 apply.

### 3.3 RIGGING

- A. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by Government under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.
- C. 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.
- D. Contractor shall 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 full responsibility. Upon request, the Government will check structure adequacy and advise Contractor of recommended restrictions.
- E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.
- F. Rigging plan and methods shall be referred to RE/COTR for evaluation prior to actual work.
- G. Restore building to original condition upon completion of rigging work.

### 3.4 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 RE/COTR.
- B. Use of chain, wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above will not be permitted. 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-69-2003. 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 (if applicable) 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.

### 3.5 MECHANICAL DEMOLITION

- A. Rigging access, other than indicated on the drawings, shall be provided by the Contractor after approval for structural integrity by the RE/COTR. Such access shall be provided without additional cost or time to the Government. Where work is in an operating plant, provide approved protection from dust and debris at all times for the safety of plant personnel and maintenance of plant operation and environment of the plant.
- B. In an operating plant, maintain the operation, cleanliness and safety. Government personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Confine the work to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Do not permit

debris to accumulate in the area to the detriment of plant operation. Perform all flame cutting to maintain the fire safety integrity of this plant. 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 RE/COTR 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, 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, all pressure gages and thermometers with wells shall remain Government property and shall be removed and delivered to RE/COTR and stored as directed. The Contractor shall 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 shall not be allowed to accumulate.

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

### 3.6 CLEANING AND PAINTING

- A. Prior to final inspection and acceptance of the plant and facilities for beneficial use by the Government, the plant facilities, equipment and systems shall be thoroughly cleaned and painted. Refer to Section 09 91 00, PAINTING.
- B. In addition, the following special conditions apply:
  - 1. Cleaning shall be thorough. 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.
  - 2. 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 gauges and thermometers.
  - j. Glass.
  - k. Name plates.
3. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.
  4. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
  5. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment if necessary to achieve this.

### **3.7 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.

### **3.8 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 misalignment when both motor and driven machine are operating at normal temperatures.

### **3.9 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.

### 3.10 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 00, GENERAL REQUIREMENTS, Article, TEMPORARY USE OF MECHANICAL AND ELECTRICAL EQUIPMENT.

### 3.11 OPERATING AND PERFORMANCE TESTS

- A. Prior to the final inspection, perform required tests as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS and submit the test reports and records to the RE/COTR.
- 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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**SECTION 23 05 12**  
**GENERAL MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section specifies the furnishing, installation and connection of motors for HVAC equipment.

**1.2 RELATED WORK**

- A. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements that are common to more than one Section of Division 26.
- B. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS: Starters, control and protection for motors.
- C. Other sections specifying motor driven equipment in Division 23.

**1.3 SUBMITTALS**

- A. In accordance with Section, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS, submit the following:
- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include electrical ratings, dimensions, mounting details, materials, horsepower, RPM, enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.
- C. Manuals:
  - 1. Submit simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals, including technical data sheets and application data.
- D. Certification: Two weeks prior to final inspection, unless otherwise noted, submit four copies of the following certification to the Resident Engineer:
  - 1. Certification that the motors have been properly applied, installed, adjusted, lubricated, and tested.

**1.4 APPLICABLE PUBLICATIONS**

- A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by designation only.
- B. National Electrical Manufacturers Association (NEMA):
  - MG 1-2006 Rev 1 2007 ...Motors and Generators

C. National Fire Protection Association (NFPA):

70-08 .....National Electrical Code (NEC)

**PART 2 - PRODUCTS**

**2.1 MOTORS**

- A. For alternating current, fractional and integral horsepower motors, NEMA Publications MG 1 and MG 2 shall apply.
- B. Voltage ratings shall be as follows:
  - 1. Single phase:
    - a. Motors connected to 120-volt systems: 115 volts.
    - b. Motors connected to 208-volt systems: 200 volts.
    - c. Motors connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
  - 2. Three phase:
    - a. Motors connected to 208-volt systems: 200 volts.
    - b. Motors, less than 74.6 kW (100 HP), connected to 240 volt or 480 volt systems: 230/460 volts, dual connection.
- C. Number of phases shall be as follows:
  - 1. Motors, less than 373 W (1/2 HP): Single phase.
  - 2. Motors, 373 W (1/2 HP) and larger: 3 phase.
  - 3. Exceptions:
    - a. Hermetically sealed motors.
    - b. Motors for equipment assemblies, less than 746 W (one HP), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.
- D. Horsepower ratings shall be adequate for operating the connected loads continuously in the prevailing ambient temperatures in areas where the motors are installed, without exceeding the NEMA standard temperature rises for the motor insulation.
- E. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting and running torque.
- F. Motor Enclosures:
  - 1. Shall be the NEMA types shown on the drawings for the motors.
  - 2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types, which are most suitable for the environmental conditions where the motors are being installed.
  - 3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.

- G. Additional requirements for specific motors, as indicated in other sections, shall also apply.
- H. Energy-Efficient Motors (Motor Efficiencies): All permanently wired polyphase motors of 746 Watts or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 746 Watts or more with open, drip-proof or totally enclosed fan-cooled enclosures shall be NEMA premium efficiency type, unless otherwise indicated. Motors provided as an integral part of motor driven equipment are excluded from this requirement if a minimum seasonal or overall efficiency requirement is indicated for that equipment by the provisions of another section.

Minimum Efficiencies Open Drip-Proof				Minimum Efficiencies Totally Enclosed Fan-Cooled			
Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM	Rating kW (HP)	1200 RPM	1800 RPM	3600 RPM
0.746 (1)	82.5%	85.5%	77.0%	0.746 (1)	82.5%	85.5%	77.0%
1.12 (1.5)	86.5%	86.5%	84.0%	1.12 (1.5)	87.5%	86.5%	84.0%
1.49 (2)	87.5%	86.5%	85.5%	1.49 (2)	88.5%	86.5%	85.5%
2.24 (3)	88.5%	89.5%	85.5%	2.24 (3)	89.5%	89.5%	86.5%
3.73 (5)	89.5%	89.5%	86.5%	3.73 (5)	89.5%	89.5%	88.5%
5.60 (7.5)	90.2%	91.0%	88.5%	5.60 (7.5)	91.0%	91.7%	89.5%
7.46 (10)	91.7%	91.7%	89.5%	7.46 (10)	91.0%	91.7%	90.2%
11.2 (15)	91.7%	93.0%	90.2%	11.2 (15)	91.7%	92.4%	91.0%
14.9 (20)	92.4%	93.0%	91.0%	14.9 (20)	91.7%	93.0%	91.0%
18.7 (25)	93.0%	93.6%	91.7%	18.7 (25)	93.0%	93.6%	91.7%
22.4 (30)	93.6%	94.1%	91.7%	22.4 (30)	93.0%	93.6%	91.7%
29.8 (40)	94.1%	94.1%	92.4%	29.8 (40)	94.1%	94.1%	92.4%

- I. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM and 3600 RPM.
- J. Premium efficiency motors shall be used where energy cost/kW x (hours use/year) > 50.

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### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install motors in accordance with manufacturer's recommendations, the NEC, NEMA, as shown on the drawings and/or as required by other sections of these specifications.

#### **3.2 FIELD TESTS**

- A. Megger all motors after installation, before start-up. All shall test free from grounds.

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**SECTION 23 05 41  
NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Noise criteria, , vibration tolerance and vibration isolation for HVAC and plumbing work.

**1.2 RELATED WORK**

- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- D. Section 23 31 00, HVAC DUCTS AND CASINGS: requirements for flexible duct connectors, sound attenuators and sound absorbing duct lining.
- E. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC: requirements for sound and vibration tests.

**1.3 QUALITY ASSURANCE**

- A. Refer to article, QUALITY ASSURANCE in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**B. Noise Criteria:**

1. Noise levels in all 8 octave bands due to equipment and duct systems shall not exceed following NC levels:

Type Of Room	NC LEVEL
Bathrooms and Toilet Rooms	40
Conference Rooms	35
Corridors(Public)	40
Lobbies, Waiting Areas	40
Offices, large open (3 or more occupants)	40
Offices, small private (2 or fewer occupants)	35
Maintenance	50

2. For equipment which has no sound power ratings scheduled on the plans, the contractor shall select equipment such that the foregoing noise criteria, local ordinance noise levels, and OSHA re-

quirements are not exceeded. Selection procedure shall be in accordance with ASHRAE Fundamentals Handbook, Chapter 8, Sound and Vibration.

3. An allowance, not to exceed 5db, may be added to the measured value to compensate for the variation of the room attenuating effect between room test condition prior to occupancy and design condition after occupancy which may include the addition of sound absorbing material, such as, furniture. This allowance may not be taken after occupancy. The room attenuating effect is defined as the difference between sound power level emitted to room and sound pressure level in room.
4. In absence of specified measurement requirements, measure equipment noise levels three feet from equipment and at an elevation of maximum noise generation.

D. Allowable Vibration Tolerances for Rotating, Non-reciprocating Equipment: Not to exceed a self-excited vibration maximum velocity of 5 mm per second (0.20 inch per second) RMS, filter in, when measured with a vibration meter on bearing caps of machine in vertical, horizontal and axial directions or measured at equipment mounting feet if bearings are concealed. Measurements for internally isolated fans and motors may be made at the mounting feet.

#### 1.4 SUBMITTALS

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  1. Vibration isolators:
    - a. Floor mountings
    - b. Hangers
    - c. Snubbers
    - d. Thrust restraints
  2. Bases.
  3. Seismic restraint provisions and bolting.
  4. Acoustical enclosures.
- C. Isolator manufacturer shall furnish with submittal load calculations for selection of isolators, including supplemental bases, based on lowest operating speed of equipment supported.



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## 1.5 APPLICABLE PUBLICATIONS

- 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. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):  
2009.....Fundamentals Handbook, Chapter 8, Sound and Vibration
- C. American Society for Testing and Materials (ASTM):  
A123/A123M-08.....Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products  
A307-07.....Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength  
D2240-05.....Standard Test Method for Rubber Property - Durometer Hardness
- D. Manufacturers Standardization (MSS):  
SP-58-02.....Pipe Hangers and Supports-Materials, Design and Manufacture
- E. Occupational Safety and Health Administration (OSHA):  
29 CFR 1910.95.....Occupational Noise Exposure

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS

- A. Type of isolator, base, and minimum static deflection shall be as required for each specific equipment application as recommended by isolator or equipment manufacturer but subject to minimum requirements indicated herein and in the schedule on the drawings.
- B. Elastometric Isolators shall comply with ASTM D2240 and be oil resistant neoprene with a maximum stiffness of 60 durometer and have a straight-line deflection curve.
- D. Uniform Loading: Select and locate isolators to produce uniform loading and deflection even when equipment weight is not evenly distributed.
- E. Color code isolators by type and size for easy identification of capacity.

## 2.3 VIBRATION ISOLATORS

- B. Hangers: Shall be combination neoprene and springs unless otherwise noted and shall allow for expansion of pipe.
1. Combination Neoprene and Spring (Type H): Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
  2. Spring Position Hanger (Type HP): Similar to combination neoprene and spring hanger except hanger shall hold piping at a fixed elevation during installation and include a secondary adjustment feature to transfer load to spring while maintaining same position.
  3. Neoprene (Type HN): Vibration hanger shall contain a double deflection type neoprene isolation element. Hanger rod shall be separated from contact with hanger bracket by a neoprene grommet.
  4. Spring (Type HS): Vibration hanger shall contain a coiled steel spring in series with a neoprene grommet. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.
  5. Hanger supports for piping 50 mm (2 inches) and larger shall have a pointer and scale deflection indicator.
- C. Snubbers: Each spring mounted base shall have a minimum of four all-directional or eight two directional (two per side) seismic snubbers that are double acting. Elastomeric materials shall be shock absorbent neoprene bridge quality bearing pads, maximum 60 durometer, replaceable and have a minimum thickness of 6 mm (1/4 inch). Air gap between hard and resilient material shall be not less than 3 mm (1/8 inch) nor more than 6 mm (1/4 inch). Restraints shall be capable of withstanding design load without permanent deformation.

## 2.4 BASES

- A. Rails (Type R): Design rails with isolator brackets to reduce mounting height of equipment and cradle machines having legs or bases that do not require a complete supplementary base. To assure adequate

stiffness, height of members shall be a minimum of 1/12 of longest base dimension but not less than 100 mm (4 inches). Where rails are used with neoprene mounts for small fans or close coupled pumps, extend rails to compensate overhang of housing.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

##### **A. Vibration Isolation:**

1. No metal-to-metal contact will be permitted between fixed and floating parts.
2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports.
3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling, and bolting.
4. Provide heat shields where elastomers are subject to temperatures over 38 degrees C (100 degrees F).
5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.
6. Non-rotating equipment such as heat exchangers and convertors shall be mounted on isolation units having the same static deflection as the isolation hangers or support of the pipe connected to the equipment.

- ##### **B. Inspection and Adjustments:**
- Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair, or replace isolators as required to reduce vibration and noise transmissions to specified levels.

#### **3.2 ADJUSTING**

- ##### **A. Adjust vibration isolators after piping systems are filled and equipment is at operating weight.**

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- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Attach thrust limits at centerline of thrust and adjust to a maximum of 6-mm (1/4inch) movement during start and stop.
- D. Adjust active height of spring isolators.
- E. Adjust snubbers according to manufacturer's recommendations.
- F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

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## SELECTION GUIDE FOR VIBRATION ISOLATORS

EQUIPMENT		ON GRADE		20FT FLOOR SPAN		30FT FLOOR SPAN		40FT FLOOR SPAN		50FT FLOOR SPAN	
		BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	ISOL TYPE
REFRIGERATION MACHINES											
PACKAGED		---	D	---	---	SP	1.0	---	SP	1.7	---
COMPRESSORS											
UP THROUGH 1-1/2 HP		---	D, L, W	---	---	---	---	---	---	---	---
2 HP AND OVER:											
500 - 750 RPM		---	D	---	---	---	---	---	---	---	---
750 RPM & OVER		---	D	---	---	---	---	---	---	---	---
PUMPS											
BASE MOUNTED	UP TO 10 HP	---	---	---	---	---	---	---	---	---	---
	15 HP THRU 40 HP	I	S	1.0	---	---	---	---	---	---	---
ROOF VENTILATORS											
ABOVE OCCUPIED AREAS:											
5 HP & OVER		---	---	---	CB	S	1.0	CB	S	1.0	S
AIR HANDLING UNIT PACKAGES											
SUSPENDED:											
UP THRU 5 HP		---	---	---	---	H	1.0	---	H	1.0	H
7-1/2 HP & OVER:											

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EQUIPMENT	ON GRADE			20FT FLOOR SPAN			30FT FLOOR SPAN			40FT FLOOR SPAN			50FT FLOOR SPAN		
	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL
UP TO 500 RPM	---	---	---	---	H, THR	1.7	---	H, THR	1.7	---	H, THR	1.7	---	H, THR	1.7
501 RPM & OVER	---	---	---	---	H, THR	1.0	---	H, THR	1.0	---	H,TH R	1.7	---	H,TH R	1.7
FLOOR MOUNTED:															
UP THRU 5 HP	---	D	---	---	---	---	---	---	---	---	---	---	---	---	---
7-1/2 HP & OVER:															
UP TO 500 RPM	---	D	---	R	S, THR	1.7	R	S, THR	1.7	R	S, THR	1.7	R	S, THR	1.7
501 RPM & OVER	---	D	---	---	S, THR	1.0	---	S, THR	1.0	R	S, THR	1.7	R	S, THR	1.7

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**NOTES:**

1. Edit the Table above to suit where isolator, other than those shown, are used, such as for seismic restraints and position limit stops.
2. For suspended floors lighter than 100 mm (4 inch) thick concrete, select deflection requirements from next higher span.
3. For separate chiller building on grade, pump isolators may be omitted.
4. Direct bolt fire pumps to concrete base. Provide pads (D) for domestic water booster pump package.
5. For projects in seismic areas, use only SS & DS type isolators and snubbers.
6. For floor mounted in-line centrifugal blowers (ARR 1): use "B" type in lieu of "R" type base.
7. Suspended: Use "H" isolators of same deflection as floor mounted.





**SECTION 23 05 93**  
**TESTING, ADJUSTING, AND BALANCING FOR HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

A. Testing, adjusting, and balancing (TAB) of heating, ventilating and air conditioning (HVAC) systems. TAB includes the following:

1. Planning systematic TAB procedures.
2. Design Review Report.
3. Systems Inspection report.
4. Duct Air Leakage test report.
5. Systems Readiness Report.
6. Balancing air and water distribution systems; adjustment of total system to provide design performance; and testing performance of equipment and automatic controls.
7. Vibration and sound measurements.
8. Recording and reporting results.

Definitions:

1. Basic TAB used in this Section: Chapter 37, "Testing, Adjusting and Balancing" of ASHRAE Handbook, "HVAC Applications".
2. TAB: Testing, Adjusting and Balancing; the process of checking and adjusting HVAC systems to meet design objectives.
3. AABC: Associated Air Balance Council.
4. NEBB: National Environmental Balancing Bureau.  
heating water
6. Air Systems: Includes all outside air, supply air, return air, exhaust air and relief air systems.
7. Flow rate tolerance: The allowable percentage variation, minus to plus, of actual flow rate from values (design) in the contract documents.

**1.2 RELATED WORK**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General Mechanical Requirements.
- B. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT: Noise and Vibration Requirements.
- C. Section 23 07 11, HVAC AND PLUMBING INSULATION: Piping and Equipment Insulation.

- D. Section 23 64 00, PACKAGED WATER CHILLERS: Testing Refrigeration Equipment.
- E. Section 23 81 00, UNITARY HVAC EQUIPMENT
- F. Section 23 36 00, AIR TERMINAL UNITS: Terminal Units Performance.
- G. Section 23 31 00, HVAC DUCTS AND CASINGS: Duct Leakage.
- H. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Controls and Instrumentation Settings.

### 1.3 QUALITY ASSURANCE

- A. Refer to Articles, Quality Assurance and Submittals, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Qualifications:
  - 1. TAB Agency: The TAB agency shall be a subcontractor of the General Contractor and shall report to and be paid by the General Contractor.
  - 2. The TAB agency shall be either a certified member of AABC or certified by the NEBB to perform TAB service for HVAC, water balancing and vibrations and sound testing of equipment. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the agency loses subject certification during this period, the General Contractor shall immediately notify the RE/COTR and submit another TAB firm for approval. Any agency that has been the subject of disciplinary action by either the AABC or the NEBB within the five years preceding Contract Award shall not be eligible to perform any work related to the TAB. All work performed in this Section and in other related Sections by the TAB agency shall be considered invalid if the TAB agency loses its certification prior to Contract completion, and the successor agency's review shows unsatisfactory work performed by the predecessor agency.
  - 3. TAB Specialist: The TAB specialist shall be either a member of AABC or an experienced technician of the Agency certified by NEBB. The certification shall be maintained for the entire duration of duties specified herein. If, for any reason, the Specialist loses subject certification during this period, the General Contractor shall immediately notify the RE/COTR and submit another TAB Specialist for approval. Any individual that has been the subject of disciplinary

action by either the AABC or the NEBB within the five years preceding Contract Award shall 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 performed by the TAB specialist shall be considered invalid if the TAB Specialist loses its certification prior to Contract completion and must be performed by an approved successor.

4. TAB Specialist shall be identified by the General Contractor within 60 days after the notice to proceed. The TAB specialist will be coordinating, scheduling and reporting all TAB work and related activities and will provide necessary information as required by the RE/COTR. The responsibilities would specifically include:
  - a. Shall directly supervise all TAB work.
  - b. Shall sign the TAB reports that bear the seal of the TAB standard. The reports shall be accompanied by report forms and schematic drawings required by the TAB standard, AABC or NEBB.
  - c. Would follow all TAB work through its satisfactory completion.
  - d. Shall provide final markings of settings of all HVAC adjustment devices.
  - e. Permanently mark location of duct test ports.
5. All TAB technicians performing actual TAB work shall be experienced and must have done satisfactory work on a minimum of 3 projects comparable in size and complexity to this project. Qualifications must be certified by the TAB agency in writing.
- C. Test Equipment Criteria: The instrumentation shall meet the accuracy/calibration requirements established by AABC National Standards or by NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems and instrument manufacturer. Provide calibration history of the instruments to be used for test and balance purpose.
- D. Tab Criteria:
  1. One or more of the applicable AABC, NEBB or SMACNA publications, supplemented by ASHRAE Handbook "HVAC Applications" Chapter 36, and requirements stated herein shall be the basis for planning, procedures, and reports.

2. Flow rate tolerance: Following tolerances are allowed. For tolerances not mentioned herein follow ASHRAE Handbook "HVAC Applications", Chapter 36, as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 90 percent of final values for pre-filters and after-filters.
  - a. Air handling unit and all other fans, cubic meters/min (cubic feet per minute): Minus 0 percent to plus 10 percent.
  - b. Air terminal units (maximum values): Minus 2 percent to plus 10 percent.
  - c. Minimum outside air: 0 percent to plus 10 percent.
  - d. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 2 percent to plus 10 percent except if the air to a space is 100 CFM or less the tolerance would be 0 to plus 5 percent.
3. Systems shall be adjusted for energy efficient operation as described in PART 3.
4. Typical TAB procedures and results shall be demonstrated to the RE/COTR for one air distribution system (including all fans, three terminal units and three rooms) and one hydronic system (pumps and three coils) as follows:
  - a. When field TAB work begins.

#### 1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submit names and qualifications of TAB agency and TAB specialists within 60 days after the notice to proceed. Submit information on three recently completed projects and a list of proposed test equipment.
- C. For use by the RE/COTR staff, submit one complete set of applicable AABC or NEBB publications that will be the basis of TAB work.
- D. Submit Following for Review and Approval:
  1. Design Review Report within 90 days for conventional design projects after the system layout on air and water side is completed by the Contractor.
  2. Systems inspection report on equipment and installation for conformance with design.

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3. Duct Air Leakage Test Report.
  4. Systems Readiness Report.
  5. Intermediate and Final TAB reports covering flow balance and adjustments, performance tests, vibration tests and sound tests.
  6. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.
- E. Prior to request for Final Inspection, submit completed Test and Balance report for the area.

#### 1.5 APPLICABLE PUBLICATIONS

- A. The following publications form a part of this specification to the extent indicated by the reference thereto. In text the publications are referenced to by the acronym of the organization.
- B. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):  
2007.....HVAC Applications ASHRAE Handbook, Chapter 37,  
Testing, Adjusting, and Balancing and Chapter  
47, Sound and Vibration Control
- C. Associated Air Balance Council (AABC):  
2002.....AABC National Standards for Total System  
Balance
- D. National Environmental Balancing Bureau (NEBB):  
7<sup>th</sup> Edition 2005 .....Procedural Standards for Testing, Adjusting,  
Balancing of Environmental Systems  
2<sup>nd</sup> Edition 2006 .....Procedural Standards for the Measurement and  
Assessment of Sound and Vibration  
2<sup>nd</sup> Edition 1999 .....Procedural Standards for Building Systems  
Commissioning
- E. Sheet Metal and Air Conditioning Contractors National Association  
(SMACNA):  
3<sup>rd</sup> Edition 2002 .....HVAC SYSTEMS-Testing, Adjusting and Balancing

#### PART 2 - PRODUCTS

##### 2.1 PLUGS

- A. Provide plastic plugs to seal holes drilled in ductwork for test purposes.

## **2.2 INSULATION REPAIR MATERIAL**

- A. See Section 23 07 11, HVAC AND PLUMBING INSULATION. Provide for repair of insulation removed or damaged for TAB work.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Refer to TAB Criteria in Article, Quality Assurance.
- B. Obtain applicable contract documents and copies of approved submittals for HVAC equipment and automatic control systems.

### **3.2 DESIGN REVIEW REPORT**

- A. The TAB Specialist shall review the Contract Plans and specifications and advise the RE/COTR of any design deficiencies that would prevent the HVAC systems from effectively operating in accordance with the sequence of operation specified or prevent the effective and accurate TAB of the system. The TAB Specialist shall provide a report individually listing each deficiency and the corresponding proposed corrective action necessary for proper system operation.

### **3.3 SYSTEMS INSPECTION REPORT**

- A. Inspect equipment and installation for conformance with design.
- B. The inspection and report is to be done after air distribution equipment is on site and duct installation has begun, but well in advance of performance testing and balancing work. The purpose of the inspection is to identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.
- C. Reports: Follow check list format developed by AABC, NEBB or SMACNA, supplemented by narrative comments, with emphasis on air handling units and fans. Check for conformance with submittals. Verify that diffuser and register sizes are correct. Check air terminal unit installation including their duct sizes and routing.

### **3.4 DUCT AIR LEAKAGE TEST REPORT**

- A. See paragraphs "Duct leakage Tests and Repairs" in Section 23 31 00, HVAC DUCTS AND CASINGS for TAB agency's role and responsibilities in witnessing, recording and reporting of deficiencies.

### **3.5 SYSTEM READINESS REPORT**

- A. Inspect each System to ensure that it is complete including installation and operation of controls.

- B. Verify that all items such as ductwork piping, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the RE/COTR.

### **3.6 TAB REPORTS**

- A. Submit an intermediate report for minimum of 50 percent of systems and equipment tested and balanced to establish satisfactory test results.
- B. The TAB contractor shall provide raw data immediately in writing to the RE/COTR if there is a problem in achieving intended results before submitting a formal report.
- C. If over 20 percent of readings in the intermediate report fall outside the acceptable range, the TAB report shall be considered invalid and all contract TAB work shall be repeated and re-submitted for approval.
- D. Do not proceed with the remaining systems until intermediate report is approved by the RE/COTR.

### **3.7 TAB PROCEDURES**

- A. Tab shall be performed in accordance with the requirement of the Standard under which TAB agency is certified by either AABC or NEBB.
- B. General: During TAB all related system components shall be in full operation. Fan and pump rotation, motor loads and equipment vibration shall be checked and corrected as necessary before proceeding with TAB. Set controls and/or block off parts of distribution systems to simulate design operation of variable volume air or water systems for test and balance work.
- C. Coordinate TAB procedures with any phased construction completion requirements for the project. Provide TAB reports for each phase of the project prior to partial final inspections of each phase of the project.
- D. Allow sufficient time in construction schedule for TAB and submission of all reports for an organized and timely correction of deficiencies.
- E. Air Balance and Equipment Test: Include air handling units, fans, terminal units, fan coil units, room diffusers/outlets/inlets.
  - 1. Artificially load air filters by partial blanking to produce air pressure drop of at least 90 percent of the design final pressure drop.

2. Adjust fan speeds to provide design air flow. V-belt drives, including fixed pitch pulley requirements, are specified in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
3. Test and balance systems in all specified modes of operation, including variable volume, economizer, and fire emergency modes. Verify that dampers and other controls function properly.
- 4.
5. Record final measurements for air handling equipment performance data sheets.

F. Water Balance and Equipment Test: Include circulating pumps and coils:

- 1.
2. Adjust flow rates for equipment. Set coils to values on equipment submittals, if different from values on contract drawings.
3. Record final measurements for hydronic equipment on performance data sheets. Include entering and leaving water temperatures for coils. Include entering and leaving air temperatures (DB/WB for cooling coils) for air handling units and reheat coils. Make air and water temperature measurements at the same time.

**3.8 VIBRATION TESTING**

- A. Furnish instruments and perform vibration measurements as specified in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT. Field vibration balancing is specified in Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Provide measurements for all rotating HVAC equipment of 373 watts (1/2 horsepower) and larger, including rotary and screw compressors, pumps, fans and motors.
- B. Record initial measurements for each unit of equipment on test forms and submit a report to the RE/COTR. Where vibration readings exceed the allowable tolerance Contractor shall be directed to correct the problem. The TAB agency shall verify that the corrections are done and submit a final report to the RE/COTR.

**3.9 SOUND TESTING**

- A. Perform and record required sound measurements in accordance with Paragraph, QUALITY ASSURANCE in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- B. Take measurements with a calibrated sound level meter and octave band analyzer of the accuracy required by AABC or NEBB.



- C. Sound reference levels, formulas and coefficients shall be according to ASHRAE Handbook, "HVAC Applications", Chapter 46, SOUND AND VIBRATION CONTROL.
- D. Determine compliance with specifications as follows:

1. When sound pressure levels are specified, including the NC Criteria in Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT:

- a. Reduce the background noise as much as possible by shutting off unrelated audible equipment.
- b. Measure octave band sound pressure levels with specified equipment "off."
- c. Measure octave band sound pressure levels with specified equipment "on."
- d. Use the DIFFERENCE in corresponding readings to determine the sound pressure due to equipment.

DIFFERENCE:	0	1	2	3	4	5 to 9	10 or More
FACTOR:	10	7	4	3	2	1	0

Sound pressure level due to equipment equals sound pressure level with equipment "on" minus FACTOR.

- e. Plot octave bands of sound pressure level due to equipment for typical rooms on a graph which also shows noise criteria (NC) curves.
2. When sound power levels are specified:
- a. Perform steps 1.a. thru 1.d., as above.
  - b. For indoor equipment: Determine room attenuating effect, i.e., difference between sound power level and sound pressure level. Determined sound power level will be the sum of sound pressure level due to equipment plus the room attenuating effect.
  - c. For outdoor equipment: Use directivity factor and distance from noise source to determine distance factor, i.e., difference between sound power level and sound pressure level. Measured sound power level will be the sum of sound pressure level due to equipment plus the distance factor. Use 10 meters (30 feet) for sound level location.

- E. Where measured sound levels exceed specified level, the installing contractor or equipment manufacturer shall take remedial action approved by the RE/COTR and the necessary sound tests shall be repeated.

### **3.10 MARKING OF SETTINGS**

- A. Following approval of Tab final Report, the setting of all HVAC adjustment devices including valves, splitters and dampers shall be permanently marked by the TAB Specialist so that adjustment can be restored if disturbed at any time. Style and colors used for markings shall be coordinated with the RE/COTR.

### **3.11 IDENTIFICATION OF TEST PORTS**

- A. The TAB Specialist shall permanently and legibly identify the location points of duct test ports. If the ductwork has exterior insulation, the identification shall be made on the exterior side of the insulation. All penetrations through ductwork and ductwork insulation shall be sealed to prevent air leaks and maintain integrity of vapor barrier.

- - - E N D - - -

SECTION 23 07 11  
HVAC AND PLUMBING INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Field applied insulation for thermal efficiency and condensation control for
  - 1. HVAC piping, ductwork and equipment.
  - 2. Plumbing piping and equipment.
- B. Definitions
  - 1. ASJ: All service jacket, white finish facing or jacket.
  - 2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
  - 3. Cold: Equipment, ductwork or piping handling media at design temperature of 16 degrees C (60 degrees F) or below.
  - 4. Concealed: Ductwork and piping above ceilings and in chases and pipe spaces.
  - 5. Exposed: Piping, ductwork, and equipment exposed to view in finished areas including mechanical, and electrical equipment rooms or exposed to outdoor weather. Attics and crawl spaces where air handling units are located are considered to be mechanical rooms. Shafts, chases unfinished attics, crawl spaces and pipe basements are not considered finished areas.
  - 6. FSK: Foil-scrim-kraft facing.
  - 7. Hot: HVAC Ductwork handling air at design temperature above 16 degrees C (60 degrees F); HVAC and plumbing equipment or piping handling media above 41 degrees C (105 degrees F)
  - 8. Density:  $\text{kg/m}^3$  - kilograms per cubic meter (Pcf - pounds per cubic foot).
  - 9. Runouts: Branch pipe connections up to 25-mm (one-inch) nominal size to fan coil units or reheat coils for terminal units.
  - 10. Thermal conductance: Heat flow rate through materials.
    - a. Flat surface: Watt per square meter (BTU per hour per square foot).
    - b. Pipe or Cylinder: Watt per square meter (BTU per hour per linear foot).

- 11. Thermal Conductivity (k): Watt per meter, per degree C (BTU per inch thickness, per hour, per square foot, per degree F temperature difference).
- 12. R: Pump recirculation.
- 13. CW: Cold water.
- 14.
- 15. HW: Hot water.
- 16.
- 17.
- 18. RS: Refrigerant suction.
- 19. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

#### 1.2 RELATED WORK

- A. Section 07 84 00, FIRESTOPPING: Mineral fiber and bond breaker behind sealant.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- C. Section 22 05 19, METERS AND GAGES FOR PLUMBING PIPING and Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING: Hot and cold water piping.
- D.
- E. Section 23 23 00, REFRIGERANT PIPING: Requirements for refrigerant piping and fittings.
- F. Section 23 21 13, HYDRONIC PIPING
- G. Section 23 31 00, HVAC DUCTS AND CASINGS: Ductwork, plenum and fittings.

#### 1.3 QUALITY ASSURANCE

- A. Refer to article QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Criteria:
  - 1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through 4.3.3.6, 4.3.10.2.6, and 5.4.6.4:
    - a. 4.3.3.1 - Pipe insulation and coverings, duct coverings, duct linings, vapor retarder facings, adhesives, fasteners, tapes, and supplementary materials added to air ducts, plenums, panels, and duct silencers used in duct systems, unless otherwise provided

for in 4.3.3.1.2 or 4.3.3.1.3, shall have, in the form in which they are used, a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

- b. 4.3.3.1.1 - Where these products are to be applied with adhesives, they shall be tested with such adhesives applied, or the adhesives used shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50 when in the final dry state. (See 4.2.4.2.)
- c. 4.3.3.1.2 - The flame spread and smoke developed index requirements of 4.3.3.1.1 shall not apply to air duct weatherproof coverings where they are located entirely outside of a building, do not penetrate a wall or roof, and do not create an exposure hazard.
- d. 4.3.3.1.3 - Smoke detectors required by 6.4.4 shall not be required to meet flame spread index or smoke developed index requirements.
- e. 4.3.3.2 - Closure systems for use with rigid and flexible air ducts tested in accordance with UL 181, Standard for Safety Factory-Made Air Ducts and Air Connectors, shall have been tested, listed, and used in accordance with the conditions of their listings, in accordance with one of the following:
  - (1)UL 181A, Standard for Safety Closure Systems for Use with Rigid Air Ducts and Air Connectors
  - (2)UL 181B, Standard for Safety Closure Systems for Use with Flexible Air Ducts and Air Connectors
- f. 4.3.3.3 - Air duct, panel, and plenum coverings and linings, and pipe insulation and coverings shall not flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C 411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service.
- g. 4.3.3.3.1 - In no case shall the test temperature be below 121°C (250°F).

- h. 4.3.3.4 - Air duct coverings shall not extend through walls or floors that are required to be fire stopped or required to have a fire resistance rating, unless such coverings meet the requirements of 5.4.6.4.
- i. 4.3.3.5 - Air duct linings shall be interrupted at fire dampers to prevent interference with the operation of devices.
- j. 4.3.3.6 - Air duct coverings shall not be installed so as to conceal or prevent the use of any service opening.
- k. 4.3.10.2.6 - Materials exposed to the airflow shall be noncombustible or limited combustible and have a maximum smoke developed index of 50 or comply with the following.
  - l. 4.3.10.2.6.1 - Electrical wires and cables and optical fiber cables shall be listed as noncombustible or limited combustible and have a maximum smoke developed index of 50 or shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
  - m. 4.3.10.2.6.2 - Pneumatic tubing for control systems shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 1820, Standard for Safety Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics.
  - n. 4.3.10.2.6.3 - Nonferrous fire sprinkler piping shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 1887, Standard for Safety Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.
  - o. 4.3.10.2.6.4 - Optical-fiber and communication raceways shall be listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.5 m (5 ft) or less when tested in accordance with UL 2024, Standard for Safety Optical-Fiber Cable Raceway.

- p. 4.3.10.2.6.5 - Loudspeakers and recessed lighting fixtures, including their assemblies and accessories, shall be permitted in the ceiling cavity plenum where listed as having a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a peak heat release rate of 100 kW or less when tested in accordance with UL 2043, Standard for Safety Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.
  - q. 4.3.10.2.6.6 - Supplementary materials for air distribution systems shall be permitted when complying with the provisions of 4.3.3.
  - r. 4.3.10.2.6.7 - Smoke detectors shall not be required to meet the provisions of this section.
  - s. 5.4.6.4 - Where air ducts pass through walls, floors, or partitions that are required to have a fire resistance rating and where fire dampers are not required, the opening in the construction around the air duct shall be as follows:
    - 1) Not exceeding a 25.4 mm (1 in.) average clearance on all sides
    - 2) Filled solid with an approved material capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subjected to the time-temperature fire conditions required for fire barrier penetration as specified in NFPA 251, Standard Methods of Tests of Fire Endurance of Building Construction and Materials
- 2. Test methods: ASTM E84, UL 723, or NFPA 255.
  - 3. Specified k factors are at 24 degrees C (75 degrees F) mean temperature unless stated otherwise. Where optional thermal insulation material is used, select thickness to provide thermal conductance no greater than that for the specified material. For pipe, use insulation manufacturer's published heat flow tables. For domestic hot water supply and return, run out insulation and condensation control insulation, no thickness adjustment need be made.
  - 4. All materials shall be compatible and suitable for service temperature, and shall not contribute to corrosion or otherwise attack surface to which applied in either the wet or dry state.

- C. Every package or standard container of insulation or accessories delivered to the job site for use must have a manufacturer's stamp or label giving the name of the manufacturer and description of the material.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings:
  - 1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM, federal and military specifications.
    - a. Insulation materials: Specify each type used and state surface burning characteristics.
    - b. Insulation facings and jackets: Each type used. Make it clear that white finish will be furnished for exposed ductwork, casings and equipment.
    - c. Insulation accessory materials: Each type used.
    - d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation.
    - e. Make reference to applicable specification paragraph numbers for coordination.

#### **1.5 STORAGE AND HANDLING OF MATERIAL**

Store materials in clean and dry environment, pipe covering jackets shall be clean and unmarred. Place adhesives in original containers. Maintain ambient temperatures and conditions as required by printed instructions of manufacturers of adhesives, mastics and finishing cements.

#### **1.6 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.
- B. Federal Specifications (Fed. Spec.):
  - L-P-535E (3)-99.....Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.
- C. Military Specifications (Mil. Spec.):



Long Island National Cemetery  
Administration / Public Restroom  
Renovation and New Equipment Building

VA Project# 815 CM 3038  
June 16, 2014

MIL-A-3316C (2)-90.....Adhesives, Fire-Resistant, Thermal Insulation  
MIL-A-24179A (2)-91.....Adhesive, Flexible Unicellular-Plastic Thermal  
Insulation  
MIL-C-19565C (1)-88.....Coating Compounds, Thermal Insulation, Fire-and  
Water-Resistant, Vapor-Barrier  
MIL-C-20079H-87.....Cloth, Glass; Tape, Textile Glass; and Thread,  
Glass and Wire-Reinforced Glass

D. American Society for Testing and Materials (ASTM):

A167-04.....Standard Specification for Stainless and  
Heat-Resisting Chromium-Nickel Steel Plate,  
Sheet, and Strip  
B209-07.....Standard Specification for Aluminum and  
Aluminum-Alloy Sheet and Plate  
C411-05.....Standard test method for Hot-Surface  
Performance of High-Temperature Thermal  
Insulation  
C449-07.....Standard Specification for Mineral Fiber  
Hydraulic-Setting Thermal Insulating and  
Finishing Cement  
C534-08.....Standard Specification for Preformed Flexible  
Elastomeric Cellular Thermal Insulation in  
Sheet and Tubular Form  
C547-07.....Standard Specification for Mineral Fiber pipe  
Insulation  
C552-07.....Standard Specification for Cellular Glass  
Thermal Insulation  
C553-08.....Standard Specification for Mineral Fiber  
Blanket Thermal Insulation for Commercial and  
Industrial Applications  
C585-90.....Standard Practice for Inner and Outer Diameters  
of Rigid Thermal Insulation for Nominal Sizes  
of Pipe and Tubing (NPS System) R (2004)  
C612-04.....Standard Specification for Mineral Fiber Block  
and Board Thermal Insulation  
C1126-04.....Standard Specification for Faced or Unfaced  
Rigid Cellular Phenolic Thermal Insulation

- C1136-08.....Standard Specification for Flexible, Low  
Permeance Vapor Retarders for Thermal  
Insulation
- D1668-97a (2006).....Standard Specification for Glass Fabrics (Woven  
and Treated) for Roofing and Waterproofing
- E84-09.....Standard Test Method for Surface Burning  
Characteristics of Building Materials
- E119-08.....Standard Test Method for Fire Tests of Building  
Construction and Materials
- E136-09.....Standard Test Methods for Behavior of Materials  
in a Vertical Tube Furnace at 750 degrees C  
(1380 F)
- E. National Fire Protection Association (NFPA):
  - 90A-08.....Installation of Air Conditioning and  
Ventilating Systems
  - 101-08.....Life Safety Code
  - 251-06.....Standard methods of Tests of Fire Endurance of  
Building Construction Materials
  - 255-06.....Standard Method of tests of Surface Burning  
Characteristics of Building Materials
- F. Underwriters Laboratories, Inc (UL):
  - 723.....UL Standard for Safety Test for Surface Burning  
Characteristics of Building Materials with  
Revision of 09/08
- G. Manufacturer's Standardization Society of the Valve and Fitting  
Industry (MSS):
  - SP58-2002.....Pipe Hangers and Supports Materials, Design,  
and Manufacture

## **PART 2 - PRODUCTS**

### **2.1 MINERAL FIBER**

- B. ASTM C553 (Blanket, Flexible) Type I, Class B-3, Density 16 kg/m<sup>3</sup> (1  
pcf), k = 0.045 (0.31), for use at temperatures up to 204 degrees C  
(400 degrees F)
- C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation),  
Class 1, k = 0.037 (0.26) for use at temperatures 230 degrees C (450  
degrees F).

## **2.2 MINERAL WOOL OR REFRACTORY FIBER**

- A. Comply with Standard ASTM C612, Class 3, 450 degrees C (850 degrees F).

## **2.3 RIGID CELLULAR PHENOLIC FOAM**

- A. Preformed (molded) pipe insulation, ASTM C1126, type III, grade 1,  $k = 0.021(0.15)$ , for temperatures up to 121 degrees C (250 degrees F) with vapor retarder and all service jacket with polyvinyl chloride premolded fitting covering.
- B. Equipment and Duct Insulation, ASTM C 1126, type II, grade 1,  $k = 0.021(0.15)$ , for temperatures up to 121 degrees C (250 degrees F) with rigid cellular phenolic insulation and covering, vapor retarder and all service jacket.

## **2.4 CELLULAR GLASS CLOSED-CELL**

- A. Comply with Standard ASTM C177, C518, density 120 kg/m<sup>3</sup> (7.5 pcf) nominal,  $k = 0.033(0.29)$  at 0 degrees C (75 degrees F).
- B. Pipe insulation for temperatures up to 200 degrees C (400 degrees F).

## **2.6 FLEXIBLE ELASTOMERIC CELLULAR THERMAL**

- A. ASTM C177, C518,  $k = 0.039$  Watt per meter, per degree C (0.27), at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for temperatures from minus 4 degrees C (40 degrees F) to 93 degrees C (200 degrees F). No jacket required.

## **2.7 INSULATION FACINGS AND JACKETS**

- A. Vapor Retarder, higher strength with low water permeance = 0.02 or less perm rating, Beach puncture 50 units for insulation facing on exposed ductwork, casings and equipment, and for pipe insulation jackets. Facings and jackets shall be all service type (ASJ) or PVDC Vapor Retarder jacketing.
- B. ASJ jacket shall be white kraft bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture 5 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 100 mm (4 inch) butt strip on end joints. Butt strip material shall be same as the jacket. Lap and butt strips shall be self-sealing type with factory-applied pressure sensitive adhesive.
- C. Vapor Retarder medium strength with low water vapor permeance of 0.02 or less perm rating), Beach puncture 25 units: Foil-Scrim-Kraft (FSK)

or PVDC vapor retarder jacketing type for concealed ductwork and equipment.

- D. Glass Cloth Jackets: Presized, minimum 0.18 kg per square meter (7.8 ounces per square yard), 2000 kPa (300 psig) bursting strength with integral vapor retarder where required or specified. Weather proof if utilized for outside service.
- E. Factory composite materials may be used provided that they have been tested and certified by the manufacturer.
- F. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be polyvinyl chloride (PVC) conforming to Fed Spec L-P-335, composition A, Type II Grade GU, and Type III, minimum thickness 0.7 mm (0.03 inches). Provide color matching vapor retarder pressure sensitive tape.
- G. Aluminum Jacket-Piping systems and circular breeching and stacks: ASTM B209, 3003 alloy, H-14 temper, 0.6 mm (0.023 inch) minimum thickness with locking longitudinal joints. Jackets for elbows, tees and other fittings shall be factory-fabricated to match shape of fitting and of 0.6 mm (0.024) inch minimum thickness aluminum. Fittings shall be of same construction as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel bands shall be installed on all circumferential joints. Bands shall be 20 mm (0.75 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.
- H. Aluminum jacket-Rectangular breeching: ASTM B209, 3003 alloy, H-14 temper, 0.5 mm (0.020 inches) thick with 32 mm (1-1/4 inch) corrugations or 0.8 mm (0.032 inches) thick with no corrugations. System shall be weatherproof if used for outside service.

## 2.8 PIPE COVERING PROTECTION SADDLES

- A. Cold pipe support: Premolded pipe insulation 180 degrees (half-shells) on bottom half of pipe at supports. Material shall be cellular glass or high density Polyisocyanurate insulation of the same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m<sup>3</sup> (3.0 pcf).

Nominal Pipe Size and Accessories Material (Insert Blocks)	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
Up through 125 (5)	150 (6) long

- B. Warm or hot pipe supports: Premolded pipe insulation (180 degree half-shells) on bottom half of pipe at supports. Material shall be high density Polyisocyanurate (for temperatures up to 149 degrees C [300 degrees F]) cellular glass. Insulation at supports shall have same thickness as adjacent insulation. Density of Polyisocyanurate insulation shall be a minimum of 48 kg/m<sup>3</sup> (3.0 pcf).

#### **2.9 ADHESIVE, MASTIC, CEMENT**

- A. Mil. Spec. MIL-A-3316, Class 1: Jacket and lap adhesive and protective finish coating for insulation.
- B. Mil. Spec. MIL-A-3316, Class 2: Adhesive for laps and for adhering insulation to metal surfaces.
- C. Mil. Spec. MIL-A-24179, Type II Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.
- D. Mil. Spec. MIL-C-19565, Type I: Protective finish for outdoor use.
- E. Mil. Spec. MIL-C-19565, Type I or Type II: Vapor barrier compound for indoor use.
- F. ASTM C449: Mineral fiber hydraulic-setting thermal insulating and finishing cement.
- G. Other: Insulation manufacturers' published recommendations.

#### **2.10 MECHANICAL FASTENERS**

- A. Pins, anchors: Welded pins, or metal or nylon anchors with tin-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
- B. Staples: Outward clinching monel or stainless steel.
- C. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy.
- D. Bands: 20 mm (3/4 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

#### **2.11 REINFORCEMENT AND FINISHES**

- A. Glass fabric, open weave: ASTM D1668, Type III (resin treated) and Type I (asphalt treated).
- B. Glass fiber fitting tape: Mil. Spec MIL-C-20079, Type II, Class 1.
- C. Tape for Flexible Elastomeric Cellular Insulation: As recommended by the insulation manufacturer.

- D. Hexagonal wire netting: 25 mm (one inch) mesh, 0.85 mm thick (22 gage) galvanized steel.
- E. Corner beads: 50 mm (2 inch) by 50 mm (2 inch), 0.55 mm thick (26 gage) galvanized steel; or, 25 mm (1 inch) by 25 mm (1 inch), 0.47 mm thick (28 gage) aluminum angle adhered to 50 mm (2 inch) by 50 mm (2 inch) Kraft paper.
- F. PVC fitting cover: Fed. Spec L-P-535, Composition A, 11-86 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 4 degrees C (40 degrees F) to 121 degrees C (250 degrees F). Below 4 degrees C (40 degrees F) and above 121 degrees C (250 degrees F). Provide double layer insert. Provide color matching vapor barrier pressure sensitive tape.

## **2.12 FIRESTOPPING MATERIAL**

- A. Other than pipe and duct insulation, refer to Section 07 84 00 FIRESTOPPING.

## **2.13 FLAME AND SMOKE**

- A. Unless shown otherwise all assembled systems shall meet flame spread 25 and smoke developed 50 rating as developed under ASTM, NFPA and UL standards and specifications. See paragraph 1.3 "Quality Assurance".

## **PART 3 - EXECUTION**

### **3.1 GENERAL REQUIREMENTS**

- A. Required pressure tests of duct and piping joints and connections shall be completed and the work approved by the Resident Engineer for application of insulation. Surface shall be clean and dry with all foreign materials, such as dirt, oil, loose scale and rust removed.
- B. Except for specific exceptions, insulate entire specified equipment, piping (pipe, fittings, valves, accessories), and duct systems. Insulate each pipe and duct individually. Do not use scrap pieces of insulation where a full length section will fit.
- C. Insulation materials shall be installed in a first class manner with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A). Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 16 degrees C (60 degrees F) and below. Lap and seal vapor barrier over ends and

- exposed edges of insulation. Anchors, supports and other metal projections through insulation on cold surfaces shall be insulated and vapor sealed for a minimum length of 150 mm (6 inches).
- D. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.
- E. Construct insulation on parts of equipment such as chilled water pumps and heads of chillers, convertors and heat exchangers that must be opened periodically for maintenance or repair, so insulation can be removed and replaced without damage. Install insulation with bolted 1 mm thick (20 gage) galvanized steel or aluminum covers as complete units, or in sections, with all necessary supports, and split to coincide with flange/split of the equipment.
- F. Insulation on hot piping and equipment shall be terminated square at items not to be insulated, access openings and nameplates. Cover all exposed raw insulation with white sealer or jacket material.
- G. Protect all insulations outside of buildings with aluminum jacket using lock joint or other approved system for a continuous weather tight system. Access doors and other items requiring maintenance or access shall be removable and sealable.
- H. HVAC work not to be insulated:
1. Internally insulated ductwork and air handling units.
  2. Relief air ducts (Economizer cycle exhaust air).
  3. Exhaust air ducts and plenums, and ventilation exhaust air shafts.
  4. Equipment: Expansion tanks and hot water pumps.
  5. In hot piping: Unions, flexible connectors, control valves, PRVs, safety valves and discharge vent piping. Insulate piping to within approximately 75 mm (3 inches) of uninsulated items.
- I. Plumbing work not to be insulated:
1. Piping and valves of fire protection system.
  2. Chromium plated brass piping.
  3. Water piping in contact with earth.
  4. Piping in pipe basement serving wall hydrants.
  5. Small horizontal cold water branch runs in partitions to individual fixtures may be without insulation for maximum distance of 900 mm (3 feet).

- J. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- K. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. The elbow/ fitting insulation shall be field-fabricated, mitered or factory prefabricated to the necessary size and shape to fit on the elbow/ fitting. Use of polyurethane spray-foam to fill a PVC elbow jacket is prohibited on cold applications.
- L. Firestop Pipe and Duct insulation:
  - 1. Provide firestopping insulation at fire and smoke barriers through penetrations. Fire stopping insulation shall be UL listed as defines in Section 07 84 00, FIRESTOPPING.
  - 2. Pipe and duct penetrations requiring fire stop insulation including, but not limited to the following:
    - a. Pipe risers through floors
    - b. Pipe or duct chase walls and floors
    - c. Smoke partitions
    - d. Fire partitions
- N. Provide metal jackets over insulation as follows:
  - 1. All piping and ducts exposed to outdoor weather.
  - 2. Piping exposed in building, within 1800 mm (6 feet) of the floor, that connects to sterilizers, kitchen and laundry equipment. Jackets may be applied with pop rivets. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.
  - 3. A 50 mm (2 inch) overlap is required at longitudinal and circumferential joints.

### 3.2 INSULATION INSTALLATION

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b.

#### B. Flexible Mineral Fiber Blanket:

- 1. Adhere insulation to metal with 100 mm (4 inch) wide strips of insulation bonding adhesive at 200 mm (8 inches) on center all



around duct. Additionally secure insulation to bottom of ducts exceeding 600 mm (24 inches) in width with pins welded or adhered on 450 mm (18 inch) centers. Secure washers on pins. Butt insulation edges and seal joints with laps and butt strips. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations with mastic. Sagging duct insulation will not be acceptable. Install firestop duct insulation where required.

2. Supply air ductwork to be insulated includes main and branch ducts from AHU discharge to room supply outlets, and the bodies of ceiling outlets to prevent condensation. Insulate sound attenuator units, coil casings and damper frames. To prevent condensation insulate trapeze type supports and angle iron hangers for flat oval ducts that are in direct contact with metal duct.
  3. Concealed supply air ductwork.
    - a. Above ceilings at a roof level: 50 mm (2 inch) thick insulation faced with FSK.
    - b. Above ceilings for other than roof level: 40 mm (1 ½ inch) thick insulation faced with FSK.
  4. Concealed return air duct above ceilings at a roof level, unconditioned areas, and in chases with external wall; 40 mm (1-1/2 inch) thick, insulation faced with FSK. Concealed return air ductwork in other locations need not be insulated.
  - 5.
  6. Concealed outside air duct: 40 mm (1-1/2 inch) thick insulation faced with FSK.
- C. Molded Mineral Fiber Pipe and Tubing Covering:
1. Fit insulation to pipe or duct, aligning longitudinal joints. Seal longitudinal joint laps and circumferential butt strips by rubbing hard with a nylon sealing tool to assure a positive seal. Staples may be used to assist in securing insulation. Seal all vapor retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide inserts and install with metal insulation shields at outside pipe supports. Install freeze protection insulation over heating cable.
  2. Contractor's options for fitting, flange and valve insulation:

- a. Insulating and finishing cement for sizes less than 100 mm (4 inches) operating at surface temperature of 16 degrees C (61 degrees F) or more.
  - b. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts. Provide two insert layers for pipe temperatures below 4 degrees C (40 degrees F), or above 121 degrees C (250 degrees F). Secure first layer of insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.
  - c. Factory molded, ASTM C547 or field mitered sections, joined with adhesive or wired in place. For hot piping finish with a smoothing coat of finishing cement. For cold fittings, 16 degrees C (60 degrees F) or less, vapor seal with a layer of glass fitting tape imbedded between two 2 mm (1/16 inch) coats of vapor barrier mastic.
  - d. Fitting tape shall extend over the adjacent pipe insulation and overlap on itself at least 50 mm (2 inches).
3. Nominal thickness in millimeters and inches specified in table below, for piping above ground:

SPEC WRITER NOTES: Insulate vent piping for PRV safety valves, receivers and flash tanks where protection to personnel is required.

Nominal Thickness of Molded Mineral Fiber Insulation		
Nominal Pipe Size, millimeters (inches):	25 (1) & below	32- 75 (1-1/4-3)
a. Domestic hot water supply and return	15 (0.5)	20(0.75)

D. Rigid Cellular Phenolic Foam:

1. Rigid closed cell phenolic insulation may be provided for piping, ductwork and equipment for temperatures up to 121 degrees C (250 degrees F).

2. Note the NFPA 90A burning characteristics requirements of 25/50 in paragraph 1.3.B
3. Provide secure attachment facilities such as welding pins.
4. Apply insulation with joints tightly drawn together
5. Apply adhesives, coverings, neatly finished at fittings, and valves.
6. Final installation shall be smooth, tight, neatly finished at all edges.
7. Minimum thickness in millimeters (inches) specified in table below, for piping above ground:

Nominal Thickness of Rigid Closed-Cell Phenolic Foam Insulation			
Nominal Pipe Size millimeters (inches):	25 (1) & below	32-75 (1 1/4-3)	100-150 (4-6)
1. 4-16 degrees C (40-60 degrees F), CH, CHR, GC, and GCR.	20 (0.75)	20 (0.75)	25 (1)
a. Run outs to Fan Coil Units.	15 (0.5)	--	--
1. 10 degrees C (50 degrees F) and less, RS for DX refrigerants.	15 (0.5)	20 (0.75)	--
2. Domestic hot water supply and return.	15 (0.5)	15 (0.5)	20 (0.75)

8. Condensation control insulation: Minimum 20 mm (0.75 inch) thick for all pipe sizes.
  - a. HVAC: Cooling coil condensation piping to waste piping fixture or drain inlet. Omit insulation on plastic piping in mechanical rooms.
  - b. Plumbing piping as follows:
    - 1) Body of roof and overflow drains horizontal runs and offsets (including elbows) of interior downspout piping in all areas above pipe basement.
    - 2) Waste piping from electric water coolers and icemakers to drainage system.

- 3) Waste piping located above basement floor from ice making and film developing equipment and air handling units, from fixture (including trap) to main vertical waste pipe.

SPEC WRITER NOTES: Need for insulation for cold water piping depends upon location of Cemetery.

- 4) Cold water piping.

E. Cellular Glass Insulation:

1. Pipe and tubing, covering nominal thickness in millimeters and inches as tabulated below for chilled water and refrigerant piping.

Nominal Thickness of Cellular Glass Insulation		
Millimeters (inches)	Thru 38 (1 1/2)	50- 150 (2-6)
1. 4-16 degrees C (40-60 degrees F) (CH and CHR pipe chase and underground)	50 (2.0)	80 (3.0)
2. 4-16 degrees C (40-60 degrees F) (CH and CHR)	40 (1.5)	50 (2.0)

2.

3. Cold equipment: 50 mm (2 inch) thick insulation faced with ASJ for chilled water pumps, water filters, chemical feeder pots or tanks, expansion tanks, air separators and air purgers.

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G. Flexible Elastomeric Cellular Thermal Insulation:

1. Apply insulation and fabricate fittings in accordance with the manufacturer's installation instructions and finish with two coats of weather resistant finish as recommended by the insulation manufacturer.
2. Pipe and tubing insulation:
  - a. Use proper size material. Do not stretch or strain insulation.
  - b. To avoid undue compression of insulation, provide cork stoppers or wood inserts at supports as recommended by the insulation manufacturer. Insulation shields are specified under Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

- c. Where possible, slip insulation over the pipe or tubing prior to connection, and seal the butt joints with adhesive. Where the slip-on technique is not possible, slit the insulation and apply it to the pipe sealing the seam and joints with contact adhesive. Optional tape sealing, as recommended by the manufacturer, may be employed. Make changes from mineral fiber insulation in a straight run of pipe, not at a fitting. Seal joint with tape.
3. Apply sheet insulation to flat or large curved surfaces with 100 percent adhesive coverage. For fittings and large pipe, apply adhesive to seams only.
4. Pipe insulation: nominal thickness in millimeters (inches as specified in table below for piping above ground:

Nominal Thickness of Flexible Elastomeric Cellular Insulation		
Nominal Pipe Size millimeters (inches)	25 (1) & below	32-75 (1 1/4-3)
1. 4-16 degrees C (40-60 degrees F) (CH, CHR, GC, GCR)	25 (1.0)	40 (1.5)
a. Runouts to fan coil units cooling coil condensate piping	20 (0.75)	40 (1.5)
b. / RS for DX refrigeration	25 (1.0)	40 (1.5)
2. Domestic hot water supply and return	15 (0.50)	20 (0.75)

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**SECTION 23 08 00**

**COMMISSIONING OF HVAC SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section apply to all sections of Division 23.
- B. This project will have selected building systems commissioned. HVAC equipment and systems are to be commissioned. A Commissioning Agent (CxA) will manage the commissioning process.

**1.2 COMMISSIONED SYSTEMS**

- A. Commissioning of the systems specified in Division 23 is part of the construction process. Documentation and testing of these systems is required in cooperation with the VA and the Commissioning Agent.
- B. The HVAC systems to be commissioned include: exhaust fans, unit heaters, energy recovery ventilators, and the VRV system.

**1.3 SUBMITTALS**

- A. The commissioning process requires review of start-up reports or installation inspection checklists for the equipment to be commissioned. The Contractor shall submit completed start-up reports and installation inspection checklists to the Commissioning Agent for review prior to functional performance testing.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.1 CONTRACTORS TESTS**

- A. Contractor tests as required by other sections of Division 23 shall be scheduled and documented. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

**3.2 SYSTEMS FUNCTIONAL PERFORMANCE TESTING:**

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems

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Functional Performance Test procedures. The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing.

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