



## Renovate A & B Wing Building 6 | Topeka VAMC

Project Number: 589A5-18-116

Bid Documents | Specifications - Volume II of III

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**A Service-Disabled Veteran-Owned Small Business**





**SECTION 10 11 13  
CHALKBOARDS AND MARKERBOARDS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

A. This section specifies markerboards.

**1.2 RELATED WORK**

B. Manufacturer, Color, and Style of Markerboards: Section 09 06 00,  
SCHEDULE FOR FINISHES.

**1.3 QUALITY ASSURANCE**

A. Provide boards that are the products of a single manufacturer, who has  
provided units as specified for a minimum of three (3) years.

**1.4 SUBMITTALS**

A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA  
AND SAMPLES.

C. Shop Drawings: Identifying all parts by name and material and showing  
design, construction, installation, anchorage and relation to adjacent  
construction.

D. Manufacturer's Literature and Data:

2. Markerboard.

E. Samples:

1. Markerboard writing surface, 152 x 152 mm (6 x 6 inches), each  
color, and texture mounted on backing.

2. Frame material, 305 mm (6 inch) length.

F. Manufacturer's qualifications.

**1.5 WARRANTY**

A. Construction Warranty: Comply with FAR clause 52.246-21, "Warranty of  
Construction".

**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 the  
basic designation only.

B. American Architectural Manufacturers Association (AAMA):

611-14.....Anodized Architectural Aluminum

2603-13.....Voluntary Specification, Performance

Requirements and Test Procedures for Pigmented  
Organic Coatings on Aluminum Extrusions and  
Panels

- C. American National Standards (ANSI):
  - Z97.1-09(R2010).....Safety Glazing Materials Used in Buildings -  
Safety Performance Specifications and Methods  
of Test
- D. ASTM International (ASTM):
  - B221-14.....Aluminum and Aluminum Alloy Extruded Bars,  
Rods, Wire, Shapes and Tubes
  - B221M-13.....Aluminum and Aluminum Alloy Extruded Bars,  
Rods, Wire, Shapes and Tubes (Metric)
  - C1048-12.....Heat-Treated Flat Glass-Kind HS, Kind FT Coated  
and Uncoated Glass
- E. Code of Federal Regulation (CFR):
  - 40 CFR 59.....Determination of Volatile Matter Content, Water  
Content, Density Volume Solids, and Weight  
Solids of Surface Coating
- F. Composite Panel Association (CPA):
  - A208.1-09.....Particleboard
  - A135.4-12.....Basic Hardboard
- G. National Association of Architectural Metal Manufacturers (NAAMM):
  - AMP 500-06.....Metal Finishes Manual
- H. Porcelain Enamel Institute (PEI)
  - 1001-11.....Architectural Porcelain Enamel

**PART 2 - PRODUCTS**

**2.1 MARKERBOARD**

- A. Provide markerboard with porcelain enamel writing surface and chalktray.
- B. Provide factory assembled unit complete in one (1) piece, without joints whenever possible. When markerboard dimensions require delivery in separate sections, prefit components at factory, disassembled for delivery and fit joints at site.
- C. Frame: Aluminum.
- D. Marker Tray: Same material as frame extend full length of markerboard.
- E. Map Rail: Not required.
- F. Provide surface such that dry erase markings are removable with felt eraser or dry cloth without ghosting.
- G. Provide face fabricated from ferromagnetic material.

**2.2 ACCESSORIES:**

- A. Provide each markerboard with an eraser and four (4) different color compatible dry erase markers.

**2.3 MATERIALS**

A. Writing Surface:

- 1. Provide markerboard writing surface composed of porcelain enamel fused to nominal 0.378 mm (28 gauge) thick steel. Laminate to a minimum 6 mm (1/4 inch) thick core material with a steel or foil backing sheet.

B. Aluminum:

- 1. Aluminum frame extrusions to be alloy 6063-T5 or 6063-T6, conform to ASTM B221M (B221). Minimum 1.5 mm (0.06 inches) thick.
- 2. Provide straight, single lengths wherever possible.
- 3. Miter corners to have hairline closure.

D. Glass:

- 1. Provide tempered glass in accordance with ANSI Z97.1 and conform to ASTM C1048, Kind FT (fully tempered), Condition A (uncoated), Type I, Class I (clear).

E. Adhesives:

- 1. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.
- 2. Adhesives to have VOC content of 50 g/L or less when calculated according to 40 CFR 59, (EPA Method 24).

**2.4 GENERAL FINISH REQUIREMENTS**

- A. Comply with NAAMM's AMP 500 Series for Architectural and Metal Products for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

**2.5 ALUMINUM FINISHES**

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm (.39 mil) or thicker.

**PART 3 - EXECUTION**

**3.1 INSTALLATION, GENERAL**

- A. Install units in accordance with the manufacturer's installation instructions with concealed fasteners.
- B. Verify partitions have received blocking and reinforcement before installation of markerboards.
- C. Assemble units in accordance with manufacturer's written instructions.
- D. Grounds Designed to Receive Clips for Snap-On Trim: Continuous and secured 305 mm (12 inches) on center.
- E. Miter trim at corners, conceal fasteners. Modify trim as required to conform to surrounding construction details.

**3.2 CLEANING**

- A. Clean in accordance with manufacturers' written instructions.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.

- - - E N D - - -

**SECTION 10 14 00**  
**SIGNAGE**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies interior signage for room numbers, directional signs exterior signage, code required signs and temporary signs.
- B. This section specifies exterior signage.

**1.2 RELATED WORK**

- A. Electrical Work: Division 26, ELECTRICAL.
- B. Lighted EXIT signs for egress purposes are specified under Division 26, ELECTRICAL.
- C. Color and Finish of Interior Signs: Section 09 06 00, SCHEDULE FOR FINISHES.

**1.3 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Provide signage that is the product of one manufacturer, who has provided signage as specified for a minimum of three (3) years. Submit manufacturer's qualifications.
- B. Installer's Qualifications: Minimum three (3) years' experience in the installation of signage of the type as specified in this Section. Submit installer's qualifications.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 00, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- B. Interior Sign Samples: Sign panels and frames, with letters and symbols, for each sign type.
  - 1. Sign Panel, 203 x 254 mm (8 x 10 inches), with letters.
  - 2. Color samples of each color, 152 x 152 mm (6 x 6 inches). Show anticipated range of color and texture.
  - 3. Sample of typeface, arrow and symbols in a typical full size layout.
- C. Exterior Sign Samples: 152 x 152 mm (6 x 6 inches) samples of each color and material.
- D. Manufacturer's Literature:
  - 1. Showing the methods and procedures proposed for the anchorage of the signage system to each surface type.
  - 2. Manufacturer's printed specifications and maintenance instructions.
- E. Sign Location Plan, showing location, type and total number of signs required.

- F. Shop Drawings: Scaled for manufacture and fabrication of sign types. Identify materials, show joints, welds, anchorage, accessory items, mounting and finishes.
- G. Full size layout patterns for dimensional letters.
- H. Manufacturer's qualifications.
- I. Installer's qualifications.

**1.5 DELIVERY AND STORAGE**

- A. Deliver materials to job in manufacturer's original sealed containers with brand name marked thereon. Protect materials from damage.
- B. Package to prevent damage or deterioration during shipment, handling, storage and installation. Maintain protective covering in place and in good repair until removal is necessary.
- C. Deliver signs only when the site and mounting services are ready for installation work to proceed.
- D. Store products in dry condition inside enclosed facilities.

**1.6 WARRANTY**

- A. Construction Warranty: Comply with FAR clause 52.246-21, "Warranty of Construction".

**1.7 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 Architectural Manufacturers Association (AAMA):
  - 611-14.....Anodized Architectural Aluminum
  - 2603-13.....Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels
- C. American National Standards Institute (ANSI):
  - A117.1-09.....Accessible and Usable Buildings and Facilities
- D. ASTM International (ASTM):
  - A36/A36M-14.....Carbon Structural Steel
  - A240/A240M-15.....Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
  - A666-10.....Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar



- A1011/A1011M-14.....Steel, Sheet and Strip, Hot-Rolled, Carbon,  
Structural, High-Strength Low-Alloy, High-  
Strength Low-Alloy with Improved Formability,  
and Ultra-High Strength
- B36/B36M-13.....Brass Plate, Sheet, Strip, and Rolled Bar
- B152/B152M-13.....Copper Sheet, Strip, Plate, and Rolled Bar
- B209-14.....Aluminum and Aluminum-Alloy Sheet and Plate
- B209M-14.....Aluminum and Aluminum-Alloy Sheet and Plate  
(Metric)
- B221-14.....Aluminum and Aluminum-Alloy Extruded Bars,  
Rods, Wire, Shapes, and Tubes
- B221M-13.....Aluminum and Aluminum-Alloy Extruded Bars,  
Rods, Wire, Shapes, and Tubes (Metric)
- C1036-11(R2012).....Flat Glass
- C1048-12.....Heat-Treated Flat Glass-Kind HS, Kind FT Coated  
and Uncoated Glass
- C1349-10.....Architectural Flat Glass Clad Polycarbonate
- D1003-13.....Test Method for Haze and Luminous Transmittance  
of Transparent Plastics
- D4802-10.....Poly(Methyl Methacrylate) Acrylic Plastic Sheet
- E. Code of Federal Regulation (CFR):
- 40 CFR 59.....Determination of Volatile Matter Content, Water  
Content, Density Volume Solids, and Weight  
Solids of Surface Coating
- F. Federal Specifications (Fed Spec):
- MIL-PRF-8184F.....Plastic Sheet, Acrylic, Modified.
- MIL-P-46144C.....Plastic Sheet, Polycarbonate
- G. National Fire Protection Association (NFPA):
- 70-14.....National Electrical Code

**PART 2 - PRODUCTS**

**2.1 SIGNAGE GENERAL**

- A. Provide signs of type, size and design shown on the construction documents.
- B. Provide signs complete with lettering, framing and related components for a complete installation.

- C. Provide graphics items as completed units produced by a single manufacturer, including necessary mounting accessories, fittings and fastenings.
- D. Do not scale construction documents for dimensions. Verify dimensions and coordinate with field conditions. Notify Contracting Officer Representative (COR) of discrepancies or changes needed to satisfy the requirements of the construction documents.

## **2.2 INTERIOR SIGN MATERIALS**

- A. Aluminum:
  - 1. Sheet and Plate: ASTM B209M (B209).
  - 2. Extrusions and Tubing: ASTM B221M (B221).
- B. Cast Acrylic Sheet: MIL-PRF-8184F; Type II, class 1, Water white non-glare optically clear. Matt finish water white clear acrylic shall not be acceptable.
- C. Polycarbonate: MIL-P-46144C; Type I, class 1.
- D. Vinyl: Premium grade 0.1 mm (0.004 inch) thick machine cut, having a pressure sensitive adhesive and integral colors.
- E. Adhesives:
  - 1. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by signage manufacturer.
  - 2. Adhesives to have VOC content of 50 g/L or less when calculated according to 40 CFR 59, (EPA Method 24).
- F. Typography: Comply with VA Signage Design Guide.
  - 1. Type Style: Helvetica Medium and Helvetica Medium Condensed. Initial caps or all caps, as indicated in Sign Message Schedule.
  - 2. Arrow: Comply with graphic standards in construction documents.
  - 3. Letter spacing: Comply with graphic standards in construction documents.
  - 4. Letter spacing: Comply with graphic standards in construction documents.
  - 5. Provide text, arrows, and symbols in size, colors, typefaces and letter spacing shown in construction documents. Text shall be a true, clean, accurate reproduction of typeface(s). Text shown in construction documents is for layout purposes only; final text for signs is listed in Sign Message Schedule.

### 2.3 EXTERIOR SIGN MATERIALS

- A. Aluminum Sheet and Plate: ASTM B209M (B209).
- B. Aluminum Extrusions: ASTM B221M (B221).
- C. Brass Sheet (Yellow Brass): ASTM B36/B36M.
- D. Bronze Plate: ASTM B36/B36M.
- E. Copper Sheet: ASTM B152/B152M.
- F. Steel Products: Structural steel products that conform to ASTM A36/A36M. Sheet and strip steel products that conform to ASTM A1011/A1011M.
- G. Stainless Steel Sheet: ASTM A240/A240M, stretcher leveled standard of flatness.
- H. Acrylic Sheet: ASTM D4802; category as standard with manufacturer for each sign. Provide type UVF.
- I. Fiberglass Sheet: Multiple laminations of glass fiber reinforced polyester resin with UV light stabilized, colorfast, nonfading, weather and stain resistant, colored polyester gel coat with manufacturer's standard finish.
- J. Polycarbonate Sheet: ASTM C1349, Appendix X1, Type II (coated, mar resistant, UV stabilized polycarbonate) with coating on both sides.
- K. Finish:
  - 1. Aluminum Finishes:
    - a. Clear Anodic Finish: AAMA 611.
  - 2. Metallic Coated Steel Finish:
    - a. Baked Enamel or Powder Coat Finish: After cleaning and pretreating, apply manufacturer's standard two (2) coat baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 0.05 mm (2 mils).

### 2.4 INTERIOR SIGN TYPES

- A. Conform to the VA Signage Design Guide.
- B. Provide sliding rail component system.
- C. Component System Signs:
  - 1. Provide interior sign system as follows:
    - a. Interchangeable system that allows for changes of graphic components of the installed sign, without changing sign in its entirety.
    - b. Provide sign system comprised of following primary components:

- 1) Rail Back: Horizontal rails, spaced to allow for uniform, modular sizing of sign types.
  - 2) Rail Insert: Mount to back of Copy Panels to allow for attachment to Rail Back.
  - 3) Copy Panels: Fabricate of acrylic materials to allow for different graphic needs.
  - 4) End Caps: Interlock to Rail Back to enclose and secure changeable Copy Panels.
  - 5) Joiners and Accent Joiners: To connect separate Rail Backs together.
  - 6) Top Accent Bars: To provide decorative trim cap that encloses the top of sign.
- c. Provide rail back, rail insert and end caps in anodized extruded aluminum.
  - d. Provide signs in system that are convertible in the field to allow for enlargement from one (1) size to another in height and width through use of joiners or accent joiners, which connect rail back panels together blindly, providing a butt joint between copy panels. Connect accent joiners to rail backs with a visible 3 mm (1/8") horizontal rib, flush to the adjacent copy insert surfaces.
  - e. Provide sign configurations as indicated on construction documents that vary in width from 228 mm (9 inches) to 2032 mm (80 inches), and have height dimensions of 50 mm (2 inches), 76 mm (3 inches), 152 mm (6 inches), 228 mm (9 inches) and 305 mm (12 inches). Height that can be increased beyond 305 mm (12 inches), by repeating height module in full or in part.
2. Provide rail back functions as internal structural member of sign. Fabricate of 6063T5-extruded aluminum, anodized black.
    - a. Fabricate to accept an extruded aluminum or plastic insert on either side, depending upon sign type.
    - b. Provide components that are convertible in field to allow for connection to other rail back panels.
    - c. Provide mounting devices including wall mounting for screw-on applications, wall mounting with pressure sensitive tape, freestanding mount, ceiling mount and other mounting devices as needed.

3. Provide rail insert functions as mounting device for copy panels on to the rail back. The rail insert mounts to the back of the copy panel with adhesive suitable for attaching particular copy insert material.
  - a. Provide copy panels that slide or snap into the horizontal rail back.
4. Provide copy panels that accept various forms of copy and graphics, and attach to the rail back with the rail insert. Provide copy panels fabricated of acrylic.
  - a. Provide copy panels that are interchangeable by sliding horizontally from either side of sign, and to other signs in system of equal or greater width or height.
  - b. Provide materials that are cleanable without use of special chemicals or cleaning solutions.
  - c. Copy Panel Materials.
    - 1) Changeable Paper/ Insert Holder: Extruded insert holder with integral rail insert for connection with structural back panel in 6063T5 aluminum with a black anodized finish.
      - a) Inserts into holder are paper with a clear 0.76 mm (.030 inches) textured cover.
      - b) Background Color: Painted, acrylic lacquer.
    - 2) Acrylic - 2 mm (.080 inches) non-glare acrylic.
      - a) Pressure bonded to extruded rail insert using adhesive.
      - b) Background Color: Painted in acrylic lacquer or acrylic enamel.
5. End Caps: Extruded using 6063T5 aluminum with a black anodized finish. End caps interlock with rail back with clips to form an integral unit, enclosing and securing the changeable copy panels, without requiring tools for assembly.
  - a. Interchangeable to each end of sign and to other signs in signage system of equal height.
  - b. Provide mechanical fasteners that can be added to the end caps that will secure it to rail back to make sign tamper resistant.
6. Joiners: Extruded using 6063T5 aluminum with a black anodized finish. Rail joiners connect rail backs together blindly, providing a butt joint between copy inserts.

7. Accent Joiners: Extruded using 6063T5 aluminum with a mirror polished finish. Connect joiner and rail backs together with a visible 3 mm (.125 inches) horizontal rib, flush to the adjacent copy panel surfaces.
8. Top Accent Rail: Extruded rail using 6063T5 aluminum with a mirror polished finish that provides a 3.2 mm (.125 inches) high decorative trim cap. Cap butts flush to adjacent copy panel and encloses top of rail back and copy panel.
9. Typography:
  - a. Vinyl First Surface Copy (non-tactile): Applied vinyl copy.
  - b. Subsurface Copy Inserts: Textured 1 mm (.030 inches) clear polycarbonate face with subsurface applied vinyl copy.
    - 1) Spray face back with paint and laminated to extruded aluminum carrier insert.
  - c. Integral Tactile Copy Inserts: Phenolic photopolymer etched with 2.3 mm (.0937 inches) raised copy.
  - d. Silk-screened First Surface Copy (non-tactile): Injection molded or extruded ABS plastic insert with first surface applied enamel silk-screened copy.
- D. Tactile Sign:
  1. Tactile sign made from a material that provides for letters, numbers and Braille to be integral with sign. Photopolymer etched metal, sandblasted phenolic or embossed material. Do not apply letters, numbers and Braille with adhesive.
  2. Numbers, letters and Braille to be raised 0.8 mm (1/32 inches) from the background surface. The draft of the letters, numbers and Braille to be tapered, vertical and clean.
  3. Braille Dots: Conform with ANSI A117.1 for Braille position and layout; (a) Dot base diameter: 1.5 mm (.059 inches) (b) Inter-dot spacing: 2.3 mm (.090 inches) (c) Horizontal separation between cells: 6.0 mm (.241 inches) (d) Vertical separation between cells: 10.0 mm (.395 inches)
  4. Paint assembly specified color. After painting, apply white or other specified color to surface of the numbers and letters. Apply protective clear coat sealant to entire sign.
  5. Finish: Eggshell, 11 to 19 degree on a 60 degree glossmeter.

- E. Provide cork or felt on bottom or mounting bracket when sign is mounted on counter or desk.
- F. For ceiling mounted signs, provide mounting hardware on the sign that allows for sign disconnection, removal, reinstallation, and reconnection.
- G. Dimensional Letters:
  - 1. Provide dimensional letters that are mill or laser cut acrylic in size and thickness indicated in construction documents.
  - 2. Provide draft of letters perpendicular to letters face.
  - 3. Fabricate letters with square corners, such as where a letter stem and bar intersect.
  - 4. Paint letters with acrylic polyurethane.
- H. Specialty Signs:
  - 1. Small Freestanding Stanchion Sign: 57 mm (2.25 inches) polished aluminum tube mounted to weighted 356 mm (14 inches) diameter polished aluminum base. Sign bracket to hold a 6 mm (.25 inches) copy panel.
  - 2. Freestanding Informational Sign: 57 mm (2.25 inches) polished aluminum tube vertical support mounted to a weighted 356 mm (14 inches) diameter 57 mm (2.25 inches) polished aluminum base. Provide rail back mechanically connected to vertical supports with copy panel attached to front and back.
  - 3. Freestanding Informational Signs for Changeable Messages: 57 mm (2.25 inches) polished aluminum tube vertical support mounted to a weighted 365 mm (14 inches) 57 mm (2.25 inches) polished aluminum base. Provide rail back mechanically connected to vertical supports with hinged locking glass door. Provide interior surface with grooved felt covered changeable letter board or vinyl impregnated tackboard.
  - 4. Card or Paper Holder: Extruded aluminum clip anodized black containing rollers to pinch and release paper.
    - a. End caps are black plastic.
  - 5. Patient Information Holder: Provide chart, file, or binder holder constructed of 18 gauge formed. Galvanized steel or aluminum painted in specified color in Section 09 06 00, SCHEDULE FOR FINISHES.

- a. Provide polished aluminum connecting rods and buttons. Provide button covers for mounting screws that permanently attach and securely conceal screws.

I. Temporary Interior Signs:

1. Fabricated from 50 kg (110 pound) matte finished white paper cut to 101 mm (4 inch) wide by 305 mm (12 inch) long.
  - a. Punched 3.2 mm (.125 inch) hole with edge of hole spaced 13 mm (.5 inch) in from edge and centered on 101 mm (4 inch) side.
  - b. Reinforce hole on both sides with suitable material that prevents tie from pulling through hole.
  - c. Ties: Steel wire 0.3 mm (0.120 inch) thick attached to tag with twist leaving 152 mm (6 inch) long free ends.
2. Mark architectural room number on sign, with broad felt marker in clearly legible numbers or letters that identify room, corridor or space as shown on construction documents.
3. Install temporary signs to rooms that have a room, corridor or space number. Attach to door frame, door knob or door pull.
  - a. Doors that do not require signs are: corridor doors in corridor with same number, folding doors or partitions, toilet doors, bathroom doors within and between rooms, closet doors within rooms, communicating doors in partitions between rooms with corridor entrance doors.
  - b. Replace and missing, damaged or illegible signs.

**2.5 FABRICATION**

- A. Design interior signage components to allow for expansion and contraction for a minimum material temperature range of 38 degrees C (100 degrees F), without causing buckling, excessive opening of joints or over stressing of adhesives, welds and fasteners.
- B. Form work to required shapes and sizes, with true curve lines and angles. Provide necessary rebates, lugs and brackets for assembly of units. Provide concealed fasteners wherever possible.
- C. Shop fabricate so far as practicable. Fasten joints flush to conceal reinforcement, or weld joints, where thickness or section permits.
- D. Level and assemble contract surfaces of connected members so joints will be tight and practically unnoticeable, without applying filling compound.
- E. Signs: Fabricate with fine, even texture to be flat and sound.



1. Maintain lines and miters sharp, arises unbroken, profiles accurate and ornament true to pattern.
  2. Plane surfaces to be smooth, flat and without oil-canning, free of rack and twist.
  3. Maximum variation from plane of surface plus or minus 0.3 mm (0.015 inches). Restore texture to filed or cut areas.
- F. Finish extruded members to be free from extrusion marks. Fabricate square turns, sharp corners, and true curves.
- G. Finish hollow signs with matching material on all faces, tops, bottoms and ends. Mitere edge joints to give appearance of solid material.
- H. Do not manufacture signs until final sign message schedule and location review has been completed by the COR and forwarded to contractor.
- I. Drill holes for bolts and screws. Mill smooth exposed ends and edges with corners slightly rounded.
- J. Form joints exposed to weather to exclude water.
- K. Movable Parts, Including Hardware: Cleaned and adjusted to operate as designed without binding or deformation of members. Center doors and covers in opening or frame.
1. Align contact surfaces fit tight and even without forcing or warping components.
- L. Pre-assemble items in shop to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.
- M. Prime painted surfaces as required. Apply finish coating of paint for complete coverage with no light or thin applications allowing substrate or primer to show.
1. Finish surface smooth, free of scratches, gouges, drips, bubbles, thickness variations, foreign matter and other imperfections.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Locate signs as shown on the Sign Location Plans.
- B. Conform to the VA Signage Design Guide for installation requirements.
- C. At each sign location there are no utility lines behind each sign location that will be affected by installation of signs.
  1. Correct and repair damage done to utilities during installation of signs at no additional cost to Government.

- D. Provide inserts and anchoring devices which must be set in concrete or other material for installation of signs. Submit setting drawings, templates, instructions and directions for installation of anchorage devices, which may involve other trades.
- E. Refer to Sign Message Schedule for mounting method. Mount signs in proper alignment, level and plumb according to the Sign Location Plan and the dimensions given on elevation and Sign Location Plans. When exact position, angle, height or location is not clear, contact COR for resolution.
- F. When signs are installed on glass, provide blank glass back up to be placed on opposite side of glass exactly behind sign being installed. Provide blank glass back that is the same size as sign being installed.
- G. Touch up exposed fasteners and connecting hardware to match color and finish of surrounding surface.
- H. At completion of sign installation, clean exposed sign surfaces. Clean and repair adjoining or adjacent surfaces that became soiled or damaged as a result of installation of signs.

- - - END - - -

**SECTION 10 21 23  
CUBICLE CURTAIN TRACKS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies cubicle curtain track (C.C.T.) and shower curtain tracks.

**1.2 RELATED WORK**

- A. Steel shapes for suspending track assembly: Section 05 50 00, METAL FABRICATIONS.
- B. Acoustical ceiling tile and suspension systems Section 09 51 00, ACOUSTICAL CEILINGS.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Samples:
  - 1. 305 mm (12 inch) long piece of cubicle curtain track with carrier access and end stop.
  - 2. Clip anchor for fastening track to grid system of acoustical
  - 3. Curtain carrier for attaching curtain to track.
- C. Shop Drawings: Showing layout of tracks and method of anchorage.
- D. Manufacturer's Literature and Data:
  - 1. Cubicle curtain track.

**1.4 DELIVERY, STORAGE AND HANDLING**

- A. Deliver material in original package marked to identify the contents, brand name, and the name of the manufacturer or supplier.
- B. Store in dry and protected location. Store so as to not bend or warp the tracks.
- C. Do not open packages until contents are needed for installation, unless verification inspection is required.

**1.5 WARRANTY**

- A. Construction Warranty: Cubicle curtain tracks are subject to the terms of the Article "Warranty of Construction," FAR clause 52.246-21.

**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 the basic designation only.

- B. ASTM International (ASTM):
  - B221-14.....Aluminum and Aluminum-Alloy Extruded Bars,  
Rods, Wire, Shapes, and Tubes
  - B221M-13.....Aluminum and Aluminum-Alloy Extruded Bars,  
Rods, Wire, Shapes, and Tubes (Metric)
  - B456-11.....Electrodeposited Coatings for Copper Plus  
Nickel Plus Chromium and Nickel Plus Chromium
- C. Aluminum Association (AA):
  - DAF 45-09.....Designation System for Aluminum Finishes
- D. American Architectural Manufacturers Association (AAMA):
  - 2603-13.....Voluntary Specification, Performance  
Requirements and Test Procedures for Pigmented  
Organic Coatings on Aluminum Extrusions and  
Panels
- E. The National Association of Architectural Metal Manufacturers (NAAMM):
  - AMP 500 Series.....Metal Finishes Manual

**PART 2 - PRODUCTS**

**2.1 CUBICLE CURTAIN TRACKS**

- A. Channel Tracks (Surface Mounted Type): Extruded aluminum,  
ASTM B221M (B221), alloy 6063, temper T5 or T6, channel shaped, with  
smooth inside raceway for curtain carriers.
- B. Surface mounted hookless curtain track.
- C. Curtain Carriers: Nylon carriers, with nylon wheels on metal or nylon  
axles.
  - 1. Equip each carrier with either stainless steel, chromium plated  
brass or steel hooks with swivel, or nickel chromium plated brass or  
stainless steel bead chain
  - 2. Hook for bead chain may be the same material and finish as the bead  
chain or may be chromium plated steel.
  - 3. Provide 2.2 carriers for every 305 mm (1 foot) of each section of  
each track length, plus one (1) additional carrier.
- D. End Stop Connectors, Ceiling Flanges and Other Accessories: Fabricate  
from the same material with the same finish as the tracks or from  
nylon.
- E. Hangers and Fittings: Fabricate from the same material with the same  
finish as the tracks. Hangers may be round or square for channel tracks

and round for tubular tracks. Design fittings to be compatible with design of tracks and to safely transmit the track load to the hangers.

- F. At end of each section of track, make provision for insertion and removal of carriers. Design to prevent accidental removal of carrier. Provide operating mechanism shall be removable with common tools.

#### **2.2. SHOWER CURTAIN TRACK**

- A. Provide water/corrosion resistant aluminum surface mounted track system and glider hooks at 10 per meter (3.28 feet).

#### **2.3 FASTENERS**

- A. Exposed Fasteners, Screws and Bolts: Stainless steel or chromium/nickel plated brass.
- B. Concealed Fasteners, Screws and Bolts: Stainless steel.
- C. Metal Clips: Anchor curtain tracks to exposed grid of lay-in acoustical tile ceilings, with concealed metal (butterfly) type or two piece snap locking type ceiling clip of high strength spring steel.
  - 1. When it is not possible to install the metal ceiling clip, the cubicle curtain track may be screwed to the ceiling grid.

#### **2.4 FINISHES**

- A. Aluminum: Finish numbers for aluminum specified are in accordance with AA DAF 45. AA-C22A31 finish, chemically etched medium matte with clear anodic coating, Class II Architectural, .01 mm (0.4 mils) thick.
- B. Chrome/Nickel Plating: Satin or polished finish, ASTM B546, minimum thickness of chromium plate as follows:
  - 1. 0.005 mm (0.2 mil) on copper alloys.
  - 2. 0.01 mm (0.4 mil) on steel.
- C. Stainless Steel: No. 4 in accordance with NAAMM AMP 500.
- D. Baked Enamel or Powder Coat Finish: AAMA 2603.

#### **2.5 FABRICATION**

- A. Weld and grind smooth joints of fabricated components.
- B. Form tracks and bends of lengths that will produce the minimum number of joints. Make track sections up to 4877 mm (16 feet) without joints. Form corner bend on a 305 mm (12 inch) radius.
- C. Provide steel anchor plates, supports, and anchors for securing components to building construction.
- D. Form flat surface without distortion.
- E. Shop assemble components and package complete with anchors and fittings.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Install tracks after finish painting and ceiling finishing operations are complete.
- B. Install track level and hangers plumb and securely anchor to the ceiling to form a rigid installation.
- C. Anchor surface mounted curtain tracks directly to exposed grid of lay-in acoustical tile ceilings with suitable fasteners, spaced approximately 610 mm (24 inches) on center.
- D. Anchor surface mounted curtain tracks to concrete, plaster and gypsum board ceilings with a minimum of 3 mm (1/8-inch) diameter fastenings or concealed clips spaced not more than 914 mm (3 feet) on center.
- E. Fasten end stop caps to prevent them from being forced out by the striking weight of carriers.
- F. Remove damaged or defective components and replace with new components or repair to the original condition.
- G. Install track rigid, plumb, level and true, and securely anchored to the overhead construction.
- H. Verify that carrier units operate smoothly and easily over the full range of travel.

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**SECTION 10 22 26.13  
ACCORDION FOLDING PARTITIONS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies electric or manually operated, top supported accordion-type folding partitions for wall to wall room division.

**1.2 RELATED WORK**

- A. Steel Supporting Members or Hanger Rods: Section 05 50 00, METAL FABRICATIONS.
- B. Wood Blocking, Rough Bucks, and Headers: Section 06 10 00, ROUGH CARPENTRY.
- C. Wood Trim: Section 06 20 00, FINISH CARPENTRY.
- D. Lock Cylinders: Section 08 71 00, DOOR HARDWARE.
- E. Color and Texture of Vinyl or Fabric and Color of Finish on Steel: Section 09 06 00, SCHEDULE FOR FINISHES.

**1.3 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Obtain products from single manufacturer who has provided units as specified for a minimum of three (3) years.
- B. Installers Qualifications: Work is to be performed by installer having three (3) years' experience in work relating to this section and approved in writing by partition manufacturer.

**1.4 PERFORMANCE REQUIREMENTS**

- A. The partitions are to provide a complete closure of opening when fully extended and latched.
- B. Provide sound rated partitions with a sound transmission class (STC) of 45 or better when tested in accordance with ASTM E90.
- C. Provide fabric and lining with flame spread rating of 25 or less, fuel contribution rating of 15 or less, and smoke generation of 50 or less when tested in accordance with ASTM E84. Complete assembly must also meet or surpass the requirements of NFPA 101 and UL 10B.

**1.5 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- B. Shop Drawings:  
Folding partition, each type, including methods of installation
- C. Samples: Panel covering, each different partition, 152 mm (6 inch) square.

D. Manufacturers' Literature and Data:

1. Folding partition each type.

E. Test Reports:

1. Fire test response characteristics.
2. Sound resistant partitions STC rating.

F. Manufacturer's Certificates:

Certificate certifying that the partition referred to in the test reports conforms to specification requirements, and that the partitions to be provided for the project are the same in all characteristics as that tested in the laboratory.

G. Manufacturer's qualifications.

H. Installer's qualifications.

I. Manufacturer's warranty.

**1.6 WARRANTY**

A. Construction Warranty: Comply with FAR clause 52.246-21, "Warranty of Construction".

B. Manufacturer Warranty: Manufacturer shall warranty their accordion folding partitions for a minimum of two (2) years from date of installation and final acceptance by the Government. Submit manufacturer warranty.

**1.7 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. ASTM International (ASTM):

A1008/A1008M-13.....Steel, sheet, Cold Rolled, Structural, High  
Strength Carbon, Low Alloy with Improved  
Formability

B221-14.....Aluminum-Alloy Extruded Bars, Rods, Wire,  
Shapes, and Tubes

B221M-13.....Aluminum-Alloy Extruded Bars, Rods, Wire,  
Shapes, and Tubes (Metric)

D751-06(R2011).....Test Methods for Coated Fabrics

E84-14.....Surface Burning Characteristics of Building  
Materials



- E90-09.....Laboratory Measurement of Airborne Sound  
Transmission Loss of Building Partitions and  
Elements
- E413-10.....Rating Sound Insulation
- E557-12.....Architectural Design and Installation Practices  
for Sound Isolation Between Spaces Separated by  
Operable Partitions
- C. National Fire Protection Association (NFPA):
- 70-14.....National Electrical Code
- 101-15(R2014).....Life Safety Code
- 286-15.....Fire Tests for Evaluating Contribution of Wall  
and Ceiling Interior Finish to Room Fire Growth
- D. Underwriters Laboratories Inc. (UL):
- 10B-10(R2009).....Fire Tests of Door Assemblies

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

A. Facing Materials:

1. General: Provide facing materials with appropriate backing that comply with indicated fire-test response characteristics, and are factory attached to accordion folding partitions with concealed fasteners. Covering fabrics must conform to the requirements of ASTM D751 and NFPA 286.
2. Woven Fabric: Manufacturer's standard 100 percent polyolefin woven fabric, from same dye lot, treated to resist stains.
3. Vinyl Coated Fabric: Manufacturer's standard mildew resistant, washable, vinyl coated fabric wall covering, complying with CFFA-W-101-D, for Class A.

B. Sheet Steel:

1. ASTM A1008/A1008M, cold rolled, commercial quality for partition tracks, lead and jamb posts.
2. The cast or heat analysis report mentioned in the ASTM is not required.

C. Aluminum Extrusions: ASTM B221M (B221), Alloy 3003.

D. Sound Insulation: Provide sound insulation as necessary to achieve the specified sound transmission class, conforming to ASTM E413.

**2.2 FABRICATION**

A. Track:

1. Minimum 2 mm (0.0747 inch) thick sheet steel.
  2. Track depth and shape: In accordance with the manufacturer's recommendations for the weight and size of the partition furnished.
  3. Steel track: Baked enamel finish.
  4. No floor track will be permitted.
- B. Lead and Jamb Posts:
1. 1.78 mm (0.0747 inch) thick sheet steel.
  2. Post depth and shape: In accordance with the manufacturer's recommendations for the weight and size of the partition furnished.
  3. Posts: Baked enamel finish.
- C. Suspension System:
1. Four (4) wheels for tandem carriers on lead posts and two (2) wheel for intermediate carriers.
  2. Wheels: Steel ball bearing with nylon or steel tread, 25 mm (1 inch) diameter for partitions up to 3962 mm (13 feet) high, and 38 mm (1-1/2 inch) diameter for partitions over 3962 mm (13 feet) high.
  3. Intermediate carriers: Placed at every other hinged pair.
- D. Frame: Steel, zinc or cadmium coated, with interior bracing at top and bottom, and mechanism for producing pantograph action.
- E. Covering:
1. Attach fabric to the framework with fasteners that permit easy removal of the cover but prevent sagging or separation.
  2. Position vertical seams in the bottoms of valleys and reinforce.
  3. Provide top and bottom edges of cover fabrics with 13 mm (1/2 inch) minimum turned hems.
  4. Support vinyl covering over insulating core with outer ply of vinyl material.
- F. Seals:
1. Provide seals at floor, ceiling, jambs and abutting edges of sound rated partitions.
  2. Insulating materials in sound resistant partition, perimeter sweep strips and jamb seals are to be the same as those used on laboratory tested models that obtained specified acoustical rating.
- G. Hardware:
1. Provide hardware of the heavy-duty type standard with the manufacturer.
  2. Provide pulls and latches for all partitions.

3. Provide partitions with keyed locks, privacy latches, magnetic contact latches.

### **2.3 FINISHES**

- A. Steel (Baked Enamel Finish):
  1. Clean exposed metal surfaces free of foreign matter, oil and grease, and then give surfaces a prime coat of paint; then apply finish coat of baked-on enamel.
- B. Steel (Prime Finish):
  1. Provide light colored prime paint after fabrication.
  2. Paint all contact surfaces of assembled work (except welded contact surfaces and metal concealed in finished work) with an additional shop coat of similar paint.

### **PART 3 - EXECUTION**

#### **3.1 EXISTING CONDITIONS**

Verify field dimensions prior to fabrication.

#### **3.2 INSTALLATION**

- A. General: Comply with ASTM E557 except as otherwise required by accordion folding partition manufacturer's written installation instructions. Install accordion folding partitions level and plumb, with tight joints and uniform appearance, and free of deformation and surface and finish irregularities.
- B. Install accordion folding partitions and accessories after other finishing operations, including painting, have been completed.
- C. Recessed Type Installation: Install so that bottom of track is flush with ceiling.
- D. Anchorage:
  1. Secure ceiling tracks to structural steel supports or other support system as shown on construction documents with 13 mm (1/2 inch) through-bolts or anchor bolts as appropriate.
  2. Provide bolts near each end of track and at intermediate points not more than 609 mm (2 feet) on centers.
- E. Adjustment:
  1. Provide shims or other means as required to make partitions close openings fully and completely.
  2. Install partitions so that leading edges fit tight to jambs or opposing partition leading edge for full height of partition.

3. Make all necessary adjustments to assure that hardware functions properly.

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**SECTION 10 26 00**  
**WALL AND DOOR PROTECTION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies wall guards, handrail/wall guard combinations, corner guards and door/door frame protectors.

**1.2 RELATED WORK**

- A. Structural Steel Corner Guards: Section 05 50 00, METAL FABRICATIONS.
- B. Armor plates and kick plates not specified in this section: Section 08 71 00, DOOR HARDWARE.
- C. Color and texture of aluminum and resilient material: Section 09 06 00, SCHEDULE FOR FINISHES.

**1.3 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Manufacturer with a minimum of three (3) years' experience in providing items of type specified.
  - 1. Obtain wall and door protection from single manufacturer.
- B. Installer's Qualifications: Installers are to have a minimum of three (3) years' experience in the installation of units required for this project.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings: Show design and installation details.
- C. Manufacturer's Literature and Data:
  - 1. Handrail/Wall Guard Combinations.
  - 2. Wall Guards.
  - 3. Corner Guards.
  - 4. Door/Door Frame Protectors.
- D. Test Report: Showing that resilient material complies with specified fire and safety code requirements.
- E. Manufacturer's qualifications.
- F. Installer's qualifications.
- G. Manufacturer's warranty.

**1.5 DELIVERY AND STORAGE**

- A. Deliver materials to the site in original sealed packages or containers marked with the name and brand, or trademark of the manufacturer.

- B. Protect from damage from handling and construction operations before, during and after installation.
- C. Store in a dry environment of approximately 21 degrees C (70 degrees F) for at least 48 hours prior to installation.

**1.6 WARRANTY**

- A. Construction Warranty: Comply with FAR clause 52.246-21 "Warranty of Construction".
- B. Manufacturer Warranty: Manufacturer shall warranty their wall and door protection for a minimum of five (5) years from date of installation and final acceptance by the Government. Submit manufacturer warranty.

**1.7 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. ASTM International (ASTM):
  - A240/A240M-14.....Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and For General Applications
  - B221-14.....Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
  - B221M-13.....Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes (Metric)
  - D256-10.....Impact Resistance of Plastics
  - D635-10.....Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position
  - E84-14.....Surface Burning Characteristics of Building Materials
- C. Aluminum Association (AA):
  - DAF 45-09.....Designation System for Aluminum Finishes
- D. American Architectural Manufacturers Association (AAMA):
  - 611-14.....Anodized Architectural Aluminum
- E. Code of Federal Regulation (CFR):
  - 40 CFR 59.....Determination of Volatile Matter Content, Water Content, Density Volume Solids, and Weight Solids of Surface Coating
- F. The National Association of Architectural Metal Manufacturers (NAAMM):

- AMP 500-06.....Metal Finishes Manual
- G. National Fire Protection Association (NFPA):  
80-13.....Standard for Fire Doors and Windows
- H. SAE International (SAE):  
J 1545-05(R2014).....Instrumental Color Difference Measurement for  
Exterior Finishes.
- I. Underwriters Laboratories Inc. (UL):  
Annual Issue.....Building Materials Directory

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Stainless Steel: A240/A240M, Type 304.
- B. Aluminum Extruded: ASTM B221M (B221), Alloy 6063, Temper T5 or T6.  
Provide aluminum alloy used for colored anodizing coating as required  
to produce specified color.
- C. Resilient Material:
1. Provide resilient material consisting of high impact resistant  
extruded acrylic vinyl, polyvinyl chloride, or injection molded  
thermal plastic conforming to the following:
    - a. Minimum impact resistance of 960.8 N-m/m (18 ft.-lbs./sq. inch)  
when tested in accordance with ASTM D256 (Izod impact, ft.-lbs.  
per inch notched).
    - b. Class 1 fire rating when tested in accordance with ASTM E84,  
having a maximum flame spread of 25 and a smoke developed rating  
of 450 or less.
    - c. Rated self-extinguishing when tested in accordance with  
ASTM D635.
    - d. Provide material labeled and tested by Underwriters Laboratories  
or other approved independent testing laboratory.
    - e. Provide resilient material for protection on fire rated doors and  
frames assemblies that is listed by the testing laboratory  
performing the tests.
    - f. Provide resilient material installed on fire rated wood/steel  
door and frame assemblies that have been tested on similar type  
assemblies. Test results of material tested on any other  
combination of door and frame assembly are not acceptable.

- g. Provide integral color with colored components matched in accordance with SAE J 1545 to within plus or minus 1.0 on the CIE-LCH scales.

## **2.2 CORNER GUARDS**

- A. Resilient, Shock-Absorbing Corner Guards: Surface mounted type.
1. Snap-on corner guard formed from resilient material, minimum 1.98 mm (0.078-inch) thick, free floating on a continuous 1.52 mm (0.060-inch) thick extruded aluminum retainer. // Retainer used for flush mounted type to act as a stop for adjacent wall finish material. // Provide appropriate mounting hardware, cushions and base plates as required.
  2. Profile: Minimum 76 mm (3 inch) long leg and 6 mm (1/4 inch) corner radius.
  3. Height: 1.22 m (4 feet) above base.
  4. Retainer Clips: Provide manufacturer's standard impact-absorbing clips.
  5. Provide factory fabricated end closure caps at top and bottom of surface mounted corner guards.
  6. Flush mounted corner guards installed on any fire rated wall to be installed in a manner that maintains the fire rating of the wall. Provide fire test of proposed corner guard system to verify compliance.
    - a. Where insulating materials are an integral part of the corner guard system, provide insulating materials furnished by the manufacturer of the corner guard system.
- B. Fabricate stainless steel corner guards of 1.27 mm (.05 inch) thick material conforming to ASTM A240/A240M, Type 302. Install corner guards as indicated on construction documents. Form corner guard to dimensions shown on construction documents.

## **2.3 WALL GUARDS AND HANDRAILS**

- A. Resilient Wall Guards and Handrails:
1. Handrail/Wall Guard Combination:
    - a. Snap-on covers of resilient material, minimum 2 mm (0.078-inch) thick.
    - b. Free-floating on a continuous, extruded aluminum retainer, minimum 1.82 mm (0.072-inch) thick.
    - c. Anchor to wall at maximum 762 mm (30 inches) on center.



2. Wall Guards:

a. Snap-on covers of resilient material, minimum 2.54 mm (0.100-inch) thick.

3. Provide handrails and wall guards with prefabricated end closure caps, inside and outside corners, concealed splices, cushions, mounting hardware and other accessories as required. End caps and corners to be field adjustable to assure close alignment with handrails and wall guards. Screw or bolt closure caps to aluminum retainer in a concealed manner.

B. Aluminum Wall Guards: Extruded aluminum, closed tubular bumper assembly mounted on wall brackets.

1. Provide wall bumper with factory fabricated end closure caps, and inside and outside corner assemblies, concealed splice plates, and other accessories standard with the manufacturer.

2. Fabricate tubular wall guards from material with a nominal wall thickness of 6.35 mm (0.250-inch), form grooves for and provide two (2) strips of continuous polyvinyl chloride cushion bumper inserts.

3. Fabricate adjustable wall brackets from aluminum having a nominal wall thickness of 5.08 mm (0.20-inch). Fasten bumper to brackets with 6.35 mm (1/4-inch) diameter aluminum or stainless steel bolts with locknuts.

C. Stainless Steel Wall Guards: Construct wall guard, including brackets, of minimum 4.76 mm (0.1875-inch) thick stainless steel.

**2.4 DOOR AND DOOR FRAME PROTECTION**

A. Fabricate door and door frame protection items from vinyl acrylic or polyvinyl chloride resilient material, minimum 1.52 mm (0.060-inch) thick, for doors and 0.89 mm (0.035-inch) thick for door frames.

B. Provide adhesive as recommended by resilient material manufacturer.

**2.5 FASTENERS AND ANCHORS**

A. Provide fasteners and anchors as required for each specific type of installation.

B. Where type, size, spacing or method of fastening is not shown or specified in construction documents, submit shop drawings showing proposed installation details.

**2.6 FINISH**

A. Aluminum: In accordance with AA DAF-45.

1. Exposed aluminum: AAMA 611 AA-M12C22A31 chemically etched medium matte, with clear anodic coating, Class II Architectural, .01 mm (0.4 mil) thick.
  2. Concealed aluminum: Mill finish as fabricated, uniform in color and free from surface blemishes.
- B. Stainless Steel: In accordance with NAAMM AMP 500 finish Number 4.
- C. Resilient Material: Embossed textures and color in accordance with SAE J1545.

**PART 3 - INSTALLATION**

**3.1 RESILIENT CORNER GUARDS**

- A. Install corner guards on walls in accordance with manufacturer's instructions.

**3.2 STAINLESS STEEL CORNER GUARDS**

- A. Mount guards on external corners of interior walls, partitions and columns as shown on construction documents.
- B. Where corner guards are installed on walls, partitions or columns finished with plaster or ceramic tile, anchor corner guards as shown on construction documents.
- C. Where corner guards are installed on gypsum board, clean surface and anchor guards with a neoprene solvent-type contact adhesive specifically manufactured for use on gypsum board construction. Remove excess adhesive from around edge of guard and allow curing undisturbed for 24 hours.

**3.3 RESILIENT WALL GUARD HANDRAIL COMBINATION**

- A. Secure guards to walls with brackets and fasteners in accordance with manufacturer's details and instructions.

**3.4 ALUMINUM WALL GUARDS**

- A. Secure brackets to walls with fasteners, spaced in accordance with manufacturer's installation instructions.

**3.5 STAINLESS STEEL WALL GUARDS**

- A. Space brackets at not more than 914 mm (3 feet) on centers and anchor to the wall in accordance with manufacturer's installation instructions.

**3.6 DOOR, DOOR FRAME PROTECTION AND HIGH IMPACT WALL COVERING**

- A. Surfaces to receive protection to be clean, smooth and free of obstructions.

- B. Install protectors after frames are in place but preceding installation of doors in accordance with approved shop drawings and manufacturer's specific instructions.
- C. Apply with adhesive in controlled environment according to manufacturer's recommendations.
- D. Protection installed on fire rated doors and frames to be installed according to NFPA 80 and installation procedures listed in UL Building Materials Directory; or, equal listing by other approved independent testing laboratory establishing the procedures.

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**SECTION 10 28 00**  
**TOILET, BATH, AND LAUNDRY ACCESSORIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

A. SUMMARY:

1. Section Includes: Toilet and bath accessories at dressing rooms, toilets, baths, locker rooms and other areas indicated on drawings.

**1.2 RELATED REQUIREMENTS**

- A. Color of finishes: Section 09 06 00, SCHEDULE FOR FINISHES.
- B. Ceramic Toilet and Bath Accessories: Section 09 30 13, CERAMIC/PORCELAIN TILING.
- C. Shower Curtain Break Away Pendant Chain Hooks: Section 10 21 23, CUBICLE CURTAIN TRACKS.

**1.3 APPLICABLE PUBLICATIONS**

- A. Comply with references to extent specified in this section.
- B. American Society of Mechanical Engineers (ASME):
  1. B18.6.4-98(R2005) - Thread Forming and Thread Cutting Tapping Screws and Metallic Drive Screws inch.
- C. American Welding Society (AWS):
  1. D10.4-86(2000) - Welding Austenitic Chromium-Nickle Stainless Steel Piping and Tubing.
- D. ASTM International (ASTM):
  1. A269/A269M-15 - Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
  2. A312/A312M-15b - Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
  3. A653/A653M-15 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  4. A666-15 - Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
  5. A1011/A1011M-14 - Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
  6. B30-14a - Copper Alloys in Ingot Form.
  7. B75/B75M-11 - Seamless Copper Tube.

8. B221-14 - Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
  9. B221M-13 - Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
  10. B456-11e1 - Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
  11. B824-14 - General Requirements for Copper Alloy Castings.
  12. C1036-11e1 - Flat Glass.
  13. C1048-12e1 - Heat-Strengthened and Fully Tempered Flat Glass.
  14. D635-14 - Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
  15. F446-85(2009) - Grab Bars and Accessories Installed in the Bathing Area.
- E. Federal Specifications (Fed. Spec.):
1. A-A-3002 - Mirror, Glass.
  2. FF-S-107C(2) - Screws, Tapping and Drive.
  3. WW-P-541/8B(1) - Plumbing Fixtures (Accessories, Land Use).
- F. National Architectural Metal Manufacturers (NAAMM):
1. AMP 500-06 - Metal Finishes Manual.

#### **1.4 SUBMITTALS**

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submittal Drawings:
1. Show size, configuration, and fabrication, anchorage and installation details.
  2. Show mounting locations and heights.
- C. Manufacturer's Literature and Data:
1. Description of each product.
  2. Installation instructions.
- D. Samples:
1. Full sized, complete assembly of each product specified.
  2. Approved samples may be incorporated into project.
- E. Certificates: Certify each product complies with specifications.
1. Soap dispensers: Certify soap dispensers are fabricated of material that will not be affected by liquid soap, aseptic detergents, and hexachlorophene solutions.

- F. Qualifications: Substantiate qualifications comply with specifications.
  - 1. Manufacturer with project experience list.
- G. Operation and Maintenance Data:
  - 1. Care instructions for each exposed finish product.

**1.5 QUALITY ASSURANCE**

- A. Manufacturer Qualifications:
  - 1. Regularly manufactures specified products.

**1.6 DELIVERY**

- A. Deliver products in manufacturer's original sealed packaging.
- B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, color, production run number, and manufacture date.
- C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

**1.7 STORAGE AND HANDLING**

- A. Store products indoors in dry, weathertight facility.
- B. Protect products from damage during handling and construction operations.

**1.8 WARRANTY**

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Aluminum: ASTM B221M (ASTM B221), Alloy 6063-T5 and Alloy 6463-T5.
- B. Stainless Steel:
  - 1. Plate Or Sheet: ASTM A666, Type 304, 0.8 mm (0.031 inch) thick unless otherwise specified.
  - 2. Tubing: ASTM A269/A269M, Grade TP 304, seamless or welded.
  - 3. Pipe: ASTM A312/A312M; Grade TP 304.
- C. Steel Sheet: ASTM A653/A653M, zinc-coated (galvanized) coating designation G90.
- D. Chrome Plating (Service Condition Number SC 2): ASTM B456.
- E. Brass Castings: ASTM B30.
- F. Copper:
  - 1. Tubing: ASTM B75/B75M.

2. Castings: ASTM B824.

G. Glass:

1. ASTM C1036, Type 1, Class 1, Quality q2, for mirrors, and for mirror doors in medicine cabinets.
2. ASTM C1036, Type 1 Class 1 Quality q3, for shelves in medicine cabinets.
3. ASTM C1048, Kind FT, Condition A, Type 1, Class 1 for glass and mirrors in Mental Health and Behavior Patient Care Units, and Security Examination Rooms.

**2.2 PRODUCTS - GENERAL**

- A. Basis of Design: Section 09 06 00, SCHEDULE FOR FINISHES.
- B. Provide each product from one manufacturer.
- C. Products Used Within Mental Health and Behavioral Patient Care Units:
  1. Provide accessories free of anchor points.
  2. Design accessories for attachment with tamper resistant hardware.

**2.3 PAPER TOWEL DISPENSERS**

- A. Surface mounted type with sloping top.
- B. Dispensing capacity for 300 sheets of any type of paper toweling.
- C. Fabricate of stainless steel.
- D. Provide door with continuous hinge at bottom, and spring tension cam lock or tumbler lock, keyed alike, at top, and refill sight slot in front.

**2.4 COMBINATION PAPER TOWEL DISPENSER AND DISPOSAL UNITS**

- A. Semi-recessed type.
- B. Dispensing capacity for 400 sheets of any type of paper toweling.
- C. Fabricate of stainless steel.
- D. Form face frames, from one piece.
- E. Provide each door with continuous stainless steel piano hinge and tumbler lock, keyed alike.
- F. Provide removable waste receptacle approximately 40 L (10.5 gal.) capacity, fabricated of 0.45 mm (0.02 inch) thick stainless steel.

**2.5 WASTE RECEPTACLES**

- A. Semi-recessed type, without doors. Fed. Spec. WW-P-541, Type II.
- B. Fabricate of stainless steel.
- C. Form face frame from one piece.



- D. Provide removable waste receptacle of approximately 45 L (12 gal.) capacity, fabricated of stainless steel.
- E. Waste receptacle key locked in place.

## **2.6 TOILET TISSUE DISPENSERS**

- A. Double roll surface mounted type.
- B. Mount on continuous backplate.
- C. Removable spindle ABS plastic or chrome plated plastic.
- D. Wood rollers are not acceptable.
- E. Toilet Tissue Dispensers Used In Mental Health And Behavioral Patient Care Units: Soft plastic rod incapable of supporting load greater than 22.6 kg (50 pounds) with concealed or tamper resistant fasteners.

## **2.7 GRAB BARS**

- A. Fed. Spec. WW-P-541/8B, Type IV, bars, surface mounted, Class 2, grab bars and complying with ASTM F446.
- B. Fabricate from stainless steel or nylon coated steel, use one type throughout project:
  - 1. Stainless steel: Grab bars, flanges, mounting plates, supports, screws, bolts, and exposed nuts and washers.
- C. Mounting:
  - 1. Swing Up Grab Bars: Exposed type.
  - 2. Metal Toilet Partitions Mounted Grab Bars: Exposed type.
  - 3. Other Types and Locations: Concealed type.
- D. Bars:
  - 1. Fabricate to 38 mm (1-1/2 inch) outside diameter.
    - a. Stainless steel, minimum 1.2 mm (0.05 inch) thick.
    - b. Nylon coated bars, minimum 1.5 mm (0.06 inch) thick.
  - 2. Fabricate in one continuous piece with ends turned toward walls.
    - a. Swing up grab bars and grab bars continuous around three sides of showers may be fabricated in two sections, with concealed slip joint between.
  - 3. Continuously weld intermediate support to grab bar.
  - 4. Swing Up Bars: Manually operated; designed to prevent bar from falling when in raised position.
- E. Flange for Concealed Mounting:

1. Minimum 2.65 mm (0.1 inch) thick, maximum 79 mm (3-1/8 inch) diameter by 13 mm (1/2 inch) deep, with minimum three set screws for securing flange to back plate.
2. Insert grab bar through center of flange and continuously weld perimeter of grab bar flush to back side of flange.
3. In lieu of providing flange for concealed mounting, and back plate as specified, grab bar may be welded to back plate covered with flange.

F. Flange for Exposed Mounting:

1. Minimum 5 mm (3/16 inch) thick, maximum 79 mm (3-1/8 inch) diameter.
2. Insert grab bar through flange and continuously weld perimeter of grab bar flush to backside of flange.

G. Back Plates:

1. Minimum 2.65 mm (0.1046 inch) thick metal.
2. Fabricate in one piece, maximum 6 mm (1/4 inch) deep, with diameter sized to fit flange. Provide slotted holes to accommodate anchor bolts.
3. Provide spreaders, through bolt fasteners, and cap nuts, where grab bars are mounted on partitions.

**2.8 CLOTHES HOOKS, ROBE OR COAT**

- A. Fabricate hook units from chromium plated brass with satin finish, or stainless steel, using 6 mm (1/4 inch) minimum thick stock, with edges and corners rounded smooth to thickness of metal, or 3 mm (1/8 inch) minimum radius.
- B. Fabricate each unit as a double hook on a single shaft, integral with or permanently fastened to wall flange, provided with concealed fastenings.
- C. Clothes Hooks Used In Mental Health And Behavioral Patient Care Units: Provide units free of anchor points and secured to the wall using tamper resistant hardware.

**2.9 TOWEL BARS**

- A. Fed. Spec. WW-P-541/8B, Type IV, Bar, Surface mounted; Class 1, towel.
- B. Stainless steel, or chromium plated copper alloy.
- C. Bar Length: 450 and 600 mm (18 and 24 inches) as shown.
- D. Finish brackets and supports to match bar.

- E. Towel Bars Used in Mental Health and Behavioral Patient Care Units:  
Design units to support maximum 1 kg (2 lbs.).

**2.10 METAL FRAMED MIRRORS**

- A. Fed. Spec. A-A-3002 metal frame; chromium finished steel, anodized aluminum, or stainless steel.
- B. Mirror Glass:
1. Minimum 6 mm (1/4 inch) thick.
  2. Set mirror in a protective vinyl glazing tape.
- C. Frames:
1. Channel or angle shaped section with face of frame minimum 9 mm (3/8 inch) wide. Fabricate with square corners.
  2. Metal Thickness 0.9 mm (0.035 inch).
  3. Filler:
    - a. Where mirrors are mounted on walls having ceramic tile wainscots not flush with wall above, provide fillers contoured to conceal void between back of mirror and wall surface.
    - b. Fabricate fillers from same material and finish as mirror frame.
- D. Back Plate:
1. Fabricate backplate for concealed wall hanging from zinc-coated, or cadmium plated 0.9 mm (0.036 inch) thick sheet steel, die cut to fit face of mirror frame.
  2. Provide set screw type theft resistant concealed fastening system for mounting mirrors.
- E. Mounting Bracket:
1. Designed to support mirror tight to wall.
  2. Designed to retain mirror with concealed set screw fastenings.
- F. Metal Framed Mirrors used in Mental Health and Behavioral Patient Care Units: Provide shatter proof glass or polished stainless steel units.

**2.11 SOAP DISHES**

- A. Fed. Spec. WW-P-541/8B, Type VI, Holder.
- B. Class 1, Soap, Surface Mounted:
1. One piece with provisions for exposed fasteners.
  2. Fabricate from chromium plated brass approximately 115 by 95 mm (4 1/2 by 3-3/4 inches) overall size with drainage openings at bottom.
- C. Soap, Recessed:

1. One piece seamless shell and flange with provisions for concealed fasteners.
2. Fabricate from 0.8 mm (0.031 inch) thick stainless steel or chromium plated brass.
3. Form surface of soap tray with raised ridges or patterned dimples to provide gripping surface for soap bar, or provide flush soap tray with a retaining lip. Plastic soap trays or tray inserts are not acceptable.

#### **2.12 MOP RACKS**

- A. Minimum 1016 mm (40 inches) long with five holders.
- B. Clamps:
  1. Minimum of 1.3 mm (0.05 inch) thick stainless steel bracket retaining channel with hard rubber serrated cam; pivot mounted to channel.
  2. Clamps to hold handles from 13 mm (1/2 inch) minimum to 32 mm (1-1/4 inch) maximum diameter.
- C. Support:
  1. Minimum 1 mm (0.04 inch) thick stainless steel hat shape channel to hold clamps away from wall as indicated.
  2. Drill wall flange for 3 mm (1/8 inch) fasteners above and below clamp locations.
- D. Secure clamps to support with oval head machine screws or rivets into continuous reinforcing back of clamps.

#### **2.13 FABRICATION - GENERAL**

- A. Welding, AWS D10.4.
- B. Grind, dress, and finish welded joints to match finish of adjacent surface.
- C. Form exposed surfaces from one sheet of stock, free of joints.
- D. Provide steel anchors and components required for secure installation.
- E. Form flat surfaces without distortion. Keep exposed surfaces free from scratches and dents. Reinforce doors to prevent warp or twist.
- F. Isolate aluminum from dissimilar metals and from contact with building materials as required to prevent electrolysis and corrosion.
- G. Hot-dip galvanized steel or stainless steel, anchors and fastening devices.

- H. Shop assemble accessories and package with components, anchors, fittings, fasteners and keys.
- I. Key items alike.
- J. Provide templates and rough-in measurements.
- K. Round and deburr edges of sheets to remove sharp edges.

#### **2.14 FINISH**

- A. Steel Paint Finish:
  - 1. Powder-Coat Finish: Manufacturer's standard two-coat finish system consisting of the following:
    - a. One coat primer.
    - b. One coat thermosetting topcoat.
    - c. Dry-film Thickness: 0.05 mm (2 mils) minimum.
    - d. Color: Refer to Section 09 06 00, SCHEDULE FOR FINISHES.
- B. Nylon Coated Steel: Nylon coating powder formulated for fluidized bonding process to steel to provide hard smooth, medium gloss finish, minimum 0.3 mm (0.012 inch) thick, rated as self-extinguishing when tested according to ASTM D635.
- C. Stainless Steel: NAAMM AMP 500; No. 4 polished finish.
- D. Aluminum Anodized Finish: NAAMM AMP 500.
  - 1. Clear Anodized Finish: AA-C22A41; Class I Architectural, 0.018 mm (0.7 mil) thick.
  - 2. Color Anodized Finish: AA-C22A42 or AA-C22A44; Class I Architectural, 0.018 mm (0.7 mil) thick.
- E. Chromium Plating: ASTM B456, satin or bright as specified, Service Condition No. SC2.

#### **2.15 ACCESSORIES**

- A. Fasteners:
  - 1. Fasteners in Mental Health and Behavioral Patient Care Units: Tamper resistant hot-dipped galvanized or stainless steel.
  - 2. Exposed Fasteners: Stainless steel or chromium plated brass, finish to match adjacent surface.
  - 3. Concealed Fasteners:
    - a. Shower, Bath Tubs, and High Moisture Areas: Stainless steel.
    - b. Other Locations: Steel, hot-dipped galvanized.
  - 4. Toggle Bolts: For use in hollow masonry or frame construction.
  - 5. Sex bolts: For through bolting on thin panels.

6. Expansion Shields: Lead or plastic for solid masonry and concrete substrate as recommended by accessory manufacturer to suit application.
7. Screws:
  - a. ASME B18.6.4.
  - b. Fed. Spec. FF-S-107, Stainless steel Type A.
- B. Adhesive: As recommended by manufacturer to suit application.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Examine and verify substrate suitability for product installation.
  1. Verify blocking to support accessories is installed and located correctly.
- B. Verify location of accessories with Contracting Officer's Representative.

#### **3.2 INSTALLATION**

- A. Install products according to manufacturer's instructions and approved submittal drawings.
  1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.
- B. Install grab bars according to ASTM F446.
- C. Set work accurately, in alignment and where indicated, parallel or perpendicular as required to line and plane of surface. Install accessories plumb, level, free of rack and twist.
- D. Toggle bolt to steel anchorage plates in frame partitions and hollow masonry. Expansion bolt to concrete or solid masonry.
- E. Install accessories to function as designed. Perform maintenance service without interference with performance of other devices.
- F. Position and install dispensers, and other devices in countertops, clear of drawers, permitting ample clearance below countertop between devices, and ready access for maintenance.
- G. Align mirrors, dispensers and other accessories even and level, when installed in battery.
- H. Install accessories to prevent striking by other moving, items or interference with accessibility.

- I. Install accessories in Mental Health and Behavioral Units with tamper resistant screws that are flush mounted so that they will not support a rope or material for hanging.

**3.3 CLEANING**

- A. After installation, clean toilet accessories according to manufacturer's instructions.

**3.4 PROTECTION**

- A. Protect accessories from damage until project completion.

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**SECTION 10 44 13  
FIRE EXTINGUISHER CABINETS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

This section covers recessed fire extinguisher cabinets.

**1.2 RELATED WORK**

- A. Acrylic glazing: Section 08 80 00, GLAZING.
- B. Field Painting: Section 09 91 00, PAINTING.

**1.3 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data: Fire extinguisher cabinet including installation instruction and rough opening required.

**1.4 APPLICATION 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 Testing and Materials (ASTM):  
D4802-15.....Poly (Methyl Methacrylate) Acrylic Plastic  
Sheet

**PART 2 - PRODUCTS**

**2.1 FIRE EXTINGUISHER CABINET**

Semi-recessed type with flat trim of size and design shown.

**2.2 FABRICATION**

- A. Form body of cabinet from 0.9 mm (0.0359 inch) thick sheet steel.
- B. Fabricate door and trim from 1.2 mm (0.0478 inch) thick sheet steel with all face joints fully welded and ground smooth.
  - 1. Glaze doors with 6 mm (1/4 inch) thick ASTM D4802, clear acrylic sheet, Category B-1, Finish 1.
  - 2. Design doors to open 180 degrees.
  - 3. Provide continuous hinge, pull handle, and adjustable roller catch.

**2.3 FINISH**

- A. Finish interior of cabinet body with baked-on semigloss white enamel.
- B. Finish door, frame with manufacturer's standard baked-on prime coat suitable for field painting.

**PART 3 - EXECUTION**

- A. Install fire extinguisher cabinets in prepared openings and secure in accordance with manufacturer's instructions.
- B. Install cabinet so that the extinguisher height within meets the requirements of NFPA 10

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**SECTION 11 73 00**  
**CEILING MOUNTED PATIENT LIFT SYSTEM**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Ceiling Mounted Patient Lift Systems for the transfer of physically challenged patients are specified in this section.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS: Requirements for pre-test of equipment.
- B. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General Electrical Requirements and items, which are common to sections of Division 26.

**1.3 QUALITY ASSURANCE**

- A. Certification for compliance is required for Ceiling Mounted Patient Lift Systems. Certifications shall be provided by the manufacturer who will conduct testing to ensure that the ceiling lift and charging system are safe and in compliance with ISO 10535 & UL 60601-1
- B. Inspection of equipment after installation is required prior to use for patient movement. Inspection shall be in accordance with manufacturer's installation checklist and the facilities installation checklist (Patient Safety Alert AL14-07).

**1.4 SUBMITTALS**

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
  - 1. Shop drawings shall show structural supports to the underside of structure. Structural calculations for the support of the track and its attachment to ceiling structure shall be submitted. Shop drawings used in the quoting phase shall be PDFs, and either 2D CAD files or 3D BIM files showing structural support to underside of structure. Shop drawings shall also provide general room layout with bed position and all obstructions to ceiling lift.
  - 2. Once the purchase order is accepted by the vendor, a set of stamped drawings shall be provided by the vendor. Shop drawings and structural calculations shall be signed and stamped by a registered structural engineer, and shall meet all code requirements in the jurisdiction having authority. Structural engineer shall ensure ceiling minimum structure capacity shall support the loads specified

in the shop and installation drawings and be in compliance with local structural and seismic codes.

3. Shop drawings shall show obstructions such as lights and sprinklers, and coordinate their relocation.
4. Manufacturer shall provide BIM (Building Information Model) for clash detection on the request of the Resident Engineer (RE), VA Construction Agent, or General Contractor.

B. Certificates of Compliance from Manufacturer

C. Manufacturer's Literature and Data:

1. Lifting Capacity
2. Lifting Speed
5. Vertical Axis Motor
6. Emergency Brake
7. Emergency Lowering Device
8. Emergency Stopping Device
9. Electronic Soft-Start and Soft-Stop Motor Control
10. Current Limiter for Circuit Protection
12. Strap Length
13. All equipment anchors and supports. Submittals shall include weights, dimensions, center of gravity, standard connections, manufacturer's recommendations and behavior problems (e.g., vibration, thermal expansion,) associated with equipment or piping so that the proposed installation can be properly reviewed.

D. Individual Room layouts showing location of lift system installation shall be approved before proceeding with installation of lifts.

E. Manufacturer's Checklist for after installation inspection.

**1.5 APPLICABLE PUBLICATIONS**

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

B. International Organization for Standardization (ISO):  
10535-06.....Hoist for the Transfer of Disabled Persons-  
Requirements and Test Methods

C. Underwriters Laboratories (UL):  
60601-1(2003).....Medical Electrical Equipment: General  
Requirements for Safety

94-2013.....UL Standards for Safety Test for Flammability  
of Plastic Materials for Parts in Devices and  
Appliances-Fifth Edition

SPEC WRITER NOTE: As of April 1, 2017 the  
FDA will no longer accept declarations of  
conformity in support of either IEC  
60601-1-2 Edition 3:2007-03 or  
ANSI/AAMI/IEC 60601-1-2: 2007/(R)2012.

- D. International Electromagnetic Commission (IEC):  
60601-1-2(2015).....Medical electrical equipment - Part 1-2:  
General requirements for basic safety and  
essential performance - Collateral Standard:  
Electromagnetic disturbances - Requirements and  
tests.
- E. VA Patient Safety Alert AL14-07

**PART 2 - PRODUCTS**

**2.1 CEILING TRACK SYSTEM**

- A. The Ceiling Track shall be made from high strength extruded aluminum or  
VA approved equal. Provide anchor supports at ceiling substrate.
- B. Installed rail shall be security tested for 1.5 times greater than the  
motor's weight capacity and maximum allowable deflection of a  
horizontal rail is no more than 1mm (1/16th inch) per 200mm (7.87 inch)  
of track length. (As per ISO 10535 standards.)

**2.2 LIFT UNIT**

- A. The Lift Unit shall be constructed of a steel frame system driven by a  
gear reduced high torque motor.
- B. The Lift system shall have the following features.
  - 1. Lifting capacity: 770 lbs (350 kg) for all lifts.
  - 2. Electronic soft-start and soft-stop motor control
  - 3. Emergency lowering device
  - 4. Emergency stopping device
  - 5. Current limiter for circuit protection in case of overload.
  - 6. Safety device that stops the motor to lift when batteries are low.
  - 8. Emergency brake (in case of mechanical failure)
  - 9. Strap length:
  - 10. Cab: VO plastic-fire retardant, UL 94

**2.3 MOTORS**

- A. Vertical Movement-DC Motor

#### **2.4 BATTERIES**

- A. The life cycle (number of charging cycles) for batteries shall be in compliance with IEC 6100-1-2.
- B. Provide rechargeable batteries with up to 120 transfers with a load of 200lbs (74kg) (for repositioning) a minimum of 50 transfers with its maximum load of 880 lbs (453.592 kg) for bariatric lifts.

#### **2.5 CHARGER**

- A. Charger

#### **2.6 STRAPS AND SLING**

- A. The straps shall meet ISO 10535, Appendix A guidelines. The straps shall ensure the patient's safety by preventing the patient from falling out of the sling.
- B. The sling shall meet ISO 10535, Appendix A guidelines. The sling shall cradle the body of the patient. Bariatric slings shall be rated to a minimum of 800 lbs.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install ceiling mounted patient lift system as per manufacturer's instruction and under the supervision of manufacturer's qualified representative and as shown on drawings.
- B. If the distance in between the suspended ceiling and anchors is more than 18" consult with manufacturer to determine if lateral braces will be required.

#### **3.2 INSTRUCTION AND PERSONNEL TRAINING**

Training shall be provided for the required personnel to educate them on proper operation and maintenance for the lift system equipment.

#### **3.3 TEST**

Conduct performance test, in the presence of the Resident Engineer (RE), Inspector of Record (IOR), and a manufacturer's field representative, to show that the patient lift system equipment and control devices operate properly and in accordance with design, specification, and code requirements.

#### **3.4 INSPECTION**

- 1. Inspection of installed ceiling mounted patient lift systems shall be conducted in accordance with the manufacturer's installation checklist and the facilities installation checklist (Patient Safety Alert AL14-07) prior to use for patient movement.

2. Periodic Inspection shall be provided by the manufacturer on a yearly basis in compliance with ISO 10535.

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**SECTION 12 24 00**  
**WINDOW SHADES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section includes cloth shades, vertical blinds and venetian blinds. Provide window shades complete, including brackets, fittings and hardware.

**1.2 RELATED WORK:**

- A. Color of shade cloth: Section 09 06 00, SCHEDULE FOR FINISHES.

**1.3 QUALITY ASSURANCE:**

- A. Manufacturer's Qualification: Submit evidence that the manufacture has a minimum of three (3) years' experience in providing item of type specified, and that the blinds have performed satisfactorily on similar installations. Submit qualifications.
- B. Submit qualifications for installers who are trained and approved by manufacturer for installation of units provided.
- C. Electrical Requirements:
  - 1. NFPA 70 Article 100.
  - 2. Listed and labeled in accordance with UL 325.
  - 3. Marked for intended use, and tested as a system.
  - 4. Individual testing of components is not acceptable in lieu of system testing.

**1.4 SUBMITTALS:**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Samples:
  - 1. Shade cloth, each type, 610 mm (24 inch) square, including cord and ring, showing color, finish and texture.
- C. Manufacturer's literature and data; showing details of construction and hardware for:  
Cloth and window shades
- D. Shop Drawings: Provide fabrication and installation details for cloth shades, including shade cloth materials, their orientation to rollers, and their seam and batten locations.
- E. Fire Testing: Submit report of flame spread and smoke developed during product material tests by independent testing laboratory.

F. Manufacturer's warranty.

**1.5 WARRANTY:**

- A. Construction Warranty: Comply with FAR clause 52.246-21, "Warranty of Construction".
- B. Manufacturer Warranty: Manufacturer shall warranty their window shades for a minimum of five (5) years from date of installation and final acceptance by the Government. Submit manufacturer's warranty.

**1.6 APPLICABLE PUBLICATIONS:**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced to in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.):
  - AA-V-00200B.....Venetian Blinds, Shade, Roller, Window, Roller, Slat, Cord, and Accessories
- C. ASTM International (ASTM):
  - A240/A240M-14.....Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
  - B221-14.....Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
  - B221M-13.....Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes (Metric)
  - G21-13.....Determining Resistance of Synthetic Polymeric Materials to Fungi
- D. National Electric Manufacturer's Association (NEMA):
  - ICS 6-93(R2006).....Industrial Control and Systems Closures
- E. National Fire Protection Association (NFPA):
  - 70-14.....National Electrical Code (NEC)
  - 701-15.....Fire Tests for Flame Propagation of Textiles and Films
- F. Underwriters Laboratories Inc. (UL):
  - 325-06(R2013).....Door, Drapery, Gate, Louver, and Window Operators and Systems

**PART 2 - PRODUCTS**

**2.1 CLOTH SHADES:**

- A. Light-Filtering Shade Cloth: Woven fabric, stain and fade resistant.
  - 1. Type: As selected by Architect.

2. Weave: Mesh.
3. Orientation on Shadeband: Up the bolt.
4. Openness Factor: 10 percent.
5. Fire-Test-Response Characteristics: Passes NFPA 701 small and large-scale vertical burn. Submit report for testing of shade cloth materials identical to products provided.
6. Drive-End Location: Right side of inside face of shade.
7. Shade Cloth Anti-Microbial Characteristics: 'No Growth' per ASTM G21 results for fungi ATCC9642, ATCC9677, and ATCC9645.
8. Cordless Shades: Provide roller containing spring operating mechanism sized to accommodate shade size indicated in construction documents. Provide with positive locking mechanism that can stop shade movement at each half-turn of roller and with manufacturer's standard pull.
  - a. Pole: Manufacturer's standard type in length required to make operation convenient from floor level and with hook for engaging pull.

**2.2 FASTENINGS:**

- A. Zinc-coated or cadmium plated steel or stainless steel fastenings of length and type recommended by manufacturer. Except as otherwise specified, provide fastenings for installation with various structural materials as follows:

Type of Fastening	Structural Material
Wood screw	Wood
Tap screw	Metal
Case-hardened, self-tapping screw in pre-drilled hole	Solid masonry, concrete
Screw or bolt in expansion shields	Solid masonry, concrete
Toggle bolts	Hollow blocks, gypsum wallboard, plaster

**2.3 FABRICATION:**

- A. Fabricate cloth shades to fit measurements of finished openings obtained at site.

- B. Cloth Shades: Rolling type, constructed of shade cloth mounted on rollers. Provide shade cloth with plain sides, and with hem at bottom to accommodate weight bar.
1. Provide separate shades for each individual sash within opening. Provide shade length that exceeds height of window by 305 mm (12 inches) measured from head to sill, in addition to material required to make-up hem:
    - a. Provide rollers with spindles, nylon bearings, tempered steel springs, and other related accessories required for positive action.
    - b. Provide rollers of diameter and wall thicknesses required to accommodate operating mechanisms, weights, and widths of shadebands indicated without deflection.
    - c. Provide rollers with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
    - d. Secure shade cloth to rollers to prevent wrinkling or folding, and on line parallel to axis of rollers so that shade hangs plumb.
    - e. Secure shade cloth with zinc-coated steel or stainless steel machine screws spaced not over 228 mm (9 inches) on centers.
    - f. Do not attach shade cloth to rollers with tacks.
    - g. Provide hem bar of extruded aluminum for entire width of shade band. Heat seal hem bar on all sides to prevent removal.
    - h. Provide eyelets with clear openings large enough to accommodate cords, without cutting into cloth when set.
    - i. Provide cords of sufficient length to permit shades to be drawn to bottom of opening with ends looped and held with cord rings. Attach cords to hems through metal eyelets in center of slats in bottom hems.

**PART 3 - EXECUTION**

**3.1 INSTALLATION:**

- A. Measure openings before fabrication. Do not scale construction documents.
- B. Cloth Shades: Mount window shades on end of face brackets, set on metal gussets, or casing of windows as required. Provide extension face brackets where necessary at mullions.

1. Locate rollers in level position as high as practicable at heads of windows.
2. Install shades to prevent infiltration of light over rollers.
3. Where extension brackets are necessary for alignment of shades, provide metal lugs, and rigidly anchor lugs and brackets.
4. Place brackets and rollers so that shades do not interfere with window and screen hardware.
7. Mount shade to allow clearances for window operation hardware.
9. Shade installation methods not specifically described, are subject to approval of Contracting Officer Representative (COR).

**3.2 ADJUSTING:**

- A. Adjust and shades to operate smoothly, free from binding or malfunction throughout entire operational range.

**3.3 CLEANING AND PROTECTION:**

- A. Clean shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions that ensure that shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged shades that cannot be repaired, in a manner approved by COR before time of Substantial Completion.

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**SECTION 12 32 00**  
**MANUFACTURED WOOD CASEWORK**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

- A. This section specifies wood veneer casework, plastic laminate casework as detailed on the construction documents, including related components and accessories required to form integral units. Wood casework items shown on the construction documents, but not specified below are to be included as part of the work under this section, and applicable portions of the specification are to apply to these items.

**1.2 RELATED WORK:**

- A. Custom Wood Casework: Section 06 20 00, FINISH CARPENTRY.  
B. Sealants: Section 07 92 00, JOINT SEALANTS.  
C. Color of Casework Finish: Section 09 06 00, SCHEDULE OF FINISHES.  
D. Resilient Base: Section 09 65 13, RESILIENT BASE AND ACCESSORIES.  
E. Backing Plates for Wall Mounted Casework: Section 09 22 16, NON-STRUCTURAL METAL FRAMING.  
F. Countertop Construction and Materials and Items Installed in Countertops: Section 12 36 00, COUNTERTOPS.  
G. Plumbing Requirements Related to Casework: Division 22, PLUMBING.  
H. Electrical Lighting and Power Requirements Related to Casework: Division 26, ELECTRICAL.

**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. Locks for doors and drawers.  
2. Adhesive cements.  
3. Casework hardware.  
C. Samples:  
1. Wood Face Veneer or Hardwood Plywood.  
2. Plastic laminate.  
D. Shop Drawings (1/2 full size):  
1. Each casework type, showing details of construction, including materials, hardware and accessories.  
2. Fastenings and method of installation.  
E. Certification:

1. Manufacturer's qualifications specified.
2. Installer's qualifications specified.

**1.4 QUALITY ASSURANCE:**

- A. Approval by COR is required of manufacturer and installer based upon certification of qualifications specified.
- B. Manufacturer's qualifications:
  1. Manufacturer is regularly engaged in design and manufacture of modular wood veneer and plastic laminate casework, casework components and accessories of scope and type similar to indicated requirements for a period of not less than five (5) years.
  2. Manufacturer has successfully completed at least three (3) projects of scope and type similar to indicated requirements.
  3. Submit manufacturer's qualifications and list of projects, including owner contact information.
- C. Installer Qualifications:
  1. Installer has completed at least three (3) projects in last five (5) years in which these products were installed.
  2. Submit installer qualifications.

**1.5 WARRANTY:**

- A. Construction Warranty: Comply with FAR clause 52.246-21 "Warranty of Construction".
- B. Manufacturer Warranty: Manufacturer shall warranty their wood casework for a minimum of five (5) years from date of installation and final acceptance by the Government. Submit manufacturer warranty.

**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. ASTM International (ASTM):
  - A240/A240M-14.....Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
  - A1008/A1008M-13.....Steel, Sheet, Cold-Rolled, Carbon, Structural, High Strength Low Alloy
  - C1036-11E1(R2012).....Flat Glass
- C. Builders Hardware Manufacturers Association (BHMA):
  - A156.1-13.....Butts and Hinges



- A156.9-10.....Cabinet Hardware
- A156.5-14.....Auxiliary Locks and Associated Products
- A156.11-14.....Cabinet Locks
- D. Composite Panel Association (CPA):
  - A208.1-09.....Particleboard
  - A208.2-09.....Medium Density Fiberboard (MDF) for Interior Applications
- E. U.S. Department of Commerce Product Standards (Prod. Std):
  - PS 1-09.....Construction and Industrial Plywood
- F. Hardwood, Plywood and Veneer Association (HPVA):
  - HP-1-09.....Hardwood and Decorative Plywood
- G. Architectural Woodwork Institute (AWI):
  - Architectural Woodwork Standards, Edition 2 Certification Program - 2014
- H. American Society of Mechanical Engineers (ASME):
  - A112.18.1-12.....Plumbing Fixture Fittings
- I. National Electrical Manufacturers Association (NEMA):
  - LD 3-05.....High Pressure Decorative Laminates
- J. Underwriters Laboratories Inc. (UL):
  - 437-08(R2013).....Key Locks
- K. Scientific Equipment and Furniture Association (SEFA):
  - 2.3-10.....Installation of Scientific Laboratory Furniture and Equipment

**PART 2 - PRODUCTS**

**2.1 PLYWOOD, HARDWOOD FACE VENEER:**

- A. HPVA HP-1, Premium Grade Quarter-sawn Red Oak.

**2.2 PLASTIC LAMINATE:**

- A. NEMA LD 3.
- B. Exposed decorative surfaces, both sides of cabinet doors, and for items having plastic laminate finish. General purpose Type HGL.
- C. Cabinet Interiors Including Shelving: Both of following options to comply with NEMA LD 3 as a minimum.
  - 1. Plastic laminate clad plywood or particleboard, MDF (excluding shelves).
- D. Backing sheet on bottom of plastic laminate covered wood tops. Backer Type BKL.
- E. Post Forming Fabrication, Decorative Surface: Post forming Type HGP.

**2.3 PLYWOOD, SOFTWOOD:**

- A. Prod. Std. PS1, five (5) ply construction from 13 mm to 28 mm (1/2 inch to 1-1/8 inch) thickness, and seven (7) ply for 31 mm (1 1/4 inch) thickness.

**2.4 PARTICLEBOARD:**

- A. CPA A208.1, Type 1, Grade M or medium density.

**2.5 MEDIUM DENSITY FIBERBOARD (MDF):**

- A. Fully waterproof bond conforming to CPA A208.1 and CPA A208.2.

**2.6 GLASS:**

- A. ASTM C1048 Kind FT Type I, Class 1, Quality q3.
- B. For Doors: 6 mm (1/4 inch) thick; except where laminated glass is shown on construction documents.
- C. For Shelves: 6 mm (1/4 inch) thick.
- D. Laminated Glass: Fabricate of two (2) sheets of 3 mm (1/8 inch) thick clear ASTM C1172 Kind LT glass, laminated together with a 1.5 mm (0.060 inch) thick vinyl interlayer, to a total overall thickness of 8 mm (5/16 inch).

**2.7 HARDWARE:**

- A. Cabinet Locks:
  - 1. Provide where locks are indicated on construction documents.
  - 2. Locked pair of hinged door over 915 mm (36 inches) high:
    - a. ANSI/BHMA A156.5, key one side.
    - b. On active leaf use three (3) point locking device, consisting of two (2) steel rods and lever controlled cam at lock, to operate by lever having lock cylinder housed therein.
    - c. On inactive leaf provide dummy lever of same design.
    - d. Provide keeper holes for locking device rods and cam.
  - 3. Door and Drawer: ANSI/BHMA A156.11 cam locks. Provide one (1) type for each condition as follows:
    - a. Drawer and Hinged Door up to 915 mm (36 inches) high: E07261.
    - b. Drawer and Hinged Door: Pin-tumbler, cylinder type lock with not less than four (4) pins or a UL 437 rated wafer lock with brass working parts and case.
    - c. Sliding Door: E07161.
  - 4. Key locks differently for each type casework and master key for each service, such as Nursing Units, Psychiatric, Administrative, Pharmacy, and each Patient Room Storage cabinet.

- a. Key drug locker inner door different from outer door.
  - b. Furnish two (2) keys per lock.
  - c. Furnish six (6) master keys per service or Nursing Unit.
5. Marking of Locks and Keys:
- a. Name of manufacturer, or trademark which can readily be identified legibly marked on each lock and key change number marked on exposed face of lock.
  - b. Key change numbers stamped on keys.
  - c. Key change numbers to provide sufficient information for manufacturer to replace key.
- B. Hinged Doors:
1. Provide doors 915 mm (36 inches) and more in height with three (3) hinges and doors less than 915 mm (36 inches) in height is to have two (2) hinges. Each door is to close against two (2) rubber bumpers.
  2. Concealed Hinges: BHMA A156.9, Type B01602, 135 degrees of opening, self-closing.
  3. Fasteners: Provide full thread wood screws to fasten hinge leaves to door and cabinet frame. Finish screws to match finish of hinges.
- C. Door Catches:
1. Friction or Magnetic type, fabricated with metal housing.
  2. Provide one (1) catch for cabinet doors 1220 mm (48 inches) high and under, and two (2) for doors over 1220 mm (48 inches) high.
- D. Drawer and Door Pulls:
1. Doors and drawers to have flush pulls, fabricated of either chromium-plated brass, chromium plated steel, stainless steel, or anodized aluminum. Drawer and door pulls to be of a design that can be operated with a force of 22.2 N (5 pounds) or less, with one (1) hand and not require tight grasping, pinching or twisting of the wrist.
- E. Drawer Slides:
1. Full extension steel slides with nylon ball-bearing rollers.
  2. Slides to have positive stop.
  3. Equip drawers with rubber bumpers.
- F. Sliding Doors:
1. Each door to be supported by two ball bearing bronze or nylon rollers, or sheaves riding on a stainless steel track at top or

- bottom, and to be restrained by a nylon or stainless steel guide at the opposite end.
2. Plastic guides are not acceptable.
  3. Each door to have rubber silencers set near top and bottom of each jamb.
- G. Shelf Standards (Except For Fixed Shelves):
1. Bright zinc-plated steel for recessed mounting with screws, 16 mm (5/8 inch) wide by 5 mm (3/16 inch) high providing 13 mm (1/2 inch) adjustment, complete with shelf supports.
- H. Gate Bolt:
1. Surface mounted barrel type with strike.
- I. Hinged Gates:
1. Gates to have two (2) double-acting hinges pivots, size as required for gate size and weight.
- J. Castors:
1. Locking type rated for 79 kg (175 lbs.) each.
- K. Floor Glides:
1. Non-skid material minimum 25 mm (1 inch) diameter with minimum 16 mm (5/8 inch) height adjustment.

**2.8 MANUFACTURED PRODUCTS:**

- A. When two (2) or more units are required, use products of one (1) manufacturer.
- B. Manufacturer of casework assemblies is to assume complete responsibility for the final assembled unit.
- C. Provide products of a single manufacturer for parts which are alike.

**2.9 FABRICATION:**

- A. Casework to be of the reveal overlay design and, except as otherwise specified, be of Premium Grade construction and of component thickness in conformance with AWI Quality Standards.
- B. Fabricate casework of plastic laminated covered plywood or particleboard as follows:
  1. Where shown, gates, doors, drawers, shelves and all semi-concealed surfaces to be plastic laminated.
  2. Horizontal and vertical reveals between doors and drawer for reveal overlay design to be 6 mm (1/4 inch) unless otherwise shown.

3. Glazed doors to have 6 mm (1/4 inch) thick glass, set in glazing compound.
  4. Sliding doors to have stops to prohibit bypass and be removable without use of tools.
- C. Provide 1.2 mm (18 gage) sheet steel sloping tops for casework where shown on construction drawings. Fasten sloping tops with oval-head screws inserted from interior. Exposed ends of sloping tops to have flush closures fastened as recommended by manufacturer.
- D. Support Members for Tops of Tables and Countertops:
1. Construct as detailed on construction documents.
  2. Provide miscellaneous steel members and anchor as shown on construction drawings.
- E. Legs For Counters:
1. Fabricate legs for counters of 1.6 mm (0.0635 inch) thick, 38 mm (1-1/2 inch) square tubular stainless steel.
  2. Secure legs to counter tops and provide legs at bottom with shoes not less than 25 mm (1 inch) in height.
  3. Fabricate shoes of stainless steel, aluminum or chromium plated brass.

**2.10 PRODUCTS OF OTHER COMPONENTS DIRECTLY RELATED TO CASEWORK:**

- A. Refer to Section 07 92 00, JOINT SEALANTS for work related to sealants used in conjunction with joints of countertops, casework systems, and adjacent materials.
- B. Refer to Section 09 65 13, RESILIENT BASE AND ACCESSORIES for work related to rubber base adhered to casework systems.
- C. Refer to Section 09 22 16, NON-STRUCTURAL METAL FRAMING for backing plates used in conjunction with wall assemblies for the attachment of casework systems.
- D. Refer to Section 12 36 11, COUNTERTOPS for work related to plastic laminate, acid-resistant plastic laminate, metal, molded resin, wood, and methyl methacrylic polymer countertops and/or shelving used in conjunction with casework systems. When countertop materials are provided by the casework manufacturer, they are to include the following features:
  1. Capable of being suspended from vertical support rails or horizontal wall strips or service modules.

2. Provided with rounded corners and impact resistant material on exposed edges.
3. Capable of being easily relocated and installed without tools.
4. Capable of being suspended and easily changed under counter mounted storage units.
5. Provide leveling adjustment capability so units can be brought into a level position.
6. Secured using fasteners. Show detail on shop drawings.
- E. Refer to Section 12 36 11, COUNTERTOPS for work related to and integral with countertop systems such as pegboards, funnel and graduate racks.
- F. Refer to Division 22, PLUMBING for the following work related to casework systems:
  1. Sinks, faucets and other plumbing service fixtures, venting, and piping systems.
  2. Compressed air, gas, vacuum and piping systems.
- G. Refer to Division 26, ELECTRICAL for the following work related to casework systems:
  1. Connections and wiring devices.
  2. Connections and lighting fixtures except when factory installed by the manufacturer.

**PART 3 - EXECUTION**

**3.1 COORDINATION:**

- A. Begin only after work of other trades is complete, including wall and floor finish completed, ceilings installed, light fixtures and diffusers installed and connected and area free of trash and debris.
- B. Verify location and size of mechanical and electrical services as required and perform cutting of components of work installed by other trades.
- C. Verify reinforcement of walls and partitions for support and anchorage of casework.
- D. Coordinate with other Divisions and Sections of the specification for work related to installation of casework systems to avoid interference and completion of service connections.

**3.2 INSTALLATION:**

- A. Install casework in accordance with manufacturer's written instructions and per SEFA 2.3 recommendations.

1. Install in available space; arranged for safe and convenient operation and maintenance.
2. Align cabinets for flush joints except where shown otherwise.
3. Install with bottom of wall cabinets in alignment and tops of base cabinets aligned level, plumb, true, and straight to a tolerance of 3.2 mm in 2438 mm (1/8 inch in 96 inches).
4. Install corner cabinets with hinges on corner side with filler or spacers sufficient to allow opening of drawers.

B. Support Rails:

1. Install true to horizontal at heights shown on construction documents; maximum tolerance for uneven floors is plus or minus 13 mm (1/2 inch).
2. Shim as necessary to accommodate variations in wall surface not exceeding 5 mm (3/16 inch) at fastener.

C. Wall Strips:

1. Install true to vertical and spaced as shown on construction documents.
2. Align slots to assure that hanging units will be level.

D. Plug Buttons:

1. Install plug buttons in predrilled or prepunched perforations not used.
2. Use chromium plate plug buttons or buttons finish to match adjacent surfaces.

E. Seal junctures of casework systems with mildew-resistant silicone sealants as specified in Section 07 92 00, JOINT SEALANTS.

**3.3. CLOSURES AND FILLER PLATES:**

- A. Close openings larger than 6 mm (1/4 inch) wide between cabinets and adjacent walls with flat, steel closure strips, scribed to required contours, or machined formed steel fillers with returns, and secured with sheet metal screws to tubular or channel members of units, or bolts where exposed on inside.
- B. Where ceilings interfere with installation of sloping tops, omit sloping tops and provide flat steel filler plates.
- C. Secure filler plates to casework top members, unless shown otherwise on construction documents.

- D. Secure filler plates more than 152 mm (6 inches) in width top edge to a continuous 25 x 25 mm (1 x 1 inch) 0.889 mm (1/16 inch) thick steel formed steel angle with screws.
- E. Anchor angle to ceiling with toggle bolts.
- F. Install closure strips at exposed ends of pipe space and offset opening into concealed space.
- G. Finish closure strips and fillers with same finishes as cabinets.

**3.4 FASTENINGS AND ANCHORAGE:**

- A. Do not anchor to wood ground strips.
- B. Provide hat shape metal spacers where fasteners span gaps or spaces.
- C. Use 6 mm (1/4 inch) diameter toggle or expansion bolts, or other appropriate size and type fastening device for securing casework to walls or floor. Use expansion bolts shields having holding power beyond tensile and shear strength of bolt and breaking strength of bolt head.
- D. Use 6 mm (1/4 inch) diameter hex bolts for securing cabinets together.
- E. Use 6 mm (1/4 inch) by minimum 38 mm (1-1/2 inch) length lag bolt anchorage to wood blocking for concealed fasteners.
- F. Use not less than No. 12 or 14 wood screws with not less than 38 mm (1-1/2 inch) penetration into wood blocking.
- G. Space fastening devices 305 mm (12 inches) on center with minimum of three (3) fasteners in 915 or 1220 mm (3 or 4 foot) unit width.
- H. Anchor floor mounted cabinets with a minimum of four (4) bolts through corner gussets. Anchor bolts may be combined with or separate from leveling device.
- I. Secure cabinets in alignment with hex bolts or other internal fastener devices removable from interior of cabinets without special tools. Do not use fastener devices which require removal of tops for access.
- J. Where units abut end to end, anchor together at top and bottom of sides at front and back. Where units are back to back, anchor backs together at corners with hex bolts placed inconspicuously inside casework.
- K. Where type, size, or spacing of fastenings is not shown on construction documents or specified, show on shop drawings proposed fastenings and method of installation.

**3.5 ADJUSTMENTS:**

- A. Adjust equipment to insure proper alignment and operation.
- B. Replace or repair damaged or improperly operating materials, components or equipment.



**3.6 CLEANING:**

- A. Immediately following installation, clean each item, removing finger marks, soil and foreign matter.
- B. Remove from job site trash, debris and packing materials.
- C. Leave installed areas clean of dust and debris.

**3.7 INSTRUCTIONS:**

- A. Provide operational and cleaning manuals and verbal instructions in accordance with Article INSTRUCTIONS, SECTION 01 00 00, GENERAL REQUIREMENTS.
- B. Provide in service training both prior to and after facility opening. Coordinate in service activities with COR.
- C. Commencing at least seven (7) days prior to opening of facility, provide one (1) four (4) hour day of on-site orientation and technical instruction on use and cleaning procedures application to products and systems specified herein.

- - - E N D - - -



**SECTION 12 36 00  
COUNTERTOPS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies casework countertops with integral accessories.
- B. Integral accessories include:
  - 1. Sinks with traps and drains.
  - 2. Mechanical Service fixtures.
  - 3. Electrical Receptacles.

**1.2 RELATED WORK**

- A. Color and patterns of plastic laminate: SECTION 09 06 00, SCHEDULE FOR FINISHES.
- B. DIVISION 22, PLUMBING.
- C. DIVISION 26, ELECTRICAL.
- D. Equipment Reference Manual for SECTION 12 36 00, COUNTERTOPS.

**1.3 SUBMITTALS**

- A. Submit in accordance with SECTION 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Shop Drawings
  - 1. Show dimensions of section and method of assembly.
  - 2. Show details of construction at a scale of 1/2 inch to a foot.
- C. Samples:
  - 1. 150 mm (6 inch) square samples each top.
  - 2. Front edge, back splash, end splash and core with surface material and booking.

**1.4 APPLICABLE PUBLICATIONS**

- A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- B. American Hardboard Association (AHA):
  - A135.4-95.....Basic Hardboard
- C. Composite Panel Association (CPA):
  - A208.1-09.....Particleboard
- D. American Society of Mechanical Engineers (ASME):
  - A112.18.1-12.....Plumbing Supply Fittings
  - A112.1.2-12.....Air Gaps in Plumbing System

A112.19.3-08(R2004).....Stainless Steel Plumbing Fixtures (Designed for  
Residential Use)

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

A167-99 (R2009).....Stainless and Heat-Resisting Chromium-Nickel  
Steel Plate, Sheet and Strip

A1008-10.....Steel, Sheet, Cold-Rolled, Carbon, Structural,  
High Strength, Low Alloy

D256-10.....Pendulum Impact Resistance of Plastic

D570-98(R2005).....Water Absorption of Plastics

D638-10.....Tensile Properties of Plastics

D785-08.....Rockwell Hardness of Plastics and Electrical  
Insulating Materials

D790-10.....Flexural Properties of Unreinforced and  
Reinforced Plastics and Electrical Insulating  
Materials

D4690-99(2005).....Urea-Formaldehyde Resin Adhesives

F. Federal Specifications (FS):

A-A-1936.....Adhesive, Contact, Neoprene Rubber

G. U.S. Department of Commerce, Product Standards (PS):

PS 1-95.....Construction and Industrial Plywood

H. National Electrical Manufacturers Association (NEMA):

LD 3-05.....High Pressure Decorative Laminates

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

A. Plastic Laminate: NEMA LD 3.

1. Concealed backing sheet Type BKL.

2. Decorative surfaces:

a. Flat components: Type GP-HGL.

b. Post forming: Type PF-HGP.

3. Chemical Resistant Surfaces

a. Flat components: Type GP-HGL.

b. Post forming: Type PF-HGP.

c. Resistance to reagents:

- 1) Test with five 0.25 mil drops remaining on surface for 16 hours followed by washing off with tap water, then cleaned with liquid soap and water, dried with soft cotton cloth and then cleaned with naphtha.

- 2) No change in color, surface texture, and original protectability remaining from test results of following reagents:

98% Acetic Acid	Butyl Alcohol	Acetone
90% Formic Acid--	Benzine	Chloroform
28% Ammonium Hydroxide	Xylene	Carbon Tetrachloride
Zinc Chloride (Sat.)	Toluene	Cresol
Sodium Carbonate (Sat.)	Gasoline	Ether
Calcium Hypochlorite (Sat.)	Kerosene	Cottonseed Oil
Sodium Chloride (Sat.)	Mineral Oil	40% Formaldehyde
Methyl Alcohol	Ethyl Acetate	Trichlorethylene
Ethyl Alcohol	Amyl Acetate	Monochlorobenzine

- 3) Superficial effects only: Slight color change, spot, or residue only with original protectability remaining from test results of following reagents:

77% Sulfuric Acid	37% Hydrochloric Acid	85% Phenol
33% Sulfuric Acid	20% Nitric Acid	Furfural
85% Phosphoric Acid	30% Nitric Acid	Dioxane

- 4) Minimum height of impact resistance: 300 mm (12 inches).

- C. Stainless Steel: ASTM A167, Type 304.
- D. Sheet Steel: ASTM A1008, cold rolled, Class 1 finish, stretcher leveled.
- E. Particleboard: CPA A208.1, Grade 2-M-2.
- F. Plywood: PS 1, Exterior type, veneer grade AC not less than five ply construction.
- G. Hardboard: ANSI/AHA A135.4, Type I, tempered, fire retardant treated, smooth surface one side.
- H. Adhesive
1. For plastic laminate FS A-A-1936.
  2. For wood products: ASTM D4690, unextended urea resin or unextended melamine resin, phenol resin, or resorcinol resin.
  3. For Field Joints:

- a. Epoxy type, resistant to chemicals as specified for plastic laminate laboratory surfaces.
- b. Fungi resistant: ASTM G-21, rating of 0.

I. Fasteners:

- 1. Metals used for welding same metal as materials joined.
- 2. Use studs, bolts, spaces, threaded rods with nuts or screws suitable for materials being joined with metal splice plates, channels or other supporting shape.

J. Solid Polymer Material:

- 1. Filled Methyl Methacrylic Polymer.
- 2. Performance properties required:

Property	Result	Test
Elongation	0.3% min.	ASTM D638
Hardness	90 Rockwell M	ASTM D785
Gloss (60° Gordon)	5-20	NEMA LD3.1
Color stability	No change	NEMA LD3 except 200 hour
Abrasion resistance	No loss of pattern Max wear depth 0.0762 mm (0.003 in) - 10000 cycles	NEMA LD3
Water absorption weight (5 max)	24 hours 0.9	ASTM D-570
Izod impact	14 N·m/m (0.25 ft-lb/in)	ASTM D256 (Method A)
Impact resistance	No fracture	NEMA LD-3 900 mm (36") drop 1 kg (2 lb.) ball
Boiling water surface resistance	No visible change	NEMA LD3
High temperature resistance	Slight surface dulling	NEMA LD3

- 3. Cast into sheet form and bowl form.
- 4. Color throughout with subtle veining through thickness.
- 5. Joint adhesive and sealer: Manufacturers silicone adhesive and sealant for joining methyl methacrylic polymer sheet.
- 6. Bio-based products will be preferred.

**2.2 SINKS**

A. Stainless Steel:

1. ANSI/ASME A112.19.3, Type 304.
  2. Self rim for plastic laminate or similar tops with concealed fasteners.
  3. Flat rim for welded into stainless steel tops.
  4. Ledge back or ledge sides with holes to receive required fixtures when mounted on countertop.
  5. Apply fire resistant sound deadening material to underside.
- B. Stainless steel circular or oval shaped bowl.
- C. Sinks of Methyl Methacrylic Polymer:
1. Minimum 19 mm (3/4 inch) thick, cast into bowl shape with overflow to drain.
  2. Provide for underhung installation to countertop.
  3. Provide openings for drain.

### **2.3 TRAPS AND FITTINGS**

- A. Material as specified in DIVISION 22, PLUMBING.
- B. For Stainless Steel Sinks:
1. Either cast or wrought brass or stainless steel P-traps and drain fittings; ASME A112.18.1
  2. Flat strainer, except where cup strainer or overflow standpipe specified.
    - a. Provide cup strainer in cabinet type 1B.
    - b. Provide stainless steel overflow stand pipe to within 38 mm (1-1/2 inches) of sink rim.
  3. Exposed surface chromium plated finish.
- C. Plaster traps:
1. Cast iron body with porcelain enamel exterior finish.
  2. 50 mm (2 inch) female threaded side inlet and outlet.
  3. Removable galvanized cage having integral baffles and replaceable brass screens.
  4. Removable gasketed cover.
  5. Minimum overall dimensions: 350 x 350 x 400 mm high (14 x 14 x 16 inches) with 175 mm (7 inch) water seal.
  6. Non-siphoning and easily accessible for cleaning.
- D. Air Gap Fittings: ASME A112.1.2.
- E. Methyl Methacrylic Polymer Sink Traps:
1. Cast or wrought brass with flat grid strainer, off-set tail piece, adjustable 38 x 32 mm (1-1/2 x 1 1/4-inch) P trap.

2. Chromium plated finish.

**2.4 WATER FAUCETS**

A. ASME A112.18.1.

1. Cast or forged brass, compression type with replaceable seat and stem assembly or replaceable cartridge.
2. Indexed lever handles either with or without head.
3. Gooseneck minimum clearance above countertop of 190 mm (7-1/2 inches), bent 180 degrees for vertical discharge.
4. Swing spouts elevated to clear handles.
5. Exposed brass surfaces chromium plated.
6. Cast combination hot and cold fixture with one piece body for multiple outlets.
7. Adapter type connection which will permit field conversion of swing spouts to fixed or gooseneck grouts or vice versa.

B. Automatic Controlled Faucets.

1. Infra-red photocell sensor and a solenoid valve to control water flow automatically.
2. Breaking light beam activates water flow.
3. Water stops when user moves away from light beam.

C. Vanity or Lavatory Faucets in Methyl Methacrylic Polymer tops:

1. Extra long center set single lever handle control.
2. Cast or wrought copper alloy, vandal resistant.
3. Stainless steel ball type with replaceable non-metallic seats, stainless steel lined sockets.
4. Handle always returning to the neutral position or cartridge body construction.
5. Provide laminar flow control device.

**2.5 FIXTURE IDENTIFICATION**

A. Code fixtures with full view plastic index buttons.

B. Use following colors and codes:

SERVICE	COLOR	CODE	COLOR OF LETTERS
Cold Water	Dark Green	CW	White
Hot Water	Red	HW	White
Laboratory Air	Orange	AIR	Black
Fuel Gas	Dark Blue	GAS	White
Laboratory Vacuum	Yellow	VAC	Black



SERVICE	COLOR	CODE	COLOR OF LETTERS
Distilled Water	White	DW	Black
Deionized Water	White	DI	Black
Oxygen	Light Green	OXY	White
Hydrogen	Pink	H	Black
Nitrogen	Gray	N	Black
All Other Gases	Light Blue	CHEM.SYM.	Black

**2.6 ELECTRICAL RECEPTACLES**

- A. Hospital grade per electrical specifications.
- B. Curb Mounted Receptacles:
  - 1. NEMA 5-20R duplex in galvanized steel box.
  - 2. Chromium plated brass or steel face plate.
- C. Pedestal Mounted Receptacles:
  - 1. NEMA 5-20R duplex installed in double faces.
  - 2. Polished stainless steel or aluminum, or chromium plated brass pedestal.

**2.7 COUNTERTOPS**

- A. Fabricate in largest sections practicable.
- B. Fabricate with joints flush on top surface.
- C. Fabricate countertops to overhang front of cabinets and end of assemblies 25 mm (one inch) except where against walls or cabinets.
- D. Provide 1 mm (0.039 inch) thick metal plate connectors or fastening devices (except epoxy resin tops).
- E. Join edges in a chemical resistant waterproof cement or epoxy cement, except weld metal tops.
- F. Fabricate with end splashes where against walls or cabinets.
- G. Splash Backs and End Splashes:
  - 1. Not less than 19 mm (3/4 inch) thick.
  - 2. Height 100 mm (4 inches) unless noted otherwise.
  - 3. Laboratories and pharmacy heights or where fixtures or outlets occur: Not less than 150 mm (6 inches) unless noted otherwise.
  - 4. Fabricate epoxy splash back in maximum lengths practical of the same material.
- H. Drill or cutout for sinks, and penetrations.
  - 1. Accurately cut for size of penetration.

2. Cutout for VL 81 photographic enlarger cabinet.
  - a. Finish cutout to fit flush with vertical side of cabinet, allowing adjustable shelf to fit into cutout space of cabinet at counter top level. Finish cutout surface as an exposed edge.
  - b. Provide braces under enlarger space to support not less than 45 kg (100 pounds) centered on opening side along backsplash.
- I. Plastic Laminate Countertops:
  1. Fabricate plastic laminate on five-ply plywood or particleboard core 19 mm (3/4 inch) thick with plastic laminate backing sheet.
  2. Front edge over cabinets not less than 38 mm (1-1/2 inches) thick except where plastic "T" insert is used, not less than 19 mm (3/4 inch) thick.
  3. Exposed Surface and edges of decorative laminated plastic or laboratory chemical resistant surface.
    - a. Use chemical resistant surface on tops 6A, 6B, and 6C.
    - b. Use decorative surface tops when noted plastic laminate, for tops 10A, 10B and 10C.
- J. Methyl Methacrylic Polymer Tops:
  1. Fabricate countertop of methyl methacrylic polymer cast sheet, 13 mm (1/2 inch) thick.
  2. Fabricate back splash and end splash to height shown.
  3. Fabricate skirt to depth shown.
  4. Fabricate with marine edge where sinks occur.
  5. Fabricate in one piece for full length from corner to corner up to 3600 mm (12 feet).
  6. Join pieces with adhesive sealant.
  7. Cut out countertop for lavatories, plumbing trim.
  8. Provide concealed fasteners and epoxy cement for anchorage of sinks to countertop.
- K. Counter Tops for Interchangeable Furniture: Counter tops, unless otherwise shown, are to be capable of vertical adjustment of 150 mm (6 inches). Fabricate tops, except CRS, in increments of units over which they fit with maximum length not to exceed 1950 mm (78 inches). Top section shall cover as many cabinet units as possible. Horizontal joints in counter tops at service strip and across depth of counter are to be watertight when in place but of a type that can be easily separated and reset when counter top is moved up or down. Fabricate CRS tops in

maximum lengths practicable, with field joints welded and ground smooth to match adjacent surfaces. Securely fasten to supporting rails with heavy metal fastening devices, or with screws, through pierced slots in such rails. Fabricate vertical splash back and reagent shelf in maximum length practicable of same material as working surface, except finish thickness shall be 19 mm (3/4 inch).

- L. Countertop products shall comply with following standards for biobased materials:

Material Type	Percent by Weight
Composite Panel	89 percent biobased material
Hardwood	89 percent biobased material
Particleboard	89 percent biobased material
Plywood	89 percent biobased material

The minimum-content standards are based on the weight (not the volume) of the material in the insulating core only.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Before installing countertops verify that wall surfaces have been finished as specified and that mechanical and electrical service locations are as required.
- B. Secure countertops to supporting rails of cabinets with metal fastening devices, or screws through pierced slots in rails.
1. Where type, size or spacing of fastenings is not shown or specified, submit shop drawings showing proposed fastenings and method of installation.
  2. Use round head bolts or screws.
  3. Use epoxy or silicone to fasten the epoxy resin countertops to the cabinets.
  4. Use wood or sheet metal screws for wood or plastic laminate tops; minimum penetration into top 16 mm (5/8 inch), screw size No 8, or 10.
- C. Rubber Moldings:
1. Where shown install molding with butt joints in horizontal runs and mitered joints at corners where ceramic tile occurs omit molding.

2. Fasten molding to wall and to splashbacks and splashends with adhesive.

D. Sinks

1. Install stainless steel sink in plastic laminate tops with epoxy compound to form watertight seal under shelf rim.
  - a. In laboratory and pharmacy fit stainless steel sink with overflow standpipe.
  - b. Install faucets and fittings on sink ledges with watertight seals where shown.
2. Install methyl methacrylic polymer sinks in manufacturers recommended adhesive sealer or epoxy compound to underside of methyl methacrylic polymer countertop.
  - a. Bolt or screw to countertop to prevent separation of bowl and fracture of adhesive sealant joint.
  - b. Install drain and traps to sink.

E. Faucets, Fixtures, and Outlets:

1. Seal opening between fixture and top.
2. Secure to top with manufacturers standard fittings.

F. Range Tops, Electrical Outlets, Film Viewer:

1. Set in cutouts with manufacturers gasket sealing joint with top to prevent water leakage.
2. Install control unit and electric outlets where shown. Seal escutcheon plate at lap if on counter or top to prevent water leakage.

**3.2 PROTECTION AND CLEANING**

- A. Tightly cover and protect against dirt, water, and chemical or mechanical injury.
- B. Clean at completion of work.

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**SECTION 21 13 13**  
**WET-PIPE SPRINKLER SYSTEMS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Design, installation and testing shall be in accordance with NFPA 13.
- C. Modification of the existing sprinkler system as indicated on the drawings and as further required by these specifications. The design and installation of the hydraulically calculated automatic wet-pipe system must be complete and ready for operation, for the remodeled portions of the building in Wing A and Wing B.

**1.2 RELATED WORK**

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Section 07 84 00, FIRESTOPPING.
- C. Section 09 91 00, PAINTING.
- D. Section 28 31 00, FIRE DETECTION AND ALARM.

**1.3 DESIGN CRITERIA**

- A. Design Basis Information: Provide design, materials, equipment, installation, inspection, and testing of the automatic sprinkler system in accordance with the requirements of NFPA 13.
  - 1. Perform hydraulic calculations in accordance with NFPA 13 utilizing the Area/Density method. Do not restrict design area reductions permitted for using quick response sprinklers throughout by the required use of standard response sprinklers in the areas identified in this section.
  - 2. Sprinkler Protection: Sprinkler hazard classifications shall be in accordance with NFPA 13. The hazard classification examples of uses and conditions identified in the Annex of NFPA 13 shall be mandatory for areas not listed below. Request clarification from the Government for any hazard classification not identified. To determining spacing and sizing, apply the following coverage classifications:

- a. Light Hazard Occupancies: Patient care, treatment, and customary access areas.
  - b. Ordinary Hazard Group 1 Occupancies: Laboratories, Mechanical Equipment Rooms, Transformer Rooms, Electrical Switchgear Rooms, Electric Closets, and Repair Shops.
  - c. Ordinary Hazard Group 2 Occupancies: Storage rooms, trash rooms, clean and soiled linen rooms, pharmacy and associated storage, laundry, kitchens, kitchen storage areas, retail stores, retail store storage rooms, storage areas, building management storage, boiler plants, energy centers, warehouse spaces, file storage areas for the entire area of the space up to 1500 square feet and Supply Processing and Distribution (SPD).
3. Hydraulic Calculations: Calculated demand including hose stream requirements shall fall no less than 10 percent below the available water supply curve.
4. Water Supply: Base water supply on a flow test of:
- a. Location: Hydrants on J Street east of facility.
  - b. Elevation Static Test Gauge: Same as test gauge
  - c. Elevation Residual Test Gauge: Same as static gauge
  - d. Static pressure: 60 psi
  - e. Residual pressure: 57 psi
  - f. Flow: 853 gpm
  - g. Date: April 5, 2019 Time 12:30 PM
5. Zoning:
- a. For each sprinkler zone provide a control valve, flow switch, and a test and drain assembly with pressure gauge. For buildings greater than two stories, provide a check valve at each control valve.
  - b. Sprinkler zones shall conform to the smoke barrier zones shown on the drawings.

#### **1.4 SUBMITTALS**

- A. Submit as one package in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. Prepare detailed working drawings that are signed by a NICET Level III or Level IV Sprinkler Technician or stamped by a Registered Professional Engineer licensed in the field

of Fire Protection Engineering. As the Government review is for technical adequacy only, the installer remains responsible for correcting any conflicts with other trades and building construction that arise during installation. Partial submittals will not be accepted. Material submittals shall be approved prior to the purchase or delivery to the job site. Suitably bind submittals in notebooks or binders and provide an index referencing the appropriate specification section. In addition to the hard copies, provide submittal items in Paragraphs 1.4(A)1 through 1.4(A)5 electronically in pdf format on a compact disc or as directed by the COR. Submittals shall include, but not be limited to, the following:

1. Qualifications:

- a. Provide a copy of the installing contractors Kansas contractor's license.
- b. Provide a copy of the NICET certification for the NICET Level III or Level IV Sprinkler Technician who prepared and signed the detailed working drawings unless the drawings are stamped by a Registered Professional Engineer licensed in the field of Fire Protection Engineering.
- c. Provide documentation showing that the installer has been actively and successfully engaged in the installation of commercial automatic sprinkler systems for the past ten years.

2. Drawings: Submit detailed 1/8 inch scale (minimum) working drawings conforming to the Plans and Calculations chapter of NFPA 13. Drawings shall include graphical scales that allow the user to determine lengths when the drawings are reduced in size. Include a plan showing the piping to the water supply test location.

3. Manufacturer's Data Sheets: Provide data sheets for all materials and equipment proposed for use on the system. Include listing information and installation instructions in data sheets. Where data sheets describe items in addition to those proposed to be used for the system, clearly identify the proposed items on the sheet.

4. Calculation Sheets:

- a. Submit hydraulic calculation sheets in tabular form conforming to the requirements and recommendations of the Plans and Calculations chapter of NFPA 13.

5. Valve Charts: Provide a valve chart that identifies the location of each control valve. Coordinate nomenclature and identification of control valves with COR. Where existing nomenclature does not exist, the chart shall include no less than the following: Tag ID No., Valve Size, Service (control valve, main drain, aux. drain, inspectors test valve, etc.), and Location.
6. Final Document Submittals: Provide as-built drawings, testing and maintenance instructions in accordance with the requirements in Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. In addition, submittals shall include, but not be limited to, the following:
  - a. A complete set of as-built drawings showing the installed system with the specific interconnections between the system switches and the fire alarm equipment. Provide a complete set in the formats as follows. Submit items 2 and 3 below on a compact disc or as directed by the COR.
    - 1) One full size (or size as directed by the COR) printed copy.
    - 2) One complete set in electronic pdf format.
    - 3) One complete set in AutoCAD format or a format as directed by the COR.
  - b. Material and Testing Certificate: Upon completion of the sprinkler system installation or any partial section of the system, including testing and flushing, provide a copy of a completed Material and Testing Certificate as indicated in NFPA 13. Certificates shall be provided to document all parts of the installation.
  - c. Operations and Maintenance Manuals that include step-by-step procedures required for system startup, operation, shutdown, and routine maintenance and testing. The manuals shall include the manufacturer's name, model number, parts list, and tools that should be kept in stock by the owner for routine maintenance, including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization, including address and telephone number, for each item of equipment.
  - d. One paper copy of the Material and Testing Certificates and the Operations and Maintenance Manuals above shall be provided in a



binder. In addition, these materials shall be provided in pdf format on a compact disc or as directed by the COR.

- e. Provide one additional copy of the Operations and Maintenance Manual covering the system in a flexible protective cover and mount in an accessible location adjacent to the riser or as directed by the COR.

**1.5 QUALITY ASSURANCE**

- A. **Installer Reliability:** The installer shall possess a valid State of Kansas contractor's license. The installer shall have been actively and successfully engaged in the installation of commercial automatic sprinkler systems for the past ten years.
- B. **Materials and Equipment:** All equipment and devices shall be of a make and type listed by UL or approved by FM, or other nationally recognized testing laboratory for the specific purpose for which it is used. All materials, devices, and equipment shall be approved by the VA. All materials and equipment shall be free from defect. All materials and equipment shall be new unless specifically indicated otherwise on the contract drawings.

**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 the basic designation only.
- B. **National Fire Protection Association (NFPA):**
  - 13-19.....Installation of Sprinkler Systems
  - 25-17.....Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems
  - 101-18.....Life Safety Code
  - 170-18.....Fire Safety Symbols
- C. **Underwriters Laboratories, Inc. (UL):**
  - Fire Protection Equipment Directory
- D. **Factory Mutual Engineering Corporation (FM):**
  - Approval Guide

**PART 2 - PRODUCTS**

**2.1 PIPING & FITTINGS**

- A. Piping and fittings for sprinkler systems shall be in accordance with NFPA 13.

1. Plain-end pipe fittings with locking lugs or shear bolts are not permitted.
2. Piping sizes 2 inches and smaller shall be black steel Schedule 40 with threaded end connections.
3. Piping sizes 2 ½ inches and larger shall be black steel Schedule 10 with grooved connections. Grooves in Schedule 10 piping shall be rolled grooved only.
4. Use nonferrous piping in MRI Scanning Rooms.
5. Plastic piping shall not be permitted except for drain piping.
6. Flexible sprinkler hose shall be FM Approved and limited to hose with threaded end fittings with a minimum inside diameter or 1-inch and a maximum length of 6-feet.

## **2.2 VALVES**

- A. General:
  1. Valves shall be in accordance with NFPA 13.
  2. Do not use quarter turn ball valves for 2 inch or larger drain valves.
- B. Control Valve: The control valves shall be a listed indicating type. Control valves shall be UL Listed or FM Approved for fire protection installations. System control valve shall be rated for normal system pressure but in no case less than 175 PSI.
- C. Check Valve: Shall be of the swing type with a flanged cast iron body and flanged inspection plate.
- D. Automatic Ball Drips: Cast brass 3/4 inch in-line automatic ball drip with both ends threaded with iron pipe threads.

## **2.4 SPRINKLERS**

- A. All sprinklers shall be FM approved quick response except "institutional" type sprinklers shall be permitted to be UL Listed quick response. "Institutional" type sprinklers in Mental Health and Behavior Units shall be UL listed or FM approved quick response type. Maximum break away strength shall be certified by the manufacturer to be no more than 85 pounds. Install "Institutional" type sprinklers where shown on the sprinkler drawings. Install semi-recessed in areas with ceilings.
- B. Temperature Ratings: In accordance with NFPA 13 except that sprinklers in elevator shafts and elevator machine rooms shall be no less than

intermediate temperature rated and sprinklers in generator rooms shall be no less than high temperature rated.

- C. Provide sprinkler guards in accordance with NFPA 13 and when the elevation of the sprinkler head is less than 7 feet 6 inches above finished floor. The sprinkler guard shall be UL listed or FM approved for use with the corresponding sprinkler.

## **2.5 SPRINKLER CABINET**

- A. Provide sprinkler cabinet with the required number of sprinkler heads of all ratings and types installed, and a sprinkler wrench for each type of sprinkler in accordance with NFPA 13. Locate adjacent to the riser.
- B. Provide a list of sprinklers installed in the property in the cabinet. The list shall include the following:
  - 1. Manufacturer, model, orifice, deflector type, thermal sensitivity, and pressure for each type of sprinkler in the cabinet.
  - 2. General description of where each sprinkler is used.
  - 3. Quantity of each type present in the cabinet.
  - 4. Issue or revision date of list.

## **2.6 SPRINKLER SYSTEM SIGNAGE**

Rigid plastic, steel or aluminum signs with white lettering on a red background with holes for easy attachment. Sprinkler system signage shall be attached to the valve or piping with chain.

## **2.7 SWITCHES:**

- A. OS&Y Valve Supervisory Switches shall be in a weatherproof die cast/red baked enamel, oil resistant, aluminum housing with tamper resistant screws, 13 mm (1/2 inch) conduit entrance and necessary facilities for attachment to the valves. Provide two SPDT switches rated at 2.5 amps at 24 VDC.
- B. Water flow Alarm Switches: Mechanical, non-coded, non-accumulative retard and adjustable from 0 to 60 seconds minimum. Set flow switches at an initial setting between 20 and 30 seconds.
- D. Valve Supervisory Switches for Ball and Butterfly Valves: May be integral with the valve.

## **2.8 GAUGES**

Provide gauges as required by NFPA 13. Provide gauges where the normal pressure of the system is at the midrange of the gauge.

**2.9 PIPE HANGERS, SUPPORTS AND RESTRAINT OF SYSTEM PIPING**

Pipe hangers, supports, and restraint of system piping shall be in accordance with NFPA 13.

**2.10 WALL, FLOOR AND CEILING PLATES**

Provide chrome plated steel escutcheon plates.

**2.12 VALVE TAGS**

Engraved black filled numbers and letters not less than 15 mm (1/2 inch) high for number designation, and not less than 8 mm (1/4 inch) for service designation on 19 gage, 40 mm (1-1/2 inches) round brass disc, attached with brass "S" hook, brass chain, or nylon twist tie.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Installation shall be accomplished by the licensed contractor. Provide a qualified technician, experienced in the installation and operation of the type of system being installed, to supervise the installation and testing of the system.
- B. Installation of Piping: Accurately cut pipe to measurements established by the installer and work into place without springing or forcing. In any situation where bending of the pipe is required, use a standard pipe-bending template. Concealed piping in spaces that have finished ceilings. Where ceiling mounted equipment exists, such as in operating and radiology rooms, install sprinklers so as not to obstruct the movement or operation of the equipment. Sidewall heads may need to be utilized. Piping shall not obstruct the minimum means of egress clearances required by NFPA 101.
- C. Welding: Conform to the requirements and recommendations of NFPA 13.
- D. Drains: Provide drips and drains, including low point drains, in accordance with NFPA 13. Pipe drains to discharge at safe points outside of the building or to sight cones attached to drains of adequate size to readily carry the full flow from each drain under maximum pressure. Do not provide a direct drain connection to sewer system or discharge into sinks. Install drips and drains where necessary and required by NFPA 13. The drain piping shall not be restricted or reduced and shall be of the same diameter as the drain collector.
- E. Supervisory Switches: Provide supervisory switches for sprinkler control valves.

- F. Waterflow Alarm Switches: Install waterflow alarm switches and valves in stairwells or other easily accessible locations.
- G. Inspector's Test Connection: Install and supply in accordance with NFPA 13, locate in a secured area, and discharge to the exterior of the building.
- H. Affix cutout disks, which are created by cutting holes in the walls of pipe for flow switches and non-threaded pipe connections to the respective waterflow switch or pipe connection near to the pipe from where they were cut.
- I. Provide escutcheon plates for exposed piping passing through walls, floors or ceilings.
- J. Sleeves: Provide for pipes passing through masonry or concrete. Provide space between the pipe and the sleeve in accordance with NFPA 13. Seal this space with a UL Listed through penetration fire stop material in accordance with Section 07 84 00, FIRESTOPPING. Where core drilling is used in lieu of sleeves, also seal space. Seal penetrations of walls, floors and ceilings of other types of construction, in accordance with Section 07 84 00, FIRESTOPPING.
- K. Provide pressure gauges at each water flow alarm switch location and at each main drain connection.
- L. Firestopping shall be provided for all penetrations of fire resistance rated construction. Firestopping shall comply with Section 07 84 00, FIRESTOPPING.
- M. Painting of Pipe: In finished areas where walls and ceilings have been painted, paint primed surfaces with two coats of paint to match adjacent surfaces, except paint valves and operating accessories with two coats of gloss red enamel. Exercise care to avoid painting sprinklers. Painting of sprinkler systems above suspended ceilings and in crawl spaces is not required. Painting shall comply with Section 09 91 00, PAINTING. Any painted sprinkler shall be replaced with a new sprinkler.
- N. Sprinkler System Signage: Provide rigid sprinkler system signage in accordance with NFPA 13 and NFPA 25. Sprinkler system signage shall include, but not limited to, the following:
  - 1. Identification Signs:
    - a. Provide signage for each control valve, drain valve, sprinkler cabinet, and inspector's test.

- b. Provide valve tags for each operable valve. Coordinate nomenclature and identification of operable valves with COR. Where existing nomenclature does not exist, the Tag Identification shall include no less than the following: (FP-B-F/SZ-#) Fire Protection, Building Number, Floor Number/Smoke Zone, and Valve Number. (E.g., FP-500-1E-001) Fire Protection, Building 500, First Floor East, Number 001.)
2. Instruction/Information Signs:
- a. Provide signage for each control valve to indicate valve function and to indicate what system is being controlled.
  - b. Provide signage indicating the number and location of low point drains.
3. Hydraulic Placards:
- a. Provide signage indicating hydraulic design information. The placard shall include location of the design area, discharge densities, required flow and residual pressure at the base of riser, occupancy classification, hose stream allowance, flow test information, and installing contractor. Locate hydraulic placard information signs at each alarm check valve.
- O. Repairs: Repair damage to the building or equipment resulting from the installation of the sprinkler system by the installer at no additional expense to the Government.
- P. Interruption of Service: There shall be no interruption of the existing sprinkler protection, water, electric, or fire alarm services without prior permission of the Contracting Officer. Contractor shall develop an interim fire protection program where interruptions involve occupied spaces. Request in writing at least one week prior to the planned interruption.

### **3.2 INSPECTION AND TEST**

- A. Preliminary Testing: Hydrostatically test system as specified in NFPA 13, in the presence of the Contracting Officers Representative (COR) or his designated representative.
- B. Final Inspection and Testing: Subject system to tests in accordance with NFPA 13, and when all necessary corrections have been accomplished, advise COR to schedule a final inspection and test. Connection to the fire alarm system shall have been in service for at

least ten days prior to the final inspection, with adjustments made to prevent false alarms. Furnish all instruments, labor and materials required for the tests and provide the services of the installation foreman or other competent representative of the installer to perform the tests. Correct deficiencies and retest system as necessary, prior to the final acceptance. Include the operation of all features of the systems under normal operations in test

**3.3 INSTRUCTIONS**

Furnish the services of a competent instructor for not less than two hours for instructing personnel in the operation and maintenance of the system, on the dates requested by the COR.

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**SECTION 22 05 11**  
**COMMON WORK RESULTS FOR PLUMBING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. The requirements of this Section shall apply to all sections of Division 22.
- B. Definitions:
  - 1. Exposed: Piping and equipment exposed to view in finished rooms.
- C. Abbreviations/Acronyms:
  - 1. ABS: Acrylonitrile Butadiene Styrene
  - 2. AC: Alternating Current
  - 3. ACR: Air Conditioning and Refrigeration
  - 4. AI: Analog Input
  - 5. AISI: American Iron and Steel Institute
  - 6. AO: Analog Output
  - 7. AWG: American Wire Gauge
  - 8. BACnet: Building Automation and Control Network
  - 9. BAg: Silver-Copper-Zinc Brazing Alloy
  - 10. BAS: Building Automation System
  - 11. BCuP: Silver-Copper-Phosphorus Brazing Alloy
  - 12. BSG: Borosilicate Glass Pipe
  - 13. CDA: Copper Development Association
  - 14. C: Celsius
  - 15. CLR: Color
  - 16. CO: Carbon Monoxide
  - 17. COR: Contracting Officer's Representative
  - 18. CPVC: Chlorinated Polyvinyl Chloride
  - 19. CR: Chloroprene
  - 20. CRS: Corrosion Resistant Steel
  - 21. CWP: Cold Working Pressure
  - 22. CxA: Commissioning Agent
  - 23. db(A): Decibels (A weighted)
  - 24. DDC: Direct Digital Control
  - 25. DI: Digital Input
  - 26. DISS: Diameter Index Safety System
  - 27. DO: Digital Output

28. DVD: Digital Video Disc
29. DN: Diameter Nominal
30. DWV: Drainage, Waste and Vent
31. ECC: Engineering Control Center
32. EPDM: Ethylene Propylene Diene Monomer
33. EPT: Ethylene Propylene Terpolymer
34. ETO: Ethylene Oxide
35. F: Fahrenheit
36. FAR: Federal Acquisition Regulations
37. FD: Floor Drain
38. FED: Federal
39. FG: Fiberglass
40. FNPT: Female National Pipe Thread
41. FPM: Fluoroelastomer Polymer
42. GPM: Gallons Per Minute
43. HDPE: High Density Polyethylene
44. Hg: Mercury
45. HOA: Hands-Off-Automatic
46. HP: Horsepower
47. HVE: High Volume Evacuation
48. ID: Inside Diameter
49. IPS: Iron Pipe Size
50. Kg: Kilogram
51. kPa: Kilopascal
52. lb: Pound
53. L/s: Liters Per Second
54. L/min: Liters Per Minute
55. MAWP: Maximum Allowable Working Pressure
56. MAX: Maximum
57. MED: Medical
58. m: Meter
59. MFG: Manufacturer
60. mg: Milligram
61. mg/L: Milligrams per Liter
62. ml: Milliliter
63. mm: Millimeter
64. MIN: Minimum

- 65. NF: Oil Free Dry (Nitrogen)
- 66. NPTF: National Pipe Thread Female
- 67. NPS: Nominal Pipe Size
- 68. NPT: Nominal Pipe Thread
- 69. OD: Outside Diameter
- 70. OSD: Open Sight Drain
- 71. OS&Y: Outside Stem and Yoke
- 72. OXY: Oxygen
- 73. PBPU: Prefabricated Bedside Patient Units
- 74. PH: Power of Hydrogen
- 75. PLC: Programmable Logic Controllers
- 76. PP: Polypropylene
- 77. PPM: Parts per Million
- 78. PSIG: Pounds per Square Inch
- 79. PTFE: Polytetrafluoroethylene
- 80. PVC: Polyvinyl Chloride
- 81. PVDF: Polyvinylidene Fluoride
- 82. RAD: Radians
- 83. RO: Reverse Osmosis
- 84. RPM: Revolutions Per Minute
- 85. RTRP: Reinforced Thermosetting Resin Pipe
- 86. SCFM: Standard Cubic Feet Per Minute
- 87. SDI: Silt Density Index
- 88. SPEC: Specification
- 89. SPS: Sterile Processing Services
- 90. STD: Standard
- 91. SUS: Saybolt Universal Second
- 92. SWP: Steam Working Pressure
- 93. TEFC: Totally Enclosed Fan-Cooled
- 94. TFE: Tetrafluoroethylene
- 95. THHN: Thermoplastic High-Heat Resistant Nylon Coated Wire
- 96. THWN: Thermoplastic Heat & Water Resistant Nylon Coated Wire
- 97. T/P: Temperature and Pressure
- 98. USDA: U.S. Department of Agriculture
- 99. V: Volt
- 100. VAC: Vacuum
- 101. VA: Veterans Administration

- 102. VAMC: Veterans Administration Medical Center
- 103. VAC: Voltage in Alternating Current
- 104. WAGD: Waste Anesthesia Gas Disposal
- 105. WOG: Water, Oil, Gas

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- D. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- E. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- F. Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.
- G. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete and Grout.
- H. Section 05 31 00, STEEL DECKING: Building Components for Attachment of Hangers.
- I. Section 05 50 00, METAL FABRICATIONS.
- J. Section 07 60 00, FLASHING AND SHEET METAL: Flashing for Wall and Roof Penetrations.
- K. Section 07 84 00, FIRESTOPPING.
- L. Section 07 92 00, JOINT SEALANTS.
- M. Section 09 91 00, PAINTING.
- N. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- O. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.
- P. Section 22 07 11, PLUMBING INSULATION.
- Q. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- R. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- S. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
- T. Section 26 29 11, MOTOR CONTROLLERS.

**1.3 APPLICABLE PUBLICATIONS**

- A. The publications listed below shall 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 Mechanical Engineers (ASME):
  - ASME Boiler and Pressure Vessel Code -
  - BPVC Section IX-2013 ...Welding, Brazing, and Fusing Qualifications
  - B31.1-2012 .....Power Piping

- C. American Society for Testing and Materials (ASTM):
- A36/A36M-2012 .....Standard Specification for Carbon Structural Steel
  - A575-96 (R2013)e1 .....Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
  - E84-2013a .....Standard Test Method for Surface Burning Characteristics of Building Materials
  - E119-2012a .....Standard Test Methods for Fire Tests of Building Construction and Materials
  - F1760-01 (R2011) .....Standard Specification for Coextruded Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content
- D. International Code Council, (ICC):
- IBC-2012 .....International Building Code
  - IPC-2012 .....International Plumbing Code
- E. Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry, Inc:
- SP-58-2009 .....Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application and Installation
  - SP-69-2003 .....Pipe Hangers and Supports - Selection and Application
- F. Military Specifications (MIL):
- P-21035B .....Paint High Zinc Dust Content, Galvanizing Repair (Metric)
- G. National Electrical Manufacturers Association (NEMA):
- MG 1-2011 .....Motors and Generators
- H. National Fire Protection Association (NFPA):
- 51B-2014 .....Standard for Fire Prevention During Welding, Cutting and Other Hot Work
  - 54-2012 .....National Fuel Gas Code
  - 70-2014 .....National Electrical Code (NEC)
- I. NSF International (NSF):
- 5-2012 .....Water Heaters, Hot Water Supply Boilers, and Heat Recovery Equipment
  - 14-2012 .....Plastic Piping System Components and Related Materials

61-2012 .....Drinking Water System Components - Health  
Effects

372-2011 .....Drinking Water System Components - Lead Content

J. Department of Veterans Affairs (VA):

PG-18-10 .....Plumbing Design Manual

PG-18-13-2011 .....Barrier Free Design Guide

#### **1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 05 11, COMMON WORK RESULTS FOR PLUMBING", with applicable paragraph identification.
- C. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements and will fit the space available.
- D. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- E. Prior to submitting shop drawings for approval, 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.
- F. Installing Contractor shall provide lists of previous installations for selected items of equipment. Contact persons who will serve as references, with telephone numbers and e-mail addresses shall be submitted with the references.
- G. Manufacturer's Literature and Data: Manufacturer's literature shall be submitted under the pertinent section rather than under this section.
  - 1. Electric motor data and variable speed drive data shall be submitted with the driven equipment.
  - 2. Equipment and materials identification.
  - 3. Firestopping materials.

4. Hangers, inserts, supports and bracing. Provide load calculations for variable spring and constant support hangers.
  5. Wall, floor, and ceiling plates.
- H. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient installation. Final review and approvals will be made only by groups.
- I. Coordination Drawings: Complete consolidated and coordinated layout drawings shall be submitted for all new systems, and for existing systems that are in the same areas. The drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8 inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show the proposed location and adequate clearance for all equipment, controls, piping, pumps, valves and other items. All valves, trap primer valves, water hammer arrestors, strainers, and equipment requiring service shall be provided with an access door sized for the complete removal of plumbing device, component, or equipment. Equipment foundations shall not be installed until equipment or piping layout drawings have been approved. Detailed layout drawings shall be provided for all piping systems. In addition, details of the following shall be provided.
1. Mechanical equipment rooms.
  2. Interstitial space.
  3. Hangers, inserts, supports, and bracing.
  4. Pipe sleeves.
  5. Equipment penetrations of floors, walls, ceilings, or roofs.
- J. 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. Include complete list indicating all components of the systems with diagrams of the internal wiring for each item of equipment.
  2. Include listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment shall be

- provided. The listing shall include belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.
- //K. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00 COMMISSIONING OF PLUMBING SYSTEMS.
- L. Submit training plans, trainer qualifications and instructor qualifications in accordance with the requirements of Section 22 08 00 COMMISSIONING OF PLUMBING SYSTEMS.//

### **1.5 QUALITY ASSURANCE**

#### **A. Products Criteria:**

1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture, supply and servicing of the specified products for at least 5 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 5 years.
2. Equipment Service: There shall be permanent service organizations, authorized and trained by manufacturers of the equipment supplied, located within 160 km (100 miles) of the project. These organizations shall come to the site and provide acceptable service to restore operations within four hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shut-down of equipment; or within 24 hours in a non-emergency. Names, mail and e-mail addresses and phone numbers of service organizations providing service under these conditions for (as applicable to the project): pumps, compressors, water heaters, critical instrumentation, computer workstation and programming shall be submitted for project record and inserted into the operations and maintenance manual.
3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
4. The products and execution of work specified in Division 22 shall conform to the referenced codes and standards as required by the



specifications. Local codes and amendments enforced by the local code official shall be enforced, if required by local authorities such as the natural gas supplier. If the local codes are more stringent, then the local code shall apply. Any conflicts shall be brought to the attention of the Contracting Officers Representative (COR).

5. 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.
  6. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
  7. 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.
  8. Asbestos products or equipment or materials containing asbestos shall not be used.
  9. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopREFERRED.gov>.
- B. 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 "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
  2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
  3. Certify that each welder and welding operator has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
  4. All welds shall be stamped according to the provisions of the American Welding Society.

- C. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the COR prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
- D. Execution (Installation, Construction) Quality:
1. All items shall be applied and installed in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract documents shall be referred to the COR for resolution. Printed copies or electronic files of manufacturer's installation instructions shall be provided to the COR at least 10 working days prior to commencing installation of any item.
  2. All items that require access, such as for operating, cleaning, servicing, maintenance, and calibration, shall be easily and safely accessible by persons standing at floor level, or standing on permanent platforms, without the use of portable ladders. Examples of these items include, but are not limited to: all types of valves, filters and strainers, transmitters, and control devices. Prior to commencing installation work, refer conflicts between this requirement and contract documents to COR for resolution.
  3. Complete layout drawings shall be required by Paragraph, SUBMITTALS. Construction work shall not start on any system until the layout drawings have been approved by VA.
  4. Installer Qualifications: Installer shall be licensed and shall provide evidence of the successful completion of at least five projects of equal or greater size and complexity. Provide tradesmen skilled in the appropriate trade.
  5. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or additional time to the Government.
- E. Guaranty: Warranty of Construction, FAR clause 52.246-21.
- F. Plumbing Systems: IPC, International Plumbing Code. Unless otherwise required herein, perform plumbing work in accordance with the latest version of the IPC. For IPC codes referenced in the contract documents,

advisory provisions shall be considered mandatory, the word "should" shall be interpreted as "shall". Reference to the "code official" or "owner" shall be interpreted to mean the COR.

G. Cleanliness of Piping and Equipment Systems:

1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading and welding of piping shall be removed.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.
3. The interior of all tanks shall be cleaned prior to delivery and beneficial use by the Government. All piping shall be tested in accordance with the specifications and the International Plumbing Code (IPC). All filters, strainers, fixture faucets shall be flushed of debris prior to final acceptance.
4. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

**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. Damaged equipment shall be replaced with an identical unit as determined and directed by the COR. Such replacement shall be at no additional cost or additional time to the Government.
3. Interiors of new equipment and piping systems shall be protected against entry of foreign matter. Both inside and outside shall be cleaned 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.

**1.7 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be

inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them on Auto-Cad version //\_\_\_\_// provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits specified.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS FOR VARIOUS SERVICES**

- A. //Non-pressure PVC pipe shall contain a minimum of 25 percent recycled content.// Steel pipe shall contain a minimum of 25 percent recycled content.
- B. Plastic pipe, fittings and solvent cement shall meet NSF 14 and shall bear the NSF seal "NSF-PW". Polypropylene pipe and fittings shall comply with NSF 14 and NSF 61. Solder or flux containing lead shall not be used with copper pipe.
- C. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system

intended for human consumption, and shall be certified in accordance with NSF 61 or NSF 372.

- D. In-line devices such as water meters, building valves, check valves, stops, valves, fittings, tanks and backflow preventers shall comply with NSF 61 and NSF 372.
- E. End point devices such as drinking fountains, lavatory faucets, kitchen and bar faucets, ice makers supply stops, and end-point control valves used to dispense drinking water must meet requirements of NSF 61 and NSF 372.

## **2.2 FACTORY-ASSEMBLED PRODUCTS**

- A. Standardization of components shall be maximized to reduce spare part requirements.
- 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 at no additional cost or time to the Government.
- C. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment, which serve the same function, shall be the same make and model.

## **2.3 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 system that conforms to contract requirements.

#### **2.4 SAFETY GUARDS**

- A. 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 8 mm (1/4 inch) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.
- B. All Equipment shall have moving parts protected from personal injury.

#### **2.5 LIFTING ATTACHMENTS**

- A. Equipment shall be provided 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, MOTOR CONTROL, CONTROL WIRING**

- A. All material and equipment furnished and installation methods used shall conform to the requirements of Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT; Section 26 29 11, MOTOR CONTROLLERS; and, Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. All electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems shall be provided. Premium efficient motors shall be provided. Unless otherwise specified for a particular application, electric motors shall have the following requirements.
- B. 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 cost or time to the Government.
  - 2. Assemblies of motors, starters, and 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. Wiring material located where temperatures can exceed 71° C (160° F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers and water heaters.

- b. Other wiring at boilers and water heaters, and to control panels, shall be NFPA 70 designation THWN.
  - c. Shielded conductors or wiring in separate conduits for all instrumentation and control systems shall be provided where recommended by manufacturer of equipment.
4. Motor sizes shall be selected 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.
- C. Motor Efficiency and Power Factor: All motors, when specified as "high efficiency or Premium Efficiency" by the project specifications on driven equipment, shall conform to efficiency and power factor requirements in Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT, with no consideration of annual service hours. Motor manufacturers generally define these efficiency requirements as "NEMA premium efficient" and the requirements generally exceed those of the Energy Policy Act (EPACT), revised 2005. Motors not specified as "high efficiency or premium efficient" shall comply with EPACT.
- D. Single-phase Motors: Capacitor-start type for hard starting applications. Motors for centrifugal pumps may be split phase or permanent split capacitor (PSC).
- E. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type. Each two-speed motor shall have two separate windings. A time delay (20 seconds minimum) relay shall be provided for switching from high to low speed.
- F. Rating: Rating shall be continuous duty at 100 percent capacity in an ambient temperature of 40° C (104° F); minimum horsepower as shown on drawings; maximum horsepower in normal operation shall not exceed nameplate rating without service factor.
- G. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame shall be measured at the time of final inspection.

## **2.7 VARIABLE SPEED MOTOR CONTROLLERS**

- A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 26 29 11, MOTOR CONTROLLERS for specifications.

- B. The combination of controller and motor shall be provided by the respective pump manufacturer, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. pumps, shall be product of a single manufacturer.
- C. Motors shall be premium efficient type, "invertor duty", 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 sheaves shall be fixed pitch.
- D. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.

## **2.8 EQUIPMENT AND MATERIALS IDENTIFICATION**

- //A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings, or shown in the maintenance manuals. Coordinate equipment and valve identification with local VAMC shops. In addition, provide bar code identification nameplate for all equipment which will allow the equipment identification code to be scanned into the system for maintenance and inventory tracking. Identification for piping is specified in Section 09 91 00, PAINTING.//
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 7 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 shall be permanently fastened to the equipment. Unit components such as water heaters, tanks, coils, filters, etc. shall be identified.
- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 7 mm (3/16 inch) high riveted or bolted to the equipment.
- D. Control Items: All temperature, pressure, and controllers shall be labeled and the component's function identified. Identify and label each item as they appear on the control diagrams.
- E. Valve Tags and Lists:
  - 1. Plumbing: All valves shall be provided with valve tags and listed on a valve list (Fixture stops not included).



2. Valve tags: Engraved black filled numbers and letters not less than 15 mm (1/2 inch) high for number designation, and not less than 8 mm (1/4 inch) for service designation on 19 gage, 40 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
3. Valve lists: Valve lists shall be created using a word processing program and printed on plastic coated cards. The plastic coated valve list card(s), sized 215 mm (8-1/2 inches) by 275 mm (11 inches) shall show valve tag number, valve function and area of control for each service or system. The valve list shall be in a punched 3-ring binder notebook. An additional copy of the valve list shall be mounted in picture frames for mounting to a wall. COR shall instruct contractor where frames shall be mounted.
4. A detailed plan for each floor of the building indicating the location and valve number for each valve shall be provided in the 3-ring binder notebook. Each valve location shall be identified with a color coded sticker or thumb tack in ceiling or access door.

## **2.9 FIRESTOPPING**

- A. Section 07 84 00, FIRESTOPPING specifies an effective barrier against the spread of fire, smoke and gases where penetrations occur for piping. Refer to Section 22 07 11, PLUMBING INSULATION, for pipe insulation.

## **2.10 GALVANIZED REPAIR COMPOUND**

- A. Mil. Spec. DOD-P-21035B, paint.

## **2.11 PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS**

- A. In lieu of the paragraph which follows, suspended equipment support and restraints may be designed and installed in accordance with the International Building Code (IBC)// and Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.// Submittals based on the International Building Code (IBC)// and Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS// requirements, or the following paragraphs of this Section shall be stamped and signed by a professional engineer registered in the state where the project is located. The Support system of suspended equipment over 227 kg (500 pounds) shall be submitted for approval of the COR in all cases. See the above specifications for lateral force design requirements.

- B. Type Numbers Specified: For materials, design, manufacture, selection, application, and installation refer to MSS SP-58. For selection and application refer to MSS SP-69. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting.
- C. For Attachment to Concrete Construction:
1. Concrete insert: Type 18, MSS SP-58.
  2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
  3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
- D. For Attachment to Steel Construction: MSS SP-58.
1. Welded attachment: Type 22.
  2. Beam clamps: Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23 mm (7/8 inch) outside diameter.
- E. Attachment to Metal Pan or Deck: As required for materials specified in // Section 05 31 00, STEEL DECKING. // Section 05 36 00, COMPOSITE METAL DECKING.//
- F. For Attachment to Wood Construction: Wood screws or lag bolts.
- G. Hanger Rods: Hot-rolled steel, ASTM A36/A36M or ASTM A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 40 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- H. Multiple (Trapeze) Hangers: Galvanized, cold formed, lipped steel channel horizontal member, not less than 43 mm by 43 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 8 mm (1/4 inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 15 mm (1/2 inch) galvanized steel bands, or insulated calcium silicate shield for insulated piping at each hanger.

- I. Pipe Hangers and Supports: (MSS SP-58), use hangers sized to encircle insulation on insulated piping. Refer to Section 22 07 11, PLUMBING INSULATION for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or insulated calcium silicate shields. Provide Type 40 insulation shield or insulated calcium silicate shield at all other types of supports and hangers including those for insulated piping.
1. General Types (MSS SP-58):
- a. Standard clevis hanger: Type 1; provide locknut.
  - b. Riser clamps: Type 8.
  - c. Wall brackets: Types 31, 32 or 33.
  - d. Roller supports: Type 41, 43, 44 and 46.
  - e. Saddle support: Type 36, 37 or 38.
  - f. Turnbuckle: Types 13 or 15.
  - g. U-bolt clamp: Type 24.
  - h. Copper Tube:
    - 1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, copper-coated, plastic coated or taped with isolation tape to prevent electrolysis.
    - 2) For vertical runs use epoxy painted, copper-coated or plastic coated riser clamps.
    - 3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
    - 4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.
  - i. Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp. //Spring Supports (Expansion and contraction of vertical piping):
    - 1) Movement up to 20 mm (3/4 inch): Type 51 or 52 variable spring unit with integral turn buckle and load indicator.
    - 2) Movement more than 20 mm (3/4 inch): Type 54 or 55 constant support unit with integral adjusting nut, turn buckle and travel position indicator. //

- j. Spring hangers are required on all plumbing system pumps one horsepower and greater.
- 2. Plumbing Piping (Other Than General Types):
  - a. Horizontal piping: Type 1, 5, 7, 9, and 10.
  - b. Chrome plated piping: Chrome plated supports.
  - c. Hangers and supports in pipe chase: Prefabricated system ABS self-extinguishing material, not subject to electrolytic action, to hold piping, prevent vibration and compensate for all static and operational conditions.
  - d. Blocking, stays and bracing: Angle iron or preformed metal channel shapes, 1.3 mm (18 gage) minimum.
- J. Pre-insulated Calcium Silicate Shields:
  - 1. Provide 360 degree water resistant high density 965 kPa (140 psig) compressive strength calcium silicate shields encased in galvanized metal.
  - 2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
  - 3. Shield thickness shall match the pipe insulation.
  - 4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
    - a. Shields for supporting cold water shall have insulation that extends a minimum of 25 mm (1 inch) past the sheet metal.
    - b. The insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS SP-69. To support the load, the shields shall have one or more of the following features: structural inserts 4138 kPa (600 psig) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36/A36M) wear plates welded to the bottom sheet metal jacket.
  - 5. Shields may be used on steel clevis hanger type supports, trapeze hangers, roller supports or flat surfaces.
- K. Seismic Restraint of Piping: Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

## **2.12 PIPE PENETRATIONS**

- A. Pipe penetration sleeves shall be installed for all pipe other than rectangular blocked out floor openings for risers in mechanical bays.

- B. Pipe penetration sleeve materials shall comply with all firestopping requirements for each penetration.
- C. To prevent accidental liquid spills from passing to a lower level, provide the following:
  - 1. For sleeves: Extend sleeve 25 mm (1 inch) above finished floor and provide sealant for watertight joint.
  - 2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
  - 3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- D. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges, with structural engineer prior approval. Any deviation from these requirements must receive prior approval of COR.
- E. Sheet metal, plastic, or moisture resistant fiber sleeves shall be provided for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
- F. Cast iron or zinc coated pipe sleeves shall be provided for pipe passing through exterior walls below grade. The space between the sleeve and pipe shall be made watertight with a modular or link rubber seal. The link seal shall be applied at both ends of the sleeve.
- G. Galvanized steel or an alternate black iron pipe with asphalt coating sleeves shall be for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. A galvanized steel sleeve shall be provided for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, sleeves shall be connected with a floor plate.
- H. Brass Pipe Sleeves shall be provided for pipe passing through quarry tile, terrazzo or ceramic tile floors. The sleeve shall be connected with a floor plate.
- I. Sleeve clearance through floors, walls, partitions, and beam flanges shall be 25 mm (1 inch) greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation plus 25 mm (1 inch) in diameter. Interior openings shall be caulked tight with firestopping material and sealant to prevent the spread of fire, smoke, water and gases.

- J. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS. Bio-based materials shall be utilized when possible.
- K. Pipe passing through roof shall be installed through a 4.9 kg per square meter copper flashing with an integral skirt or flange. Skirt or flange shall extend not less than 200 mm (8 inches) from the pipe and set in a solid coating of bituminous cement. Extend flashing a minimum of 250 mm (10 inches) up the pipe. Pipe passing through a waterproofing membrane shall be provided with a clamping flange. The annular space between the sleeve and pipe shall be sealed watertight.

#### **2.13 TOOLS AND LUBRICANTS**

- A. Furnish, and turn over to the COR, special tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Tool Containers: metal, permanently identified for intended service and mounted, or located, where directed by the COR.
- D. Lubricants: A minimum of 0.95 L (1 quart) of oil, and 0.45 kg (1 pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application. Bio-based materials shall be utilized when possible.

#### **2.14 WALL, FLOOR AND CEILING PLATES**

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

#### **2.15 ASBESTOS**

- A. Materials containing asbestos are not permitted.

**PART 3 - EXECUTION**

**3.1 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING**

- A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. Piping, sleeves, inserts, hangers, and equipment shall be located clear of windows, doors, openings, light outlets, and other services and utilities. Equipment layout drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review.
- B. Manufacturer's published recommendations shall be followed for installation methods not otherwise specified.
- C. Operating Personnel Access and Observation Provisions: All equipment and systems shall be arranged to provide clear view and easy access, without use of portable ladders, for maintenance, testing and operation of all devices including, but not limited to: all equipment items, valves, backflow preventers, filters, strainers, transmitters, sensors, meters and control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Maintenance and operating space and access provisions that are shown on the drawings shall not be changed nor reduced.
- D. Structural systems necessary for pipe and equipment support shall be coordinated to permit proper installation.
- E. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- F. Cutting Holes:
  - 1. Holes shall be located to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance and drilling done only after approval by COR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to COR for approval.
  - 2. Waterproof membrane shall not be penetrated. Pipe floor penetration block outs shall be provided outside the extents of the waterproof membrane.
  - 3. Holes through concrete and masonry shall be cut by rotary core drill. Pneumatic hammer, impact electric, and hand or manual hammer type drill will not be allowed, except as permitted by COR where working area space is limited.

- G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other services are not shown but must be provided.
- H. Protection and Cleaning:
1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the COR. Damaged or defective items in the opinion of the COR, shall be replaced at no additional cost or time to the Government.
  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. Pipe openings, equipment, and plumbing fixtures shall be tightly covered against dirt or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- I. Concrete and Grout: Concrete and shrink compensating grout 25 MPa (3000 psig) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE, shall be used for all pad or floor mounted equipment.
- J. Gages, thermometers, valves and other devices shall be installed with due regard for ease in reading or operating and maintaining said devices. Thermometers and gages shall be located and positioned to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- K. Interconnection of Controls and Instruments: Electrical interconnection is generally not shown but shall be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, alarms, instruments and computer workstations. Comply with NFPA 70.
- L. Many plumbing systems interface with the HVAC control system. See the HVAC control points list and Section 23 09 23, DIRECT DIGITAL CONTROL SYSTEM FOR HVAC.
- M. 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 cause the least interfere with normal operation of the facility.
- N. Work in Animal Research Areas: Seal all pipe penetrations with silicone sealant to prevent entrance of insects.
- O. Work in bathrooms, restrooms, housekeeping closets: All pipe penetrations behind escutcheons shall be sealed with plumbers putty.
- P. Switchgear Drip Protection: Every effort shall be made to eliminate the installation of pipe above data equipment, and electrical and telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints. Drain valve shall be provided in low point of casement pipe.
- Q. 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 or additional time 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 electrical conduit, 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 may require temporary installation or relocation of equipment and piping. Temporary equipment or pipe installation or relocation shall be provided to maintain continuity of operation of existing facilities.
- 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 paragraph 3.1 shall apply.

- C. Temporary facilities and piping shall be completely removed back to the nearest active distribution branch or main pipe line and any openings in structures sealed. Dead legs are not allowed in potable water systems. Necessary blind flanges and caps shall be provided to seal open piping remaining in service.

### **3.3 RIGGING**

- A. Openings in building structures shall be planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered and will be considered by Government under specified restrictions of phasing and service requirements as well as structural integrity of the building.
- C. All openings in the building shall be closed 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.
- E. Contractor shall check all clearances, weight limitations and shall provide 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 COR for evaluation prior to actual 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. Holes shall be drilled or burned in structural steel ONLY with the prior written approval of the COR.
- B. The use of chain pipe supports, wire or strap hangers; wood for blocking, stays and bracing, or hangers suspended from piping above shall not be permitted. Rusty products shall be replaced.
- C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents

use. A minimum of 15 mm (1/2 inch) clearance between pipe or piping covering and adjacent work shall be provided.

D. For horizontal and vertical plumbing pipe supports, refer to the International Plumbing Code (IPC) and these specifications.

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.
3. Tubing and capillary systems shall be supported in channel troughs.

F. Floor Supports:

1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.
2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Structural drawings shall be reviewed for additional requirements. 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 grout 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 LUBRICATION**

- A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. All devices and equipment shall be field checked for proper lubrication.
- B. All devices and equipment shall be equipped with required lubrication fittings. A minimum of one liter (one quart) of oil and 0.45 kg (1 pound) of grease of manufacturer's recommended grade and type for each different application shall be provided. All materials shall be

delivered to COR in unopened containers that are properly identified as to application.

- C. A separate grease gun with attachments for applicable fittings shall be provided for each type of grease applied.
- D. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.
- E. All lubrication points shall be extended to one side of the equipment.

### **3.6 PLUMBING SYSTEMS DEMOLITION**

- A. Rigging access, other than indicated on the drawings, shall be provided after approval for structural integrity by the COR. Such access shall be provided without additional cost or time to the Government. Where work is in an operating plant, approved protection from dust and debris shall be provided at all times for the safety of plant personnel and maintenance of plant operation and environment of the plant.
- B. In an operating plant, cleanliness and safety shall be maintained. The plant shall be kept in an operating condition. Government personnel will be carrying on their normal duties of operating, cleaning and maintaining equipment and plant operation. Work shall be confined to the immediate area concerned; maintain cleanliness and wet down demolished materials to eliminate dust. Dust and debris shall not be permitted to accumulate in the area to the detriment of plant operation. All flame cutting shall be performed to maintain the fire safety integrity of this plant. Adequate fire extinguishing facilities shall be available at all times. All work shall be performed in accordance with recognized fire protection standards including NFPA 51B. Inspections will be made by personnel of the VA Medical Center, and the Contractor shall follow all directives of the COR with regard to rigging, safety, fire safety, and maintenance of operations.
- C. Unless specified otherwise, all piping, wiring, conduit, and other devices associated with the equipment not re-used in the new work shall be completely removed from Government property per Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT. This includes all concrete equipment pads, pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. All openings shall be sealed 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 COR 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. Coordinate with the COR and Infection Control.

### **3.7 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. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Scratches, scuffs, and abrasions shall be repaired prior to applying prime and finish coats.
  2. The following Material and Equipment shall NOT be painted:
    - a. Motors, controllers, control switches, and safety switches.
    - b. Control and interlock devices.
    - c. Regulators.
    - d. Pressure reducing valves.
    - e. Control valves and thermostatic elements.
    - f. Lubrication devices and grease fittings.
    - g. Copper, brass, aluminum, stainless steel and bronze surfaces.
    - h. Valve stems and rotating shafts.
    - i. Pressure gages and thermometers.
    - j. Glass.
    - k. Name plates.

3. Control and instrument panels shall be cleaned, and damaged surfaces repaired. Touch-up painting shall be made with matching paint type and color obtained from manufacturer or computer matched.
4. Pumps, motors, steel and cast-iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same paint type and color as utilized by the pump manufacturer.
5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats per Section 09 91 00, Painting.
6. The final result shall be a smooth, even-colored, even-textured factory finish on all items. The entire piece of equipment shall be repainted, if necessary, to achieve this. Lead based paints shall not be used.

### **3.8 IDENTIFICATION SIGNS**

- A. Laminated plastic signs, with engraved lettering not less than 7 mm (3/16 inch) high, shall be provided that designates equipment function, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.
- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, and performance data shall be placed on factory-built equipment.
- C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

### **3.9 STARTUP AND TEMPORARY OPERATION**

- A. Startup of equipment shall be performed as described in the equipment specifications. Vibration within specified tolerance shall be verified 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.
- B. The commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Contracting Officer's Representative and Commissioning Agent. Provide a minimum of 2 weeks prior notice.

**3.10 OPERATING AND PERFORMANCE TESTS**

- A. Prior to the final inspection, all required tests shall be performed as specified in Section 01 00 00, GENERAL REQUIREMENTS, Article, TESTS and submit the test reports and records to the COR.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the Government.
- C. When completion of certain work or systems occurs at a time when final control settings and adjustments cannot be properly made to make performance tests, then conduct such performance tests and finalize control settings during the first actual seasonal use of the respective systems following completion of work. Rescheduling of these tests shall be requested in writing to COR for approval.
- D. Perform tests as required for commissioning provisions in accordance with Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS and Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

**3.11 OPERATION AND MAINTENANCE MANUALS**

- A. All new and temporary equipment and all elements of each assembly shall be included.
- B. Data sheet on each device listing model, size, capacity, pressure, speed, horsepower, impeller size, and other information shall be included.
- C. Manufacturer's installation, maintenance, repair, and operation instructions for each device shall be included. Assembly drawings and parts lists shall also be included. A summary of operating precautions and reasons for precautions shall be included in the Operations and Maintenance Manual.
- D. Lubrication instructions, type and quantity of lubricant shall be included.
- E. Schematic diagrams and wiring diagrams of all control systems corrected to include all field modifications shall be included.
- F. Set points of all interlock devices shall be listed.
- G. Trouble-shooting guide for the control system troubleshooting shall be inserted into the Operations and Maintenance Manual.

- H. The control system sequence of operation corrected with submittal review comments shall be inserted into the Operations and Maintenance Manual.
- I. Emergency procedures for shutdown and startup of equipment and systems.

**3.12 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

**3.13 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative to instruct VA Personnel in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

- - - E N D - - -



**SECTION 22 05 12**  
**GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the general motor requirements for plumbing equipment and applies to all sections of Division 22.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- E. Section 26 24 19, MOTOR-CONTROL CENTERS: Motor Control Centers.
- F. Section 26 29 11, MOTOR CONTROLLERS: Starters, control and protection of motors.

**1.3 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 Bearing Manufacturers Association (ABMA):  
ABMA 9-1990 (R2008) ....Load Ratings and Fatigue Life for Ball Bearings
- C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):  
841-2009 .....IEEE Standard for Petroleum and Chemical  
Industry-Premium-Efficiency, Severe-Duty,  
Totally Enclosed Fan-Cooled (TEFC) Squirrel  
Cage Induction Motors--Up to and Including 370  
kW (500 HP)
- D. International Code Council (ICC):  
IPC-2012 .....International Plumbing Code
- E. National Electrical Manufacturers Association (NEMA):  
MG 1-2011 .....Motors and Generators  
MG 2-2001 (R2007) .....Safety Standard for Construction and Guide for  
Selection, Installation and Use of Electric  
Motors and Generators

250-2008 .....Enclosures for Electrical Equipment (1000 Volts  
Maximum)

F. National Fire Protection Association (NFPA):

70-2011 .....National Electrical Code (NEC)

#### 1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT", with applicable paragraph identification.
- C. Shop Drawings:
1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  2. Motor nameplate information shall be submitted including electrical ratings, dimensions, mounting details, materials, horsepower, power factor, current as a function of speed, current efficiency, speed as a function of load, RPM, enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.
  3. Motor parameters required for the determination of the Reed Critical Frequency of vertical hollow shaft motors shall be submitted.
- D. Operating and Maintenance Manuals: Companion copies of complete maintenance and operating manuals, including technical data sheets and application data shall be submitted simultaneously with the shop drawings. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replaceable parts:
1. Include complete list indicating all components of the systems.
  2. Include complete diagrams of the internal wiring for each item of equipment.
  3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- E. Certification: Two weeks prior to final inspection, unless otherwise noted, the following certification shall be submitted to the Contracting Officer's Representative (COR).

1. Certification shall be submitted stating that the motors have been properly applied, installed, adjusted, lubricated, and tested.

#### **1.5 QUALITY ASSURANCE**

- A. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

### **PART 2 - PRODUCTS**

#### **2.1 MOTORS**

- A. For alternating current, fractional and integral horsepower motors, NEMA MG 1 and NEMA MG 2 shall apply.
- B. For severe duty totally enclosed motors, IEEE 841 shall apply.
- C. 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. Motors, 74.6 kW (100 HP) or larger, connected to 240-volt systems: 230 volts.
    - d. Motors, 74.6 kW (100 HP) or larger, connected to 480-volt systems: 460 volts.
    - e. Motors connected to high voltage systems: Shall conform to NEMA MG 1 Standards for connection to the nominal system voltage shown on the drawings.
- D. 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 (1 HP), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.
- E. 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.
- F. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting, acceleration and running torque without exceeding nameplate ratings or considering service factor.
- G. 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 per NEMA 250, 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.
  - 4. All motors in hazardous locations shall be approved for the application and meet the Class and Group as required by the area classification.
- H. Electrical Design Requirements:
- 1. Motors shall be continuous duty.
  - 2. The insulation system shall be rated minimum of Class B, 130 degrees C (266 degrees F).
  - 3. The maximum temperature rise by resistance at rated power shall not exceed Class B limits, 80 degrees C (144 degrees F).
  - 4. The speed/torque and speed/current characteristics shall comply with NEMA Design A or B, as specified.
  - 5. Motors shall be suitable for full voltage starting, unless otherwise noted. Coordinate motor features with applicable motor controllers.
  - 6. Motors for variable frequency drive applications shall adhere to NEMA MG 1, Part 30, Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable Voltage or Adjustable Frequency

Controls, or both, or NEMA MG 1, Part 31, Definite Purpose Inverter Fed Polyphase Motors.

I. Mechanical Design Requirements:

1. Bearings shall be rated for a minimum fatigue life of 26,280 hours for belt-driven loads and 100,000 hours for direct-drive loads based on L10 (Basic Rating Life) at full load direct coupled, except vertical high thrust motors which require a 40,000 hour rating. A minimum fatigue life of 40,000 hours is required for VFD drives.
2. Vertical motors shall be capable of withstanding a momentary up thrust of at least 30 percent of normal down thrust.
3. Grease lubricated bearings shall be designed for electric motor use. Grease shall be capable of the temperatures associated with electric motors and shall be compatible with Polyurea based greases.
4. Grease fittings, if provided, shall be Alemite type or equivalent.
5. Oil lubricated bearings, when specified, shall have an externally visible sight glass to view oil level.
6. Vibration shall not exceed 3.8 mm (0.15 inch) per second, unfiltered peak.
7. Noise level shall meet the requirements of the application.
8. Motors on 180 frames and larger shall have provisions for lifting eyes or lugs capable of a safety factor of 5.
9. All external fasteners shall be corrosion resistant.
10. Condensation heaters, when specified, shall keep motor windings at least 5 degrees C (9 degrees F) above ambient temperature.
11. Winding thermostats, when specified shall be normally closed, connected in series.
12. Grounding provisions shall be in the main terminal box.

J. Additional requirements for specific motors, as indicated in other sections, shall also apply.

K. NEMA Premium Efficiency Electric Motors, Motor Efficiencies: All permanently wired polyphase motors of 746 W (1 HP) or more shall meet the minimum full-load efficiencies as indicated in the following table, and as specified in this specification. Motors of 746 W (1 HP) 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%
37.3 (50)	94.1%	94.5%	93.0%	37.3 (50)	94.1%	94.5%	93.0%
44.8 (60)	94.5%	95.0%	93.6%	44.8 (60)	94.5%	95.0%	93.6%
56.9 (75)	94.5%	95.0%	93.6%	56.9 (75)	94.5%	95.4%	93.6%
74.6 (100)	95.0%	95.4%	93.6%	74.6 (100)	95.0%	95.4%	94.1%
93.3 (125)	95.0%	95.4%	94.1%	93.3 (125)	95.0%	95.4%	95.0%
112 (150)	95.4%	95.8%	94.1%	112 (150)	95.8%	95.8%	95.0%
149.2 (200)	95.4%	95.8%	95.0%	149.2 (200)	95.8%	96.2%	95.4%

L. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM and 3600 RPM. Power factor correction capacitors shall be installed unless the motor is controlled by a variable frequency drive. The power factor correction capacitors shall be able to withstand high voltage transients and power line variations without breakdown.

**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.

B. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no cost to the Government.

**3.2 FIELD TESTS**

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

**3.3 COMMISSIONING**

A. Not Used.

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**SECTION 22 05 19**  
**METERS AND GAGES FOR PLUMBING PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the requirements for water meters and gages primarily used for troubleshooting the system and to indicate system performance.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- E. Section 25 10 10, ADVANCED UTILITY METERING SYSTEM.

**1.3 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 Mechanical Engineers (ASME):
  - B40.100-2013 .....Pressure Gauges and Gauge Attachments
  - B40.200-2008 .....Thermometers, Direct Reading and Remote Reading
- C. American Water Works Association (AWWA):
  - C700-2009 .....Standard for Cold Water Meters, Displacement Type, Bronze Main Case
  - C701-2012 .....Cold Water Meters-Turbine Type, for Customer Service
  - C702-2010 .....Cold Water Meters - Compound Type
  - C706-2010 .....Direct-Reading, Remote-Registration Systems for Cold-Water Meters
- D. Institute of Electrical and Electronics Engineers (IEEE):
  - C2-2012 .....National Electrical Safety Code (NESC)
- E. International Code Council (ICC):
  - IPC-2012 .....International Plumbing Code
- F. National Fire Protection Association (NFPA):
  - 70-2011 .....National Electrical Code (NEC)

G. NSF International (NSF):

61-2012 .....Drinking Water System Components - Health  
Effects

372-2011 .....Drinking Water System Components - Lead Content

**1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 05 19, METERS AND GAGES FOR PLUMBING PIPING", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Water Meter.
  - 2. Pressure Gages.
  - 3. Thermometers.
  - 4. Product certificates for each type of meter and gage.
  - 5. BACnet communication protocol.
- D. Operations and Maintenance manual shall include:
  - 1. System Description.
  - 2. Major assembly block diagrams.
  - 3. Troubleshooting and preventive maintenance guidelines.
  - 4. Spare parts information.
- E. Shop Drawings shall include the following: One line, wiring and terminal diagrams including terminals identified, protocol or communication modules, and Ethernet connections.

**1.5 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit copies of complete operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be inserted into a three ring binder per the requirements of Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written

description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. A list of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

## **PART 2 - PRODUCTS**

### **2.1 PRESSURE GAGES FOR WATER AND SEWAGE USAGE**

- A. ASME B40.100 all metal case 115 mm (4-1/2 inches) diameter, bottom connected throughout, graduated as required for service, and identity labeled. Range shall be 0 to 1380 kPa (0 to 200 psig) gage.
- B. The pressure element assembly shall be bourdon tube. The mechanical movement shall be lined to pressure element and connected to pointer.
- C. The dial shall be non-reflective aluminum with permanently etched scale markings graduated in kPa and psig.
- D. The pointer shall be dark colored metal.
- E. The window shall be glass.
- F. The ring shall be brass or stainless steel.
- G. The accuracy shall be grade A, plus or minus 1 percent of middle half of scale range.
- H. The pressure gage for water domestic use shall conform to NSF 61 and NSF 372.

### **2.2 THERMOMETERS**

- A. Thermometers shall be straight stem, metal case, red liquid-filled thermometer, approximately 175 mm (7 inches) high, 4 degrees C to 100 degrees C (40 degrees F to 212 degrees F). Thermometers shall comply with ASME B40.200.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Direct mounted pressure gages shall be installed in piping tees with pressure gage located on pipe at the most readable position.
- B. Valves and snubbers shall be installed in piping for each pressure gage.
- C. Test plugs shall be installed on the inlet and outlet pipes of all heat exchangers or water heaters serving more than one plumbing fixture.

- D. Pressure gages shall be installed where indicated on the drawings and at the following locations:
1. Building water service entrance into building.
  2. Inlet and outlet of each pressure reducing valve.
  3. Suction and discharge of each domestic water pump or re-circulating hot water return pump.
- E. Water meter installation shall conform to AWWA C700, AWWA C701, and AWWA C702. Electrical installations shall conform to IEEE C2, NFPA 70, and to the requirements specified herein. New materials shall be provided.
- F. Remote readout register shall be mounted at the location indicated on the drawings or as directed by the COR.
- G. Thermometers shall be installed on the water heater inlet and outlet piping, thermostatic mixing valve outlet piping, and the hot water circulation pump inlet piping.
- H. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no cost to the Government.

### **3.2 FIELD QUALITY CONTROL**

- A. The meter assembly shall be visually inspected and operationally tested. The correct multiplier placement on the face of the meter shall be verified.

### **3.3 TRAINING**

- A. A training course shall be provided to the medical center on meter configuration and maintenance. Training manuals shall be supplied for all attendees with four additional copies supplied. The training course shall cover meter configuration, troubleshooting, and diagnostic procedures.

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**SECTION 22 05 23**  
**GENERAL-DUTY VALVES FOR PLUMBING PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the requirements for general-duty valves for domestic water and sewer systems.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- F. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

**1.3 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 Mechanical Engineers (ASME):  
A112.14.1-2003 .....Backwater Valves
- C. American Society of Sanitary Engineering (ASSE):  
1001-2008 .....Performance Requirements for Atmospheric Type  
Vacuum Breakers  
1003-2009 .....Performance Requirements for Water Pressure  
Reducing Valves for Domestic Water Distribution  
Systems  
1011-2004 .....Performance Requirements for Hose Connection  
Vacuum Breakers  
1013-2011 .....Performance Requirements for Reduced Pressure  
Principle Backflow Preventers and Reduced  
Pressure Principle Fire Protection Backflow  
Preventers  
1015-2011 .....Performance Requirements for Double Check  
Backflow Prevention Assemblies and Double Check  
Fire Protection Backflow Prevention Assemblies

- 1017-2009 .....Performance Requirements for Temperature  
Actuated Mixing Valves for Hot Water  
Distribution Systems
- 1020-2004 .....Performance Requirements for Pressure Vacuum  
Breaker Assembly
- 1035-2008 .....Performance Requirements for Laboratory Faucet  
Backflow Preventers
- 1069-2005 .....Performance Requirements for Automatic  
Temperature Control Mixing Valves
- 1070-2004 .....Performance Requirements for Water Temperature  
Limiting Devices
- 1071-2012 .....Performance Requirements for Temperature  
Actuated Mixing Valves for Plumbed Emergency  
Equipment
- D. American Society for Testing and Materials (ASTM):
- A126-2004 (R2009) .....Standard Specification for Gray Iron Castings  
for Valves, Flanges, and Pipe Fittings
- A276-2013a .....Standard Specification for Stainless Steel Bars  
and Shapes
- A536-1984 (R2009) .....Standard Specification for Ductile Iron  
Castings
- B62-2009 .....Standard Specification for Composition Bronze  
or Ounce Metal Castings
- B584-2013 .....Standard Specification for Copper Alloy Sand  
Castings for General Applications
- E. International Code Council (ICC):
- IPC-2012 .....International Plumbing Code
- F. Manufacturers Standardization Society of the Valve and Fittings  
Industry, Inc. (MSS):
- SP-25-2008 .....Standard Marking Systems for Valves, Fittings,  
Flanges and Unions
- SP-67-2011 .....Butterfly Valves
- SP-70-2011 .....Gray Iron Gate Valves, Flanged and Threaded  
Ends
- SP-71-2011 .....Gray Iron Swing Check Valves, Flanged and  
Threaded Ends
- SP-80-2013 .....Bronze Gate, Globe, Angle, and Check Valves

SP-85-2011 .....Gray Iron Globe & Angle Valves, Flanged and  
Threaded Ends

SP-110-2010 .....Ball Valves Threaded, Socket-Welding, Solder  
Joint, Grooved and Flared Ends

G. National Environmental Balancing Bureau (NEBB):

7th Edition 2005           Procedural Standards for Testing, Adjusting,  
Balancing of Environmental Systems

H. NSF International (NSF):

61-2012 .....Drinking Water System Components - Health  
Effects

372-2011 .....Drinking Water System Components - Lead Content

I. University of Southern California Foundation for Cross Connection  
Control and Hydraulic Research (USC FCCCHR):

9th Edition .....Manual of Cross-Connection Control

**1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING", with applicable paragraph identification.
- C. Manufacturer's Literature and Data Including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Ball Valves.
  - 2. Gate Valves.
  - 3. Butterfly Valves.
  - 4. Balancing Valves.
  - 5. Check Valves.
  - 6. Globe Valves.
  - 7. Water Pressure Reducing Valves and Connections.
  - 8. Backwater Valves.
  - 9. Backflow Preventers.
  - 10. Chainwheels.
  - 11. Thermostatic Mixing Valves.
- D. Test and Balance reports for balancing valves.

- E. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replaceable parts:
  - 1. Include complete list indicating all components of the systems.
  - 2. Include complete diagrams of the internal wiring for each item of equipment.
  - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
  - 4. Piping diagrams of thermostatic mixing valves to be installed.
- F. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the Contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- G. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Valves shall be prepared for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, grooves, and weld ends.
  - 3. Set angle, gate, and globe valves closed to prevent rattling.
  - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
  - 5. Set butterfly valves closed or slightly open.
  - 6. Block check valves in either closed or open position.
- B. Valves shall be prepared for storage as follows:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher than ambient dew point temperature.
- C. A sling shall be used for large valves. The sling shall be rigged to avoid damage to exposed parts. Hand wheels or stems shall not be used as lifting or rigging points.

#### **PART 2 - PRODUCTS**

##### **2.1 VALVES, GENERAL**

- A. Asbestos packing and gaskets are prohibited.
- B. Bronze valves shall be made with dezincification resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc shall not be permitted.



- C. Valves in insulated piping shall have 50 mm or DN50 (2 inch) stem extensions and extended handles of non-thermal conductive material that allows operating the valve without breaking the vapor seal or disturbing the insulation. Memory stops shall be fully adjustable after insulation is applied.
- D. Exposed Valves over 65 mm or DN65 (2-1/2 inches) installed at an elevation over 3.6 m (12 feet) shall have a chain-wheel attachment to valve hand-wheel, stem, or other actuator.
- E. All valves used to supply potable water shall meet the requirements of NSF 61 and NSF 372.
- F. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

## 2.2 SHUT-OFF VALVES

- A. Cold, Hot and Re-circulating Hot Water:
  - 1. 50 mm or DN50 (2 inches) and smaller: Ball, MSS SP-110, Ball valve shall be full port three piece or two piece with a union design with adjustable stem package. Threaded stem designs are not allowed. The ball valve shall have a SWP rating of 1035 kPa (150 psig) and a CWP rating of 4138 kPa (600 psig). The body material shall be Bronze ASTM B584, Alloy C844. The ends shall be non-lead solder.
  - 2. Less than 100 mm DN100 (4 inches): Butterfly shall have an iron body with EPDM seal and aluminum bronze disc. The butterfly valve shall meet MSS SP-67, type I standard. The butterfly valve shall have a SWP rating of 1380 kPa (200 psig). The valve design shall be lug type suitable for bidirectional dead-end service at rated pressure. The body material shall meet ASTM A536, ductile iron.
  - 3. 100 mm DN100 (4 inches) and larger:
    - a. Class 125, OS&Y, Cast Iron Gate Valve. The gate valve shall meet MSS SP-70 type I standard. The gate valve shall have a CWP rating of 1380 kPa (200 psig). The valve materials shall meet ASTM A126, grey iron with bolted bonnet, flanged ends, bronze trim, and positive-seal resilient solid wedge disc. The gate valve shall be

gear operated for sizes under 200 mm or DN200 (8 inches) and crank operated for sizes 200 mm or DN200 (8 inches) and above.

- b. Single flange, ductile iron butterfly valves: The single flanged butterfly valve shall meet the MSS SP-67 standard. The butterfly valve shall have a CWP rating of 1380 kPa (200 psig). The butterfly valve shall be lug type, suitable for bidirectional dead-end service at rated pressure without use of downstream flange. The body material shall comply with ASTM A536 ductile iron. The seat shall be EPDM with stainless steel disc and stem.
- c. Grooved end, ductile iron butterfly valves. The grooved butterfly valve shall meet the MSS SP-67 standard. The grooved butterfly valve shall have a CWP rating of 1380 kPa (200 psig). The valve materials shall be epoxy coated ductile iron conforming to ASTM A536 with two piece stainless steel stem, EPDM encapsulated ductile iron disc, and EPDM seal. The butterfly valve shall be gear operated.

B. Reagent Grade Water: Valves for reagent grade, reverse osmosis, or deionized water service shall be ball type of same material as used for pipe.

### **2.3 BALANCING VALVES**

- A. Hot Water Re-circulating, 75 mm or DN75 (3 inches) and smaller manual balancing valve shall be of bronze body, brass ball construction with glass and carbon filled TFE seat rings and designed for positive shutoff. The manual balancing valve shall have differential pressure read-out ports across the valve seat area. The read out ports shall be fitting with internal EPT inserts and check valves. The valve body shall have 8 mm or DN8 NPT (1/4 inch NPT) tapped drain and purge port. The valves shall have memory stops that allow the valve to close for service and then reopened to set point without disturbing the balance position. All valves shall have calibrated nameplates to assure specific valve settings.
- B. Larger than 75 mm or DN75 (3 inches): Manual balancing valves shall be of heavy duty cast iron flanged construction with 861 kPa (125 psig) flange connections. The flanged manual balancing valves shall have either a brass ball with glass and carbon filled TFE seal rings or fitted with a bronze seat, replaceable bronze disc with EPDM seal

insert and stainless steel stem. The design pressure shall be 1200 kPa (175 psig) at 121 degrees C (250 degrees F).

#### **2.4 CHECK VALVES**

- A. 75 mm or DN75 (3 inches) and smaller shall be Class 125, bronze swing check valves with non-metallic disc suitable for type of service. The check valve shall meet MSS SP-80 Type 4 standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a Y pattern horizontal body design with bronze body material conforming to ASTM B62, solder joints, and PTFE or TFE disc.
- B. 100 mm or DN100 (4 inches) and larger:
  - 1. Check valves shall be Class 125, iron swing check valve with lever and weight closure control. The check valve shall meet MSS SP-71 Type I standard. The check valve shall have a CWP rating of 1380 kPa (200 psig). The check valve shall have a clear or full waterway body design with gray iron body material conforming to ASTM A126, bolted bonnet, flanged ends, bronze trim.
  - 2. All check valves on the discharge side of submersible sump pumps shall have factory installed exterior level and weight with sufficient weight to prevent the check valve from hammering against the seat when the sump pump stops.

#### **2.5 GLOBE VALVES**

- A. 75 mm or DN75 (3 inches) or smaller: Class 150, bronze globe valve with non-metallic disc. The globe valve shall meet MSS SP-80, Type 2 standard. The globe valve shall have a CWP rating of 2070 kPa (300 psig). The valve material shall be bronze with integral seal and union ring bonnet conforming to ASTM B62 with solder ends, copper-silicon bronze stem, PTFE or TFE disc, and malleable iron hand wheel.
- B. Larger than 75 mm or DN75 (3 inches): Similar to above, except with cast iron body and bronze trim, Class 125, iron globe valve. The globe valve shall meet MSS SP-85, Type 1 standard. The globe valve shall have a CWP rating of 1380 kPa (200 psig). The valve material shall be gray iron with bolted bonnet conforming to ASTM A126 with flanged ends, bronze trim, and malleable iron handwheel.

#### **2.6 WATER PRESSURE REDUCING VALVE AND CONNECTIONS**

- A. 75 mm or DN75 (3 inches) or smaller: The pressure reducing valve shall consist of a bronze body and bell housing, a separate access cover for the plunger, and a bolt to adjust the downstream pressure. The pressure

reducing valve shall meet ASSE 1003. The bronze bell housing and access cap shall be threaded to the body and shall not require the use of ferrous screws. The assembly shall be of the balanced piston design and shall reduce pressure in both flow and no flow conditions. The assembly shall be accessible for maintenance without having to remove the body from the line.

- B. 100 mm or DN100 (4 inches) and larger: The pressure reducing valve shall consist of a flanged cast iron body and rated to 1380 kPa (200 psig). The valve shall have a large elastomer diaphragm for sensitive response. The pressure reducing valve shall meet ASSE 1003.
- C. The regulator shall have a tap for pressure gauge.
- D. The regulator shall have a temperature rating of 100 degrees C (212 degrees F) for hot water or hot water return service. Pressure regulators shall have accurate pressure regulation to 6.9 kPa (+/- 1 psig).
- E. Setting: Entering water pressure, discharge pressure, capacity, size, and related measurements shall be as shown on the drawings.
- F. Connections Valves and Strainers: Shut off valves shall be installed on each side of reducing valve and a bypass line equal in size to the regulator inlet pipe shall be installed with a normally closed globe valve. A strainer shall be installed on inlet side of, and same size as pressure reducing valve. A pressure gage shall be installed on the inlet and outlet of the valve.

## **2.7 BACKWATER VALVE**

- A. The backwater valve shall have a cast iron body, automatic thermoplastic type valve seat and flapper suited for water service. The flapper shall be slightly open during periods of non-operation. The pressure reducing valve shall meet ASME A112.14.1. The cleanout shall be extended to the finish floor and fit with a threaded countersunk plug. A clamping device shall be included when the cleanout extends through the waterproofing membrane.
- B. When the backwater valve is installed greater than 600 mm (24 inches) below the finish floor elevation, a pit or manhole large enough for a repair person can enter to service the backwater valve shall be installed.

## 2.8 BACKFLOW PREVENTERS

- A. A backflow prevention assembly shall be installed at any point in the plumbing system where the potable water supply comes in contact with a potential source of contamination. The backflow prevention assembly shall be approved by the University of Southern California Foundation for Cross Connection Control and Hydraulic Research (USCFCCC).
- B. The reduced pressure principle backflow prevention assembly shall be ASSE listed 1013 with full port OS&Y positive-seal resilient gate valves and an integral relief monitor switch. The main body and access cover shall be epoxy coated ductile iron conforming to ASTM A536 grade 4. The seat ring and check valve shall be the thermoplastic type suited for water service. The stem shall be stainless steel conforming to ASTM A276. The seat disc shall be the elastomer type suited for water service. The checks and the relief valve shall be accessible for maintenance without removing the device from the line. An epoxy coated wye type strainer with flanged connections shall be installed on the inlet. Reduced pressure backflow preventers shall be installed in the following applications.
1. Deionizers.
  2. Sterilizers.
  3. Stills.
  4. Dialysis, Deionized or Reverse Osmosis Water Systems.
  5. Water make up to heating systems, cooling tower, chilled water system, generators, and similar equipment consuming water.
  6. Water service entrance from loop system.
  7. Dental equipment.
  8. Power washer.
  9. Medical equipment.
  10. Process equipment.
  11. Autopsy, on each hot and cold water outlet at each table or sink.
  12. Reclaimed water systems.
- C. The pipe applied or integral atmospheric vacuum breaker shall be ASSE listed 1001. The main body shall be cast bronze. The seat disc shall be the elastomer type suited for water service. The device shall be accessible for maintenance without removing the device from the service line. The installation shall not be in a concealed or inaccessible location or where the venting of water from the device during normal

operation is deemed objectionable. Atmospheric vacuum breakers shall be installed in the following applications.

1. Hose bibs and sinks with threaded outlets.
  2. Disposers.
  3. Showers (telephone/handheld type).
  4. Hydrotherapy units.
  5. All kitchen equipment, if not protected by air gap.
  6. Ventilating hoods with wash down system.
  7. Film processor.
  8. Detergent system.
  9. Fume hoods.
  10. Glassware washers.
  11. Service sinks (integral with faucet only).
  12. Laundry tubs (integral with faucet only).
  13. Sitz baths.
- D. The hose connection vacuum breaker shall be ASSE listed 1011. The main body shall be cast brass with stainless steel working parts. The diaphragm and disc shall be the elastomer type suited for water service. The device shall permit the attachment of portable hoses to hose thread outlets. Hose connection vacuum breakers shall be installed in the following locations requiring non-continuous pressure:
1. Hose bibbs and wall hydrants.
- E. The pressure vacuum breaker shall be ASSE listed 1020. The main body shall be brass. The disc and O-ring seal shall be the elastomer type. The valve seat and disc float shall be the thermoplastic type. Tee handle or lever handle shut-off ball valves. Test cocks for testing and draining where freezing conditions occur. All materials shall be suitable for water service. The device shall be accessible for maintenance without removing the device from the service line. The installation shall not be in a concealed or inaccessible location or where the venting of water from the device during normal operation is deemed objectionable. Pressure vacuum breakers shall be installed in the following locations requiring continuous pressure and no backpressure including equipment with submerged inlet connections:
1. Lawn Irrigation.
- F. The laboratory faucet vacuum breaker shall be ASSE listed 1035. The main body shall be cast brass. Dual check valves with stainless steel

working parts. The diaphragm and disc shall be the elastomer type suited for water service. The device shall permit the attachment of portable hoses to laboratory faucets for non-continuous pressure applications.

- G. The double check backflow prevention assembly shall be ASSE listed 1015 and supply with full port, OS&Y, positive-seal, resilient gate valves. The main body and access cover shall be epoxy coated ductile iron conforming to ASTM A536 grade. The seat ring and check valve shall be the thermoplastic type suited for water service. The stem shall be stainless steel conforming to ASTM A276. The seat disc shall be the elastomer type suited for water service. The first and second check valve shall be accessible for maintenance without removing the device from the line. Double check valves shall be installed in the following location requiring continuous pressure subject to backpressure and backsiphonage conditions.
1. Lawn Irrigation.
  2. Food Processing Equipment.
  3. Laundry equipment.

## **2.9 THERMOSTATIC MIXING VALVES**

- A. Thermostatic Mixing Valves shall comply with the following general performance requirements:
1. Shall meet ASSE requirements for water temperature control.
  2. The body shall be cast bronze or brass with corrosion resistant internal parts preventing scale and biofilm build-up. Provide chrome-plated finish in exposed areas.
  3. No special tool shall be required for temperature adjustment, maintenance, replacing parts and disinfecting operations.
  4. Valve shall be able to be placed in various positions without making temperature adjustment or reading difficult.
  5. Valve finish shall be chrome plated in exposed areas.
  6. Valve shall allow easy temperature adjustments to allow hot water circulation. Internal parts shall be able to withstand disinfecting operations of chemical and thermal treatment of water temperatures up to 82°C (180°F) for 30 minutes or 50 mg/L (50 ppm) chlorine residual concentration for 24 hours.
  7. Parts shall be easily removed or replaced without dismantling the valves, for easy scale removal and disinfecting of parts.

8. Valve shall have a manual adjustable temperature control with locking mechanism to prevent tampering by end user. Outlet temperature shall be visible to ensure outlet temperature does not exceed specified limits, particularly after thermal eradication procedures.
  9. Provide mixing valves with integral check valves with screens and stop valves.
- B. Master Thermostatic Water Mixing Valves:
1. Application: Tempered water distribution from hot water source.
  2. Standard: ASSE 1017.
  3. Pressure Rating: 861 kPa (125 psig).
  4. Type: Exposed-mounting or Cabinet-type, as indicated, thermostatically controlled water mixing valve.
  5. Connections: Flanged or threaded union inlets and outlet.
  7. Cabinet: Factory-fabricated, stainless steel, for recessed or surface mounting and with hinged, stainless-steel door.
  8. Thermometers shall be provided to indicate mixed water temperature.
  9. Provide a high temperature alarm device to detect mixing valve failure.
- C. Hi-Lo Water-Mixing-Valve Assemblies:
1. Application: Tempered water distribution from hot water source covering a wide range of flow.
  2. Description: Factory-fabricated, cabinet-type or exposed-mounting, thermostatically controlled, water-mixing-valve assembly in two-valve parallel arrangement including pressure regulators, pressure gages and thermometer.
  3. Large-Flow Parallel: Master thermostatic water mixing valve and downstream pressure regulator with pressure gages on inlet and outlet.
  4. Small-Flow Parallel: Master thermostatic water mixing valve.
  5. Master Thermostatic Mixing Valves: Comply with ASSE 1017.
  6. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
  7. Component Pressure Ratings: 861 kPa (125 psig) minimum, unless otherwise indicated.
  9. Connections: Soldered or threaded union inlets and outlet.



10. Thermometers shall be provided to indicate mixed water temperature.
  11. Provide a high temperature alarm device to detect mixing valve failure.
- D. Automatic Water Temperature Control Mixing Valves:
1. Application: Gang plumbing fixtures point-of-use when no other mixing at fixtures occurs.
  2. Standard: ASSE 1069.
  3. Pressure Rating: 861 kPa (125 psig).
  4. Type: Thermostatically controlled water mixing valve set at 43 degrees C (110 degrees F).
  5. Connections: Threaded union or soldered inlets and outlet.
  6. Thermometers shall be provided to indicate mixed water temperature.
  7. Upon cold water supply failure the hot water flow shall automatically be reduced to 0.5 gpm maximum.
  8. Provide a high temperature alarm device to detect mixing valve failure.
- E. Water Temperature Limiting Devices:
1. Application: Single plumbing fixture point-of-use such as sinks or lavatories.
  2. Standard: ASSE 1070.
  3. Pressure Rating: 861 kPa (125 psig).
  4. Type: Thermostatically controlled water mixing valve set at 43 degrees C (110 degrees F).
  5. Connections: Threaded union, compression or soldered inlets and outlet.
  6. Upon cold water supply failure the hot water flow shall automatically be reduced to 0.2 gpm maximum.
- F. Temperature Activated Mixing Valves:
1. Application: Emergency eye/face/drench shower equipment.
  2. Standard: ASSE 1071.
  3. Pressure Rating: 861 kPa (125 psig).
  4. Type: Thermostatically controlled water mixing valve set at 24-30 degrees C (75-85 degrees F).
  5. Connections: Soldered or threaded union inlets and outlet.
  7. Thermometers shall be provided to indicate mixed water temperature.

8. Upon cold water supply failure the hot water flow shall automatically be reduced to 0.5 gpm maximum.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Valve interior shall be examined for cleanliness, freedom from foreign matter, and corrosion. Special packing materials shall be removed, such as blocks, used to prevent disc movement during shipping and handling.
- B. Valves shall be operated in positions from fully open to fully closed. Guides and seats shall be examined and made accessible by such operations.
- C. Threads on valve and mating pipe shall be examined for form and cleanliness.
- D. Mating flange faces shall be examined for conditions that might cause leakage. Bolting shall be checked for proper size, length, and material. Gaskets shall be verified for proper size and that its material composition is suitable for service and free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

#### **3.2 INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Valves shall be located for easy access and shall be provide with separate support. Valves shall be accessible with access doors when installed inside partitions or above hard ceilings.
- C. Valves shall be installed in horizontal piping with stem at or above center of pipe.
- D. Valves shall be installed in a position to allow full stem movement.
- E. Check valves shall be installed for proper direction of flow and as follows:
  1. Swing Check Valves: In horizontal position with hinge pin level and on top of valve.
- E. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction. Locate backflow preventers in same room as connected equipment or system.

1. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
- G. Install pressure gages on outlet of backflow preventers.
- H. Do not install bypass piping around backflow preventers.
- I. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets.
  1. Install thermometers if specified.
  2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- J. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no cost to the Government.

### **3.3 LABELING AND IDENTIFYING**

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  1. Calibrated balancing valves.
  2. Master, thermostatic, water mixing valves.
  3. Manifold, thermostatic, water-mixing-valve assemblies.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

### **3.4 ADJUSTING**

- A. Valve packing shall be adjusted or replaced after piping systems have been tested and put into service but before final adjusting and balancing. Valves shall be replaced if persistent leaking occurs.
- B. Set field-adjustable flow set points of balancing valves and record data. Ensure recorded data represents actual measured or observed conditions. Permanently mark settings of valves and other adjustment devices allowing settings to be restored. Set and lock memory stops. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

- D. Testing and adjusting of balancing valves shall be performed by an independent NEBB Accredited Test and Balance Contractor. A final settings and flow report shall be submitted to the VA Contracting Officer's Representative (COR).

**3.5 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

**3.6 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative to instruct VA Personnel in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

- - E N D - - -

**SECTION 22 07 11**  
**PLUMBING INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Field applied insulation for thermal efficiency and condensation control for the following:
1. Plumbing piping and equipment.
- B. Definitions:
1. ASJ: All Service Jacket, Kraft paper, white finish facing or jacket.
  2. Air conditioned space: Space having air temperature and/or humidity controlled by mechanical equipment.
  3. All insulation systems installed within supply, return, exhaust, relief and ventilation air plenums shall be limited to uninhabited crawl spaces, areas above a ceiling or below the floor, attic spaces, interiors of air conditioned or heating ducts, and mechanical equipment rooms shall be noncombustible or shall be listed and labeled as having a flame spread indexes of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E84 or UL 723. Note: ICC IMC, Section 602.2.1.
  4. Cold: Equipment or piping handling media at design temperature of 15 degrees C (60 degrees F) or below.
  5. Concealed: Piping above ceilings and in chases, interstitial space, and pipe spaces.
  6. Exposed: Piping and equipment exposed to view in finished areas including mechanical equipment rooms or exposed to outdoor weather. Shafts, chases, interstitial spaces, unfinished attics, crawl spaces and pipe basements are not considered finished areas.
  7. FSK: Foil-scrim-Kraft facing.
  8. Hot: Plumbing equipment or piping handling media above 40 degrees C (104 degrees F).
  9. Density:  $\text{kg/m}^3$  - kilograms per cubic meter (Pcf - pounds per cubic foot).
  10. Thermal conductance: Heat flow rate through materials.
    - a. Flat surface: Watts per square meter (BTU per hour per square foot).

- b. Pipe or Cylinder: Watts per linear meter (BTU per hour per linear foot) for a given outside diameter.
11. Thermal Conductivity (k): Watts per meter, per degree K (BTU - inch thickness, per hour, per square foot, per degree F temperature difference).
12. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). For the purpose of this specification, vapor retarders/vapor barriers shall have a maximum published permeance of .02 perms.
13. HWR: Hot water recirculating.
14. CW: Cold water.
15. SW: Soft water.
16. HW: Hot water.
17. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

## **1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS: Insulation material and insulation production method.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 07 84 00, FIRESTOPPING: Mineral fiber and bond breaker behind sealant.
- F. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: General mechanical requirements and items, which are common to more than one section of Division 22.
- G. Section 22 05 19, METERS AND GAGES FOR PLUMBING PIPING: Hot and cold water piping.
- H. Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING: Hot and cold water piping.
- I. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- J. Section 23 21 13, HYDRONIC PIPING: electrical heat tracing systems.

## **1.3 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. American Society for Testing and Materials (ASTM):

- B209-2014 .....Standard Specification for Aluminum and  
Aluminum-Alloy Sheet and Plate
- C411-2011 .....Standard Test Method for Hot-Surface  
Performance of High-Temperature Thermal  
Insulation
- C449-2007 (R2013) .....Standard Specification for Mineral Fiber  
Hydraulic-Setting Thermal Insulating and  
Finishing Cement
- C450-2008 (R2014) .....Standard Practice for Fabrication of Thermal  
Insulating Fitting Covers for NPS Piping, and  
Vessel Lagging
- Adjunct to C450 .....Compilation of Tables that Provide Recommended  
Dimensions for Prefab and Field Thermal  
Insulating Covers, etc.
- C533-2013 .....Standard Specification for Calcium Silicate  
Block and Pipe Thermal Insulation
- C534/C534M-2014 .....Standard Specification for Preformed Flexible  
Elastomeric Cellular Thermal Insulation in  
Sheet and Tubular Form
- C547-2015 .....Standard Specification for Mineral Fiber Pipe  
Insulation
- C552-2014 .....Standard Specification for Cellular Glass  
Thermal Insulation
- C553-2013 .....Standard Specification for Mineral Fiber  
Blanket Thermal Insulation for Commercial and  
Industrial Applications
- C591-2013 .....Standard Specification for Unfaced Preformed  
Rigid Cellular Polyisocyanurate Thermal  
Insulation
- C680-2014 .....Standard Practice for Estimate of the Heat Gain  
or Loss and the Surface Temperatures of  
Insulated Flat, Cylindrical, and Spherical  
Systems by Use of Computer Programs
- C612-2014 .....Standard Specification for Mineral Fiber Block  
and Board Thermal Insulation

- C1126-2014 .....Standard Specification for Faced or Unfaced  
Rigid Cellular Phenolic Thermal Insulation
- C1136-2012 .....Standard Specification for Flexible, Low  
Permeance Vapor Retarders for Thermal  
Insulation
- C1710-2011 .....Standard Guide for Installation of Flexible  
Closed Cell Preformed Insulation in Tube and  
Sheet Form
- D1668/D1668M-1997a (2014)e1 Standard Specification for Glass Fabrics  
(Woven and Treated) for Roofing and  
Waterproofing
- E84-2015a .....Standard Test Method for Surface Burning  
Characteristics of Building Materials
- E2231-2015 .....Standard Practice for Specimen Preparation and  
Mounting of Pipe and Duct Insulation to Assess  
Surface Burning Characteristics
- C. Federal Specifications (Fed. Spec.):
- L-P-535E-1979 .....Plastic Sheet (Sheeting): Plastic Strip; Poly  
(Vinyl Chloride) and Poly (Vinyl Chloride -  
Vinyl Acetate), Rigid.
- D. International Code Council, (ICC):
- IMC-2012 .....International Mechanical Code
- E. Military Specifications (Mil. Spec.):
- MIL-A-3316C (2)-1990 ...Adhesives, Fire-Resistant, Thermal Insulation
- MIL-A-24179A (2)-1987 ..Adhesive, Flexible Unicellular-Plastic Thermal  
Insulation
- MIL-PRF-19565C (1)-1988 Coating Compounds, Thermal Insulation, Fire-and  
Water-Resistant, Vapor-Barrier
- MIL-C-20079H-1987 .....Cloth, Glass; Tape, Textile Glass; and Thread,  
Glass and Wire-Reinforced Glass
- F. National Fire Protection Association (NFPA):
- 90A-2015 .....Standard for the Installation of Air-  
Conditioning and Ventilating Systems
- G. Underwriters Laboratories, Inc (UL):
- 723-2008 (R2013) .....Standard for Test for Surface Burning  
Characteristics of Building Materials



1887-2004 (R2013) .....Standard for Fire Test of Plastic Sprinkler  
Pipe for Visible Flame and Smoke  
Characteristics

H. 3E Plus® version 4.1 Insulation Thickness Computer Program: Available  
from NAIMA with free download; <http://www.pipeinsulation.net>

#### **1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 07 11, PLUMBING INSULATION", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
- D. Shop Drawings:
  - 1. All information, clearly presented, shall be included to determine compliance with drawings and specifications and ASTM Designation, Federal and Military specifications.
    - a. Insulation materials: Specify each type used and state surface burning characteristics.
    - b. Insulation facings and jackets: Each type used and state surface burning characteristics.
    - c. Insulation accessory materials: Each type used.
    - d. Manufacturer's installation and fitting fabrication instructions for flexible unicellular insulation shall follow the guidelines in accordance with ASTM C1710.
    - e. Make reference to applicable specification paragraph numbers for coordination.
    - f. All insulation fittings (exception flexible unicellular insulation) shall be fabricated in accordance with ASTM C450 and the referenced Adjunct to ASTM C450.
- F. Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

## 1.5 QUALITY ASSURANCE

A. Refer to article QUALITY ASSURANCE, in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

B. Criteria:

1. Comply with NFPA 90A, particularly paragraphs 4.3.3.1 through

4.3.3.6, 4.3.11.2.6, parts of which are quoted as follows:

4.3.3.1 Pipe and duct insulation and 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 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 ASTM E84 and appropriate mounting practice, e.g. ASTM E2231.

4.3.3.3 Coverings and linings for air ducts, pipes, plenums and panels including all pipe and duct insulation materials shall not flame, glow, smolder, or smoke when tested in accordance with a similar test for pipe covering, ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation, at the temperature to which they are exposed in service. In no case shall the test temperature be below 121 degrees C (250 degrees F).

4.3.11.2.6.3 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.

4.3.11.2.6.8 Smoke detectors shall not be required to meet the provisions of Section 4.3.

2. Test methods: ASTM E84, UL 723, and ASTM E2231.

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 shall have a manufacturer's stamp or

label giving the name of the manufacturer, description of the material, and the production date or code.

- D. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

#### **1.6 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version 2017 provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing

agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

#### **1.7 STORAGE AND HANDLING OF MATERIAL**

- A. Store materials in clean and dry environment, pipe insulation 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.

### **PART 2 - PRODUCTS**

#### **2.1 MINERAL FIBER OR FIBER GLASS**

- A. ASTM C612 (Board, Block), Class 1 or 2, density 48 kg/m<sup>3</sup> (nominal 3 pcf),  $k = 0.037$  (.26) at 24 degrees C (75 degrees F), external insulation for temperatures up to 204 degrees C (400 degrees F).
- B. ASTM C553 (Blanket, Flexible) Type I, Class B-5, Density 32 kg/m<sup>3</sup> (nominal 2 pcf),  $k = 0.04$  (0.27) at 24 degrees C (75 degrees F), 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) at 24 degrees C (75 degrees F), for use at temperatures up to 230 degrees C (446 degrees F) with an all service vapor retarder jacket (ASJ) and with polyvinyl chloride (PVC) premolded fitting covering.

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

- A. Comply with Standard ASTM C612, Class 3, 450 degrees C (842 degrees F).

#### **2.3 RIGID CELLULAR PHENOLIC FOAM**

- A. Preformed (molded) pipe insulation, ASTM C1126, Type III, grade 1,  $k = 0.021$ (0.15) at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with vapor retarder and all service vapor retarder jacket (ASJ) and with PVC premolded fitting covering.
- B. Equipment Insulation, ASTM C1126, Type II, grade 1,  $k = 0.021$  (0.15) at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with rigid cellular phenolic insulation and covering, and all service vapor retarder jacket (ASJ).

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

- A. Comply with Standard ASTM C552, density 120 kg/m<sup>3</sup> (7.5 pcf) nominal,  $k = 0.033$  (0.29) at 24 degrees C (75 degrees F).

- B. Pipe insulation for use at process temperatures below ambient air to 482 degrees C (900 degrees F) with or without all service vapor retarder jacket (ASJ).
- C. Pipe insulation for use at process temperatures for pipe and tube below ambient air temperatures or where condensation control is necessary are to be installed with a vapor retarder/barrier system of with or without all service vapor retarder sealed jacket (ASJ) system. Without ASJ shall require all longitudinal and circumferential joints to be vapor sealed with vapor barrier mastic.
- D. Cellular glass thermal insulation intended for use on surfaces operating at temperatures between -268 and 482 degrees C (-450 and 900 degrees F). It is possible that special fabrication or techniques for pipe insulation, or both, shall be required for application in the temperature range from 121 to 427 degrees C (250 to 800 degrees F).

#### **2.5 POLYISOCYANURATE CLOSED-CELL RIGID**

- A. Preformed (fabricated) pipe insulation, ASTM C591, Type IV,  $K=0.027(0.19)$  at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for use at temperatures up to 149 degree C (300 degree F) with factory applied PVDC or all service vapor retarder jacket with PVC premolded fitting covers.
- B. Equipment and duct insulation, ASTM C591, Type IV,  $K=0.027(0.19)$  at 24 degrees C (75 degrees F), for use at temperatures up to 149 degrees C (300 degrees F) with PVDC or all service jacket vapor retarder jacket.

#### **2.6 FLEXIBLE ELASTOMERIC CELLULAR THERMAL**

- A. ASTM C534/C534M,  $k = 0.039 (0.27)$  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 (199 degrees F). Under high humidity exposures for condensation control an external vapor retarder/barrier jacket is required. Consult ASTM C1710.

#### **2.7 CALCIUM SILICATE**

- A. Preformed pipe Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- B. Premolded Pipe Fitting Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- C. Equipment Insulation: ASTM C533, Type I and Type II.

D. Characteristics:

<b>Insulation Characteristics</b>		
<b>ITEMS</b>	<b>TYPE I</b>	<b>TYPE II</b>
Surface Temperature, maximum degrees C (degrees F)	649 (1200)	927 (1700)
Density (dry), Kg/m <sup>3</sup> (lb/ ft <sup>3</sup> )	240 (15)	352 (22)
Thermal conductivity: Min W/ m K (Btu in/h ft <sup>2</sup> degrees F)@ mean temperature of 93 degrees C (199 degrees F)	0.065 (0.45)	0.078 (0.540)
Surface burning characteristics: Flame spread Index, Maximum	0	0
Smoke Density index, Maximum	0	0

**2.8 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 pipe insulation jackets. Facings and jackets shall be ASJ or PVDC Vapor Retarder jacketing.
- B. ASJ shall be white finish (kraft paper) bonded to 0.025 mm (1 mil) thick aluminum foil, fiberglass reinforced, with pressure sensitive adhesive closure. Comply with ASTM C1136. Beach puncture is 50 units, suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75 mm (3 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: FSK or PVDC type for concealed ductwork and equipment.
- D. Except for flexible elastomeric cellular thermal insulation (not for high humidity exposures), field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping as well as on interior piping exposed to outdoor air (i.e.; in ventilated attics, piping in ventilated (not air conditioned) spaces, etc.) in high humidity locations conveying fluids below ambient temperature. The vapor barrier jacket shall consist of a multi-layer

laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.

- E. Except for cellular glass thermal insulation, when all longitudinal and circumferential joints are vapor sealed with a vapor barrier mastic or caulking, vapor barrier jackets may not be provided. For aesthetic and physical abuse applications, exterior jacketing is recommended. Otherwise field applied vapor barrier jackets shall be provided, in addition to the applicable specified facings and jackets, on all exterior piping as well as on interior piping exposed to outdoor air (i.e.; in ventilated attics, piping in ventilated (not air conditioned) spaces, etc.) in high humidity locations conveying fluids below ambient temperature. The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.
- F. Glass Cloth Jackets: Presized, minimum 0.18 kg per square meter (7.8 ounces per square yard), 2070 kPa (300 psig) bursting strength with integral vapor retarder where required or specified. Weather proof if utilized for outside service.
- G. Pipe fitting insulation covering (jackets): Fitting covering shall be premolded to match shape of fitting and shall be PVC conforming to Fed Spec L-P-535E, 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. Staples, tacks, or any other attachment that penetrates the PVC covering is not allowed on any form of a vapor barrier system in below ambient process temperature applications.
- H. 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 or with cut aluminum gores to match shape of fitting and of 0.6 mm (0.024 inch) minimum thickness aluminum. Aluminum fittings shall be of same construction with an internal moisture barrier as straight run jackets but need not be of the same alloy. Factory-fabricated stainless steel bands with wing

seals shall be installed on all circumferential joints. Bands shall be 15 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.

- I. 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.

**2.9 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).

<b>Nominal Pipe Size and Accessories Material (Insert Blocks)</b>	
<b>Nominal Pipe Size mm (inches)</b>	<b>Insert Blocks mm (inches)</b>
Up through 125 (5)	150 (6) long
150 (6)	150 (6) long
200 (8), 250 (10), 300 (12)	225 (9) long
350 (14), 400 (16)	300 (12) long
450 through 600 (18 through 24)	350 (14) 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 or calcium silicate. 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).

**2.10 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-24179A, Type II Class 1: Adhesive for installing flexible unicellular insulation and for laps and general use.



- D. Mil. Spec. MIL-PRF-19565C, Type I: Protective finish for outdoor use.
- E. Mil. Spec. MIL-PRFC-19565C, 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.

#### **2.11 MECHANICAL FASTENERS**

- A. Pins, anchors: Welded pins, or metal or nylon anchors with galvanized steel or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
- B. Staples: Outward clinching galvanized steel. Staples are not allowed for below ambient vapor barrier applications.
- C. Wire: 1.3 mm thick (18 gage) soft annealed galvanized or 1.9 mm (14 gage) copper clad steel or nickel copper alloy or stainless steel.
- D. Bands: 13 mm (1/2 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.
- E. Tacks, rivets, screws or any other attachment device capable of penetrating the vapor retarder shall NOT be used to attach/close the any type of vapor retarder jacketing. Thumb tacks sometimes used on PVC jacketing and preformed fitting covers closures are not allowed for below ambient vapor barrier applications.

#### **2.12 REINFORCEMENT AND FINISHES**

- A. Glass fabric, open weave: ASTM D1668/D1668M, Type III (resin treated) and Type I (asphalt or white resin treated).
- B. Glass fiber fitting tape: Mil. Spec MIL-C-20079H, 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-535E, Composition A, 11-86 Type II, Grade GU, with Form B Mineral Fiber insert, for media temperature 10 to 121 degrees C (50 to 250 degrees F). Below 10 degrees C (50 degrees F) and above 121 degrees C (250 degrees F) provide mitered pipe insulation

of the same type as insulating straight pipe. Provide double layer insert. Provide vapor barrier pressure sensitive tape matching the color of the PVC jacket.

### **2.13 FIRESTOPPING MATERIAL**

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

### **2.14 FLAME AND SMOKE**

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

## **PART 3 - EXECUTION**

### **3.1 GENERAL REQUIREMENTS**

- A. Required pressure tests of piping joints and connections shall be completed and the work approved by the Contracting Officer's Representative (COR) 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 or as noted, insulate all specified equipment, and piping (pipe, fittings, valves, accessories). Insulate each pipe individually. Do not use scrap pieces of insulation where a full length section will fit.
- C. Where removal of insulation of piping and equipment is required to comply with Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT and Section 02 82 13.13, GLOVEBAG ASBESTOS ABATEMENT, such areas shall be reinsulated to comply with this specification.
- D. Insulation materials shall be installed with smooth and even surfaces, with jackets and facings drawn tight and smoothly cemented down and sealed at all laps. Insulation shall be continuous through all sleeves and openings, except at fire dampers and duct heaters (NFPA 90A).
- E. Vapor retarders shall be continuous and uninterrupted throughout systems with operating temperature 15 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).
- F. Install vapor stops with operating temperature 15 degrees C (60 degrees F) and below at all insulation terminations on either side of valves, pumps, fittings, and equipment and particularly in straight lengths

every 4.6 to 6.1 meters (approx. 15 to 20 feet) of pipe insulation. The annular space between the pipe and pipe insulation of approx. 25 mm (1 inch) in length at every vapor stop shall be sealed with appropriate vapor barrier sealant. Bio-based materials shall be utilized when possible.

- G. Construct insulation on parts of equipment such as cold water pumps 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. Do not insulate over equipment nameplate data.
- H. 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 coating (caution about coating's maximum temperature limit) or jacket material.
- I. 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.
- J. Plumbing work not to be insulated unless otherwise noted:
  - 1. Piping and valves of fire protection system.
  - 2. Chromium plated brass piping.
  - 3. Water piping in contact with earth.
  - 4. Distilled water piping.
- K. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum wet or dry film thickness. Bio-based materials shall be utilized when possible.
- L. Elbows, flanges and other fittings shall be insulated with the same material as is used on the pipe straights. Use of polyurethane or polyisocyanurate spray-foam to fill a PVC elbow jacket is prohibited on cold applications.
- M. Firestop Pipe insulation:
  - 1. Provide firestopping insulation at fire and smoke barriers through penetrations. Firestopping insulation shall be UL listed as defined in Section 07 84 00, FIRESTOPPING.

2. Pipe penetrations requiring fire stop insulation including, but not limited to the following:
  - a. Pipe risers through floors
  - b. Pipe chase walls and floors
  - c. Smoke partitions
  - d. Fire partitions
  - e. Hourly rated walls
- N. Freeze protection of above grade outdoor piping (over heat tracing tape): 20 mm (3/4 inch) thick insulation, for all pipe sizes 75 mm (3 inches) and smaller and 25 mm (1 inch) thick insulation for larger pipes. Provide metal jackets for all pipe insulations. Provide freeze protection for cold water make-up piping and equipment where indicated on the drawings as described in Section 23 21 13, HYDRONIC PIPING (electrical heat tracing systems).
- O. Provide vapor barrier systems as follows:
  1. All piping exposed to outdoor weather.
  2. All interior piping conveying fluids exposed to outdoor air (i.e. in attics, ventilated (not air conditioned) spaces, etc.) below ambient air temperature //in high humidity locations.
- P. Provide metal jackets over insulation as follows:
  1. All plumbing piping exposed to outdoor weather.
  2. Piping exposed in building, within 1829 mm (6 feet) of the floor, that connects to sterilizers, kitchen and laundry equipment. Jackets may be applied with pop rivets except for cold pipe or tubing applications. Provide aluminum angle ring escutcheons at wall, ceiling or floor penetrations.
  3. A 50 mm (2 inch) jacket overlap is required at longitudinal and circumferential joints with the overlap at the bottom.
- Q. Provide PVC jackets over insulation as follows:
  1. Piping exposed in building, within 1829 mm (6 feet) of the floor, on piping that is not precluded in previous sections.
  2. A 50 mm (2 inch) jacket overlap is required at longitudinal and circumferential joints with the overlap at the bottom.

### **3.2 INSULATION INSTALLATION**

- A. Mineral Fiber Board:
  1. Vapor retarder faced board: Apply board on pins spaced not more than 300 mm (12 inches) on center each way, and not less than 75 mm (3

inches) from each edge of board. In addition to pins, apply insulation bonding adhesive to entire underside of horizontal metal surfaces. (Bio-based materials shall be utilized when possible.) Butt insulation edges tightly and seal all joints with laps and butt strips. After applying speed clips cut pins off flush and apply vapor seal patches over clips.

2. Plain unfaced board:

- a. Insulation shall be scored, beveled or mitered to provide tight joints and be secured to equipment with bands spaced 225 mm (9 inches) on center for irregular surfaces or with pins and clips on flat surfaces. Use corner beads to protect edges of insulation.
- b. For hot equipment: Stretch 25 mm (1 inch) mesh wire, with edges wire laced together, over insulation and finish with insulating and finishing cement applied in one coat, 6 mm (1/4 inch) thick, trowelled to a smooth finish.
- c. For cold equipment: Apply meshed glass fabric in a tack coat 1.5 to 1.7 square meter per liter (60 to 70 square feet per gallon) of vapor mastic and finish with mastic at 0.3 to 0.4 square meter per liter (12 to 15 square feet per gallon) over the entire fabric surface.

3. Cold equipment: 40 mm (1-1/2inch) thick insulation faced with vapor retarder ASJ or FSK. Seal all facings, laps, and termination points and do not use staples or other attachments that may puncture ASJ or FSK.

- a. Water filter, chemical feeder pot or tank.
- b. Pneumatic, cold storage water and surge tanks.

4. Hot equipment: 40 mm (1-1/2 inch) thick insulation faced with unsealed ASJ or FSK.

- a. Domestic water heaters and hot water storage tanks (not factory insulated).
- b. Booster water heaters for dietetics dish and pot washers and for washdown grease-extracting hoods.

B. Molded Mineral Fiber Pipe and Tubing Covering:

1. Fit insulation to pipe, aligning all 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 except for cold piping. Seal all vapor retarder penetrations on cold piping with a generous application of vapor barrier mastic. Provide cellar glass 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 15 degrees C (60 degrees F) or more.
    - b. Factory premolded, one piece PVC covers with mineral fiber, (Form B), inserts surface temperature of above 4 degrees C (40 degrees F) to 121 degrees C (250 degrees F). Provide mitered preformed insulation of the same type as the installed straight pipe insulation for pipe temperatures below 4 degrees C (40 degrees F). Secure first layer of mineral fiber insulation with twine. Seal seam edges with vapor barrier mastic and secure with fitting tape.
    - c. Factory preformed, ASTM C547 or fabricated mitered sections, joined with adhesive or (hot only) wired in place. (Bio-based materials shall be utilized when possible.) For hot piping finish with a smoothing coat of finishing cement. For cold fittings, 15 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 the schedule at the end of this section.
- C. Rigid Cellular Phenolic Foam:
1. Rigid closed cell phenolic insulation may be provided, exterior only, for piping, ductwork and equipment for temperatures up to 121 degrees C (250 degrees F).
  2. Note the ASTM E84 or UL 723 surface burning characteristics requirements of maximum 25/50 indexes in paragraph "Quality Assurance".
  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 the schedule at the end of this section.
  8. Condensation control insulation: Minimum 25 mm (1 inch) thick for all pipe sizes depending on high humidity exposures.
    - a. Body of roof and overflow drains horizontal runs and offsets (including elbows) of interior downspout piping in all areas above pipe basement.
    - b. Waste piping from electric water coolers and icemakers to drainage system.
    - c. Waste piping located above basement floor from ice making and film developing equipment and air handling units, from equipment (including trap) to main vertical waste pipe.
    - d. MRI quench vent piping.
    - e. Bedpan sanitizer atmospheric vent
    - f. Reagent grade water piping.
    - g. Cold water piping, exterior only.
- D. Cellular Glass Insulation:
1. Pipe and tubing, covering nominal thickness in millimeters and inches as specified in the schedule at the end of this section.
  2. Underground piping other than or in lieu of that specified in Section 22 11 00, FACILITY WATER DISTRIBUTION: Type II, factory jacketed with a 3 mm laminate jacketing consisting of 3000 mm x 3000 mm (10 ft x 10 ft) asphalt impreganted glass fabric, bituminous mastic and outside protective plastic film.
    - a. 75 mm (3 inches) thick for hot water piping.
    - b. As scheduled at the end of this section for chilled water piping.
    - c. Underground piping: Apply insulation with joints tightly butted. Seal longitudinal self-sealing lap. Use field fabricated or factory made fittings. Seal butt joints and fitting with jacketing as recommended by the insulation manufacturer. Use 100 mm (4 inch) wide strips to seal butt joints.
    - d. Provide expansion chambers for pipe loops, anchors and wall penetrations as recommended by the insulation manufacturer.

- e. Underground insulation shall be inspected and approved by the COR as follows:
    - 1) Insulation in place before coating.
    - 2) After coating.
  - f. Sand bed and backfill: Minimum 75 mm (3 inches) all around insulated pipe or tank, applied after coating has dried.
  - g. All piping up to 482 degrees C (900 degrees F) requiring protection from physical heavy contact/abuse including in mechanical rooms and exposures to the public.
3. Cold equipment: 50 mm (2 inch) thick insulation faced with ASJ.
- E. Polyisocyanurate Closed-Cell Rigid Insulation:
- 1. Polyisocyanurate closed-cell rigid insulation (PIR) may be provided for exterior piping and equipment for temperature up to 149 degree C (300 degree F).
  - 2. Install insulation, vapor retarder and jacketing per manufacturer's recommendations. Particular attention should be paid to recommendations for joint staggering, adhesive application, external hanger design, expansion/contraction joint design and spacing and vapor retarder integrity.
  - 3. Install insulation with all joints tightly butted (except expansion joints in hot applications). Provide insulation contractions joints for very cold process temperatures.
  - 4. If insulation thickness exceeds 65 mm (2-1/2 inches), install as a double layer system with longitudinal (lap) and butt joint staggering as recommended by manufacturer.
  - 5. For cold applications, vapor retarder shall be installed in a continuous manner. No staples, rivets, screws or any other attachment device capable of penetrating the vapor retarder shall be used to attach the vapor retarder or jacketing. No wire ties capable of penetrating the vapor retarder shall be used to hold the insulation in place. Stainless steel banding shall be used for cold applications to attach PVC or metal jacketing.
  - 6. 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 or polyisocyanurate spray-foam to fill PVC elbow jacket is prohibited on cold applications.

7. For cold applications, the vapor retarder on elbows/fittings shall be either mastic-fabric-mastic or 2 mil thick PVDC vapor retarder adhesive tape. Bio-based materials shall be utilized when possible.
8. All PVC and metal jacketing shall be installed so as to naturally shed water. Joints shall point down and shall be sealed with either adhesive or caulking (except for periodic slip joints). Bio-based materials shall be utilized when possible.
9. Note the NFPA 90A burning characteristic requirements of 25/50 in paragraph "Quality Assurance". Refer to paragraph "General Requirements" for items not to be insulated.
10. Minimum thickness in millimeter (inches) specified in the schedule at the end of this section.

F. 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. External vapor barrier jacketing may be required for expected or anticipated high humidity exposures. See ASTM C1710.
2. Pipe and tubing insulation:
  - a. Use proper size material. Do not stretch or strain insulation.
  - b. To avoid undue compression of insulation, use supports as recommended by the elastomeric insulation manufacturer.  
Insulation shields are specified under Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
  - 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. Bio-based materials shall be utilized when possible.
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 the schedule at the end of this section.

G. Calcium Silicate:

1. Minimum thickness in millimeter (inches) specified below for piping other than in boiler plant.

<b>Nominal Thickness Of Calcium Silicate Insulation (Non-Boiler Plant)</b>				
Nominal Pipe Size Millimeters (Inches)	Thru 25 (1)	32 to 75 (1-1/4 to 3)	100-200 (4 to 8)	Greater than 200 (8)
93-260 degrees C (199-500 degrees F) (HPS, HPR)	100 (4)	125 (5)	150 (6)	Greater than 150 (6)

2. MRI Quench Vent Insulation: Type I, class D, 150 mm (6 inch) nominal thickness.

**3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

**3.4 PIPE INSULATION SCHEDULE**

- A. Provide insulation for piping systems as scheduled below:

<b>Insulation Thickness Millimeters (Inches)</b>					
		<b>Nominal Pipe Size Millimeters (Inches)</b>			
<b>Operating Temperature Range/Service</b>	<b>Insulation Material</b>	<b>Less than 25 (1)</b>	<b>25 - 32 (1 - 1¼)</b>	<b>38 - 75 (1½ - 3)</b>	<b>100 (4) and Greater</b>
38-60 degrees C (100-140 degrees F) (Domestic Hot Water Supply and Return)	Mineral Fiber (Above ground piping only)	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
38-60 degrees C (100-140 degrees F) (Domestic Hot Water Supply and Return)	Rigid Cellular Phenolic Foam (Above ground piping only) (exterior locations only)	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
38-60 degrees C (100-140 degrees F) (Domestic Hot Water Supply and Return)	Polyiso- cyanurate Closed-Cell Rigid (Exterior)	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)

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	Locations only)				
38-60 degrees C (100-140 degrees F) (Domestic Hot Water Supply and Return)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
38-60 degrees C (100-140 degrees F) (Domestic Hot Water Supply and Return)	Cellular Glass Thermal	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
4-15 degrees C (40-60 degrees F)	Rigid Cellular Phenolic Foam (Above ground piping only) (exterior locations only)	25 (1.0)	25 (1.0)	25 (1.0)	25 (1.0)
4-15 degrees C (40-60 degrees F)	Polyisocyanurate Closed-Cell Rigid (Exterior Locations only)	25 (1.0)	25 (1.0)	25 (1.0)	25 (1.0)
(4-15 degrees C (40-60 degrees F)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	25 (1.0)	25 (1.0)	25 (1.0)	25 (1.0)
4-15 degrees C (40-60 degrees F)	Cellular Glass Thermal	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)

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**SECTION 22 11 00  
FACILITY WATER DISTRIBUTION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Domestic water systems, including piping, equipment and all necessary accessories as designated in this section.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 07 84 00, FIRESTOPPING.
- F. Section 07 92 00, JOINT SEALANTS.
- G. Section 09 91 00, PAINTING.
- H. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic Restraint.
- I. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- J. Section 22 07 11, PLUMBING INSULATION.
- K. SECTION 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

**1.3 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 Mechanical Engineers (ASME):
  - A13.1-2007 (R2013) .....Scheme for Identification of Piping Systems
  - B16.3-2011 .....Malleable Iron Threaded Fittings: Classes 150 and 300
  - B16.9-2012 .....Factory-Made Wrought Buttwelding Fittings
  - B16.11-2011 .....Forged Fittings, Socket-Welding and Threaded
  - B16.12-2009 (R2014) ....Cast Iron Threaded Drainage Fittings
  - B16.15-2013 .....Cast Copper Alloy Threaded Fittings: Classes 125 and 250
  - B16.18-2012 .....Cast Copper Alloy Solder Joint Pressure Fittings

- B16.22-2013 .....Wrought Copper and Copper Alloy Solder-Joint  
Pressure Fittings
- B16.24-2011 .....Cast Copper Alloy Pipe Flanges and Flanged  
Fittings: Classes 150, 300, 600, 900, 1500, and  
2500
- B16.51-2013 .....Copper and Copper Alloy Press-Connect Fittings  
ASME Boiler and Pressure Vessel Code -  
BPVC Section IX-2015 ...Welding, Brazing, and Fusing Qualifications
- C. American Society of Sanitary Engineers (ASSE):
- 1010-2004 .....Performance Requirements for Water Hammer  
Arresters
- D. American Society for Testing and Materials (ASTM):
- A47/A47M-1999 (R2014) ..Standard Specification for Ferritic Malleable  
Iron Castings
- A53/A53M-2012 .....Standard Specification for Pipe, Steel, Black  
and Hot-Dipped, Zinc-Coated, Welded and  
Seamless
- A183-2014 .....Standard Specification for Carbon Steel Track  
Bolts and Nuts
- A269/A269M-2014e1 .....Standard Specification for Seamless and Welded  
Austenitic Stainless Steel Tubing for General  
Service
- A312/A312M-2015 .....Standard Specification for Seamless, Welded,  
and Heavily Cold Worked Austenitic Stainless  
Steel Pipes
- A403/A403M-2014 .....Standard Specification for Wrought Austenitic  
Stainless Steel Piping Fittings
- A536-1984 (R2014) .....Standard Specification for Ductile Iron  
Castings
- A733-2013 .....Standard Specification for Welded and Seamless  
Carbon Steel and Austenitic Stainless Steel  
Pipe Nipples
- B32-2008 (R2014) .....Standard Specification for Solder Metal
- B43-2014 .....Standard Specification for Seamless Red Brass  
Pipe, Standard Sizes
- B61-2008 (R2013) .....Standard Specification for Steam or Valve  
Bronze Castings

- B62-2009 .....Standard Specification for Composition Bronze  
or Ounce Metal Castings
- B75/B75M-2011 .....Standard Specification for Seamless Copper Tube
- B88-2014 .....Standard Specification for Seamless Copper  
Water Tube
- B584-2014 .....Standard Specification for Copper Alloy Sand  
Castings for General Applications
- B687-1999 (R2011) .....Standard Specification for Brass, Copper, and  
Chromium-Plated Pipe Nipples
- C919-2012 .....Standard Practice for Use of Sealants in  
Acoustical Applications
- D1785-2012 .....Standard Specification for Poly (Vinyl  
Chloride) (PVC) Plastic Pipe, Schedules 40, 80,  
and 120
- D2000-2012 .....Standard Classification System for Rubber  
Products in Automotive Applications
- D2564-2012 .....Standard Specification for Solvent Cements for  
Poly (Vinyl Chloride) (PVC) Plastic Piping  
Systems
- D2657-2007 .....Standard Practice for Heat Fusion Joining of  
Polyolefin Pipe and Fittings
- D2855-1996 (R2010) .....Standard Practice for Making Solvent-Cemented  
Joints with Poly (Vinyl Chloride) (PVC) Pipe  
and Fittings
- D4101-2014 .....Standard Specification for Polypropylene  
Injection and Extrusion Materials
- E1120-2008 .....Standard Specification for Liquid Chlorine
- E1229-2008 .....Standard Specification for Calcium Hypochlorite
- F2389-2010 .....Standard Specification for Pressure-rated  
Polypropylene (PP) Piping Systems
- F2620-2013 .....Standard Practice for Heat Fusion Joining of  
Polyethylene Pipe and Fittings
- F2769-2014 .....Standard Specification for Polyethylene of  
Raised Temperature (PE-RT) Plastic Hot and  
Cold-Water Tubing and Distribution Systems
- E. American Water Works Association (AWWA):
- C110-2012 .....Ductile-Iron and Gray-Iron Fittings

- C151-2009 .....Ductile Iron Pipe, Centrifugally Cast
- C153-2011 .....Ductile-Iron Compact Fittings
- C203-2008 .....Coal-Tar Protective Coatings and Linings for  
Steel Water Pipelines - Enamel and Tape - Hot  
Applied
- C213-2007 .....Fusion-Bonded Epoxy Coating for the Interior  
and Exterior of Steel Water Pipelines
- C651-2014 .....Disinfecting Water Mains
- F. American Welding Society (AWS):
  - A5.8M/A5.8-2011-AMD1 ...Specification for Filler Metals for Brazing and  
Braze Welding
- G. International Code Council (ICC):
  - IPC-2012 .....International Plumbing Code
- H. Manufacturers Specification Society (MSS):
  - SP-58-2009 .....Pipe Hangers and Supports - Materials, Design,  
Manufacture, Selection, Application, and  
Installation
  - SP-72-2010a .....Ball Valves with Flanged or Butt-Welding Ends  
for General Service
  - SP-110-2010 .....Ball Valves Threaded, Socket-Welding, Solder  
Joint, Grooved and Flared Ends
- I. NSF International (NSF):
  - 14-2015 .....Plastics Piping System Components and Related  
Materials
  - 61-2014a .....Drinking Water System Components - Health  
Effects
  - 372-2011 .....Drinking Water System Components - Lead Content
- J. Plumbing and Drainage Institute (PDI):
  - PDI-WH 201-2010 .....Water Hammer Arrestors
- K. Department of Veterans Affairs:
  - H-18-8-2013 .....Seismic Design Handbook

**1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.



- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 11 00, FACILITY WATER DISTRIBUTIONS", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. All items listed in Part 2 - Products.
- D. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replacement parts:
  - 1. Include complete list indicating all components of the systems.
  - 2. Include complete diagrams of the internal wiring for each item of equipment.
  - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- E. Completed System Readiness Checklist provided by the CxA and completed by the Contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- F. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

#### **1.5 QUALITY ASSURANCE**

- A. A certificate shall be submitted prior to welding of steel piping showing the Welder's certification. The certificate shall be current and no more than one year old. Welder's qualifications shall be in accordance with ASME BPVC Section IX.
- B. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be by the same manufacturer as the groove components.
- C. All pipe, couplings, fittings, and specialties shall bear the identification of the manufacturer and any markings required by the applicable referenced standards.
- D. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more

information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

#### **1.6 SPARE PARTS**

- A. For mechanical press-connect fittings, provide tools required for each pipe size used at the facility.

#### **1.7 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A list of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version 20172017 provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certificate if applicable that all results of tests were within limits specified. If a certificate is not available, all documentation shall be on the Certifier's letterhead.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead are prohibited in any potable water system intended for human consumption, and shall be certified in accordance with NSF 61 or NSF 372. Endpoint devices used to dispense water for drinking shall meet the requirements of NSF 61, Section 9.
- B. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended.

**2.2 UNDERGROUND WATER SERVICE CONNECTIONS TO BUILDINGS**

- A. From inside face of exterior wall to a distance of approximately 1500 mm (5 feet) outside of building and underground inside building, material to be the same for the size specified inside the building.
- B. 75 mm (3 inch) Diameter and Greater: Ductile iron, AWWA C151, 2413 kPa (350 psig) pressure class, exterior bituminous coating, and cement lined. Bio-based materials shall be utilized when possible. Provide flanged and anchored connection to interior piping.
- C. Under 75 mm (3 inch) Diameter: Copper tubing, ASTM B88, Type K, seamless, annealed. Fittings are as specified in paragraph "Above Ground (Interior) Water Piping". Use brazing alloys, AWS A5.8M/A5.8, Classification BCuP.
- D. Flexible Expansion Joint: Ductile iron with ball joints rated for 1725 kPa (250 psig) working pressure conforming to AWWA C153, capable of deflecting a minimum of 20 degrees in each direction. Flexible expansion joint size shall match the pipe size it is connected to and shall have the expansion capability designed as an integral part of the ductile iron ball castings. Pressure containing parts shall be lined with a minimum of 15 mils of fusion bonded epoxy conforming to the applicable requirements of AWWA C213 and shall be factory tested with a 1500 volt spark test. Flexible expansion joint shall have flanged connections conforming to AWWA C110. Bolts and nuts shall be 316 stainless steel and gaskets shall be neoprene. The flexible expansion fitting shall not expand or exert an axial thrust under internal water pressure. Provide piping joint restraints at each mechanical joint end connection and piping restraints at the penetration of the building wall. The restraints shall be provided to address the developed thrust at the change of piping direction.

### **2.3 ABOVE GROUND (INTERIOR) WATER PIPING**

- A. Pipe: Copper tube, ASTM B88, Type K or L, drawn. For pipe 150 mm (6 inches) and larger, stainless steel, ASTM A312, schedule 40 shall be used.
- B. Fittings for Copper Tube:
1. Wrought copper or bronze castings conforming to ASME B16.18 and B16.22. Unions shall be bronze, MSS SP-72, MSS SP-110, solder or braze joints. Use 95/5 tin and antimony for all soldered joints.
  2. Grooved fittings, 50 to 150 mm (2 to 6 inch) wrought copper ASTM B75/B75M C12200, 125 to 150 mm (5 to 6 inch) bronze casting ASTM B584, C84400. Mechanical grooved couplings, 2070 kpa (300 psig) minimum ductile iron, ASTM A536 Grade 448-310-12 (Grade 65-45-12), or malleable iron, ASTM A47/A47M Grade 22410 (Grade 32510) housing, with EPDM gasket, steel track head bolts, ASTM A183, coated with copper colored alkyd enamel.
  3. Mechanical press-connect fittings for copper pipe and tube shall conform to the material and sizing requirements of ASME B16.51, NSF 61 approved, 50 mm (2 inch) size and smaller mechanical press-connect fittings, double pressed type, with EPDM (ethylene propylene diene monomer) non-toxic synthetic rubber sealing elements and unpressed fitting identification feature.
  4. Mechanically formed tee connection: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall ensure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting. Braze joints.
  5. Flanged fittings, bronze, class 150, solder-joint ends conforming to ASME B16.24.

### **2.6 TRAP PRIMER WATER PIPING**

- A. Pipe: Copper tube, ASTM B88, type K, hard drawn.
- B. Fittings: Bronze castings conforming to ASME B16.18 Solder joints.
- C. Solder: ASTM B32 alloy type Sb5. Provide non-corrosive flux.

## **2.7 STRAINERS**

- A. Provide on high pressure side of pressure reducing valves, on suction side of pumps, on inlet side of indicating and control instruments and equipment subject to sediment damage and where shown on drawings. Strainer element shall be removable without disconnection of piping.
- B. Water: Basket or "Y" type with easily removable cover and brass strainer basket.
- C. Body: Less than 75 mm (3 inches), brass or bronze; 75 mm (3 inches) and greater, cast iron or semi-steel.

## **2.8 DIELECTRIC FITTINGS**

- A. Provide dielectric couplings or unions between pipe of dissimilar metals.

## **2.9 STERILIZATION CHEMICALS**

- A. Hypochlorite: ASTM E1120.
- B. Liquid Chlorine: ASTM E1229.

## **2.10 WATER HAMMER ARRESTER**

- A. Closed copper tube chamber with permanently sealed 413 kPa (60 psig) air charge above a Double O-ring piston. Two high heat Buna-N O-rings pressure packed and lubricated with FDA approved silicone compound. All units shall be designed in accordance with ASSE 1010. Access shall be provided where devices are concealed within partitions or above ceilings. Size and install in accordance with PDI-WH 201 requirements. Provide water hammer arrestors at:
  - 1. All solenoid valves.
  - 2. All groups of two or more flush valves.
  - 3. All quick opening or closing valves.
  - 4. All medical washing equipment.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. General: Comply with the International Plumbing Code and the following:
  - 1. Install branch piping for water from the piping system and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
  - 2. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for plastic and glass, shall be reamed to remove

- burrs and a clean smooth finish restored to full pipe inside diameter.
3. All pipe runs shall be laid out to avoid interference with other work/trades.
  4. Install union and shut-off valve on pressure piping at connections to equipment.
  5. Pipe Hangers, Supports and Accessories:
    - a. All piping shall be supported per the IPC, H-18-8 Seismic Design Handbook, MSS SP-58, and SMACNA as required.
    - b. Shop Painting and Plating: Hangers, supports, rods, inserts and accessories used for pipe supports shall be shop coated with zinc chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
    - c. Floor, Wall and Ceiling Plates, Supports, Hangers:
      - 1) Solid or split un-plated cast iron.
      - 2) All plates shall be provided with set screws.
      - 3) Pipe Hangers: Height adjustable clevis type.
      - 4) Adjustable Floor Rests and Base Flanges: Steel.
      - 5) Concrete Inserts: "Universal" or continuous slotted type.
      - 6) Hanger Rods: Mild, low carbon steel, fully threaded or Threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
      - 7) Pipe Hangers and Riser Clamps: Malleable iron or carbon steel. Pipe Hangers and riser clamps shall have a copper finish when supporting bare copper pipe or tubing.
      - 8) Rollers: Cast iron.
      - 9) Self-drilling type expansion shields shall be "Phillips" type, with case hardened steel expander plugs.
      - 10) Hangers and supports utilized with insulated pipe and tubing shall have 180 degree (minimum) metal protection shield centered on and welded to the hanger and support. The shield thickness and length shall be engineered and sized for distribution of loads to preclude crushing of insulation without breaking the vapor barrier. The shield shall be sized for the insulation and have flared edges to protect vapor-retardant jacket facing. To prevent the shield from

sliding out of the clevis hanger during pipe movement, center-ribbed shields shall be used.

- 11) Miscellaneous Materials: As specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6.1 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. Provide all necessary auxiliary steel to provide that support.
  - 12) With the installation of each flexible expansion joint, provide piping restraints for the upstream and downstream section of the piping at the flexible expansion joint. Provide calculations supporting the restraint length design and type of selected restraints. Restraint calculations shall be based on the criteria from the manufacturer regarding their restraint design.
6. Install chrome plated cast brass escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
  7. Penetrations:
    - a. Firestopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke, and gases as specified in Section 07 84 00, FIRESTOPPING. Completely fill and seal clearances between raceways and openings with the firestopping materials.
    - b. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS. Bio-based materials shall be utilized when possible.
    - c. Acoustical sealant: Where pipes pass through sound rated walls, seal around the pipe penetration with an acoustical sealant that is compliant with ASTM C919.
  8. Mechanical press-connect fitting connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is

fully engaged (inserted) in the fitting. Ensure the tube is completely inserted to the fitting stop (appropriate depth) and squared with the fitting prior to applying the pressing jaws onto the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer. Minimum distance between fittings shall be in accordance with the manufacturer's requirements. When the pressing cycle is complete, visually inspect the joint to ensure the tube has remained fully inserted, as evidenced by the visible insertion mark.

- B. Domestic Water piping shall conform to the following:
1. Grade all lines to facilitate drainage. Provide drain valves at bottom of risers and all low points in system. Design domestic hot water circulating lines with no traps.
  2. Connect branch lines at bottom of main serving fixtures below and pitch down so that main may be drained through fixture. Connect branch lines to top of main serving only fixtures located on floor above.

### **3.2 TESTS**

- A. General: Test system either in its entirety or in sections. Submit testing plan to COR 10 working days prior to test date.
- B. Potable Water System: Test after installation of piping and domestic water heaters, but before piping is concealed, before covering is applied, and before plumbing fixtures are connected. Fill systems with water and maintain hydrostatic pressure of 1035 kPa (150 psig) gage for two hours. No decrease in pressure is allowed. Provide a pressure gage with a shutoff and bleeder valve at the highest point of the piping being tested. Pressure gauge shall have 1 psig increments.
- C. Re-agent Grade Water Systems: Fill system with water and maintain hydrostatic pressure of 1380 kPa (200 psig) gage during inspection and prove tight.
- D. All Other Piping Tests: Test new installed piping under 1-1/2 times actual operating conditions and prove tight.
- E. The test pressure shall hold for the minimum time duration required by the applicable plumbing code or authority having jurisdiction.

### **3.3 STERILIZATION**

- A. After tests have been successfully completed, thoroughly flush and sterilize the interior domestic water distribution system in accordance with AWWA C651.



B. Use liquid chlorine or hypochlorite for sterilization.

**3.4 COMMISSIONING**

A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

B. Components provided under this section of the specification will be tested as part of a larger system.

**3.5 DEMONSTRATION AND TRAINING**

A. Provide services of manufacturer's technical representative to instruct VA Personnel in operation and maintenance of the system.

B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

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**SECTION 22 11 23  
DOMESTIC WATER PUMPS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Hot water circulating pump, hot water recirculation pump and domestic water pressure booster system.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic Restraint.
- F. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- G. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT.
- H. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS: Requirements for commissioning, systems readiness checklist, and training.
- I. Section 26 29 11, MOTOR CONTROLLERS.

**1.3 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 Mechanical Engineers (ASME):
  - ASME Boiler and Pressure Code -
  - BPVC Section VIII-1-2015 Rules for Construction of Pressure Vessels, Division 1
  - BPVC Section VIII-2-2015 Rules for Construction of Pressure Vessels, Division 2-Alternative Rules
- C. American Society for Testing and Materials (ASTM):
  - A48/A48M-2003 (R2012) ..Standard Specification for Gray Iron Castings
  - B584-2014 .....Standard Specification for Copper Alloy Sand Castings for General Applications
- D. International Code Council (ICC)
  - IPC-2012 .....International Plumbing Code

- E. National Electrical Manufacturers Association (NEMA):  
ICS 6-1993 (R2001, R2006) Industrial Control and Systems:  
Enclosures  
250-2014 .....Enclosures for Electrical Equipment (1000 Volts  
Maximum)
- F. NSF International (NSF)  
61-2014a .....Drinking Water System Components - Health  
Effects  
372-2011 .....Drinking Water System Components - Lead Content
- G. Underwriters' Laboratories, Inc. (UL):  
508-1999 (R2013) .....Standards for Industrial Control Equipment  
778-2010 (R2014) .....Standard for Motor-Operated Water Pumps

#### 1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 11 23, DOMESTIC WATER PUMPS", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
1. Pump:  
a. Manufacturer and model.  
b. Operating speed.  
c. Capacity.  
d. Characteristic performance curves.
2. Motor:  
a. Manufacturer, frame and type.  
b. Speed.  
c. Current Characteristics.  
d. Efficiency.
4. Drive: Information in accordance with Section 26 29 11, MOTOR CONTROLLERS.
- D. Certificate of shop test for domestic water booster system. Provide certified performance curves.

- E. Certified copies of all the factory and construction site test data sheets and reports.
- F. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
  - 1. Include complete list indicating all components of the systems.
  - 2. Include complete diagrams of the internal wiring for each item of equipment.
  - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- G. Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- H. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

#### **1.5 QUALITY ASSURANCE**

- A. General:
  - 1. UL Compliance: Comply with UL 778 for motor-operated water pumps.
  - 2. Design Criteria:
    - a. Pump sizes, capacities, pressures, operating characteristics and efficiency shall be as scheduled.
    - b. Head-capacity curves shall slope up to maximum head at shut-off. Select pumps near the midrange of the curve, and near the point of maximum efficiency, without approaching the pump curve end point and possible cavitation and unstable operation. Select pumps for open systems so that required net positive suction head (NPSHR) does not exceed the net positive head available (NPSHA).
    - c. Pump Driver: Furnish with pump. Size shall be non-overloading at any point on the head-capacity curve, including in a parallel or series pumping installation with one pump in operation.
    - d. Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard and other accessories specified. Statically and dynamically balance all rotating parts.
    - e. Furnish each pump and motor with a nameplate giving the manufacturers name, serial number of pump, capacity in GPM and

- head in feet at design condition, horsepower, voltage, frequency, speed and full load current and motor efficiency.
- f. Test all pumps before shipment. The manufacturer shall certify all pump ratings.
  - g. After completion of balancing, provide replacement of impellers or trim impellers to provide specified flow at actual pumping head, as installed.
- B. Hot Water Circulating and Recirculating Pumps: Components shall be assembled by a single manufacturer and the pump motor assembly shall be the standard cataloged product of the manufacturer.
- C. Domestic Water Pressure Booster System:
- 1. Components shall be furnished by a single manufacturer and the system shall be the standard cataloged product of the manufacturer.
  - 2. Shop Test: Water booster unit and its component parts shall undergo a thorough electric and hydraulic operating test prior to shipment. Tests shall include a system operating flow test from zero to 100 percent of design flow rate under specified suction and system pressure conditions. Certified performance curves shall be furnished.
- D. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

#### **1.6 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all

special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version 2017 provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead shall be prohibited in any potable water system intended for human consumption, and shall be certified in accordance with NSF 61 or NSF 372.

### **2.2 HOT WATER RECIRCULATING PUMP**

- A. General:
  - 1. Centrifugal, single stage, pump. Driver shall be electric motor, close coupled or connected by flexible or magnetic coupling. Pump for hot water system shall be designed for quiet, trouble-free operation at a minimum of 82 degrees C (180 degrees F) water service and 1,035 kPa (150 psig).
  - 2. Mounting shall be in-line, vertical or horizontal as indicated on drawing schedules.
  - 3. Stamped or engraved stainless steel nameplate.
  - 4. Motors: Maximum 40 degrees C (104 degrees F) ambient temperature rise, drip-proof, for operation with current, voltage, phase and

cycle shown in schedule on Electrical drawings, conforming to NEMA Type 4. Motors shall be equipped with thermal overload protection. When motor has cooled down it shall re-start automatically if the operating control has been left on and the system requires pump to start.

5. Pump shall operate continuously with on-off switch, or with an HOA switch for automatically controlled pumps, for manual shut down. In the inlet and outlet piping of the pump, shutoff valves shall be installed to permit service to the pump, strainer, and check valve without draining the system.
6. A check valve shall be installed in the pump discharge piping immediately downstream of the pump. A strainer with drain valve and removable strainer screen or basket shall be installed immediately upstream of the pump. Flexible pipe connectors and isolation pipe hangers shall be installed to prevent pump vibration from being transferred to adjacent piping and the building structure.

B. Vertical, In-Line Pumps:

1. Close-coupled pump and motor with maximum 3,600 rpm rotational speed.
2. Bronze-fitted cast iron body construction with solid steel shaft and flanged connections. Pump shall be suitable for mounting in a vertical or horizontal position, and shall be capable of pumping the capacity scheduled on drawings.
3. Bearings: Permanently oil lubricated and sealed, stainless steel ball bearings.
4. Impeller shall be high grade, cast brass or bronze, accurately machined and properly balanced.
5. Seal: Mechanical, with carbon-steel rotating ring, stainless steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.

**PART 3 - EXECUTION**

**3.1 STARTUP AND TESTING**

- A. Make tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.



- B. System Test: After installation is completed provide an operational test of the completed system including flow rates, pressure compliance, alarms and all control functions.
- C. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- D. The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and CxA. Contractor shall provide a minimum of 10 working days prior to startup and testing.

**3.2 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

**3.3 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative to instruct VA Personnel in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

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**SECTION 22 13 00  
FACILITY SANITARY AND VENT PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section pertains to sanitary sewer and vent systems, including piping, equipment and all necessary accessories as designated in this section.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 07 84 00, FIRESTOPPING: Penetrations in rated enclosures.
- F. Section 07 92 00, JOINT SEALANTS: Sealant products.
- G. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.
- H. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: Pipe Hangers and Supports, Materials Identification.
- I. Section 22 07 11, PLUMBING INSULATION.
- J. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS
- K. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
- L. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

**1.3 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 Mechanical Engineers (ASME):
  - A13.1-2007 .....Scheme for the Identification of Piping Systems
  - A112.36.2M-1991(R 2012) Cleanouts
  - A112.6.3-2001 (R2007) ..Standard for Floor and Trench Drains
  - B1.20.1-2013 .....Pipe Threads, General Purpose (Inch)
  - B16.1-2010 .....Gray Iron Pipe Flanges and Flanged Fittings
  - B16.4-2011 .....Standard for Grey Iron Threaded Fittings  
Classes 125 and 250

- B16.15-2013 .....Cast Copper Alloy Threaded Fittings, Classes  
125 and 250
- B16.18-2012 .....Cast Copper Alloy Solder Joint Pressure  
Fittings
- B16.21-2011 .....Nonmetallic Flat Gaskets for Pipe Flanges
- B16.22-2013 .....Wrought Copper and Copper Alloy Solder-Joint  
Pressure Fittings
- B16.23-2011 .....Cast Copper Alloy Solder Joint Drainage  
Fittings: DWV
- B16.24-2001 (R2006) ....Cast Copper Alloy Pipe Flanges and Flanged  
Fittings
- B16.29-2012 .....Wrought Copper and Wrought Copper Alloy Solder-  
Joint Drainage Fittings: DWV
- B16.39-2009 .....Malleable Iron Threaded Pipe Unions Classes  
150, 250, and 300
- B18.2.1-2012 .....Square, Hex, Heavy Hex, and Askew Head Bolts  
and Hex, Heavy Hex, Hex Flange, Lobed Head, and  
Lag Screws (Inch Series)
- C. American Society of Sanitary Engineers (ASSE):
  - 1001-2008 .....Performance Requirements for Atmospheric Type  
Vacuum Breakers
  - 1018-2001 .....Performance Requirements for Trap Seal Primer  
Valves - Potable Water Supplied
  - 1044-2001 .....Performance Requirements for Trap Seal Primer  
Devices - Drainage Types and Electronic Design  
Types
  - 1079-2012 .....Performance Requirements for Dielectric Pipe  
Unions
- D. American Society for Testing and Materials (ASTM):
  - A53/A53M-2012 .....Standard Specification for Pipe, Steel, Black  
And Hot-Dipped, Zinc-coated, Welded and  
Seamless
  - A74-2013a .....Standard Specification for Cast Iron Soil Pipe  
and Fittings
  - A888-2013a .....Standard Specification for Hubless Cast Iron  
Soil Pipe and Fittings for Sanitary and Storm  
Drain, Waste, and Vent Piping Applications

- B32-2008 .....Standard Specification for Solder Metal
- B43-2009 .....Standard Specification for Seamless Red Brass  
Pipe, Standard Sizes
- B75-2011 .....Standard Specification for Seamless Copper Tube
- B88-2009 .....Standard Specification for Seamless Copper  
Water Tube
- B306-2013 .....Standard Specification for Copper Drainage Tube  
(DWV)
- B584-2013 .....Standard Specification for Copper Alloy Sand  
Castings for General Applications
- B687-1999 (R 2011) .....Standard Specification for Brass, Copper, and  
Chromium-Plated Pipe Nipples
- B813-2010 .....Standard Specification for Liquid and Paste  
Fluxes for Soldering of Copper and Copper Alloy  
Tube
- B828-2002 (R 2010) .....Standard Practice for Making Capillary Joints  
by Soldering of Copper and Copper Alloy Tube  
and Fittings
- C564-2012 .....Standard Specification for Rubber Gaskets for  
Cast Iron Soil Pipe and Fittings
- D1785-2012 .....Standard Specification for Poly(Vinyl Chloride)  
(PVC) Plastic Pipe, Schedules 40, 80, and 120
- D2321-2011 .....Standard Practice for Underground Installation  
of Thermoplastic Pipe for Sewers and Other  
Gravity-Flow Applications
- D2564-2012 .....Standard Specification for Solvent Cements for  
Poly(Vinyl Chloride) (PVC) Plastic Piping  
Systems
- D2665-2012 .....Standard Specification for Poly(Vinyl Chloride)  
(PVC) Plastic Drain, Waste, and Vent Pipe and  
Fittings
- D2855-1996 (R 2010) .....Standard Practice for Making Solvent-Cemented  
Joints with Poly(Vinyl Chloride) (PVC) Pipe and  
Fittings
- D5926-2011 .....Standard Specification for Poly(Vinyl Chloride)  
(PVC) Gaskets for Drain, Waste, and Vent (DWV),  
Sewer, Sanitary, and Storm Plumbing Systems

- F402-2005 (R 2012) .....Standard Practice for Safe Handling of Solvent  
Cements, Primers, and Cleaners Used for Joining  
Thermoplastic Pipe and Fittings
- F477-2010 .....Standard Specification for Elastomeric Seals  
(Gaskets) for Joining Plastic Pipe
- F1545-1997 (R 2009) ....Standard Specification for Plastic-Lined  
Ferrous Metal Pipe, Fittings, and Flanges
- E. Cast Iron Soil Pipe Institute (CISPI):
- 2006 .....Cast Iron Soil Pipe and Fittings Handbook
- 301-2012 .....Standard Specification for Hubless Cast Iron  
Soil Pipe and Fittings for Sanitary and Storm  
Drain, Waste, and Vent Piping Applications
- 310-2012 .....Specification for Coupling for Use in  
Connection with Hubless Cast Iron Soil Pipe and  
Fittings for Sanitary and Storm Drain, Waste,  
and Vent Piping Applications
- F. Copper Development Association, Inc. (CDA):
- A4015 .....Copper Tube Handbook
- G. International Code Council (ICC):
- IPC-2012 .....International Plumbing Code
- H. Manufacturers Standardization Society (MSS):
- SP-123-2013 .....Non-Ferrous Threaded and Solder-Joint Unions  
for Use With Copper Water Tube
- I. National Fire Protection Association (NFPA):
- 70-2014 .....National Electrical Code (NEC)
- J. Plumbing and Drainage Institute (PDI):
- WH-201 (R 2010) .....Water Hammer Arrestors Standard
- K. Underwriters' Laboratories, Inc. (UL):
- 508-99 (R2013) .....Standard For Industrial Control Equipment

**1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 13 00, FACILITY SANITARY AND VENT PIPING", with applicable paragraph identification.

- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Piping.
  - 2. Floor Drains.
  - 3. Grease Removal Unit.
  - 4. Cleanouts.
  - 5. Trap Seal Protection.
  - 6. Penetration Sleeves.
  - 7. Pipe Fittings.
  - 8. Traps.
  - 9. Exposed Piping and Fittings.
- D. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane or the floor drain.

#### **1.5 QUALITY ASSURANCE**

- A. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopREFERRED.gov>.

#### **1.6 AS-BUILT DOCUMENTATION**

- A. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them on Auto-Cad version 2017 provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- B. Certification documentation shall be provided prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and a certification that all results of tests were within limits specified.

**PART 2 - PRODUCTS**

**2.1 SANITARY WASTE, DRAIN, AND VENT PIPING**

- A. Cast iron waste, drain, and vent pipe and fittings.
  - 1. Cast iron waste, drain, and vent pipe and fittings shall be used for the following applications:
    - a. Pipe buried in or in contact with earth.
    - b. Sanitary pipe extensions to a distance of approximately 1500 mm (5 feet) outside of the building.
    - c. Interior waste and vent piping above grade.
  - 2. Cast iron Pipe shall be bell and spigot or hubless (plain end or no-hub or hubless).
  - 3. The material for all pipe and fittings shall be cast iron soil pipe and fittings and shall conform to the requirements of CISPI 301, ASTM A888, or ASTM A74.
  - 4. Cast iron pipe and fittings shall be made from a minimum of 95 percent post-consumer recycled material.
  - 5. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions. Couplings for hubless joints shall conform to CISPI 310. Joints for hub and spigot pipe shall be installed with compression gaskets conforming to the requirements of ASTM C564.
- B. Copper Tube, (DWV):
  - 1. Copper DWV tube sanitary waste, drain and vent pipe may be used for piping above ground, except for urinal drains.
  - 2. The copper DWV tube shall be drainage type, drawn temper conforming to ASTM B306.
  - 3. The copper drainage fittings shall be cast copper or wrought copper conforming to ASME B16.23 or ASME B16.29.
  - 4. The joints shall be lead free, using a water flushable flux, and conforming to ASTM B32.
- C. Polyvinyl Chloride (PVC)
  - 1. Polyvinyl chloride (PVC) pipe and fittings are permitted where the waste temperature is below 60 degrees C (140 degrees F).
  - 2. PVC piping and fittings shall NOT be used for the following applications:
    - a. Waste collected from steam condensate drains.



- b. Spaces such as mechanical equipment rooms, kitchens, Sterile Processing Services, sterilizer areas, and areas designated for sleep.
  - c. Vertical waste and soil stacks serving more than two floors.
  - d. Exposed in mechanical equipment rooms.
  - e. Exposed inside of ceiling return plenums.
3. Polyvinyl chloride sanitary waste, drain, and vent pipe and fittings shall be solid core sewer piping conforming to ASTM D2665, sewer and drain series with ends for solvent cemented joints.
4. Fittings: PVC fittings shall be solvent welded socket type using solvent cement conforming to ASTM D2564.

## **2.2 SPECIALTY PIPE FITTINGS**

- A. Transition pipe couplings shall join piping with small differences in outside diameters or different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be elastomeric, sleeve type reducing or transition pattern and include shear and corrosion resistant metal, tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:
- 1. For cast iron soil pipes, the sleeve material shall be rubber conforming to ASTM C564.
  - 2. For PVC soil pipes, the sleeve material shall be elastomeric seal or PVC, conforming to ASTM F477 or ASTM D5926.
  - 3. For dissimilar pipes, the sleeve material shall be PVC conforming to ASTM D5926, or other material compatible with the pipe materials being joined.
- B. The dielectric fittings shall conform to ASSE 1079 with a pressure rating of 861 kPa (125 psig) at a minimum temperature of 82 degrees C (180 degrees F). The end connection shall be solder joint copper alloy and threaded ferrous.
- C. Dielectric flange insulating kits shall be of non-conducting materials for field assembly of companion flanges with a pressure rating of 1035 kPa (150 psig). The gasket shall be neoprene or phenolic. The bolt sleeves shall be phenolic or polyethylene. The washers shall be phenolic with steel backing washers.
- D. The di-electric nipples shall be electroplated steel nipple complying with ASTM F1545 with a pressure rating of 2070 kPa (300 psig) at 107

degrees C (225 degrees F). The end connection shall be male threaded.

The lining shall be inert and noncorrosive propylene.

### **2.3 CLEANOUTS**

- A. Cleanouts shall be the same size as the pipe, up to 100 mm (4 inches); and not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be easily accessible and shall be gastight and watertight. Minimum clearance of 600 mm (24 inches) shall be provided for clearing a clogged sanitary line.
- B. Floor cleanouts shall be gray iron housing with clamping device and round, secured, scoriated, gray iron cover conforming to ASME A112.36.2M. A gray iron ferrule with hubless, socket, inside calk or spigot connection and counter sunk, taper-thread, brass or bronze closure plug shall be included. The frame and cover material and finish shall be nickel-bronze copper alloy with a square shape. The cleanout shall be vertically adjustable for a minimum of 50 mm (2 inches). When a waterproof membrane is used in the floor system, clamping collars shall be provided on the cleanouts. Cleanouts shall consist of wye fittings and eighth bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, carpet cleanout markers shall be provided. Two way cleanouts shall be provided where indicated on drawings and at every building exit. The loading classification for cleanouts in sidewalk areas or subject to vehicular traffic shall be heavy duty type.
- C. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. If there are no fixtures installed on the lowest floor, the cleanout shall be installed at the base of the stack. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary tees. Nickel-bronze square frame and stainless steel cover with minimum opening of 150 by 150 mm (6 by 6 inches) shall be furnished at each wall cleanout. Where the piping is concealed, a fixture trap or a fixture with integral trap, readily removable without disturbing concealed pipe, shall be accepted as a cleanout equivalent providing the opening to be used as a cleanout opening is the size required.

- D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/hubless cast iron ferrule. Plain end (hubless) piping in interstitial space or above ceiling may use plain end (hubless) blind plug and clamp.

#### **2.4 FLOOR DRAINS**

- A. General Data: floor drain shall comply with ASME A112.6.3. A caulking flange, inside gasket, or hubless connection shall be provided for connection to cast iron pipe, screwed or no hub outlets for connection to steel pipe. The drain connection shall be bottom outlet. A membrane clamp and extensions shall be provided, if required, where installed in connection with waterproof membrane. Puncturing membrane other than for drain opening will not be permitted. Double drainage pattern floor drains shall have integral seepage pan for embedding into floor construction, and weep holes to provide adequate drainage from pan to drain pipe. For drains not installed in connection with a waterproof membrane, a 1.1 to 1.8 Kg (2.5 to 4 lbs.) flashing membrane, 600 mm (24 inches) square or another approved waterproof membrane shall be provided.
- B. Type C (FD-C) medium duty (non-traffic) floor drain shall comply with ASME A112.6.3. The type C floor drain shall have a cast iron body, double drainage pattern, clamping device, light duty nickel bronze adjustable strainer with round or square grate of 150 mm (6 inches) width or diameter minimum for toilet rooms, showers and kitchens.
- C. Type E (FD-E) floor drain shall comply with ASME A112.6.3. The type E floor drain shall have a heavy, cast iron body, double drainage pattern, heavy non-tilting nickel bronze grate not less than 300 mm (12 inches) square, removable sediment bucket. Clearance between body and bucket shall be ample for free flow of waste water. For traffic use, an extra heavy duty load classification ductile iron grate shall be provided.
- FR. Type S (FD-S) floor sink shall comply with ASME A112.6.3. The type S floor sink shall be constructed from type 304 stainless steel and shall be 300 mm (12 inches) square, and 200 mm (8 inches deep). The interior surface shall be polished. The double drainage flange shall be provided with weep holes, internal dome strainer, and heavy duty non-tilting loose set grate. A clamping device shall be provided.

- X. Type Z (FD-Z) trench drain shall comply with ASME A112.6.3. The type Z trench drain shall be suitable for shower thresholds and constructed of Type 304 stainless steel. The stainless steel slotted grate shall be not less than 100 mm (4 inches) wide with anchor supports, tile edge, bottom outlet and combination membrane flashing collar.

## **2.7 TRAPS**

- A. Traps shall be provided on all sanitary branch waste connections from fixtures or equipment not provided with traps. Exposed brass shall be polished brass chromium plated with nipple and set screw escutcheons. Concealed traps may be rough cast brass or same material as the piping they are connected to. Slip joints are not permitted on sewer side of trap. Traps shall correspond to fittings on cast iron soil pipe or steel pipe respectively, and size shall be as required by connected service or fixture.

## **2.8 PRIMER VALVES AND TRAP SEAL PRIMER SYSTEMS**

- B. Trap Primer (TP-1): The trap seal primer valve shall be hydraulic, supply type with a pressure rating of 861 kPa (125 psig) and conforming to standard ASSE 1018.
1. The inlet and outlet connections shall be 15 mm or DN15 (NPS 1/2 inch)
  2. The trap seal primer valve shall be fully automatic with an all brass or bronze body.
  3. The trap seal primer valve shall be activated by a drop in building water pressure, no adjustment required.
  4. The trap seal primer valve shall include a manifold when serving two, three, or four traps.
  5. The manifold shall be omitted when serving only one trap.

## **2.9 PENETRATION SLEEVES**

- A. A sleeve flashing device shall be provided at points where pipes pass through membrane waterproofed floors or walls. The sleeve flashing device shall be manufactured, cast iron fitting with clamping device that forms a sleeve for the pipe floor penetration of the floor membrane. A galvanized steel pipe extension shall be included in the top of the fitting that will extend 50 mm (2 inches) above finished floor and galvanized steel pipe extension in the bottom of the fitting that will extend through the floor slab. A waterproof caulked joint shall be provided at the top hub.

**PART 3 - EXECUTION**

**3.1 PIPE INSTALLATION**

- A. The pipe installation shall comply with the requirements of the International Plumbing Code (IPC) and these specifications.
- B. Branch piping shall be installed for waste from the respective piping systems and connect to all fixtures, valves, cocks, outlets, casework, cabinets and equipment, including those furnished by the Government or specified in other sections.
- C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe shall be reamed to full size after cutting.
- D. All pipe runs shall be laid out to avoid interference with other work.
- E. The piping shall be installed above accessible ceilings where possible.
- F. The piping shall be installed to permit valve servicing or operation.
- G. The piping shall be installed free of sags and bends.
- H. Seismic restraint shall be installed where required by code.
- I. Changes in direction for soil and waste drainage and vent piping shall be made using appropriate branches, bends and long sweep bends. Sanitary tees and short sweep quarter bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and eighth bend fittings shall be used if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- J. Buried soil and waste drainage and vent piping shall be laid beginning at the low point of each system. Piping shall be installed true to grades and alignment indicated with unbroken continuity of invert. Hub ends shall be placed upstream. Required gaskets shall be installed according to manufacturer's written instruction for use of lubricants, cements, and other installation requirements.
- K. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings"
- L. Aboveground copper tubing shall be installed according to Copper Development Association's (CDA) "Copper Tube Handbook".

- //M. Aboveground PVC piping shall be installed according to ASTM D2665.  
Underground PVC piping shall be installed according to ASTM D2321.//
- N. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no cost to the Government.

### **3.2 JOINT CONSTRUCTION**

- A. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub and spigot, cast iron piping with calked joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- C. Hubless or No-hub, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.
- D. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc cutters. Threaded pipe ends shall be reamed to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service.
  2. Pipe sections with damaged threads shall be replaced with new sections of pipe.
- E. Copper tube and fittings with soldered joints shall be joined according to ASTM B828. A water flushable, lead free flux conforming to ASTM B813 and a lead free alloy solder conforming to ASTM B32 shall be used.
- F. For PVC piping, solvent cement joints shall be used for joints. All surfaces shall be cleaned and dry prior to applying the primer and solvent cement. Installation practices shall comply with ASTM F402. The joint shall conform to ASTM D2855 and ASTM D2665 appendixes.

### **3.3 SPECIALTY PIPE FITTINGS**

- A. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.
- B. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.

**3.4 PIPE HANGERS, SUPPORTS AND ACCESSORIES**

- A. All piping shall be supported according to the International Plumbing Code (IPC), Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and these specifications. Where conflicts arise between these the code and Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING the most restrictive or the requirement that specifies supports with highest loading or shortest spacing shall apply.
- B. Hangers, supports, rods, inserts and accessories used for pipe supports shall be painted according to Section 09 91 00, PAINTING. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
- C. Horizontal piping and tubing shall be supported within 300 mm (12 inches) of each fitting or coupling.
- D. Horizontal cast iron piping shall be supported with the following maximum horizontal spacing and minimum hanger rod diameters:
  - 1. 40 mm or DN40 to 50 mm or DN50 (NPS 1-1/2 inch to NPS 2 inch): 1500 mm (60 inches) with 10 mm (3/8 inch) rod.
  - 2. 75 mm or DN75 (NPS 3 inch): 1500 mm (60 inches) with 15 mm (1/2 inch) rod.
  - 3. 100 mm or DN100 to 125 mm or DN125 (NPS 4 inch to NPS 5 inch): 1500 mm (60 inches) with 18 mm (5/8 inch) rod.
  - 4. 150 mm or DN150 to 200 mm or DN200 (NPS 6 inch to NPS 8 inch): 1500 mm (60 inches) with 20 mm (3/4 inch) rod.
  - 5. 250 mm or DN250 to 300 mm or DN300 (NPS 10 inch to NPS 12 inch): 1500 mm (60 inch) with 23 mm (7/8 inch) rod.
- E. The maximum spacing for plastic pipe shall be 1.22 m (4 feet).
- F. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 4.6 m (15 feet).
- G. In addition to the requirements in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, Floor, Wall and Ceiling Plates, Supports, Hangers shall have the following characteristics:
  - 1. Solid or split unplated cast iron.
  - 2. All plates shall be provided with set screws.
  - 3. Height adjustable clevis type pipe hangers.
  - 4. Adjustable floor rests and base flanges shall be steel.

5. Hanger rods shall be low carbon steel, fully threaded or threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
  6. Riser clamps shall be malleable iron or steel.
  7. Rollers shall be cast iron.
  8. See Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, for requirements on insulated pipe protective shields at hanger supports.
- H. Miscellaneous materials shall be provided as specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6.1 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. All necessary auxiliary steel shall be provided to provide that support.
- I. Cast escutcheon with set screw shall be provided at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- J. Penetrations:
1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, a fire stop shall be installed that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Clearances between raceways and openings shall be completely filled and sealed with the fire stopping materials.
  2. Water proofing: At floor penetrations, clearances shall be completely sealed around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS.
- K. Exhaust vents shall be extended separately through roof. Sanitary vents shall not connect to exhaust vents.

### **3.5 TESTS**

- A. Sanitary waste and drain systems shall be tested either in its entirety or in sections.
- B. Waste System tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.
  1. If entire system is tested for a water test, tightly close all openings in pipes except highest opening, and fill system with water



to point of overflow. If the waste system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.

2. For an air test, an air pressure of 34 kPa (5 psig) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gage shall be used for the air test.
3. After installing all fixtures and equipment, open water supply so that all p-traps can be observed. For 15 minutes of operation, all p-traps shall be inspected for leaks and any leaks found shall be corrected.
4. Final Tests: Either one of the following tests may be used.
  - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of .25 kPa (1 inch of water) with a smoke machine. Chemical smoke is prohibited.
  - b. Peppermint Test: Introduce 60 ml (2 ounces) of peppermint into each line or stack.

### **3.6 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

- - - E N D - - -



**SECTION 22 14 00  
FACILITY STORM DRAINAGE**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the requirements for storm drainage systems, including piping and all necessary accessories as designated in this section.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 07 84 00, FIRESTOPPING: Penetrations in rated enclosures.
- F. Section 07 92 00, JOINT SEALANTS.
- G. Section 09 91 00, PAINTING: Preparation and finish painting and identification of piping systems.
- H. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic Restraint.
- I. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: Pipe Hangers and Supports, Materials Identification.
- J. Section 22 05 33, HEAT TRACING FOR PLUMBING PIPING.
- K. Section 22 07 11, PLUMBING INSULATION.
- L. SECTION 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

**1.3 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 Mechanical Engineers (ASME):
  - A112.6.4-2003 (R2012) .Roof, Deck, and Balcony Drains
  - A13.1-2007 (R2013) .....Scheme for Identification of Piping Systems
  - B1.20.1-2013 .....Pipe Threads, General Purpose, Inch
  - B16.3-2011 .....Malleable Iron Threaded Fittings: Classes 150  
and 300
  - B16.9-2012 .....Factory-Made Wrought Buttwelding Fittings

- B16.11-2011 .....Forged Fittings, Socket-Welding and Threaded
- B16.12-2009 (R2014) ....Cast Iron Threaded Drainage Fittings
- B16.15-2013 .....Cast Copper Alloy Threaded Fittings: Classes  
125 and 250
- B16.18-2012 .....Cast Copper Alloy Solder-Joint Pressure  
Fittings
- B16.22-2013 .....Wrought Copper and Copper Alloy Solder-Joint  
Pressure Fittings
- B16.23-2011 .....Cast Copper Alloy Solder Joint Drainage  
Fittings - DWV
- B16.29-2012 .....Wrought Copper and Wrought Copper Alloy Solder-  
Joint Drainage Fittings - DWV
- C. American Society of Sanitary Engineering (ASSE)  
1079-2012 .....Performance Requirements for Dielectric Pipe  
Unions
- D. American Society for Testing and Materials (ASTM):
- A47/A47M-1999 (R2014) ..Standard Specification for Ferritic Malleable  
Iron Castings
- A53/A53M-2012 .....Standard Specification for Pipe, Steel, Black  
And Hot-Dipped, Zinc-coated Welded and Seamless
- A74-2013a .....Standard Specification for Cast Iron Soil Pipe  
and Fittings
- A183-2014 .....Standard Specification for Carbon Steel Track  
Bolts and Nuts
- A312/A312M-2015 .....Standard Specification for Seamless, Welded,  
and Heavily Cold Worked Austenitic Stainless  
Steel Pipes
- A536-1984 (R2014) .....Standard Specification for Ductile Iron  
Castings
- A733-2013 .....Standard Specification for Welded and Seamless  
Carbon Steel and Austenitic Stainless Steel  
Pipe Nipples
- A888-2013a .....Standard Specification for Hubless Cast Iron  
Soil Pipe and Fittings for Sanitary and Storm  
Drain, Waste, and Vent Piping Applications
- B32-2008 (R2014) .....Standard Specification for Solder Metal

- B61-2008 (R2013) .....Standard Specification for Steam or Valve  
Bronze Castings
- B62-2009 .....Standard Specification for Composition Bronze  
or Ounce Metal Castings
- B75/B75M-2011 .....Standard Specification for Seamless Copper Tube
- B88-2014 .....Standard Specification for Seamless Copper  
Water Tube
- B306-2013 .....Standard Specification for Copper Drainage Tube  
(DWV)
- B584-2014 .....Standard Specification for Copper Alloy Sand  
Castings for General Applications
- B687-1999 (R2011) .....Standard Specification for Brass, Copper, and  
Chromium-Plated Pipe Nipples
- B828-2002 (R2010) .....Standard Practice for Making Capillary Joints  
by Soldering of Copper and Copper Alloy Tube  
and Fittings
- B813-2010 .....Standard Specification for Liquid and Paste  
Fluxes for Soldering of Copper and Copper Alloy  
Tube
- C564-2014 .....Standard Specification for Rubber Gaskets for  
Cast Iron Soil Pipe and Fittings
- C1173-2010 (R2014) .....Standard Specification for Flexible Transition  
Couplings for Underground Piping Systems
- D1785-2012 .....Standard Specification for Poly(Vinyl Chloride)  
(PVC) Plastic Pipe, Schedules 40, 80 and 120
- D2000-2012 .....Standard Classification System for Rubber  
Products in Automotive Applications
- D2321-2014e1 .....Standard Practice for Underground Installation  
of Thermoplastic Pipe for Sewers and Other  
Gravity-Flow Applications
- D2564-2012 .....Standard Specification for Solvent Cements for  
Poly (Vinyl Chloride) (PVC) Plastic Piping  
Systems
- D2665-2014 .....Standard Specification for Poly (Vinyl  
Chloride) (PVC) Plastic Drain, Waste, and Vent  
Pipe and Fittings

- D2855-1996 (R2010) .....Standard Practice for Making Solvent-Cemented  
Joints with Poly (Vinyl Chloride) (PVC) Pipe  
and Fittings
- D4101-2014 .....Standard Specification for Polypropylene  
Injection and Extrusion Materials
- D5926-2011 .....Standard for Poly (Vinyl Chloride) (PVC)  
Gaskets for Drain, Waste, and Vent (DWV),  
Sewer, Sanitary, and Storm Plumbing Systems
- F477-2014 .....Standard Specification for Elastomeric Seals  
(Gaskets) for Joining Plastic Pipe
- F656-2010 .....Standard Specification for Primers for Use in  
Solvent Cement Joints of Poly (Vinyl Chloride)  
(PVC) Plastic Pipe and Fittings
- F1545-2015 .....Standard Specification for Plastic-Lined  
Ferrous Metal Pipe, Fittings, and Flanges
- E. American Welding Society (AWS):
- A5.8M/A5.8 AMD1-2011 ...Specification for Filler Metals for Brazing and  
Braze Welding
- F. Copper Development Association (CDA):
- A4015-2011 .....Copper Tube Handbook
- G. Cast Iron Soil Pipe Institute (CISPI):
- 301-2012 .....Standard Specification for Hubless Cast Iron  
Soil Pipe and Fittings for Sanitary and Storm  
Drain, Waste, and Vent Piping Applications
- 310-2012 .....Standard Specification for Coupling for Use in  
Connection with Hubless Cast Iron Soil Pipe and  
Fittings for Sanitary and Storm Drain, Waste,  
and Vent Piping Applications
- H. International Code Council (ICC):
- IPC-2012 .....International Plumbing Code
- I. Manufacturers Standardization Society of the Valve and Fittings  
Industry, Inc. (MSS):
- SP-72-2010a .....Ball Valves with Flanged or Butt-Welding Ends  
for General Service
- SP-110-2010 .....Ball Valves Threaded, Socket-Welding, Solder  
Joint, Grooved and Flared Ends

#### **1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 14 00, FACILITY STORM DRAINAGE", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Pipe and Fittings.
  - 2. Specialty Pipe Fittings.
  - 3. Cleanouts.
  - 5. Expansion Joints.
  - 7. Sleeve Flashing Devices.
- D. Detailed shop drawing of clamping device and extensions when required in connection with the waterproofing membrane.
- E. Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- F. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

#### **1.5 QUALITY ASSURANCE**

- A. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

#### **1.6 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in

electronic version on compact disc or DVD inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version 2017 provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

## **PART 2 - PRODUCTS**

### **2.1 STORM WATER DRAIN PIPING**

- A. Cast Iron Storm Pipe and Fittings:
  - 1. Cast iron storm pipe and fittings shall be used for the following applications:
    - a. Pipe buried in or in contact with earth.
    - b. Extension of pipe to a distance of approximately 1500 mm (5 feet) outside of building walls.
    - c. Interior storm piping above grade.
    - d. All mechanical equipment rooms or other areas containing mechanical air handling equipment.



2. The cast iron storm pipe shall be bell and spigot, or hubless (plain end or no-hub) as required by selected jointing method.
  3. The material for all pipe and fittings shall be cast iron soil pipe and fittings and shall conform to the requirements of CISPI 301, ASTM A888, or ASTM A74.
  4. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions. Couplings for hubless joints shall conform to CISPI 310. Joints for hub and spigot pipe shall be installed with compression gaskets conforming to the requirements of ASTM C564.
- B. Copper Tube, (DWV): May be used for piping above ground.
1. The copper DWV tube shall be drainage type, drawn temper conforming to ASTM B306.
  2. The copper drainage fittings shall be cast copper or wrought copper conforming to ASME B16.23 or ASME 16.29.
  3. The joints shall be lead free, using a water flushable flux, and conforming to ASTM B32.
- C. Polyvinyl Chloride (PVC):
1. PVC storm sewer pipe and fittings are permitted for single story structures except for mechanical equipment rooms and other areas containing air handling equipment or hot water generation equipment.
  2. PVC storm sewer pipe and fittings shall be schedule 40 solid core piping conforming to ASTM D1785 and ASTM D2665, Sewer and Drain Series, with ends for solvent cemented joints.
  3. PVC joints shall be solvent welded socket type using solvent cement conforming to ASTM D2564 and adhesive primer conforming to ASTM F656. Bio-based materials shall be utilized when possible.
- D. Roof drain piping and body of drain in locations where the outdoor conditions are subject to freezing shall be insulated.

## **2.2 PUMPED DRAIN PIPING**

- A. Pumped drain piping 75 mm (3 inches) and less shall be copper tube conforming to ASTM B88, type K or L. For pumped drain piping 100 mm (4 inches) and greater, galvanized steel conforming to ASTM A53/A53M, seamless, schedule 40 may be used.
- B. Pumped drain pipe fittings shall comply with the following:
1. Wrought copper or bronze castings for use with copper tube conforming to ASME B16.18 and B16.22.

2. Unions, for use with copper tube up to 50 mm (2 inches) shall be cast with bronze, conforming to ASME B16.18 and ASTM B584 with solder or braze joints.
  3. Grooved fittings, for use with copper tube 65 mm to 100 mm (2-1/2 to 4 inch) shall be wrought copper conforming to ASTM B75/B75M, alloy C12200, 125 to 150 mm (5 to 6 inch) bronze castings conforming to ASTM B584.
  4. Mechanical grooved couplings shall have a ductile iron housing conforming to ASTM A536 (Grade 65-45-12) elastomer gasket suitable for potable water service and process temperature and steel track head bolts conforming to ASTM A183, housing shall be coated with colored alkyd enamel paint.
- C. Adapters shall be provided for joining pipe with different end connections.
- D. The solder shall be lead free using a water flushable, non-corrosive flux conforming to ASTM B32.
- E. Dielectric fittings and specialties shall be provided when joining pipe of dissimilar metals.

### **2.3 SPECIALTY PIPE FITTINGS**

- A. Transition pipe couplings shall join piping with small differences in outside diameters or be of different materials. End connections shall be of the same size and compatible with the pipes being joined. The transition coupling shall be unshielded, elastomeric, sleeve type reducing or transition pattern conforming with ASTM C1173 and include shear ring and corrosion resistant metal tension band and tightening mechanism on each end. The transition coupling sleeve coupling shall be of the following material:
1. For cast iron soil pipes, the sleeve material shall be rubber conforming to ASTM C564.
  2. For PVC soil pipes, the sleeve material shall be elastomeric seal conforming to ASTM F477 or PVC conforming to ASTM D5926.
  3. dissimilar pipes, the sleeve material shall be PVC conforming to ASTM D5926, or other material compatible with the pipe materials being joined.

### **2.4 CLEANOUTS**

- A. Cleanouts shall be the same size as the pipe, up to 100 mm (4 inches); not less than 100 mm (4 inches) for larger pipe. Cleanouts shall be

easily accessible and shall be gastight and watertight. A minimum clearance of 600 mm (24 inches) shall be provided for clearing a clogged storm sewer line.

- B. Floor cleanouts shall be gray iron housing with clamping device and round, secured, scoriated, gray iron cover conforming to ASME A112.36.2M. A gray iron ferrule with hubless, socket, inside caulk or spigot connection and counter sunk, taper-thread, brass or bronze closure plug shall be included. The frame and cover material and finish shall be nickel-bronze copper alloy with a square shape. The cleanout shall be vertically adjustable for a minimum of 50 mm (2 inches). When a waterproof membrane is used in the floor system, clamping collars shall be provided on the cleanouts. Cleanouts shall consist of wye fittings and eighth bends with brass or bronze screw plugs. Cleanouts in the resilient tile floors, quarry tile and ceramic tile floors shall be provided with square top covers recessed for tile insertion. In the carpeted areas, carpet cleanout markers shall be provided. Two way cleanouts shall be provided where indicated on the drawings and at each building exit. The loading classification for cleanouts in sidewalk areas or subject to vehicular traffic shall be heavy duty.
- C. Cleanouts shall be provided at or near the base of the vertical stacks with the cleanout plug located approximately 600 mm (24 inches) above the floor. The cleanouts shall be extended to the wall access cover. Cleanout shall consist of sanitary tees. Nickel bronze square frame and stainless steel cover with minimum opening of 150 mm by 150 mm (6 inch by 6 inch) shall be provided at each wall cleanout.
- D. In horizontal runs above grade, cleanouts shall consist of cast brass tapered screw plug in fitting or caulked/no hub cast iron ferrule. Plain end (no-hub) piping in interstitial space or above ceiling may use plain end (no-hub) blind plug and clamp.

## **2.5 WATERPROOFING**

- A. A sleeve flashing device shall be provided at points where pipes pass through membrane waterproofed floors or walls. The sleeve flashing device shall be manufactured, cast iron fitting with clamping device that forms a sleeve for the pipe floor penetration of the floor membrane. A galvanized steel pipe extension shall be included in the top of the fitting that will extend 50 mm (2 inches) above finished floor and galvanized steel pipe extension in the bottom of the fitting

that will extend through the floor slab. A waterproofed caulked joint shall be provided at the top hub.

**PART 3 - EXECUTION**

**3.1 PIPE INSTALLATION**

- A. The pipe installation shall comply with the requirements of the IPC and these specifications.
- B. Branch piping shall be installed from the piping system and connect to all drains and outlets.
- C. Pipe shall be round and straight. Cutting shall be done with proper tools. Pipe, except for glass, shall be reamed to remove burrs and a clean smooth finish restored to full pipe inside diameter.
- D. All pipe runs shall be laid out to avoid interference with other work/trades.
- E. The piping shall be installed above accessible ceilings to allow for ceiling panel removal.
- F. Unless otherwise stated on the documents, minimum horizontal slope shall be one inch for every 2.44 m (8 feet) (1 percent slope) of pipe length.
- G. The piping shall be installed free of sags and bends.
- H. Seismic restraint shall be installed where required by code.
- I. Changes in direction for storm drainage piping shall be made using appropriate branches, bends and long sweep bends. Sanitary tees and short sweep  $\frac{1}{4}$  bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Long turn double wye branch and  $\frac{1}{8}$  bend fittings shall be used if two drains are installed back to back or side by side with common drain pipe. Do not change direction of flow more than 90 degrees. Proper size of standard increaser and reducers shall be used if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- J. Buried storm drainage piping shall be laid beginning at the low point of each system. Piping shall be installed true to grades and alignment indicated with unbroken continuity of invert. Hub ends shall be placed upstream. Required gaskets shall be installed according to manufacturer's written instruction for use of lubricants, cements, and other installation requirements. Bio-based materials shall be utilized when possible.

- K. Cast iron piping shall be installed according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings"
- L. Aboveground copper tubing shall be installed according to CDA A4015.
- M. Aboveground PVC piping shall be installed according to ASTM D2665.  
Underground PVC piping shall be installed according to ASTM D2321.

### **3.2 JOINT CONSTRUCTION**

- A. Hub and spigot, cast iron piping with gasket joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hub and spigot, cast iron piping with calked joints shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
- C. Hubless, cast iron piping shall be joined in accordance with CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.
- D. For threaded joints, thread pipe with tapered pipe threads according to ASME B1.20.1. The threads shall be cut full and clean using sharp disc cutters. Threaded pipe ends shall be reamed to remove burrs and restored to full pipe inside diameter. Pipe fittings and valves shall be joined as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is required by the pipe service
  - 2. Pipe sections with damaged threads shall be replaced with new undamaged sections of pipe at no additional time or cost to Government.
- E. Copper tube and fittings with soldered joints shall be joined according to ASTM B828. A water flushable, lead free flux conforming to ASTM B813 and a lead free alloy solder conforming to ASTM B32 shall be used.
- F. For PVC piping, solvent cement joints shall be used for joints. All surfaces shall be cleaned and dry prior to applying the primer and solvent cement. Installation practices shall comply with ASTM F402. The joint shall conform to ASTM D2855 and ASTM D2665 appendices.

### **3.3 SPECIALTY PIPE FITTINGS**

- A. Transition coupling shall be installed at pipe joints with small differences in pipe outside diameters.

- B. Dielectric fittings shall be installed at connections of dissimilar metal piping and tubing.

### **3.4 PIPE HANGERS, SUPPORTS AND ACCESSORIES**

- A. All piping shall be supported according to the IPC, Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and these specifications.
- B. Hangers, supports, rods, inserts and accessories used for Pipe supports shall be shop coated with zinc Chromate primer paint. Electroplated copper hanger rods, hangers and accessories may be used with copper tubing.
- C. Horizontal piping and tubing shall be supported within 300 mm (12 inches) of each fitting or coupling.
- D. Horizontal cast iron piping shall be supported with the following maximum horizontal spacing and minimum hanger rod diameters:
  - 1. NPS 1-1/2 to NPS 2 (DN 40 to DN 50): 1500 mm (60 inches) with 10 mm (3/8 inch) rod.
  - 2. NPS 3 (DN 80): 1500 mm (60 inches) with 15 mm (1/2 inch) rod.
  - 3. NPS 4 to NPS 5 (DN 100 to DN 125): 1500 mm (60 inches) with 18 mm (5/8 inch) rod.
  - 4. NPS 6 to NPS 8 (DN 150 to DN 200): 1500 mm (60 inches) with 20 mm (3/4 inch) rod.
  - 5. NPS 10 to NPS 12 (DN 250 to DN 300): 1500 mm (60 inches) with 23 mm (7/8 inch) rod.
- E. The maximum support spacing for horizontal plastic shall be 1.22 m (4 feet).
- F. Vertical piping and tubing shall be supported at the base, at each floor, and at intervals no greater than 4.6 m (15 feet).
- G. In addition to the requirements in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, floor, wall and ceiling plates shall have the following characteristics:
  - 1. Solid or split unplated cast iron.
  - 2. All plates shall be provided with set screws.
  - 3. Height adjustable clevis type pipe hangers.
  - 4. Adjustable Floor Rests and Base Flanges shall be steel.
  - 5. Hanger Rods shall be low carbon steel, fully threaded or threaded at each end with two removable nuts at each end for positioning rod and hanger and locking each in place.
  - 6. Riser Clamps shall be malleable iron or steel.

7. Roller shall be cast iron.
8. Hangers and supports utilized with insulated pipe and tubing shall have 180 degree (minimum) metal protection shield centered on and welded to the hanger and support. The shield shall be 100 mm (4 inches) in length and be 1.6 mm (16 gage) steel. The shield shall be sized for the insulation.
- H. Miscellaneous materials shall be provided as specified, required, directed or as noted on the drawings for proper installation of hangers, supports and accessories. If the vertical distance exceeds 6.1 m (20 feet) for cast iron pipe additional support shall be provided in the center of that span. All necessary auxiliary steel shall be provided to provide that support.
- I. Cast escutcheon with set screw shall be installed at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- J. Penetrations:
  1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoke partitions, or floors, a fire stop shall be installed that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING. Clearances between raceways and openings shall be completely filled and sealed with the fire stopping materials.
  2. Water proofing: At floor penetrations, Clearances around the pipe shall be completely sealed and made watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS. Bio-based materials shall be utilized when possible.

### **3.5 INSULATION**

- A. Insulate horizontal sections and 600 mm (2 feet) past changes of direction to vertical sections for interior section of roof drains. Install insulation in accordance with the requirements of Section 22 07 11, PLUMBING INSULATION.

### **3.6 TESTS**

- A. Storm sewer system shall be tested either in its entirety or in sections.
- B. Storm Water Drain tests shall be conducted before trenches are backfilled or fixtures are connected. A water test or air test shall be conducted, as directed.

1. If entire system is tested with water, tightly close all openings in pipes except the highest opening, and fill system with water to point of overflow. If system is tested in sections, tightly plug each opening except highest opening of section under test, fill each section with water and test with at least a 3 m (10 foot) head of water. In testing successive sections, test at least upper 3 m (10 feet) of next preceding section so that each joint or pipe except upper most 3 m (10 feet) of system has been submitted to a test of at least a 3 m (10 foot) head of water. Water shall be kept in the system, or in portion under test, for at least 15 minutes before inspection starts. System shall then be tight at all joints.
2. For an air test, an air pressure of 34 kPa (5 psig) gage shall be maintained for at least 15 minutes without leakage. A force pump and mercury column gage shall be used for the test.
3. Final Tests: While either one of the following tests may be used, Contractor shall check with VA as to which test will be performed.
  - a. Smoke Test: After fixtures are permanently connected and traps are filled with water, fill entire drainage and vent systems with smoke under pressure of 0.25 kPa (1 inch of water) with a smoke machine. **Chemical smoke is prohibited.**
  - b. Peppermint Test: Introduce .06 liters (2 ounces) of peppermint into each line or stack.
- C. COR shall witness all tests. Contractor shall coordinate schedules with the COR and CxA. Contractor shall provide a minimum of 10 working days prior to flushing, disinfection/sterilization, startup, and testing.

### **3.7 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

### **3.8 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative to instruct VA Personnel in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

- - - E N D - - -



**SECTION 22 35 00**  
**DOMESTIC WATER HEAT EXCHANGERS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section describes the requirements for domestic hot water heat exchangers including thermometers and all necessary accessories, connections and equipment.
- B. Application is for indirect water heating utilizing steam or hot water as a medium, and can be used for heat recovery or solar systems for pre-heating water prior to primary water heating equipment.
- C. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 11, SUSTAINABLE DESIGN REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete and Grout.
- F. Section 09 91 00, PAINTING: Preparation and finish painting.
- G. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENT FOR NON STRUCTURAL COMPONENTS: Seismic Restraint for Equipment.
- H. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- I. Section 22 05 19, METERS AND GAGES FOR PLUMBING PIPING.
- J. Section 22 05 23, GENERAL-DUTY VALVES FOR PLUMBING PIPING.
- K. Section 22 07 11, PLUMBING INSULATION.
- L. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- M. Section 22 11 00, FACILITY WATER DISTRIBUTION: Piping, Fittings, Valves and Gages.
- N. Section 22 11 23, DOMESTIC WATER PUMPS: Circulating Pump.
- O. Section 23 56 00, SOLAR ENERGY HEATING SYSTEM.

**1.3 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 for Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
  - 90.1 (2013) .....Energy Standard for Buildings Except Low-Rise Residential Buildings
- C. American National Standard Institute (ANSI):
  - Z21.22B-2001 (R2008) ...Relief Valves for Hot Water Supply Systems
- D. American Society of Mechanical Engineers (ASME):
  - ASME Boiler and Pressure Vessel Code -
    - BPVC Section IV-2013 ...Rules for Construction of Heating Boilers
    - BPVC Section VIII-1-2013 Rules for Construction of Pressure Vessels, Division 1
      - Form U-1 .....Manufacturer's Data Report for Pressure Vessels
      - B1.20.1-2013 .....Pipe Threads, General Purpose (Inch)
      - B16.5-2013 .....Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard
      - B16.24-2011 .....Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500
      - PTC 25.3-02 .....Pressure Relief Devices
- E. National Fire Protection Association (NFPA):
  - 70-2011 .....National Electrical Code (NEC)
- F. NSF International (NSF):
  - 61-2012 .....Drinking Water System Components - Health Effects
  - 372-2011 .....Drinking Water System Components - Lead Content
- G. Underwriter Laboratories (UL):
  - 207-2013 .....Standard for Refrigerant-Containing Components and Accessories, Nonelectrical
  - 778-2002 .....Standard for Motor-Operated Water Pumps

**1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 35 00, DOMESTIC WATER HEAT EXCHANGERS", with applicable paragraph identification.

- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
1. Heat Exchangers.
  2. Heat Reclaimers.
  3. Pressure and Temperature Relief Valves.
  4. Steam Control Valves.
  5. Heating Hot Water Control Valves.
  6. Thermometers.
  7. Pressure Gages.
  8. Vacuum Breakers.
  9. Safety Valves.
  10. Expansion Tanks.
  11. Heat Traps.
- D. A form U-1 or other documentation stating compliance with the ASME Boiler and Pressure Vessel Code.
- E. Shop drawings shall include wiring diagrams for power, signal and control functions.
- F. Seismic qualification certificates shall be submitted that details equipment anchorage components identifies equipment center of gravity with mounting and anchorage provisions, and whether the seismic qualification certificate is based on an actual test or calculations.
- G. Submit documentation indicating compliance with applicable requirements of ASHRAE 90.1, Unfired Storage Tanks, for Service Water Heating.
- H. Complete operating and maintenance manuals including wiring diagrams, technical data sheets and information for ordering replaceable parts:
1. Include complete list indicating all components of the systems.
  2. Include complete diagrams of the internal wiring for each item of equipment.
  3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- I. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

- J. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

#### **1.5 QUALITY ASSURANCE**

- A. Equipment components in contact with potable water shall meet compliance requirements in documents NSF 61 and NSF 372.
- B. Comply with American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1 for efficiency performance.
- C. The domestic water heat exchanger shall conform to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENT FOR NON STRUCTURAL COMPONENTS on seismic restraint requirements, withstanding Seismic movement without separation of any parts from the equipment when subjected to a seismic event.
- D. The heat exchanger shall be certified and labeled by an independent testing agency.
- E. Circulating pump shall be installed per NFPA 70.
- F. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopREFERRED.gov>.

#### **1.6 AS-BUILT DOCUMENTATION**

- A. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.

- B. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them on Auto-Cad version //\_\_\_\_// provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.

**PART 2 - PRODUCTS**

**2.1 SHELL AND TUBE, DOMESTIC WATER HEAT EXCHANGERS**

- A. The shell and tube heat exchangers shall be double wall semi-instantaneous type, vertical with water in the shell and steam in the tubes. Heat exchanger shall be of counter-flow design. The shell and tube heat exchanger shall be a packaged assembly of tank, heat exchanger coils, control valves, controls, and specialties constructed of ASME code cupro-nickel shell with 1035 kPa (150 psig) minimum working pressure. Heat exchanger shall comply with NSF 61 and NSF 372 for barrier materials for potable-water tank linings. Provide with access for cleaning and disinfection. Heat exchanger capacities are scheduled on the drawings.
- B. The stand or skid shall be factory fabricated for floor mounting.
- C. The tappings (openings) shall be factory fabricated of materials compatible with the tank and in accordance with appropriate ASME standards for piping connections, pressure and temperature relief valve, pressure gauge, thermometer, drain valve, anode rods and controls. The openings shall be in accordance with ASME standards listed below:
1. 50 mm or DN50 (2 inch) and smaller: Threaded ends according to ASME B1.20.1.
  2. 65 mm or DN65 (2-1/2 inch) and larger: Flanged ends according to ASME B16.5 for steel and stainless steel flanges, and according to ASME B16.24.
- D. Shell insulation shall comply with ASHRAE 90.1 and suitable for operating temperature. The entire shell and nozzles shall be completely surrounded except connections, gages and controls.
- E. The heat exchanger coils shall be constructed from copper copper alloy and fabricated in a helix wound or straight tube configuration for

steam heating medium. The pressure rating shall be equal to or greater than the steamsupply pressure plus 50 percent.

- F. The temperature controls shall be designed for an output temperature of 60 degrees C (140 degrees F) based upon an adjustable temperature transmitter that operates a control valve and is capable of maintaining outlet water temperature within 2 degrees C (4 degrees F) of setting. Heaters shall be capable of raising the discharge temperature to 77-82 degrees C (170-180 degrees F) for thermal eradication.
1. Steam control valve if required shall regulate the control of steam flow to control water temperature and shall be electronically operated. The outlet water temperature shall not vary more than  $\pm 1$  degrees C ( $\pm 2.5$  degrees F).
  2. A drip trap, steam condensate trap (if required), Y strainer, vacuum breaker, and pressure gage shall be factory sized and piped with steam control valve.
  4. A normally closed solenoid valve shall be rated at 5 amps, 120-volt. Solenoid valve shall close the steamsupply to the heating coil, should the water temperature in the tank reach the high set point.
- G. Safety control shall be automatic, high temperature limit shutoff device.
- H. The relief valves shall be ASME rated and stamped for combination temperature and pressure relief valves.
- //I. The pressure storage vessel shall be all welded construction and ASME BPVC Section VIII-1 stamped for a working pressure of 1035 kPa (150 psig). The shell of the exchanger shall cupro-nickel. Lining shall meet NSF 61 and NSF 372 requirements. The storage vessel shall be provided with a fiberglass insulation system in compliance with ASHRAE 90.1, with jacket, and a magnesium anode. Provide with access for cleaning and disinfection.

## **2.5 THERMOMETERS**

- A. Thermometers shall be rigid stem or remote sensing, scale or dial type with an aluminum, black metal, stainless steel, or chromium plated brass case. The thermometer shall be back connected, red liquid (alcohol or organic-based) fill, vapor, bi-metal or gas actuated, with 225 mm (9 inches) high scale dial or circular dial 50 to 125 mm (2 to 5 inches) in diameter graduated from 4 to 100 degrees C (40 to 210

degrees F), with two-degree graduations guaranteed accurate within one scale division. The socket shall be separable, double-seat, micrometer-fittings, with extension neck not less than 65 mm (2 1/2 inches) to clear tank or pipe covering. The thermometer shall be suitable for 20 mm (3/4 inch) pipe threads. Thermometers may be console-mounted with sensor installed in separate thermometer well.

#### **2.6 SAFETY VALVES FOR SHELL AND COIL HEATERS**

- A. Separate combination pressure/temperature relief valves shall be provided on each water heater.
- B. A double solenoid safety system shall be provided for each shell and coil heater to function as a safety over temperature prevention system. System shall consist of aquastat, pilot light, solenoid safety valve and solenoid water safety valve located in the control circuit. The aquastat shall be set at 60 degrees C (140 degrees F).

#### **2.7 DOMESTIC HOT WATER EXPANSION TANKS**

- A. A steel pressure rated tank constructed with welded joints and factory installed butyl rubber diaphragm shall be installed as scheduled. The air precharge shall be set to minimum system operating pressure at tank.
- B. The tappings shall be factory fabricated steel, welded to the tank and include ASME B1.20.1 pipe thread.
- C. The interior finish shall comply with NSF 61 and NSF 372 for barrier materials for potable water tank linings and the liner shall extend into and through the tank fittings and outlets.
- D. The air charging valve shall be factory installed.

#### **2.8 HEAT TRAPS**

- A. Heat traps shall be installed in accordance with ASHRAE 90.1 unless provided integrally with the heaters.

#### **2.9 COMBINATION TEMPERATURE AND PRESSURE RELIEF VALVES**

- A. The combination pressure and temperature relief Valve shall be ANSI Z21.22 and ASME rated and constructed of all brass or bronze with a self-closing reseating valve. The relief valves shall include a relieving capacity greater than the heat input and include a pressure setting less than the water heater's working pressure rating. Sensing element shall extend into storage tank.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. The water heaters shall be installed on concrete bases. Refer to Specification Section 03 30 00, CAST-IN-PLACE CONCRETE and Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- B. The water heaters shall be installed level and plumb and securely anchored.
- C. Water heaters shall be installed and connected in accordance with manufacturer's written instructions with manufacturer's recommended clearances.
- D. All pressure and temperature relief valves discharge shall be piped to nearby floor drains with air gap or break.
- E. Thermometers and isolation valves shall be installed on water heater inlet and outlet piping and shall be positioned such that they can be read by an operator or staff standing on floor or walkway.
- F. The thermostatic control shall be set for a minimum setting of 60 degrees C (140 degrees F) for storage heaters and regulated to a maximum discharge temperature of 54 degrees C (130 degrees F) for distribution to personnel.
- G. Shutoff valves shall be installed on the domestic water supply piping to the water heater and on the domestic hot water outlet piping.
- H. All manufacturer's required clearances shall be maintained.
- //I. The domestic water heaters shall be installed with seismic restraint devices.//
- J. A combination temperature and pressure relief valve shall be installed at the top portion of the storage tank. The sensing element shall extend into the tank. The relief valve outlet drain piping shall discharge by positive air gap into a floor drain.
- K. Piping type heat traps shall be installed on the inlet and outlet piping of the domestic water heater storage tanks, unless provided integrally with the tanks.
- L. Water heater drain piping shall be installed as indirect waste to spill by positive air gap into open drains or over floor drains. Hose end drain valves shall be installed at low points in water piping for gas fueled domestic hot water heaters without integral drains.
- M. Dielectric unions shall be provided if there are dissimilar metals between the water heater connections and the attached piping.



- N. Provide vacuum breakers per ANSI Z21.22 on the inlet pipe if the water heater is bottom fed.
- O. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no cost to the Government.

### **3.2 LEAKAGE TEST**

- A. Before piping connections are made, the water heaters shall be tested at a hydrostatic pressure of 1380 kPa (200 psig) for water heaters rated at less than 1103 kPa (160 psig) and 1654 kPa (240 psig) for units with an maximum working pressure of 1103 kPa (160 psig) or over. Any failed test shall be corrected and the water heater shall be replaced with a new unit at no additional cost to the VA.

### **3.3 PERFORMANCE TEST**

- A. Ensure that all of the remote water outlets will have a minimum of 43 degrees C (110 degrees F) and a maximum of 49 degrees C (120 degrees F) water flow at all times. If necessary, make all correction to balance the return water system or reset the thermostat to make the system comply with design requirements.

### **3.4 STARTUP AND TESTING**

- A. As recommended by product manufacturer and listed standards and under actual or simulated operating conditions, tests shall be conducted to prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with each integrated system.
- B. The tests shall include system capacity, control function, and alarm functions.
- C. When any defects are detected, correct defects and repeat test at no additional costs to the Government.
- //D. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Contracting Officer's Representative and Commissioning Agent. Provide a minimum of 7 days prior to notice.//

### **3.5 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.//

**3.6 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative to instruct VA Personnel in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

- - - E N D - - -

**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.
- B. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 07 92 00, JOINT SEALANTS: Sealing between fixtures and other finish surfaces.
- F. Section 08 31 13, ACCESS DOORS AND FRAMES: Flush panel access doors.
- G. Section 10 21 13, TOILET COMPARTMENTS: Through bolts.
- H. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- I. Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS: Requirements for commissioning, systems readiness checklist, and training.
- J. 22 13 00, FACILITY SANITARY AND VENT PIPING.

**1.3 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-1997 (R2012) .Supports for Off-the-Floor Plumbing Fixtures for Public Use
  - A112.19.1-2013 .....Enameled Cast Iron and Enameled Steel Plumbing Fixtures
  - A112.19.2-2013 .....Ceramic Plumbing Fixtures
  - A112.19.3-2008 .....Stainless Steel Plumbing Fixtures
- C. American Society for Testing and Materials (ASTM):
  - A276-2013a .....Standard Specification for Stainless Steel Bars and Shapes

B584-2008 .....Standard Specification for Copper Alloy Sand  
Castings for General Applications

D. CSA Group:

B45.4-2008 (R2013) .....Stainless Steel Plumbing Fixtures

E. National Association of Architectural Metal Manufacturers (NAAMM):

AMP 500-2006 .....Metal Finishes Manual

F. American Society of Sanitary Engineering (ASSE):

1016-2011 .....Automatic Compensating Valves for Individual  
Showers and Tub/Shower Combinations

G. NSF International (NSF):

14-2013 .....Plastics Piping System Components and Related  
Materials

61-2013 .....Drinking Water System Components - Health  
Effects

372-2011 .....Drinking Water System Components - Lead Content

H. American with Disabilities Act (A.D.A)

I. International Code Council (ICC):

IPC-2015 .....International Plumbing Code

**1.4 SUBMITTALS**

A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 40 00, PLUMBING FIXTURES", with applicable paragraph identification.

C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, connections, and capacity.

D. Operating Instructions: Comply with requirements in Section 01 00 00, GENERAL REQUIREMENTS.

E. Completed System Readiness Checklist provided by the CxA and completed by the Contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

- F. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

#### **1.5 QUALITY ASSURANCE**

- A. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

#### **1.6 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be // in electronic version on compact disc or DVD // inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in AutoCAD version // \_\_\_\_// provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation

shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Material or equipment containing a weighted average of greater than 0.25 percent lead is prohibited in any potable water system intended for human consumption, and shall be certified in accordance with NSF 61 or NSF 372. Endpoint devices used to dispense water for drinking shall meet the requirements of NSF 61.
- B. Plastic pipe, fittings, and solvent cement shall meet NSF 14 and shall be NSF listed for the service intended.

### **2.2 STAINLESS STEEL**

- A. Corrosion-resistant Steel (CRS):
  - 1. Plate, Sheet and Strip: CRS flat products shall conform to chemical composition requirements of any 300 series steel specified in ASTM A276.
  - 2. Finish: Exposed surfaces shall have standard polish (ground and polished) equal to NAAMM finish Number 4.
- B. Die-cast zinc alloy products are prohibited.

### **2.3 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 solid-surface, wood and metal casework, laboratory furniture and pharmacy furniture. Locate stops centrally above or below fixture in accessible location.
- B. Furnish keys for lock shield stops to the COR.
- C. Supply from stops not integral with faucet shall be chrome plated copper flexible tubing or flexible stainless steel with inner core of non-toxic polymer.
- D. Supply pipe from wall to valve stop shall be rigid threaded IPS copper alloy pipe, i.e. red brass pipe nipple, chrome plated where exposed.
- E. Mental Health Area: Provide stainless steel drain guard for all lavatories not installed in casework.

#### 2.4 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.

#### 2.5 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. **Aerators are prohibited.**
- B. Flow Control Restrictor:
  - 1. Capable of restricting flow from 32 ml/s to 95 ml/s (0.5 gpm to 1.5 gpm) for lavatories; 125 ml/s to 140 ml/s (2.0 gpm to 2.2 gpm) for sinks P-505 through P-520, P-524 and P-528; and 174 ml/s to 190 ml/s (2.75 gpm to 3.0 gpm) for dietary food preparation and rinse sinks or as specified.
  - 2. Compensates for pressure fluctuation maintaining flow rate specified above within 10 percent between 170 kPa and 550 kPa (25 psig and 80 psig).
  - 3. Operates by expansion and contraction, eliminates mineral/sediment build-up with self-cleaning action, and is capable of easy manual cleaning.

#### 2.6 CARRIERS

- A. 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. ASME A112.6.1M, lavatory, // chair carrier for thin wall construction // concealed arm support // //steel plate as detailed on drawing //. All lavatory chair carriers shall be capable of supporting the lavatory with a 250-pound vertical load applied at the front of the fixture.
- 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.

## 2.7 WATER CLOSETS

- A. (P-101) Water Closet (Floor Mounted, ASME A112.19.2, Figure 6)-office and industrial, elongated bowl, siphon jet 4.8 L (1.28 gallons) per flush, floor outlet. Top of seat shall be 435 mm to 438 mm (17-1/8 inches to 17-1/4 inches) above finished floor.
1. Seat: Institutional/Industrial, extra heavy duty, chemical resistant, solid plastic, open front less cover for elongated bowls, integrally molded bumpers, concealed check hinge with stainless steel post. Seat shall be posture contoured body design. Color shall be white.
  2. Fittings and Accessories: Floor flange fittings-cast iron; Gasket-wax; bolts with chromium plated cap nuts and washers.
  3. Flush valve: Large chloramines resistant diaphragm, semi-red brass valve body, exposed chrome plated, non-hold open ADA approved side oscillating handle water saver design per flush with maximum 10 percent variance, top spud connection, adjustable tailpiece, one-inch IPS screwdriver back check angle stop with vandal resistant cap, high back pressure vacuum breaker, solid-ring pipe support, and sweat solder adapter with cover tube and cast set screw wall flange. Set centerline of inlet 292 mm (11-1/2 inches) above seat. Seat bumpers shall be integral part of flush valve. Valve body, cover, tailpiece and control stop shall be in conformance with ASTM B584 Alloy classification for semi-red brass.
- B. (P-114) Bariatric Floor Mounted Water Closet ASME A112.19.2, Fully enclosed floor mounted with integral seat , siphon jet, white-powder-coated, 14 gage type 304 stainless steel construction with white powder coating and hinged seat with cover, flush valve operated, top of seat 450 mm (18 inches) above floor. Bio-based materials shall be utilized when possible. Rated for bariatric use - 1000 pound minimum capacity.
1. Fittings and Accessories: Gaskets-neoprene, bolts with chromium plated cap nuts and washers, and extra heavy-duty carrier.
  2. Flush Valve: exposed chrome plated diaphragm type with low force ADA compliant 4.8 L (1.28 gallon) per flush, seat bumper, integral screwdriver stop and vacuum breaker, solid-ring pipe support, and escutcheon.



## **2.9 BATHTUBS**

- A. (P-301) Bathtub, free standing type hydro massage bathtub with wall mounted mixing valve, fill control valve and drain shall be furnished by the Owner.
  - 1. Provide rough-in and final waste and water connections including installation of accessories supplied with the fixture.
  - 2. Prior to starting work, obtain from the Owner, the manufacturers' written installation instruction for the bathtub being installed.

## **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 0.25 percent lead content by dry weight. Faucet flow rates shall be 3.9 L/m (1.5 gpm) for private lavatories and either 1.9 L/m (0.5 gpm) or 1.0 liter (0.25 gallons) per cycle for public lavatories.
- C. (P-418) Lavatory (Sensor Control, Gooseneck Spout, ASME A112.19.2) straight back, approximately 508 mm by 457 mm (20 inches by 18 inches) and a 102 mm (4 inches) minimum apron, first quality vitreous china with punching for gooseneck spout. Set rim 864 mm (34 inches) above finished floor.
  - 1. Faucet: Solid cast brass construction, chrome plated, gooseneck spout with outlet 102 mm to 127 mm (4 inches to 5 inches) above rim. Electronic sensor operated, 102 mm (4 inches) center set mounting, battery operated electronic module. Provide laminar flow control device. Breaking the light beam shall activate the water flow. Flow shall stop when user moves away from light beam.
  - 2. Drain: Cast or wrought brass with flat grid strainer with offset tailpiece, brass, chrome plated.
  - 3. Stops: Angle type. See paragraph "Stops".
  - 4. Trap: Cast copper alloy, 38 mm by 32 mm (1 1/2 inches by 1 1/4 inches) P-trap. Adjustable with connected elbow and 17 gage tubing extension to wall. Exposed metal trap surface and connection hardware shall be chrome plated with a smooth bright finish. Set trap parallel to wall.
  - 5. Provide cover for exposed piping, drain, stops and trap per A.D.A.

## 2.11 SINKS AND LAUNDRY TUBS

- A. Dimensions for sinks and laundry tubs are specified, length by width (distance from wall) and depth.
- B. (P-502) Service Sink (Corner, Floor Mounted) stain resistant terrazzo, 711 mm by 711 mm by 305 mm (28 inches by 28 inches by 12 inches) with 152 mm (6 inches) drop front. Terrazzo, composed of marble chips and white Portland cement, shall develop compressive strength of 20684 kPa (3000 psig) seven days after casting. Provide extruded aluminum cap on front side.
  - 1. Faucet: Solid brass construction, 9.5 L/m (2.5 gpm) combination faucet with replaceable Monel seat, removable replacement unit containing all parts subject to wear, integral check/stops, mounted on wall above sink. Spout shall have a pail hook, 19 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. Provide 914 mm (36 inches) hose with wall hook. Centerline of rough in is 1219 mm (48 inches) above finished floor.
  - 2. Drain: 76 millimeter (3 inches) cast brass drain with nickel bronze strainer.
  - 3. Trap: P-trap, drain through floor.
- D. (P-524) Sink, (CRS, Double Compartment, Counter Top, ASME A112.19.3, Kitchen Sinks) self-rimming, approximately 838 mm by 559 mm (33 inches by 22 inches) with two compartments inside dimensions approximately 343 mm by 406 mm by 191 mm (13 1/2 inches by 16 inches by 7 1/2 inches), minimum 20 gage CRS. Corners and edges shall be well rounded.
  - 1. Faucet: Kitchen sink, solid brass construction, 8.3 L/m (2.2 gpm) swing spout, chrome plated copper alloy with spray and hose.
  - 2. Drain: Drain plug with cup strainer, stainless steel.
  - 3. Trap: Cast copper alloy, 38 mm (1 1/2 inches) P-trap with cleanout plug, continuous drain with wall connection and escutcheon.
  - 4. Provide cover for exposed piping, drain, stops and trap per A.D.A.
- E. (P-528) Sink (CRS, Single Compartment, Counter Top ASME A112.19.2, Kitchen Sinks) self-rimming, back faucet ledge, approximately 533 mm by

559 mm (21 inches by 22 inches) with single compartment inside dimensions approximately 406 mm by 483 mm by 191 mm (16 inches by 19 inches by 7 1/2 inches) deep. Shall be minimum of 1.3 mm thick (18 gauge) CRS. Corners and edges shall be well rounded:

1. Faucet: Solid brass construction, 8.3 L/m (2.2 gpm) deck mounted combination faucet with Monel or ceramic seats, removable replacement unit containing all parts subject to ware, swivel gooseneck spout with approximately 203 mm (8 inches) reach with spout outlet 102 mm (4 inches) wrist blades .
2. Drain: Drain plug with cup strainer, stainless steel.
3. Trap: Cast copper alloy 38 mm (1 1/2 inches) P-trap with cleanout plug. Provide wall connection and escutcheon.
4. Provide cover for exposed piping, drain, stops and trap per A.D.A.

#### **2.12 DISPENSER, DRINKING WATER**

- A. Standard rating conditions: 10 degrees C (50 degrees F) water with 27 degrees C (80 degrees F) inlet water temperature and 32 degrees C (90 degrees F) ambient air temperature.
- B. (P-608) Electric Water Cooler (Mechanically Cooled, Wall Hung, Wheelchair, with Glass Filler) bubbler style, air cooled compressor, 15 ml/s (15 gph) minimum capacity, lead free. Top shall be one piece type 304 CRS anti-splash design. Cabinet, CRS satin finish, approximately 457 mm by 457 mm by 635 mm (18 inches by 18 inches by 25 inches) high with mounting plate. Unit shall be push bar operated with front and side bars, automatic stream regulator, and heavy chrome plated brass push down glass filler with adjustable flow control, and all trim chrome plated. Set bubbler 914 mm (36 inches) above finished floor. Provide with bottle filler option.

#### **2.13 SHOWER BATH FIXTURE**

- A. (P-701) Shower Bath Fixture (Detachable, Wall Mounted, Concealed Supplies, Type T/P Combination Valve):
  1. Shower Installation: Wall mounted detachable spray assembly, 600 mm (24 inch) wall bar, elevated vacuum breaker, supply elbow and flange and valve. All external trim, chrome plated metal.
  2. Shower Head Assembly: Metallic shower head with flow control to limit discharge to 5.7 l/m (1.5 gpm), 1524 mm (60 inches) length of rubber lined CRS, chrome plated metal flexible, or white vinyl reinforced hose and supply wall elbow. Design showerhead to fit in

- palm of hand. Provide CRS or chrome plated metal wall bar with an adjustable swivel hanger for showerhead. Fasten wall bar securely to wall for hand support.
3. Valves: Type T/P combination thermostatic and pressure balancing, with chrome plated metal lever type operating handle adjustable for rough-in variations and chrome plated metal or CRS face plate. Valve body shall be any suitable copper alloy. Internal parts shall be copper, nickel alloy, CRS or thermoplastic material. Valve inlet and outlet shall be 13 mm (1/2 inch) IPS. Provide external screwdriver check stops, vacuum breaker and temperature limit stops. Set stops for a maximum temperature of 50 degrees C (122 degrees F). All exposed fasteners shall be vandal resistant. Valve shall provide a minimum of 5.7 l/m (1.5 gpm) at 310 kPa (45 psig) pressure drop.

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

- B. (P-804) Hose Bibb (Single Faucet, Wall Mounted to Exposed Supply Pipe): Cast or wrought copper alloy, single faucet with replaceable Monel seat, removable replacement unit containing all parts subject to wear, mounted on wall 914 mm (36 inches) above floor to concealed supply pipe. Provide faucet with 19 mm (3/4 inch) hose coupling thread on spout and vacuum breaker. Four-arm handle on faucet 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 bright finish.
- C. (P-808) Washing Machine Supply and Drain Units: Fabricate of 16-gage steel with highly corrosion resistant epoxy finish. Unit to have 51 mm (2 inches) drain connection, 13 mm (1/2 inch) combination MPT brass sweat connection, ball type shut-off valve, 51 mm (2 inches) cast brass P-trap. Size 229 mm by 375 mm (9 inches by 14 3/4 inches) rough wall opening 203 mm by 330 mm by 92 mm (8 inches by 13 inches by 3 5/8 inches). Centerline of box shall be 1118 mm (44 inches) above finished floor.
- H. (P-812) Water Supply Box Units: Fabricate of 16-gage steel with highly corrosion resistant epoxy finish. Unit to have 13 mm (1/2 inch) combination MPT brass sweat connection, ball type shut-off valve. Size 229 mm by 298 mm (9 inches by 11 3/4 inches) rough wall opening 203 mm by 254 mm by 92 mm (8 inches by 10 inches by 3 5/8 inches). Bottom of box shall be 457 mm (18 inches) above finished floor.

K. (P-815) Roof Hydrant: Non-freeze, pedestal type hydrant with cast aluminum weather resistant dome control handle, 304 stainless steel shroud with welded stainless steel flange, 125 lb. 1" bronze globe angle valve with male hose fitting, quick disconnect with built in vacuum breaker, stainless steel reservoir. Insulation R-8, cellular foam insulation, under-deck support flange with hardware. Provide integral vacuum breaker which automatically drains when shut below roof deck to reservoir.

### **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. Bio-based materials shall be utilized when possible.
- 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 76 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 32 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. Aerators are prohibited on lavatories and sinks.
- J. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no cost or additional time to the Government.

**3.2 CLEANING**

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

**3.3 WATERLESS URINAL**

- A. Manufacturer shall provide an operating manual and onsite training for the proper care and maintenance of the urinals.

**3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

**3.5 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative to instruct VA Personnel in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

- - - E N D - - -

**SECTION 22 63 00**  
**GAS SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Central Laboratory and Healthcare Gas Systems: Consisting of oxygen complete, ready for operation, including all necessary piping, fittings, valves, cabinets, station outlets, rough-ins, ceiling services, gages, alarms including low voltage wiring, cylinder manifolds, pressure regulators, dew point monitor, carbon monoxide monitor and all necessary parts, accessories, connections and equipment. Match existing station outlet and inlet terminal connections.
- B. Oxygen System: Ready for connection to existing outside bulk supply tank, but not including tank.
- C. Laboratory and healthcare gas system alarm wiring from equipment to alarm panels.
- D. A complete listing of all acronyms and abbreviations are included in Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 07 84 00, FIRESTOPPING: Sealing around pipe penetrations to maintain the integrity of time rated construction.
- F. Section 07 92 00, JOINT SEALANTS: Sealing around pipe penetrations through the floor to prevent moisture migration.
- G. Section 10 25 13, PATIENT BED SERVICE WALLS: Prefabricated bedside patient units (PBPU).
- H. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic Restraint.
- I. Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING: General requirements and items common to more than one section of Division 22.
- J. Section 22 05 12, GENERAL MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT: Electric motors.

- K. SECTION 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS: Requirements for commissioning, systems readiness checklist, and training.
- L. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Alarm interface with BAS.
- M. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Control wiring.
- N. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduit.
- O. Section 26 27 26, WIRING DEVICES: Electrical wiring and accessories.
- P. Section 26 29 11, MOTOR CONTROLLERS: Motor starters.

**1.3 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 Mechanical Engineers (ASME):
  - A13.1-2007 (R2013) .....Scheme for the Identification of Piping Systems
  - B16.15-2013 .....Cast Copper Alloy Threaded Fittings: Classes 125 and 250
  - B16.22-2013 .....Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
  - B16.50-2013 .....Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings
  - B40.100-2013 .....Pressure Gauges and Gauge Attachments
  - ASME Boiler and Pressure Vessel Code -
  - BPVC Section VIII-2015 .Rules for Construction of Pressure Vessels, Division I
  - BPVC Section IX-2015 ...Welding, Brazing, and Fusing Qualifications
- C. American Society of Sanitary Engineers (ASSE):
  - 6000 Series-2012 .....Professional Qualifications Standard for Medical Gas Systems Personnel
- D. American Society for Testing and Materials (ASTM):
  - B43-2014 .....Standard Specification for Seamless Red Brass Pipe, Standard Sizes
  - B687-1999 (2011) .....Standard Specification for Brass, Copper, and Chromium-Plated Pipe Nipples
  - B819-2000 (R2011) .....Standard Specification for Seamless Copper Tube for Medical Gas Systems



- D1785-2012 .....Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- E. American Welding Society (AWS):
- A5.8M/A5.8-2011 .....Specification for Filler Metals for Brazing and Braze Welding
- B2.2/B2.2M-2010 .....Specification for Brazing Procedure and Performance Qualification
- F. Compressed Gas Association (CGA):
- C-9-2013 .....Standard Color Marking of Compressed Gas Containers for Medical Use
- G-4.1-2009 .....Cleaning Equipment for Oxygen Service
- G-10.1-2008 .....Commodity Specification for Nitrogen
- P-9-2008 .....The Inert Gases: Argon, Nitrogen, and Helium
- V-1-2013 .....Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections
- G. Manufacturing Standardization Society (MSS):
- SP-72-2010a .....Ball Valves With Flanged or Butt-Welding Ends For General Service
- SP-110-2010 .....Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends
- H. National Electrical Manufacturers Association (NEMA):
- ICS 6-1993 (R2001, R2006) Industrial Control and Systems Enclosures
- I. National Fire Protection Association (NFPA):
- 99-2015 .....Health Care Facilities Code

#### 1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 22 63 00, GAS SYSTEMS FOR LABORATORY AND HEALTHCARE FACILITIES", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
1. Piping.

2. Valves.
  3. Inlet and outlet cocks
  4. Valve cabinets.
  5. Gages.
  6. Station outlets and rough-in assemblies.
  7. Ceiling services.
  8. Alarm controls and panels.
  9. Pressure Switches.
  10. Manifolds.
- D. Station Outlets: Submit letter from manufacturer stating that outlets are designed and manufactured to comply with NFPA 99. Outlet shall bear label of approval as an assembly, of Underwriters Laboratories, Inc., or Associated Factory Mutual Research Corporation.
- E. Certification: The completed systems have been installed, tested, purged, analyzed and verified in accordance with the requirements of this specification. Certification shall be submitted to COR.
- F. Completed System Readiness Checklist provided by the CxA and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- G. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

#### **1.5 QUALITY ASSURANCE**

- A. Materials and Installation: In accordance with NFPA 99 and as specified.
- B. Equipment Installer: Show technical qualifications and previous experience in installing laboratory and healthcare equipment on three similar projects. Submit names, phone numbers, and addresses of referenced projects. Installers shall meet the qualifications of ASSE Standard Series 6000.
- C. Equipment Supplier: Provide evidence of equivalent product installed at three installations similar to this project that has been in satisfactory and efficient operation for three years. Submit names, phone numbers, and addresses where the product is installed.

- D. Laboratory and healthcare System Testing Organization: The testing shall be conducted by a party technically competent and experienced in the field of laboratory and healthcare pipeline testing. Testing and systems verification shall be performed by personnel meeting the qualifications of ASSE Standard Series 6000. Such testing shall be performed by a party other than the installing contractor.
- E. Provide the names of three projects where testing of medical or laboratory gases systems has been performed by the testing agency. Include the name of the project, names of such persons at that project who supervised the work for the project owner, or who accepted the report for the project owner, and a written statement that the projects listed required work of similar scope to that set forth in this specification.
- F. Submit the testing agency's detailed procedure which shall be followed in the testing of this project. Include details of the testing sequence, procedures for cross connection tests, outlet function tests, alarm tests, purity tests, etc., as required by this specification. For purity test procedures, include data on test methods, types of equipment to be used, calibration sources and method references.
- G. Certification: Provide COR documentation 10 working days prior to submitting request for final inspection to include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits allowed by this specification.
- H. "Hot taps" are prohibited for operating medical oxygen systems. Methods for connection and extension of active and pressurized medical gas systems without subsequent medical gas testing and verification are prohibited.
- I. Bio-Based Materials: For products designated by the USDA's Bio-Preferred Program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specifications section. For more information regarding the product categories covered by the Bio-Preferred Program, visit <http://www.biopreferred.gov>.

## **1.6 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be in electronic version on compact disc or DVD inserted into a three ring binder. All aspects of system operation and maintenance procedures, including piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices such as damper and door closure interlocks shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version 2017 provided on compact disk or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

## **PART 2 - PRODUCTS**

### **2.1 PIPING AND FITTINGS**

- A. Copper Tubing: Type "K", ASTM B819, seamless copper tube, hard drawn temper, with wrought copper fittings conforming to ASME B16.22 or brazing fittings complying with ASME B16.50. Size designated reflecting

nominal inside diameter. All tubing and fittings shall be labeled "ACR/OXY", "OXY", "OXY/MED", "ACR/MED", or "MED".

- B. Brazing Alloy: AWS A5.8M/A5.8, Classification BCuP, greater than 538 degrees C (1000 degrees F) melting temperature. Flux is strictly prohibited for copper-to-copper connections.
- C. Threaded Joints: Polytetrafluoroethylene (Teflon) tape.
- D. Underground Protective Pipe: Polyvinyl Chloride (PVC), ASTM D1785, Schedule 80.
- E. Memory metal couplings: Temperature and pressure rating shall not be less than that of a brazed joint in accordance with NFPA 99, paragraph 5.1.10.6.1.
- F. Apply piping identification labels at the time of installation in accordance with NFPA 99. Apply supplementary color identification in accordance with CGA Pamphlet C-9.
- G. Special Fittings: The following special fittings shall be permitted to be used in lieu of brazed joints:
  - 1. Memory-metal couplings having temperature and pressure ratings joints not less than that of a brazed joint.
  - 2. Listed or approved metallic gas tube fittings that, when made up, provide a permanent joint having the mechanical, thermal, and sealing integrity of a brazed joint.
  - 3. Dielectric fittings where required by the manufacturer of special medical equipment to electrically isolate the equipment from the piping distribution system.
  - 4. Axially swaged, elastic strain preload fittings providing metal to metal seal having pressure and temperature ratings not less than that of a brazed joint and when complete are permanent and non-separable.

## **2.2 EXPOSED LABORATORY AND HEALTHCARE GASES PIPING**

- A. Finished Room: Use iron pipe size (IPS) chrome plated brass or stainless steel piping for exposed laboratory and healthcare gas piping connecting fixtures, casework, cabinets, equipment and reagent racks when not concealed by apron including those furnished by the Government or specified in other sections.
  - 1. Pipe: ASTM B43, standard weight.
  - 2. Fittings: Fittings shall comply with ASME B16.15 cast bronze threaded fittings with chrome finish (125 and 250 psig Classes).

3. Nipples: Nipples shall comply with ASTM B687, chromium-plated.
4. Unions: Unions shall comply with MSS SP-72, MSS SP-110, brass or bronze with chrome finish. Unions 65 mm (2-1/2 inches) and greater shall be flange type with approved gaskets.
5. Valves: Valves shall comply with MSS SP-72, MSS SP-110, brass or bronze with chrome finish.

### **2.3 VALVES**

- A. Ball: In-line, other than zone valves in cabinets:
  1. 75 mm (3 inches) and smaller: Bronze/ brass body, MSS SP-72, MSS SP-110, Type II, Class 150, Style 1, with tubing extensions for brazed connections, full port, three-piece or double union end connections, Teflon seat seals, full flow, 4138 kPa (600 psig) WOG minimum working pressure, with locking type handle, cleaned for oxygen use and labeled for intended service.
  2. 75 to 100 mm (3 to 4 inches): Bronze/ brass body, MSS SP-72 MSS SP-110, Type II, Class 150, Style 1 with tubing extensions brazed to flanges, full port, three piece, double seal, Teflon seals, full flow, 4138 kPa (600 psig) WOG minimum working pressure, with locking type handle, cleaned for oxygen use and labeled for intended service.
- B. Check:
  1. 75 mm (3 inches) and smaller: Bronze/brass body, straight through design for minimum pressure drop, spring loaded, self-aligning with Teflon cone seat, vibration free, silent operation, supplied NPT female threads at each end with flow direction arrow permanently cast into, cleaned for oxygen use and labeled for intended service, 2758 kPa (400 psig) WOG minimum working pressure.
  2. 100 mm (4 inches) and larger: Iron body, bronze trim, swing type, vertical or horizontal installation, flange connection, with flow direction arrow permanently cast into, cleaned for oxygen use and labeled for intended service, 1035 kPa (150 psig) WSP.
- C. Zone Valve in Cabinet: Ball valve, bronze/ brass body, double seal, three piece or double union end connections, replaceable Teflon seat seals, Teflon stem seal, 4138 kPa (600 psig) WOG, cold, non-shock gas working pressure service to 100 kPa (29 inches Hg), cleaned for oxygen use and labeled for intended service, blowout proof stem, one quarter turn of handle to completely open or close. Provide tubing extensions

factory brazed, and pressure tested. Provide 3.2 mm (1/8 inch) NPT gauge port for a 50 mm (2 inch) diameter monitoring gauge downstream of the shut off valve. Zone valves shall be securely attached to the cabinet and provided with type "K" copper tube extensions for making connection to system piping outside the cabinet. Zone valves shall be products of one manufacturer, and uniform throughout in pattern, overall size and appearance. Trim with color coded plastic inserts or color coded stick-on labels. Install valves in cabinets such that cover window cannot be in place when any valve is in the closed position. Color coding for identification plates and labels is as follows:

SERVICE LABEL	IDENTIFICATION COLORS	MFG. STD. CLR.
OXYGEN	White letters on green background	GREEN

**2.4 VALVE CABINETS**

- A. Flush mounted commercially available item for use with laboratory and healthcare services, not lighter than 1.3 mm (18 gage) steel or 1.9 mm (14 gage) extruded aluminum, rigidly assembled, of adequate size to accommodate valve(s) and fittings. Punch or drill sides to receive tubing. Provide anchors to secure cabinet to wall construction. Seal openings in cabinet to be dust tight. Locate bottom of cabinet 1375 mm (4 feet 6 inches) above finished floor.
- B. Mount engraved rigid plastic identification plate on wall above or adjacent to cabinet. Color code identification plate to match gas identification colors as indicated above. Identification plate shall be clearly visible at all times. Provide inscriptions on plate to read in substance: "VALVE CONTROL SUPPLY TO ROOMS."
- C. Cover plate: Fabricate from 1.3 mm (18 gage) sheet metal with satin chromed finish, extruded anodized aluminum, or 0.85 mm (22 gage) stainless steel. Provide cover window of replaceable plastic, with a corrosion resistant device or lever secured to window for emergency window removal. Permanently paint or stencil on window: CAUTION-CLOSE ONLY IN EMERGENCY, SHUT-OFF VALVES FOR PIPED GASES", or equivalent wording. Configure such that it is not possible to install window with any valve in the closed position. Each valve shall have gauge upstream of valve inside valve box.

- D. Cabinets and isolation valves shall be located and piped as shown on drawings, and at a minimum, so as to allow the isolation of each smoke compartment separately. No cabinet shall serve more than one smoke compartment.

## **2.5 GAGES**

- A. Pressure Gages: Includes gages temporarily supplied for testing purposes.
1. For line pressure use adjacent to source equipment: ASME B40.1, pressure gage, single, size 115 mm (4-1/2 inches), for compressed air, nitrogen and oxygen, accurate to within 2 percent, with metal case. Range shall be two times operating pressure. Dial graduations and figures shall be black on a white background, or white on a black background. Gage shall be cleaned for oxygen use, labeled for appropriate service, and marked "USE NO OIL". Install with gage cock.
  2. For all services downstream of main shutoff valve: Manufactured for oxygen use, labeled for the appropriate service and marked "USE NO OIL", 40 mm (1-1/2 inch) diameter gage with dial range 1 to 690 kPa (1 to 100 psig) for air service.

## **2.6 STATION OUTLETS**

- A. For all services except ceiling hose drops and nitrogen system: For designated service, consisting of a quick coupler and inlet supply tube. Provide coupler that is non-interchangeable with other services, and leak proof under three times the normal working pressure. Equip each station outlet with an automatic valve and a secondary check valve to conform with NFPA 99. Equip each station inlet with an automatic valve to conform with NFPA 99. Place valves in the assembly to provide easy access after installation for servicing and replacement, and to facilitate line blow-out, purging, and testing. Fasten each outlet and inlet securely to rough-in to prevent floating and provide each with a capped stub length of 6 mm (1/4-inch) (10 mm outside diameter) (3/8-inch outside diameter) tubing for connection to supply. Identification of each gas service shall be permanently cast into the back plate and shall be visible through a transparent plastic guard. Label stub tubing for appropriate service. Rough-in kits and test plugs for PBPU are furnished under this specification but installed by manufacturer of



PBPU before initial test specified herein. Install completion kits (valve body and face plate) for the remainder of required tests.

**2.8 STATION OUTLET ROUGH-IN**

- A. Anchor flush mounted rough-in securely to unit or wall construction.
- B. Modular Cover Plate: Die cast back plate, two-piece 0.85 mm (22 gage) stainless steel or 1.6 mm (16 gage) chromium plated metal, with mounting flanges on all four sides, secured to rough-in with stainless steel or chromium plated countersunk screws.
- C. Cover Plate for PBPU: One-piece with construction and material as indicated for modular cover plate.
- D. Provide permanent, metal or plastic, identification plates securely fastened at each outlet and inlet opening, with inscription for appropriate service using color coded letters and background. Metal plates shall have letters embossed on baked-on enamel background. Color coding for identification plates is as follows:

SERVICE LABEL	IDENTIFICATION PLATE COLORS
OXYGEN	White letters on green background and vice versa

**2.10 ALARMS**

- A. Provide all low voltage control wiring, including wiring from alarm relay interface control cabinet to BAS, required for complete, proper functioning system, in conformance with Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. Run wiring in conduit, in conformance with Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS.
- D. Alarm Functions:
  - 1. Oxygen alarms: Pressure alarms: Functions when pressure in branch drops below 275 kPa (40 psig),  $\pm 14$  kPa ( $\pm 2$  psig) or increases above 414 kPa (60 psig),  $\pm 14$  kPa ( $\pm 2$  psig) set points; operated by pressure switches or transmitters.

E. Alarm Panels:

1. General: Modular design, easily serviced and maintained; alarms operate on alternating current (AC) low voltage control circuit; provide required number of transformers for efficient functioning of complete system. Alarm panels shall be integral units, reporting oxygen as required.
2. Box: Flush mounted, sectional or one piece, corrosion resistant. Size box to accommodate required number of service functions for each location, and for one audible signal in each box. Anchor box securely. Provide spare capacity to accommodate 50 percent of the number of provided alarm points.
3. Cover plate: Designed to accommodate required number of signals, visual and audible, for each location, and containing adequate operating instructions within the operator's view. Bezel shall be extruded aluminum, chromium plated metal, or plastic. Secure to the box with chromium plated or stainless steel countersunk screws.
4. Service indicator lights: Red translucent plastic or LED with proper service identification inscribed thereon. Number of lights and service instruction shall be as required for each location. Provide each panel with a green test button of the same material, inscribed with "PUSH TO TEST" or similar message.
5. Audible signal: Provide one in each alarm panel and connect electrically with all service indicator light functions.
6. Controls:
  - a. Visual signal: When the condition occurs which any individual service indicator light is to report, button for particular service shall give a lighted visual signal which cannot be canceled until such condition is corrected.
  - b. Audible signal: Alarm shall give an audible signal upon circuit energization of any visual signal. Audible signal shall be continuous until silenced by pushing a button. This shall cancel and reset audible only, and not affect the visual signal. After silencing, subsequent alarms shall reactivate the audible alarm.
  - c. Signal tester: Test button or separate normal light shall be continuously lighted to indicate electrical circuit serving each individual alarm is energized. Pushing test button shall

temporarily activate all visual signals and sound audible signal, thereby providing desired indications of status of system.

- F. Alarm Relay Interface Control Cabinet: Design cabinet to transfer the closed circuit alarm signals through relays to a set of terminals for monitoring signals at the BAS without interrupting the closed circuit system. Constructed of 1.9 mm (14 gage) steel, conforming with NEMA ICS 6, Type 1, enclosures. Provide both normally open and normally closed contacts for output signals, with number of circuits required for full alarm capability at the BAS. Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC for compatibility.
- G. Alarm Network Communication: Network communications board shall be installed in local alarm and connected to the facility's Ethernet. Local alarm modules shall send information to the master alarm and the data can be downloaded thru the computer connected to the facility's Ethernet. Master alarm displays the message, sounds its alarm and saves the information in an event log. This event log shall be downloaded to a computer file for tracking data and troubleshooting.

#### **2.11 PRESSURE SWITCHES**

- A. General purpose, contact or mercury type, allowing both high and low pressure set points, with contact type provided with a protective dust cover; adjustable range; switches activate when indicated by alarm requirements. Use one orifice nipple (or DISS demand check valve) for each sensor or pressure switch.

#### **2.15 PRESSURE REGULATORS**

- A. For 690 kPa (100 psig) regulator, provide duplex in parallel, valve for maintenance shut-down without service interruption. For additional pressures, locate regulators remote from compressor near point of use, and provide with isolation valves and valve bypass.
1. For systems 5 L/s (10 SCFM) and below: Brass or bronze body and trim, reduced pressure range 170 to 850 kPa (25 to 123 psig) adjustable, spring type, diaphragm operated, relieving. Delivered pressure shall vary not more than 1.0 kPa (0.15 psig) for each 10 kPa (1.5 psig) variation in inlet pressure.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. In accordance with NFPA 99. Run buried oxygen piping in PVC protective pipe for entire length including enclosure of fittings and changes of direction.
- B. Install cast escutcheon with set screw at each wall, floor and ceiling penetration in exposed finished locations and within cabinets and millwork.
- C. Open ends of tube shall be capped or plugged at all times or otherwise sealed until final assembly to prevent infiltration of any foreign matter.
- D. Cut piping square and accurately with a tube cutter (sawing is prohibited) to measurements determined at place of installation. Ream tube to remove burrs, being careful not to expand tube, and so no chips of copper remain in the tube. Work into place without springing or forcing. Bottom tube in socket so there are no gaps between tube and fitting. Exercise care in handling equipment and tools used in cutting or reaming of tube to prevent oil or grease being introduced into tubing. Where contamination has occurred, material is no longer suitable for oxygen service.
- E. Spacing of hangers: NFPA 99.
- F. Rigidly support valves and other equipment to prevent strain on tube or joints.
- G. While being brazed, joints shall be continuously purged with oil free nitrogen. The flow of purged gas shall be maintained until joint is cool to touch.
- H. Do not bend tubing. Use fittings.
- I. Support ceiling column assembly from heavy sub-mounting castings furnished with the unit as part of roughing-in. Anchor with 15 mm (1/2-inch) diameter bolts attached to angle iron frame supported from structural ceiling, unless otherwise indicated.
- J. Provide two 25 mm (1 inch) minimum conduits from ceiling column assembly to adjacent corridor, one for mass spectrometer tubing and wiring and one for monitor wiring, for connection to signal cabling network.
- K. Install pressure switches, transmitter and gauges to be easily accessed, and provide access panel where installed above plaster

ceiling. Install pressure switch and sensors with orifice nipple between the pipe line and switches/sensors.

- L. Apply pipe labeling during installation process and not after installation is completed. Size of legend letters shall be in accordance with ASME A13.1.
- M. Pipe compressor intake to a source of clean ambient air as indicated in NFPA 99.
- N. After initial leakage testing is completed, allow piping to remain pressurized with testing gas until testing agency performs final tests.
- O. Penetrations:
  - 1. Fire Stopping: Where pipes pass through fire partitions, fire walls, smoked partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with intumescent materials only. Completely fill and seal clearances between raceways and openings with the fire stopping material.
  - 2. Waterproofing: At floor penetrations, completely seal clearances around the pipe and make watertight with sealant as specified in Section 07 92 00, JOINT SEALANTS. Bio-based materials shall be utilized when possible.
- P. Provide 40 mm (1-1/2 inch) diameter line pressure gage downstream of zone valve in cabinets.
- Q. Provide zone valves in cabinets where indicated and outside each Operating Room and a minimum one zone valve assembly for each 18 outlet set.

### **3.2 STARTUP AND TESTING**

- A. Initial Tests: Blow down and high and low pressure leakage tests as required by NFPA 99 with documentation.
- B. Laboratory and/or healthcare testing agency shall perform the following:
  - 1. Perform and document all cross connection tests, labeling verification, supply system operation, and valve and alarm operation tests as required by, and in accordance with NFPA 99 and the procedures set forth in pre-qualification documentation.
  - 2. Verify that the systems, as installed, meet or exceed the requirements of NFPA 99, this specification, and that the systems operate as required.

3. Piping purge test: For each positive pressure gas system, verify cleanliness of piping system. Filter a minimum of 1000 liters (35 cubic feet) of gas through a clean white 0.45 micron filter at a minimum velocity of 100 liters per minute (3.5 SCFM). Filter shall show no discoloration, and shall accrue no more than 0.1 mg (0.0000035 ounces) of matter. Test each zone at the outlet most remote from the source. Perform test with the use of an inert gas as described in CGA P-9.
4. Piping purity test: For each positive pressure system, verify purity of piping system. Test each zone at the most remote outlet for dew point, carbon monoxide, total hydrocarbons (as methane), and halogenated hydrocarbons, and compare with source gas. The two tests shall in no case exceed variation as specified in paragraph, "Maximum Allowable Variation". Perform test with the use of an inert gas as described in CGA P-9.
5. Outlet and inlet flow test:
  - a. Test all outlets for flow. Perform test with the use of an inert gas as described in CGA P-9.
  - b. Oxygen outlets shall deliver 100 Lpm (3.5 SCFM) with a pressure drop of no more than 34 kPa (5 psig), and static pressure of 345 kPa (50 psig).
6. Source Contamination Test: Analyze each pressure gas source for concentration of contaminants, by volume. Take samples for air system test at the intake and at a point immediately downstream of the final filter outlet. The compared tests shall in no case exceed variation as specified in paragraph "Maximum Allowable Variation". Allowable concentrations are below the following:

Dew point, air	4 degrees C (40 degrees F) pressure dew point at 690 kPa (100 psig)
Carbon monoxide, air	10 mg/L (ppm)
Carbon dioxide, air	500 mg/L (ppm)
Gaseous hydrocarbons as methane, air	25 mg/L (ppm)
Halogenated hydrocarbons, air	2 mg/L (ppm)

7. Analysis Test:

- a. Analyze each pressure gas source and outlet for concentration of gas, by volume.
- b. Make analysis with instruments designed to measure the specific gas dispensed.
- c. Allowable concentrations are within the following:
  - 1) Laboratory air 19.5 percent to 23.5 percent oxygen.

Oxygen	>=97% plus oxygen
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8. Maximum Allowable Variation: Between comparative test results required are as follows:

Dew point	2 degrees C (35 degrees F)
Carbon monoxide	2 mg/L (ppm)
Total hydrocarbons as methane	1 mg/L (ppm)
Halogenated hydrocarbons	2 mg/L (ppm)

C. The CxA will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and CxA. Contractor shall provide a minimum of 10 working days prior to startup and testing.

**3.3 CONNECTION TO EXISTING LABORATORY GAS SYSTEM:**

- A. Contractor shall test the existing system for hydrocarbons, dew point, etc. per NFPA 99. If problems are present, the COR would notify the facility of the results. The facility would then make the necessary repairs and/or maintenance prior to connecting to new system.
- B. Install shut-off valve at the connection of new line to existing line.
- C. Time for shutdown of the existing laboratory and healthcare system shall be coordinated at least 10 work days prior to shutdown with the COR and VA Medical Center.
- D. Shut off all oxygen zone valves and gas riser valves if the section to be connected cannot be totally isolated from the remainder of the system.
- E. Prior to any work being done, check the new pipeline for particulate or other forms of contamination per NFPA 99.

- F. Ensure that the correct type of pipe tubing and fittings are being used.
- G. Make a spot check of the existing pipelines in the facility to determine the level of cleanness present.
- H. Reduce the pressure to zero and make the tie-in as quickly as possible. A nitrogen purge is not required since this would require another opening in the pipe.
- I. After the tie-in is made and allowed to cool, slowly bleed the source gas back into the pipeline. Test the work area for leaks with soapy water and repair any leaks.
- J. After all leaks, if any, are repaired and the line is fully recharged, perform blow down and testing. Open the zone that is closest to the main to the system, access the closest outlet to the work, and blow the main through the outlet. After the outlet blows clear into a white cloth, make an additional check at a zone most distant from the work. Perform all required NFPA 99 tests after connection.

#### **3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

#### **3.5 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative to instruct VA Personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 22 08 00, COMMISSIONING OF PLUMBING SYSTEMS.

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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. Exterior: Piping, ductwork, and equipment exposed to weather be it temperature, humidity, precipitation, wind, or solar radiation.

C. Abbreviations/Acronyms:

1. ac: Alternating Current
2. ACR: Air Conditioning and Refrigeration
3. AI: Analog Input
4. AISI: American Iron and Steel Institute
5. AO: Analog Output
6. ASJ: All Service Jacket
7. AWG: American Wire Gauge
8. BACnet: Building Automation and Control Networking Protocol
9. BAg: Silver-Copper-Zinc Brazing Alloy
10. BAS: Building Automation System
11. BCuP: Silver-Copper-Phosphorus Brazing Alloy
12. bhp: Brake Horsepower
13. Btu: British Thermal Unit
14. Btu/h: British Thermal Unit Per Hour
15. CDA: Copper Development Association
16. C: Celsius
17. CD: Compact Disk
18. CFM: Cubic Foot Per Minute
19. CH: Chilled Water Supply
20. CHR: Chilled Water Return
21. CLR: Color
22. CO: Carbon Monoxide
23. COR: Contracting Officer's Representative
24. CPD: Condensate Pump Discharge
25. CPM: Cycles Per Minute

- 26. CPVC: Chlorinated Polyvinyl Chloride
- 27. CRS: Corrosion Resistant Steel
- 28. CTPD: Condensate Transfer Pump Discharge
- 29. CTPS: Condensate Transfer Pump Suction
- 30. CW: Cold Water
- 31. CWP: Cold Working Pressure
- 32. CxA: Commissioning Agent
- 33. dB: Decibels
- 34. dB(A): Decibels (A weighted)
- 35. DDC: Direct Digital Control
- 36. DI: Digital Input
- 37. DO: Digital Output
- 38. DVD: Digital Video Disc
- 39. DN: Diameter Nominal
- 40. DWV: Drainage, Waste and Vent
- 41. EPDM: Ethylene Propylene Diene Monomer
- 42. EPT: Ethylene Propylene Terpolymer
- 43. ETO: Ethylene Oxide
- 44. F: Fahrenheit
- 45. FAR: Federal Acquisition Regulations
- 46. FD: Floor Drain
- 47. FED: Federal
- 48. FG: Fiberglass
- 49. FGR: Flue Gas Recirculation
- 50. FOS: Fuel Oil Supply
- 51. FOR: Fuel Oil Return
- 52. FSK: Foil-Scrim-Kraft facing
- 53. FWPD: Feedwater Pump Discharge
- 54. FWPS: Feedwater Pump Suction
- 55. GC: Chilled Glycol Water Supply
- 56. GCR: Chilled Glycol Water Return
- 57. GH: Hot Glycol Water Heating Supply
- 58. GHR: Hot Glycol Water Heating Return
- 59. gpm: Gallons Per Minute
- 60. HDPE: High Density Polyethylene
- 61. Hg: Mercury
- 62. HOA: Hands-Off-Automatic

- 63. hp: Horsepower
- 64. HPS: High Pressure Steam (414 kPa (60 psig) and above)
- 65. HPR: High Pressure Steam Condensate Return
- 66. HW: Hot Water
- 67. HWH: Hot Water Heating Supply
- 68. HWHR: Hot Water Heating Return
- 69. Hz: Hertz
- 70. ID: Inside Diameter
- 71. IPS: Iron Pipe Size
- 72. kg: Kilogram
- 73. klb: 1000 lb
- 74. kPa: Kilopascal
- 75. lb: Pound
- 76. lb/hr: Pounds Per Hour
- 77. L/s: Liters Per Second
- 78. L/min: Liters Per Minute
- 79. LPS: Low Pressure Steam (103 kPa (15 psig) and below)
- 80. LPR: Low Pressure Steam Condensate Gravity Return
- 81. MAWP: Maximum Allowable Working Pressure
- 82. MAX: Maximum
- 83. MBtu/h: 1000 Btu/h
- 84. MBtu: 1000 Btu
- 85. MED: Medical
- 86. m: Meter
- 87. MFG: Manufacturer
- 88. mg: Milligram
- 89. mg/L: Milligrams Per Liter
- 90. MIN: Minimum
- 91. MJ: Megajoules
- 92. ml: Milliliter
- 93. mm: Millimeter
- 94. MPS: Medium Pressure Steam (110 kPa (16 psig) through 414 kPa (60 psig))
- 95. MPR: Medium Pressure Steam Condensate Return
- 96. MW: Megawatt
- 97. NC: Normally Closed
- 98. NF: Oil Free Dry (Nitrogen)

- 99. Nm: Newton Meter
- 100. NO: Normally Open
- 101. NOx: Nitrous Oxide
- 102. NPT: National Pipe Thread
- 103. NPS: Nominal Pipe Size
- 104. OD: Outside Diameter
- 105. OSD: Open Sight Drain
- 106. OS&Y: Outside Stem and Yoke
- 107. PC: Pumped Condensate
- 108. PID: Proportional-Integral-Differential
- 109. PLC: Programmable Logic Controllers
- 110. PP: Polypropylene
- 111. PPE: Personal Protection Equipment
- 112. ppb: Parts Per Billion
- 113. ppm: Parts Per Million
- 114. PRV: Pressure Reducing Valve
- 115. PSIA: Pounds Per Square Inch Absolute
- 116. psig: Pounds Per Square Inch Gauge
- 117. PTFE: Polytetrafluoroethylene
- 118. PVC: Polyvinyl Chloride
- 119. PVDC: Polyvinylidene Chloride Vapor Retarder Jacketing, White
- 120. PVDF: Polyvinylidene Fluoride
- 121. rad: Radians
- 122. RH: Relative Humidity
- 123. RO: Reverse Osmosis
- 124. rms: Root Mean Square
- 125. RPM: Revolutions Per Minute
- 126. RS: Refrigerant Suction
- 127. RTD: Resistance Temperature Detectors
- 128. RTRF: Reinforced Thermosetting Resin Fittings
- 129. RTRP: Reinforced Thermosetting Resin Pipe
- 130. SCFM: Standard Cubic Feet Per Minute
- 131. SPEC: Specification
- 132. SPS: Sterile Processing Services
- 133. STD: Standard
- 134. SDR: Standard Dimension Ratio
- 135. SUS: Saybolt Universal Second

- 136. SW: Soft water
- 137. SWP: Steam Working Pressure
- 138. TAB: Testing, Adjusting, and Balancing
- 139. TDH: Total Dynamic Head
- 140. TEFC: Totally Enclosed Fan-Cooled
- 141. TFE: Tetrafluoroethylene
- 142. THERM: 100,000 Btu
- 143. THHN: Thermoplastic High-Heat Resistant Nylon Coated Wire
- 144. THWN: Thermoplastic Heat & Water-Resistant Nylon Coated Wire
- 145. T/P: Temperature and Pressure
- 146. USDA: U.S. Department of Agriculture
- 147. V: Volt
- 148. VAC: Vacuum
- 149. VA: Veterans Administration
- 150. VAC: Voltage in Alternating Current
- 151. VA CFM: VA Construction & Facilities Management
- 152. VA CFM CSS: VA Construction & Facilities Management, Consulting Support Service
- 153. VAMC: Veterans Administration Medical Center
- 154. VHA OCAMES: Veterans Health Administration - Office of Capital Asset Management Engineering and Support
- 155. VR: Vacuum condensate return
- 156. WCB: Wrought Carbon Steel, Grade B
- 157. WG: Water Gauge or Water Column
- 158. WOG: Water, Oil, Gas

## **1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.
- D. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS
- E. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- F. Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.
- G. Section 03 30 00, CAST-IN-PLACE CONCRETE.
- H. Section 07 84 00, FIRESTOPPING.
- I. Section 07 92 00, JOINT SEALANTS.
- J. Section 09 91 00, PAINTING.

- K. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- L. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION.
- M. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- N. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- O. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- P. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- Q. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- R. Section 23 36 00, AIR TERMINAL UNITS.
- S. Section 23 82 00, CONVECTION HEATING AND COOLING UNITS.
- T. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- U. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
- V. Section 26 29 11, MOTOR CONTROLLERS.

**1.3 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. Where conflicts occur these specifications and the VHA standard will govern.
- B. Air Movement and Control Association (AMCA):  
410-1996 .....Recommended Safety Practices for Users and  
Installers of Industrial and Commercial Fans
- C. American Society of Mechanical Engineers (ASME):  
B31.1-2014 .....Power Piping  
B31.9-2014 .....Building Services Piping  
ASME Boiler and Pressure Vessel Code:  
BPVC Section IX-2015 ...Welding, Brazing, and Fusing Qualifications
- D. American Society for Testing and Materials (ASTM):  
A36/A36M-2014 .....Standard Specification for Carbon Structural  
Steel  
A575-1996(R2013)e1 .....Standard Specification for Steel Bars, Carbon,  
Merchant Quality, M-Grades
- E. Association for Rubber Products Manufacturers (ARPM):  
IP-20-2015 .....Specifications for Drives Using Classical  
V-Belts and Sheaves

- IP-21-2009 .....Specifications for Drives Using Double-V  
(Hexagonal) Belts
- IP-24-2010 .....Specifications for Drives Using Synchronous  
Belts
- IP-27-2015 .....Specifications for Drives Using Curvilinear  
Toothed Synchronous Belts
- F. Manufacturers Standardization Society (MSS) of the Valve and Fittings  
Industry, Inc.:
- SP-58-2009 .....Pipe Hangers and Supports-Materials, Design,  
Manufacture, Selection, Application, and  
Installation
- SP-127-2014a .....Bracing for Piping Systems: Seismic-Wind-  
Dynamic Design, Selection, and Application
- G. Military Specifications (MIL):
- MIL-P-21035B-2003 .....Paint High Zinc Dust Content, Galvanizing  
Repair (Metric)
- H. National Fire Protection Association (NFPA):
- 70-2014 .....National Electrical Code (NEC)
- 101-2015 .....Life Safety Code
- I. Department of Veterans Affairs (VA):
- PG-18-10-2016 .....Physical Security and Resiliency Design Manual

#### **1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 05 11, COMMON WORK RESULTS FOR HVAC", with applicable paragraph identification.
- C. If the project is phased submit complete phasing plan/schedule with manpower levels prior to commencing work. The phasing plan shall be detailed enough to provide milestones in the process that can be verified.
- D. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements, and all equipment that requires regular maintenance, calibration, etc are accessible from the floor or permanent work platform. It is the Contractor's responsibility to

ensure all submittals meet the VA specifications and requirements and it is assumed by the VA that all submittals do meet the VA specifications unless the Contractor has requested a variance in writing and approved by COR prior to the submittal. If at any time during the project it is found that any item does not meet the VA specifications and there was no variance approval the Contractor shall correct at no additional cost or time to the Government even if a submittal was approved.

- E. If equipment is submitted which differs in arrangement from that shown, provide documentation proving equivalent performance, design standards and drawings that show the rearrangement of all associated systems. Additionally, any impacts on ancillary equipment or services such as foundations, piping, and electrical shall be the Contractor's responsibility to design, supply, and install at no additional cost or time to the Government. VA approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.
- F. Prior to submitting shop drawings for approval, Contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed contract documents, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.
- G. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together. Coordinate and properly integrate materials and equipment to provide a completely compatible and efficient installation.
- H. Samples: Samples will not be required, except for insulation or where materials offered differ from specification requirements. Samples shall be accompanied by full description of characteristics different from specification. The Government, at the Government's expense, will perform evaluation and testing if necessary. The Contractor may submit samples of additional material at the Contractor's option; however, if additional samples of materials are submitted later, pursuant to Government request, adjustment in contract price and time will be made.
- I. Coordination/Shop Drawings:
  - 1. Submit complete consolidated and coordinated shop drawings for all new systems, and for existing systems that are in the same areas.



2. The coordination/shop drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8-inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show locations and adequate clearance for all equipment, piping, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed coordination/shop drawings of all piping and duct systems. The drawings should include all lockout/tagout points for all energy/hazard sources for each piece of equipment. Coordinate lockout/tagout procedures and practices with local VA requirements.
  3. Do not install equipment foundations, equipment or piping until coordination/shop drawings have been approved.
  4. In addition, for HVAC systems, provide details of the following:
    - a. Mechanical equipment rooms.
    - b. Hangers, inserts, supports, and bracing.
    - c. Pipe sleeves.
    - d. Duct or equipment penetrations of floors, walls, ceilings, or roofs.
- J. Manufacturer's Literature and Data: Include full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity. Submit under the pertinent section rather than under this section.
1. Submit belt drive with the driven equipment. Submit selection data for specific drives when requested by the COR.
  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. Provide complete stress analysis for variable spring and constant support hangers.
  6. Wall, floor, and ceiling plates.
- K. Rigging Plan: Provide documentation of the capacity and weight of the rigging and equipment intended to be used. The plan shall include the

path of travel of the load, the staging area and intended access, and qualifications of the operator and signal person.

L. 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.

2. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:

a. Include complete list indicating all components of the systems.

b. Include complete diagrams of the internal wiring for each item of equipment.

c. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.

3. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment: Belt manufacturer, model number, size and style, and distinguished whether of multiple belt sets.

M. Provide copies of approved HVAC equipment submittals to the TAB and Commissioning Subcontractor.

N. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the Contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

**1.5 QUALITY ASSURANCE**

A. Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality institutional-class and industrial-class products of manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in industrial and institutional HVAC.

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 (or longer as specified elsewhere). 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 workstation, 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 and/or additional requirements.
2. Refer to all other sections for quality assurance requirements for systems and equipment specified therein.
3. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
4. The products and execution of work specified in Division 33 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments shall be enforced, along with requirements of local utility companies. The most stringent requirements of these specifications, local codes, or utility company requirements shall always apply. Any conflicts shall be brought to the attention of the COR.
5. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be of the same manufacturer and model number, or if different models are required they shall be of the same manufacturer and identical to the greatest extent possible (i.e., same model series).

6. Assembled Units: Performance and warranty of all components that make up an assembled unit shall be the responsibility of the manufacturer of the completed assembly.
  7. 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.
  8. Use of asbestos products or equipment or materials containing asbestos is prohibited.
- E. HVAC Equipment Service Providers: Service providers shall be authorized and trained by the manufacturers of the equipment supplied. These providers shall be capable of responding onsite and provide acceptable service to restore equipment operations within 4 hours of receipt of notification by phone, e-mail or fax in event of an emergency, such as the shutdown of equipment; or within 24 hours in a non-emergency. Submit names, mail and e-mail addresses and phone numbers of service personnel and companies providing service under these conditions for (as applicable to the project): fans, air handling units, chillers, cooling towers, control systems, pumps, critical instrumentation, computer workstation and programming.
- 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 BPVC Section IX. Provide proof of current certification.
  2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
  3. Certify that each welder and welding operator has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
  4. All welds shall be stamped according to the provisions of the AWS or ASME as required herein and by the associated code.
- G. Manufacturer's Recommendations: Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the COR with submittals. Installation of the item will not be allowed to proceed until the

recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material and removal by the Contractor and no additional cost or time to the Government.

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 documents to the COR for resolution. Provide written hard copies and computer files on CD or DVD of manufacturer's installation instructions to the COR with submittals prior to commencing installation of any item. Installation of the item will not be allowed to proceed until the recommendations are received and approved by the VA. 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 documents to the COR for resolution. Failure of the Contractor to resolve, or point out any issues will result in the Contractor correcting at no additional cost or time to the Government.
3. Complete coordination/shop drawings shall be required in accordance with Paragraph, SUBMITTALS. Construction work shall not start on any system until the coordination/shop drawings have been approved by VA.
4. Workmanship/craftsmanship will be of the highest quality and standards. The VA reserves the right to reject any work based on poor quality of workmanship this work shall be removed and done again at no additional cost or time to the Government.

I. Upon request by Government, provide lists of previous installations for selected items of equipment. Include contact persons who will serve as references, with current telephone numbers and e-mail addresses.

J. Guaranty: Warranty of Construction, FAR Clause 52.246-21.

**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 or theft.
2. Large equipment such as boilers, chillers, cooling towers, fans, and air handling units if shipped on open trailer trucks shall be covered with shrink on plastics or waterproof tarpaulins that provide protection from exposure to rain, road salts and other transit hazards. Protection shall be kept in place until equipment is moved into a building or installed as designed.
3. Repair damaged equipment in first class, new operating condition and appearance; or, replace same as determined and directed by the COR. Such repair or replacement shall be at no additional cost or time to the Government.
4. 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.
5. 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.
6. Protect plastic piping and tanks from ultraviolet light (sunlight).

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. Boilers shall be left clean following final internal inspection by Government insurance representative or inspector.
5. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.

### 1.7 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD and inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing Contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing Contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
  1. As-built drawings are to be provided, with a copy of them in three-dimensional Building Information Modeling (BIM) software version 2019 provided on CD or DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that

all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics\_), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

**1.8 JOB CONDITIONS - WORK IN EXISTING BUILDING**

- A. Building Operation: Government employees will be continuously operating and managing all facilities, including temporary facilities that serve the VAMC.
- B. Maintenance of Service: Schedule all work to permit continuous service as required by the VAMC.
- C. Steam and Condensate Service Interruptions: Limited steam and condensate service interruptions, as required for interconnections of new and existing systems, will be permitted by the COR during periods when the demands are not critical to the operation of the VAMC. These non-critical periods are limited to between 8 pm and 5 am in the appropriate off-season (if applicable). Provide at least 10 working days advance notice to the COR. The request shall include a detailed plan on the proposed shutdown and the intended work to be done along with manpower levels. All equipment and materials must be onsite and verified with plan 5 days prior to the shutdown or it will need to be rescheduled.
- D. Phasing of Work: Comply with all requirements shown on contract documents. Contractor shall submit a complete detailed phasing plan/schedule with manpower levels prior to commencing work. The phasing plan shall be detailed enough to provide milestones in the process that can be verified.
- E. Building Working Environment: Maintain the architectural and structural integrity of the building and the working environment at all times. Maintain the interior of building at 18 degrees C (65 degrees F) minimum. Limit the opening of doors, windows or other access openings to brief periods as necessary for rigging purposes. Storm water or ground water leakage is prohibited. Provide daily clean-up of construction and demolition debris on all floor surfaces and on all



equipment being operated by VA. Maintain all egress routes and safety systems/devices.

- F. Acceptance of Work for Government Operation: As new equipment, systems and facilities are made available for operation and these items are deemed of beneficial use to the Government, inspections will be made and tests will be performed. Based on the inspections, a list of contract deficiencies will be issued to the Contractor. After correction of deficiencies as necessary for beneficial use, the Contracting Officer will process necessary acceptance and the equipment will then be under the control and operation of Government personnel.
- G. Temporary Facilities: Refer to Paragraph, TEMPORARY PIPING AND EQUIPMENT in this section.

**PART 2 - PRODUCTS**

**2.1 FACTORY-ASSEMBLED PRODUCTS**

- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Performance and warranty of all components that make up an assembled unit shall be the responsibility of the manufacturer of the completed assembly.
  - 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. Equipment and components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a nameplate 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 must be approved by the VA, but may 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 V-BELT DRIVES**

- A. Type: ARPM standard V-belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.
- B. Dimensions, rating and selection standards: ARPM IP-20 and ARPM IP-21.
- C. Minimum Horsepower Rating: Motor horsepower plus recommended ARPM service factor (not less than 20 percent) in addition to the ARPM allowances for pitch diameter, center distance, and arc of contact.
- D. Maximum Speed: 25 m/s (5000 feet per minute).
- E. Adjustment Provisions: For alignment and ARPM standard allowances for installation and take-up.
- F. Drives may utilize a single V-Belt (any cross section) when it is the manufacturer's standard.
- G. Multiple Belts: Matched to ARPM specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.
- H. Sheaves and Pulleys:
  - 1. Material: Pressed steel, or close-grained cast iron.
  - 2. Bore: Fixed or bushing type for securing to shaft with keys.
  - 3. Balanced: Statically and dynamically.
  - 4. Groove spacing for driving and driven pulleys shall be the same.
- I. 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 the design air flow branch, 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.

J. Final Drive Set: If adjustment is required beyond the capabilities of the factory drive set, the final drive set shall be provided as part of this contract at no additional cost or time to the Government.

#### **2.4 SYNCHRONOUS BELT DRIVES**

- A. Type: ARPM synchronous belts with proper motor pulley and driven sheave. Belts shall be constructed of reinforced cord and rubber.
- B. Dimensions, rating and selection standards: ARPM IP-24 and ARPM IP-27.
- C. Minimum Horsepower Rating: Motor horsepower plus recommended ARPM service factor (not less than 20 percent) in addition to the ARPM allowances for pitch diameter, center distance, and arc of contact.
- D. Maximum Speed: 25 m/s (5000 feet per minute).
- E. Adjustment Provisions: For alignment and ARPM standard allowances for installation and take-up.
- F. Drives may utilize a single belt of manufacturer's standard width for the application.
- G. Multiple Belts: Matched to ARPM specified limits by measurement on a belt measuring fixture. Seal matched sets together to prevent mixing or partial loss of sets. Replacement, when necessary, shall be an entire set of new matched belts.
- H. Sheaves and Pulleys:
  - 1. Material: Pressed steel, or close-grained cast iron.
  - 2. Bore: Fixed or bushing type for securing to shaft with keys.
  - 3. Balanced: Statically and dynamically.
- I. Final Drive Set: The final fan speeds required to just meet the system CFM and pressure requirements, without throttling the design air flow branch, shall be determined by fan law calculation. If adjustment is required beyond the capabilities of the factory drive set, the final drive set shall be provided as part of this contract at no additional cost or time to the Government.

#### **2.5 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-gauge sheet steel; all edges shall be hemmed and ends shall be bent into flanges and the flanges shall be 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.
- C. V-belt and sheave assemblies shall be totally enclosed, firmly mounted, non-resonant. Guard shall be an assembly of minimum 22-gauge sheet steel and expanded or perforated metal to permit observation of belts. 25 mm (1 inch) diameter hole shall be provided at each shaft centerline to permit speed measurement.
- D. Materials: Sheet steel, expanded metal or wire mesh rigidly secured so as to be removable without disassembling pipe, duct, or electrical connections to equipment.
- E. Access for Speed Measurement: 25 mm (1 inch) diameter hole at each shaft center.

## **2.6 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.

## **2.7 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 AND STEAM GENERATION EQUIPMENT; Section 26 29 11, MOTOR CONTROLLERS; and, Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide special energy efficient premium efficiency type motors as scheduled.

## **2.8 VARIABLE SPEED MOTOR CONTROLLERS**

- A. Refer to Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS and Section 26 29 11, MOTOR CONTROLLERS for specifications.
- B. Coordinate variable speed motor controller communication protocol with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

- C. Provide variable speed motor controllers with or without a bypass contactor as indicated in contract drawings.
- D. 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.
- E. Motors shall be premium efficiency 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.
- F. Controller shall not add any current or voltage transients to the input ac power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the ac power system.

## **2.9 EQUIPMENT AND MATERIALS IDENTIFICATION**

- A. Use symbols, nomenclature and equipment numbers specified, shown on the contract documents and shown in the maintenance manuals. Identification for piping is specified in Section 09 91 00, PAINTING.
- B.
- C. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 5 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.
- D. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 5 mm (3/16 inch) high riveted or bolted to the equipment.
- E. Control Items: Label all instrumentation, temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.
- F. Valve Tags and Lists:
  - 1. HVAC and Mechanical Rooms: Provide for all valves other than for equipment in Section 23 82 00, CONVECTION HEATING AND COOLING UNITS and Section 23 36 00, AIR TERMINAL UNITS.

2. Valve tags: Engraved black filled numbers and letters not less than 15 mm (1/2 inch) high for number designation, and not less than 6 mm (1/4 inch) for service designation on 19-gauge 40 mm (1-1/2 inches) round brass disc, attached with brass "S" hook or brass chain.
3. Valve lists: Typed or printed plastic coated card(s), sized 215 mm (8-1/2 inches) by 275 mm (11 inches) showing tag number, valve function and area of control, for each service or system. Punch sheets for a 3-ring notebook.
4. Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color-coded thumb tack in ceiling.

G. Ceiling Grid Labels:

1. 50 mm (2 inch) long by 15 mm (1/2 inch) wide by 0.025 mm (1 mil) thick UV resistant metalized polyester label with red border color and black custom lettering on white background interior. Peel and stick adhesive backing. Label and adhesive manufactured specifically for use in equipment inventory tagging.
2. Custom print labels with above ceiling HVAC equipment numbers.

**2.10 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 AND BOILER PLANT INSULATION, for firestop pipe and duct insulation.

**2.11 GALVANIZED REPAIR COMPOUND**

- A. Mil-P-21035B, paint form.

**2.12 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 by 100 mm (2 by 4 inches) 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 275 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. Type Numbers specified refer to this standard. For selection and application comply with MSS SP-58. Refer to Section 05 50 00, METAL FABRICATIONS, for miscellaneous metal support materials and prime coat painting requirements.
- D. Attachment to Concrete Building Construction:
1. Concrete insert: MSS SP-58, Type 18.
  2. Self-drilling expansion shields and machine bolt expansion anchors: Permitted in concrete not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
  3. Power-driven fasteners: Permitted in existing concrete or masonry not less than 100 mm (4 inches) thick when approved by the COR for each job condition.
- E. Attachment to Steel Building Construction:
1. Welded attachment: MSS SP-58, Type 22.
  2. Beam clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 23 mm (7/8 inch) outside diameter.
- F. Attachment to existing structure: Support from existing floor/roof frame.
- G. Attachment to Wood Construction: Wood screws or lag bolts.
- H. Hanger Rods: Hot-rolled steel, ASTM A36/A36M or ASTM A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 40 mm (1-1/2 inches) minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
- I. Hangers Supporting Multiple Pipes (Trapeze Hangers): Galvanized, cold formed, lipped steel channel horizontal member, not less than 41 mm by 41 mm (1-5/8 inches by 1-5/8 inches), 2.7 mm (12 gauge), designed to accept special spring held, hardened steel nuts. Trapeze hangers are prohibited for use for steam supply and condensate piping.
1. Allowable hanger load: Manufacturers rating less 91 kg (200 pounds).

2. Guide individual pipes on the horizontal member of every other trapeze hanger with 6 mm (1/4 inch) U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 15 mm (1/2 inch) galvanized steel bands, or 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 AND BOILER PLANT 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. Piping Systems except High and Medium Pressure Steam (MSS SP-58):
  - a. Standard clevis hanger: Type 1; provide locknut.
  - b. Riser clamps: Type 8.
  - c. Wall brackets: Types 31, 32 or 33.
  - d. Roller supports: Type 41, 43, 44 and 46.
  - e. Saddle support: Type 36, 37 or 38.
  - f. Turnbuckle: Types 13 or 15. Preinsulate.
  - g. U-bolt clamp: Type 24.
  - h. Copper Tube:
    - 1) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with non-adhesive isolation tape to prevent electrolysis.
    - 2) For vertical runs use epoxy painted or plastic-coated riser clamps.
    - 3) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
    - 4) Insulated Lines: Provide pre-insulated calcium silicate shields sized for copper tube.
  - i. Supports for plastic piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.



3. High and Medium Pressure Steam (MSS SP-58):
    - a. Provide eye rod or Type 17 eye nut near the upper attachment.
    - b. Piping 50 mm (2 inches) and larger: Type 43 roller hanger. For roller hangers requiring seismic bracing provide a Type 1 clevis hanger with Type 41 roller attached by flat side bars.
    - c. Piping with Vertical Expansion and Contraction:
      - 1) Movement up to 20 mm (3/4 inch): Type 51 or 52 variable spring unit with integral turn buckle and load indicator.
      - 2) Movement more than 20 mm (3/4 inch): Type 54 or 55 constant support unit with integral adjusting nut, turn buckle and travel position indicator.
  4. Convertor and Expansion Tank Hangers: May be Type 1 sized for the shell diameter. Insulation where required will cover the hangers.
- K. Pre-insulated Calcium Silicate Shields:
1. Provide 360-degree water resistant high density 965 kPa (140 psig) compressive strength calcium silicate shields encased in galvanized metal.
  2. Pre-insulated calcium silicate shields to be installed at the point of support during erection.
  3. Shield thickness shall match the pipe insulation.
  4. The type of shield is selected by the temperature of the pipe, the load it must carry, and the type of support it will be used with.
    - a. Shields for supporting chilled or cold water shall have insulation that extends a minimum of 25 mm (1 inch) past the sheet metal. Provide for an adequate vapor barrier in chilled lines.
    - b. The pre-insulated calcium silicate shield shall support the maximum allowable water filled span as indicated in MSS SP-58. To support the load, the shields may have one or more of the following features: structural inserts 4138 kPa (600 psig) compressive strength, an extra bottom metal shield, or formed structural steel (ASTM A36/A36M) wear plates welded to the bottom sheet metal jacket.
  5. Shields may be used on steel clevis hanger type supports, roller supports or flat surfaces.

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

### **2.13 PIPE PENETRATIONS**

- A. Install sleeves during construction for other than blocked out floor openings for risers in mechanical bays.
- B. To prevent accidental liquid spills from passing to a lower level, provide the following:
  - 1. For sleeves: Extend sleeve 25 mm (1 inch) above finished floor and provide sealant for watertight joint.
  - 2. For blocked out floor openings: Provide 40 mm (1-1/2 inch) angle set in silicone adhesive around opening.
  - 3. For drilled penetrations: Provide 40 mm (1-1/2 inch) angle ring or square set in silicone adhesive around penetration.
- C. Penetrations through beams or ribs are prohibited, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of COR.
- D. 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.
- E. 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.
- F. 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. Provide sleeve for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.
- G. Brass Pipe Sleeves: Provide for pipe passing through quarry tile, terrazzo or ceramic tile floors. Connect sleeve with floor plate.
- H. Sleeves are not required for wall hydrants for fire department connections or in drywall construction.
- I. 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.

- J. Sealant and Adhesives: Shall be as specified in Section 07 92 00, JOINT SEALANTS.

#### **2.14 DUCT PENETRATIONS**

- A. Provide curbs for roof mounted piping, ductwork and equipment. Curbs shall be 450 mm (18 inches) high with continuously welded seams, built-in cant strip, interior baffle with acoustic insulation, curb bottom, hinged curb adapter.
- B. Provide firestopping for openings through fire and smoke barriers, maintaining minimum required rating of floor, ceiling or wall assembly. See section 07 84 00, FIRESTOPPING.

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

- A. Furnish, and turn over to the COR, tools not readily available commercially, that are required for disassembly or adjustment of equipment and machinery furnished.
- B. Grease Guns with Attachments for Applicable Fittings: One for each type of grease required for each motor or other equipment.
- C. Refrigerant Tools: Provide system charging/Evacuation equipment, gauges, fittings, and tools required for maintenance of furnished equipment.
- D. Tool Containers: Hardwood or metal, permanently identified for intended service and mounted, or located, where directed by the COR.
- E. Lubricants: A minimum of 0.95 L (1 quart) of oil, and 0.45 kg (1 pound) of grease, of equipment manufacturer's recommended grade and type, in unopened containers and properly identified as to use for each different application.

#### **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. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

## **2.17 ASBESTOS**

- A. Materials containing asbestos are prohibited.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

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

### **3.2 ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING**

- A. Location of piping, sleeves, inserts, hangers, and equipment, access provisions shall be coordinated with the work of all trades. The coordination/shop drawings shall be submitted for review. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, light outlets, and other services and utilities. Equipment coordination/shop drawings shall be prepared to coordinate proper location and personnel access of all facilities. The drawings shall be submitted for review. 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 gauges 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 contract documents.
- C. Equipment and Piping Support: Coordinate structural systems necessary for pipe and equipment support with pipe and equipment locations to permit proper installation.
- D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- E. Cutting Holes:
  - 1. Cut holes through concrete and masonry by rotary core drill.  
Pneumatic hammer, impact electric, and hand or manual hammer type

- drill is prohibited, except as permitted by COR where working area space is limited.
2. Locate holes to avoid interference with structural members such as slabs, columns, ribs, beams or reinforcing. Holes shall be laid out in advance and drilling done only after approval by COR. If the Contractor considers it necessary to drill through structural members, this matter shall be referred to COR for approval.
  3. Do not penetrate membrane waterproofing.
- F. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- G. Electrical Interconnection of Instrumentation or Controls: 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. Devices shall be located so they are easily accessible for testing, maintenance, calibration, etc. The COR has the final determination on what is accessible and what is not. Comply with NFPA 70.
- H. Protection and Cleaning:
1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations and as approved by the COR. Damaged or defective items in the opinion of the COR, shall be replaced.
  2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical, or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- I. Concrete and Grout: Use concrete and non-shrink grout 20 MPa (3000 psig) minimum, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
- J. Install gauges, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gauges to be easily read by operator or

staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.

- K. Install steam piping expansion joints as per manufacturer's recommendations.
- 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.
- M. Work in Animal Research Areas: Seal all pipe and duct penetrations with silicone sealant to prevent entrance of insects.
- N. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical and data/telephone switchgear. If this is not possible, encase pipe in a second pipe with a minimum of joints. Installation of piping, ductwork, leak protection apparatus or other installations foreign to the electrical installation shall not be located in the space equal to the width and depth of the equipment and extending from to a height of 1.8 m (6 feet) above the equipment or to ceiling structure, whichever is lower (NFPA 70).
- O. Inaccessible Equipment:
  - 1. Where the Government determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance or inspections, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost or time 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, but not limited to motors, fans, pumps, belt guards, transformers, high voltage lines, conduit and raceways, piping, hot surfaces, and ductwork. The COR has final determination on whether an installation meets this requirement or not.

### **3.3 TEMPORARY PIPING AND EQUIPMENT**

- A. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.
- B. 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 Paragraph, ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING apply.
- C. Temporary facilities and piping shall be completely removed and any openings in structures sealed. Provide necessary blind flanges and caps to seal open piping remaining in service.

### **3.4 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 requirements 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. Follow approved rigging plan.
- G. Restore building to original condition upon completion of rigging work.

### 3.5 PIPE AND EQUIPMENT SUPPORTS

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels designed by a structural engineer, secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the COR.
- B. Use of chain pipe supports; wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above are prohibited. Replace or thoroughly clean rusty products and paint with zinc primer.
- C. Hanger rods shall be used that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 15 mm (1/2 inch) clearance between pipe or piping covering and adjacent work.
- D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP-58. Provide additional supports at valves, strainers, in-line pumps and other heavy components. Provide a support within one foot of each elbow.
- E. HVAC Vertical Pipe Supports:
  - 1. Up to 150 mm (6-inch pipe), 9 m (30 feet) long, bolt riser clamps to the pipe below couplings, or welded to the pipe and rests supports securely on the building structure.
  - 2. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.
- F. 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.
  - 3. Tubing and capillary systems shall be supported in channel troughs.
- G. Floor Supports:
  - 1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Concrete bases and structural systems shall be anchored and doweled to resist forces under operating and seismic conditions (if applicable) without excessive displacement or structural failure.



2. Bases and supports shall not be located and installed until equipment mounted thereon has been approved. Bases shall be sized to match equipment mounted thereon plus 50 mm (2 inch) excess on all edges. Chiller foundations shall have horizontal dimensions that exceed chiller base frame dimensions by at least 150 mm (6 inches) on all sides. Structural contract documents shall be reviewed for additional requirements. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.
4. For seismic anchoring, refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

### **3.6 MECHANICAL DEMOLITION**

- A. Rigging access, other than indicated on the contract documents, shall be provided by the Contractor after approval for structural integrity by the COR. Such access shall be provided without additional cost or time to the Government. Where work is in an 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 facility, 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. Debris accumulated in the area to the detriment of plant operation is prohibited. 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 VAMC, and Contractor shall follow all directives of the COR with regard to rigging, safety, fire safety, and maintenance of operations.
- C. Unless specified otherwise, all piping, wiring, conduit, and other devices associated with the equipment not re-used in the new work shall

be completely removed from Government property per Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT. This includes all concrete pads, pipe, valves, fittings, insulation, and all hangers including the top connection and any fastenings to building structural systems. All openings shall be sealed after removal of equipment, pipes, ducts, and other penetrations in roof, walls, floors, in an approved manner and in accordance with contract documents where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the contract documents of the other disciplines in the project for additional facilities to be demolished or handled.

- D. All indicated valves including gate, globe, ball, butterfly and check, all pressure gauges and thermometers with wells shall remain Government property and shall be removed and delivered to COR and stored as directed. The Contractor shall remove all other material and equipment, devices and demolition debris under these contract documents. Such material shall be removed from Government property expeditiously and shall not be allowed to accumulate.
- E. Asbestos Insulation Removal: Conform to Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.

### **3.7 CLEANING AND PAINTING**

- A. Prior to final inspection and acceptance of the 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. Solvents, cleaning materials and methods recommended by the manufacturers shall be used for the specific tasks. All rust shall be removed prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.
  - 2. The following material and equipment shall not be painted:
    - 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. Nameplates.
- 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 paint type and color as utilized by the pump manufacturer.
  - 5. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats. This may include painting exposed metals where hangers were removed or where equipment was moved or removed.
  - 6. Paint shall withstand the following temperatures without peeling or discoloration:
    - a. Condensate and Feedwater: 38 degrees C (100 degrees F) on insulation jacket surface and 121 degrees C (250 degrees F) on metal pipe surface.
    - b. Steam: 52 degrees C (125 degrees F) on insulation jacket surface and 190 degrees C (374 degrees F) on metal pipe surface.
  - 7. 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.
  - 8. Lead based paints are prohibited.

### **3.8 IDENTIFICATION SIGNS**

- A. Provide laminated plastic signs, with engraved lettering not less than 5 mm (3/16 inch) high, designating functions, for all equipment, switches, motor controllers, relays, meters, control devices, including automatic control valves. Nomenclature and identification symbols shall correspond to that used in maintenance manual, and in diagrams specified elsewhere. Attach by chain, adhesive, or screws.
- B. Factory Built Equipment: Metal plate, securely attached, with name and address of manufacturer, serial number, model number, size, performance.
- C. Pipe Identification: Refer to Section 09 91 00, PAINTING.

- D. Attach ceiling grid label on ceiling grid location directly underneath above-ceiling air terminal, control system component, valve, filter unit, fan etc.

### **3.9 MOTOR AND DRIVES**

- A. Use synchronous belt drives only on equipment controlled by soft starters or variable frequency drive motor controllers without a bypass contactor. Use V-belt drives on all other applications.
- B. Alignment of V-Belt Drives: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane.
- C. Alignment of Synchronous Belt Drives: Set driving and driven shafts parallel and align so that the corresponding pulley flanges are in the same plane.
- D. Alignment of Direct-Connect Drives: Securely mount motor in accurate alignment so that shafts are per coupling manufacturer's tolerances when both motor and driven machine are operating at normal temperatures.

### **3.10 LUBRICATION**

- A. All equipment and devices requiring lubrication shall be lubricated prior to initial operation. Field-check all devices for proper lubrication.
- B. All devices and equipment shall be equipped with required lubrication fittings or devices. A minimum of 0.95 liter (1 quart) of oil and 0.45 kg (1 pound) of grease of manufacturer's recommended grade and type for each different application shall be provided; also provide 12 grease sticks for lubricated plug valves. Deliver all materials to COR in unopened containers that are properly identified as to application.
- C. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.
- D. All lubrication points shall be extended to one side of the equipment.

### **3.11 STARTUP, TEMPORARY OPERATION AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.

- C. The Commissioning Agent will observe startup and Contractor testing of selected equipment. Coordinate the startup and Contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.
- D. Startup of equipment shall be performed as described in equipment specifications. Vibration within specified tolerance shall be verified 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.

### **3.12 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 in individual Division 23 specification sections and submit the test reports and records to the COR.
- B. Should evidence of malfunction in any tested system, or piece of equipment or component part thereof, occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost or time 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 conduct such performance tests and finalize control settings for heating systems and for cooling systems respectively during first actual seasonal use of respective systems following completion of work. Rescheduling of these tests shall be requested in writing to COR for approval.
- D. No adjustments may be made during the acceptance inspection. All adjustments shall have been made by this point.
- E. Perform tests as required for commissioning provisions in accordance with Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS and Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

### **3.13 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

**3.14 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

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**SECTION 23 05 12**  
**GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies the furnishing, installation and connection of motors for HVAC and steam generation equipment.
- B. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- F. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- G. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- H. Section 26 24 19, MOTOR CONTROL CENTERS.
- I. Section 26 29 11, MOTOR CONTROLLERS.

**1.3 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. Where conflicts occur these specifications and the VHA standard will govern.
- B. American Bearing Manufacturers Association (ABMA):
  - 9-2015 .....Load Ratings and Fatigue Life for Ball Bearings
  - 11-2015 .....Load Ratings and Fatigue Life for Roller Bearings
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
  - 90.1-2013 .....Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings
- D. Institute of Electrical and Electronics Engineers (IEEE):
  - 112-2004 .....Standard Test Procedure for Polyphase Induction Motors and Generators
  - 841-2009 .....IEEE Standard for Petroleum and Chemical Industry-Premium-Efficiency, Severe-Duty,

Totally Enclosed Fan-Cooled (TEFC) Squirrel  
Cage Induction Motors--Up to and Including 370  
kW (500 hp)

E. National Electrical Manufacturers Association (NEMA):

- MG 1-2014 .....Motors and Generators
- MG 2-2014 .....Safety Standard for Construction and Guide for  
Selection, Installation and Use of Electric  
Motors and Generators
- 250-2014 .....Enclosures for Electrical Equipment (1000 Volts  
Maximum)

F. National Fire Protection Association (NFPA):

- 70-2014 .....National Electrical Code (NEC)

**1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT", with applicable paragraph identification.
- C. Submit motor submittals with driven equipment.
- D. Shop Drawings:
  - 1. Provide documentation to demonstrate compliance with contract documents.
  - 2. Motor nameplate information shall be submitted including electrical ratings, efficiency, bearing data, power factor, frame size, dimensions, mounting details, materials, horsepower, voltage, phase, speed (RPM), enclosure, starting characteristics, torque characteristics, code letter, full load and locked rotor current, service factor, and lubrication method.
- E. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
- F. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:



1. Include complete list indicating all components of the systems.
  2. Include complete diagrams of the internal wiring for each item of equipment.
  3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- G. Certification: Two weeks prior to final inspection, unless otherwise noted, certification shall be submitted to the COR stating that the motors have been properly applied, installed, adjusted, lubricated, and tested.
- H. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- I. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

#### **1.5 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD and inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or

breach of the 'third party testing company' requirement. Provide record drawings as follows:

1. As-built drawings are to be provided, with a copy of them in three-dimensional Building Information Modeling (BIM) software version 2019 provided on CD or DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

## **PART 2 - PRODUCTS**

### **2.1 MOTORS**

- A. For alternating current, fractional and integral horsepower motors, NEMA MG 1 and NEMA MG 2 shall apply.
- B. For severe duty TEFC motors, IEEE 841 shall apply.
- C. All material and equipment furnished and installation methods shall conform to the requirements of Section 26 29 11, MOTOR CONTROLLERS; and Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES. Provide all electrical wiring, conduit, and devices necessary for the proper connection, protection and operation of the systems. Provide premium efficiency type motors. Unless otherwise specified for a particular application, use electric motors with the following requirements.

- D. Single-phase Motors: Motors for centrifugal fans and pumps may be split phase or permanent split capacitor (PSC) type. Provide capacitor-start type for hard starting applications.
- E. Poly-phase Motors: NEMA Design B, Squirrel cage, induction type.
1. Two Speed Motors: Each two-speed motor shall have two separate windings. Provide a time- delay (20 seconds minimum) relay for switching from high to low speed.
- F. 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: 208-230/460 volts, dual connection.
    - c. Motors, 74.6 kW (100 hp) or larger, connected to 240-volt systems: 230 volts.
    - d. Motors, 74.6 kW (100 hp) or larger, connected to 480-volt systems: 460 volts.
    - e. Motors connected to high voltage systems (Over 600V): Shall conform to NEMA MG 1 for connection to the nominal system voltage shown on the drawings.
- G. 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 (1 hp), may be single phase provided the manufacturer of the proposed assemblies cannot supply the assemblies with three phase motors.
- H. 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.

I. Motor designs, as indicated by the NEMA code letters, shall be coordinated with the connected loads to assure adequate starting, acceleration, and running torque without exceeding nameplate ratings or considering service factor.

J. Motor Enclosures:

1. Shall be the NEMA types as specified and/or shown in the Contract Documents.
2. Where the types of motor enclosures are not shown on the drawings, they shall be the NEMA types per NEMA 250, which are most suitable for the environmental conditions where the motors are being installed. Enclosure requirements for certain conditions are as follows:
  - a. Motors located outdoors, indoors in wet or high humidity locations, or in unfiltered airstreams shall be totally enclosed type.
  - b. Where motors are located in an NEC 511 classified area, provide TEFC explosion proof motor enclosures.
  - c. Where motors are located in a corrosive environment, provide TEFC enclosures with corrosion resistant finish.
3. Enclosures shall be primed and finish coated at the factory with manufacturer's prime coat and standard finish.

K. Electrical Design Requirements:

1. Motors shall be continuous duty.
2. The insulation system shall be rated minimum of Class B, 130 degrees C (266 degrees F).
3. The maximum temperature rise by resistance at rated power shall not exceed Class B limits, 80 degrees C (176 degrees F).
4. The speed/torque and speed/current characteristics shall comply with NEMA Design A or B, as specified.
5. Motors shall be suitable for full voltage starting, unless otherwise noted. Coordinate motor features with applicable motor controllers.
6. Motors for variable frequency drive applications shall adhere to NEMA MG 1, Part 30, Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General-Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both, or NEMA MG 1, Part 31, Definite-Purpose Inverter-Fed Polyphase Motors.

L. Mechanical Design Requirements:

1. Bearings shall be rated in accordance with ABMA 9 or ABMA 11 for a minimum fatigue life of 26,280 hours for belt-driven loads and 100,000 hours for direct-drive loads based on L10 (Basic Rating Life) at full load direct coupled, except vertical high thrust motors which require a 40,000 hours rating. A minimum fatigue life of 40,000 hours is required for VFD drives.
2. Vertical motors shall be capable of withstanding a momentary up thrust of at least 30 percent of normal down thrust.
3. Grease lubricated bearings shall be designed for electric motor use. Grease shall be capable of the temperatures associated with electric motors and shall be compatible with Polyurea based greases.
4. Grease fittings, if provided, shall be Alemite type or equivalent.
5. Oil lubricated bearings, when specified, shall have an externally visible sight glass to view oil level.
6. Vibration shall not exceed 3.8 mm (0.15 inch) per second, unfiltered peak.
7. Noise level shall meet the requirements of the application.
8. Motors on 180 frames and larger shall have provisions for lifting eyes or lugs capable of a safety factor of 5.
9. All external fasteners shall be corrosion resistant.
10. Condensation heaters, when specified, shall keep motor windings at least 5 degrees C (9 degrees F) above ambient temperature.
11. Winding thermostats, when specified shall be normally closed, connected in series.
12. Grounding provisions shall be in the main terminal box.

M. 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 cost or time 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. Wiring material located where temperatures can exceed 71 degrees C (160 degrees F) shall be stranded copper with Teflon FEP insulation with jacket. This includes wiring on the boilers.
  - b. Other wiring at boilers and to control panels shall be NFPA 70 designation THWN.
  - c. 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-duty" per NEMA MG 1, Part 31, Definite-Purpose Inverter-Fed Polyphase Motors. Provide motor shaft grounding apparatus that will protect bearings from damage from stray currents.
- N. Additional requirements for specific motors, as indicated in the other sections listed in paragraph, RELATED SECTIONS shall also apply.
- O. NEMA Premium Efficiency Electric Motors (Motor Efficiencies): All permanently wired polyphase motors of 746 W (1 hp) or more shall meet the minimum full-load efficiencies as indicated in the following table. Motors of 746 W (1 hp) or more with open, drip-proof, or TEFC 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 Premium Efficiencies Open Drip-Proof				Minimum Premium Efficiencies Totally Enclosed Fan-Cooled (TEFC)			
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%
37.3 (50)	94.1%	94.5%	93.0%	37.3 (50)	94.1%	94.5%	93.0%
44.8 (60)	94.5%	95.0%	93.6%	44.8 (60)	94.5%	95.0%	93.6%
56.9 (75)	94.5%	95.0%	93.6%	56.9 (75)	94.5%	95.4%	93.6%
74.6 (100)	95.0%	95.4%	93.6%	74.6 (100)	95.0%	95.4%	94.1%
93.3 (125)	95.0%	95.4%	94.1%	93.3 (125)	95.0%	95.4%	95.0%
112 (150)	95.4%	95.8%	94.1%	112 (150)	95.8%	95.8%	95.0%
149.2 (200)	95.4%	95.8%	95.0%	149.2 (200)	95.8%	96.2%	95.4%

P. Minimum Power Factor at Full Load and Rated Voltage: 90 percent at 1200 RPM, 1800 RPM, and 3600 RPM. Power factor correction capacitors shall be provided unless the motor meets the 0.90 requirement without it or if the motor is controlled by a variable frequency drive. The power factor correction capacitors shall be able to withstand high voltage transients and power line variations without breakdown.

Q. Energy Efficiency of Small Motors (Motor Efficiencies): All motors under 746 W (1 hp) shall meet the requirements of the DOE Small Motor Regulation.

<b>Polyphase Open Motors Average full load efficiency</b>				<b>Capacitor-start capacitor-run and capacitor-start induction run open motors Average full load efficiency</b>			
<b>Rating kW (hp)</b>	<b>6 poles</b>	<b>4 poles</b>	<b>2 poles</b>	<b>Rating kW (hp)</b>	<b>6 poles</b>	<b>4 poles</b>	<b>2 poles</b>
0.18 (0.25)	67.5	69.5	65.6	0.18 (0.25)	62.2	68.5	66.6
0.25 (0.33)	71.4	73.4	69.5	0.25 (0.33)	66.6	72.4	70.5
0.37 (0.5)	75.3	78.2	73.4	0.37 (0.5)	76.2	76.2	72.4
0.55 (0.75)	81.7	81.1	76.8	0.55 (0.75)	80.2	81.8	76.2

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

**3.2 FIELD TESTS**

- A. All tests shall be witnessed by the Commissioning Agent or by the COR.
- B. Perform an electric insulation resistance Test using a megohmmeter on all motors after installation, before startup. All shall test free from grounds.
- C. Perform Load test in accordance with IEEE 112, Test Method B, to determine freedom from electrical or mechanical defects and compliance with performance data.
- D. Insulation Resistance: Not less than one-half meg-ohm between stator conductors and frame, to be determined at the time of final inspection.
- E. All test data shall be compiled into a report form for each motor and provided to the contracting officer or their representative.

**3.3 STARTUP AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

**3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.



**3.5 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for one hour to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

- - - E N D - - -



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

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Noise criteria, seismic restraints for equipment, vibration tolerance and vibration isolation for HVAC and plumbing work.

**1.2 RELATED WORK**

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA and SAMPLES.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- F. Section 23 31 00, HVAC DUCTS and CASINGS.
- M. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

**1.3 QUALITY ASSURANCE**

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

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
Audio Speech Pathology	25
Audio Suites	25
Auditoriums, Theaters	35-40
Bathrooms and Toilet Rooms	40
Chapels	35
Conference Rooms	35
Corridors (Nurse Stations)	40
Corridors(Public)	40
Dining Rooms, Food Services/ Serving	40
Examination Rooms	35
Gymnasiums	50
Kitchens	50
Laboratories (With Fume Hoods)	45 to 55
Laundries	50
Lobbies, Waiting Areas	40
Locker Rooms	45
Offices, Large Open	40

Offices, Small Private	35
Operating Rooms	40
Patient Rooms	35
Phono/Cardiology	25
Recreation Rooms	40-45
Shops	50
SPD (Decontamination and Clean Preparation)	45
Therapeutic Pools	45
Treatment Rooms	35
Warehouse	50
X-Ray and General Work Rooms	40

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 requirements are not exceeded. Selection procedure shall be in accordance with ASHRAE Fundamentals Handbook, Chapter 7, 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.

//C. Seismic Restraint Requirements:

1. Equipment:
  - a. All mechanical equipment not supported with isolators external to the unit shall be securely anchored to the structure. Such mechanical equipment shall be properly supported to resist a

horizontal force of 20 percent of the weight of the equipment furnished.

- b. All mechanical equipment mounted on vibration isolators shall be provided with seismic restraints capable of resisting a horizontal force of 50 percent of the weight of the equipment furnished.
2. Piping: Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
3. Ductwork: Refer to specification Section 23 31 00, HVAC DUCTS AND CASINGS.
- 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.
- D. Seismic Requirements: Submittals are required for all equipment anchors, supports and seismic restraints. Submittals shall include weights, dimensions, standard connections, and manufacturer's certification that all specified equipment will withstand seismic Lateral Force requirements as shown on drawings.

**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 7, Sound and Vibration
- C. American Society for Testing and Materials (ASTM):  
A123/A123M-09 .....Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products  
A307-07b .....Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength  
D2240-05(2010) .....Standard Test Method for Rubber Property - Durometer Hardness
- D. Manufacturers Standardization (MSS):  
SP-58-2009 .....Pipe Hangers and Supports-Materials, Design and Manufacture
- E. Occupational Safety and Health Administration (OSHA):  
29 CFR 1910.95 .....Occupational Noise Exposure
- F. American Society of Civil Engineers (ASCE):  
ASCE 7-10 .....Minimum Design Loads for Buildings and Other Structures.
- G. American National Standards Institute / Sheet Metal and Air Conditioning Contractor's National Association (ANSI/SMACNA):  
001-2008 .....Seismic Restraint Manual: Guidelines for Mechanical Systems, 3rd Edition.
- H. International Code Council (ICC):  
2009 IBC .....International Building Code.
- I. Department of Veterans Affairs (VA):  
H-18-8 2010 .....Seismic Design Requirements.

**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.
- C. Exposure to weather: Isolator housings to be either hot dipped galvanized or powder coated to ASTM B117 salt spray testing standards. Springs to be powder coated or electro galvanized. All hardware to be electro galvanized. In addition provide limit stops to resist wind velocity. Velocity pressure established by wind shall be calculated in accordance with section 1609 of the International Building Code. A minimum wind velocity of 75 mph shall be employed.
- 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.

## **2.2 SEISMIC RESTRAINT REQUIREMENTS FOR EQUIPMENTS**

- A. Bolt pad mounted equipment, without vibration isolators, to the floor or other support using ASTM A307 standard bolting material.
- B. Floor mounted equipment, with vibration Isolators: Type SS. Where Type N isolators are used provide channel frame base horizontal restraints bolted to the floor, or other support, on all sides of the equipment Size and material required for the base shall be as recommended by the isolator manufacturer.
- C. On all sides of suspended equipment, provide bracing for rigid supports and provide restraints for resiliently supported equipment.

## **2.3 VIBRATION ISOLATORS**

- A. Floor Mountings:
  - 1. Double Deflection Neoprene (Type N): Shall include neoprene covered steel support plated (top and bottom), friction pads, and necessary bolt holes.
  - 2. Spring Isolators (Type S): Shall be free-standing, laterally stable and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.
  - 3. Captive Spring Mount for Seismic Restraint (Type SS):
    - a. Design mounts to resiliently resist seismic forces in all directions. Snubbing shall take place in all modes with adjustment to

limit upward, downward, and horizontal travel to a maximum of 6 mm (1/4-inch) before contacting snubbers. Mountings shall have a minimum rating of one G coefficient of gravity as calculated and certified by a registered structural engineer.

- b. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50 percent of the rated deflection. Mountings shall have ports for spring inspection. Provide an all directional neoprene cushion collar around the equipment bolt.
4. Spring Isolators with Vertical Limit Stops (Type SP): Similar to spring isolators noted above, except include a vertical limit stop to limit upward travel if weight is removed and also to reduce movement and spring extension due to wind loads. Provide clearance around restraining bolts to prevent mechanical short circuiting. Isolators shall have a minimum seismic rating of one G.
  5. Pads (Type D), Washers (Type W), and Bushings (Type L): Pads shall be natural rubber or neoprene waffle, neoprene and steel waffle, or reinforced duck and neoprene. Washers and bushings shall be reinforced duck and neoprene. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).
  6. Seismic Pad (Type DS): Pads shall be natural rubber / neoprene waffle with steel top plate and drilled for an anchor bolt. Washers and bushings shall be reinforced duck and neoprene. Size pads for a maximum load of 345 kPa (50 pounds per square inch).
- 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.
  6. Hangers used in seismic applications shall be provided with a neoprene and steel rebound washer installed  $\frac{1}{4}$ ' clear of bottom of hanger housing in operation to prevent spring from excessive upward travel
- 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.
- D. Thrust Restraints (Type THR): Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow a maximum movement of 6 mm (1/4 inch) when the fan starts and stops. Restraint assemblies shall include rods, angle brackets and other hardware for field installation.

#### **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.

- B. Integral Structural Steel Base (Type B): Design base with isolator brackets to reduce mounting height of equipment which require a complete supplementary rigid 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 (four inches).
- C. Inertia Base (Type I): Base shall be a reinforced concrete inertia base. Pour concrete into a welded steel channel frame, incorporating prelocated equipment anchor bolts and pipe sleeves. Level the concrete to provide a smooth uniform bearing surface for equipment mounting. Provide grout under uneven supports. Channel depth shall be a minimum of 1/12 of longest dimension of base but not less than 150 mm (six inches). Form shall include 13-mm (1/2-inch) reinforcing bars welded in place on minimum of 203 mm (eight inch) centers running both ways in a layer 40 mm (1-1/2 inches) above bottom. Use height saving brackets in all mounting locations. Weight of inertia base shall be equal to or greater than weight of equipment supported to provide a maximum peak-to-peak displacement of 2 mm (1/16 inch).
- D. Curb Mounted Isolation Base (Type CB): Fabricate from aluminum to fit on top of standard curb with overlap to allow water run-off and have wind and water seals which shall not interfere with spring action. Provide resilient snubbers with 6 mm (1/4 inch) clearance for wind resistance. Top and bottom bearing surfaces shall have sponge type weather seals. Integralspring isolators shall comply with Spring Isolator (Type S) requirements.

## **2.5 SOUND ATTENUATING UNITS**

Refer to specification Section 23 31 00, HVAC DUCTS and CASINGS.

## **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 with a deflection equal to that used on the corresponding equipment.
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.
- 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 1/4inch (6-mm) 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.
- G. Torque anchor bolts according to equipment manufacturer's recommendations to resist seismic forces.

**3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

- - - E N D - - -

**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	BASE TYPE	ISOL TYPE	MIN DEFL	BASE TYPE	ISOL TYPE	MIN DEFL	
<b>REFRIGERATION MACHINES</b>																
ABSORPTION	---	D	0.3	---	SP	0.8	---	SP	1.5	---	SP	1.5	---	SP	2.0	
PACKAGED HERMETIC	---	D	0.3	---	SP	0.8	---	SP	1.5	---	SP	1.5	R	SP	2.5	
OPEN CENTRIFUGAL	B	D	0.3	B	SP	0.8	---	SP	1.5	B	SP	1.5	B	SP	3.5	
RECIPROCATING:																
ALL	---	D	0.3	---	SP	0.8	R	SP	2.0	R	SP	2.5	R	SP	3.5	
<b>COMPRESSORS AND VACUUM PUMPS</b>																
UP THROUGH 1-1/2 HP	---	D, L, W	0.8	----	D, L, W	0.8	---	D, L, W	1.5	---	D, L, W	1.5	---	D, L, W	---	
2 HP AND OVER:																
500 - 750 RPM	---	D	0.8	---	S	0.8	---	S	1.5	---	S	1.5	---	S	2.5	
750 RPM & OVER	---	D	0.8	---	S	0.8	---	S	1.5	---	S	1.5	---	S	2.5	
<b>PUMPS</b>																
CLOSE COUPLED	UP TO 1-1/2 HP	---	---	---	---	D, L, W	---	---	D, L, W	---	---	D, L, W	---	---	D, L, W	---
	2 HP & OVER	---	---	---	I	S	0.8	I	S	1.5	I	S	1.5	I	S	2.0

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
LARGE INLINE	Up to 25 HP	---	---	---	---	S	0.75	---	S	1.50	---	S	1.50	---	---	NA
	26 HP THRU 30 HP	---	---	---	---	S	1.0	---	S	1.50	---	S	2.50	---	---	NA
BASE MOUNTED	UP TO 10 HP	---	---	---	---	D, L, W	---	---	D, L, W	---	---	D, L, W	---	---	D, L, W	---
	15 HP THRU 40 HP	I	S	1.0	I	S	1.0	I	S	2.0	I	S	2.0	I	S	2.0
	50 HP & OVER	I	S	1.0	I	S	1.0	I	S	2.0	I	S	2.5	I	S	2.5
<b>ROOF FANS</b>																
ABOVE OCCUPIED AREAS:																
5 HP & OVER		---	---	---	CB	S	1.0	CB	S	1.0	CB	S	1.0	CB	S	1.0
<b>CENTRIFUGAL FANS</b>																
UP TO 50 HP:																
UP TO 200 RPM		B	N	0.3	B	S	2.5	B	S	2.5	B	S	3.5	B	S	3.5
201 - 300 RPM		B	N	0.3	B	S	2.0	B	S	2.5	B	S	2.5	B	S	3.5
301 - 500 RPM		B	N	0.3	B	S	2.0	B	S	2.0	B	S	2.5	B	S	3.5
501 RPM & OVER		B	N	0.3	B	S	2.0	B	S	2.0	B	S	2.0	B	S	2.5

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
60 HP & OVER:															
UP TO 300 RPM	B	S	2.0	I	S	2.5	I	S	3.5	I	S	3.5	I	S	3.5
301 - 500 RPM	B	S	2.0	I	S	2.0	I	S	2.5	I	S	3.5	I	S	3.5
501 RPM & OVER	B	S	1.0	I	S	2.0	I	S	2.0	I	S	2.5	I	S	2.5
<b>COOLING TOWERS</b>															
UP TO 500 RPM	---	---	---	---	SP	2.5	---	SP	2.5	---	SP	2.5	---	SP	3.5
501 RPM & OVER	---	---	---	---	SP	0.75	---	SP	0.75	---	SP	1.5	---	SP	2.5
<b>INTERNAL COMBUSTION ENGINES</b>															
UP TO 25 HP	I	N	0.75	I	N	1.5	I	S	2.5	I	S	3.5	I	S	4.5
30 THRU 100 HP	I	N	0.75	I	N	1.5	I	S	2.5	I	S	3.5	I	S	4.5
125 HP & OVER	I	N	0.75	I	N	1.5	I	S	2.5	I	S	3.5	I	S	4.5
<b>AIR HANDLING UNIT PACKAGES</b>															
SUSPENDED:															
UP THRU 5 HP	---	---	---	---	H	1.0	---	H	1.0	---	H	1.0	---	H	1.0
7-1/2 HP & OVER:															
UP TO 500 RPM	---	---	---	---	H, THR	1.5	---	H, THR	2.5	---	H, THR	2.5	---	H, THR	2.5
501 RPM & OVER	---	---	---	---	H, THR	0.8	---	H, THR	0.8	---	H, TH R	0.8	---	H, TH R	2.0

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
<b>FLOOR MOUNTED:</b>															
UP THRU 5 HP	---	D	---	---	S	1.0	---	S	1.0	---	S	1.0	---	S	1.0
7-1/2 HP & OVER:															
UP TO 500 RPM	---	D	---	R	S, THR	1.5	R	S, THR	2.5	R	S, THR	2.5	R	S, THR	2.5
501 RPM & OVER	---	D	---	---	S, THR	0.8	---	S, THR	0.8	R	S, THR	1.5	R	S, THR	2.0
<b>HEAT PUMPS</b>															
ALL	---	S	0.75	---	S	0.75	---	S	0.75	CB	S	1.5	---	---	NA
<b>CONDENSING UNITS</b>															
ALL	---	SS	0.25	---	SS	0.75	---	SS	1.5	CB	SS	1.5	---	---	NA
<b>IN-LINE CENTRIFUGAL AND VANE AXIAL FANS, FLOOR MOUNTED: (APR 9)</b>															
UP THRU 50 HP:															
UP TO 300 RPM	---	D	---	R	S	2.5	R	S	2.5	R	S	2.5	R	S	3.5
301 - 500 RPM	---	D	---	R	S	2.0	R	S	2.0	R	S	2.5	R	S	2.5
501 - & OVER	---	D	---	---	S	1.0	---	S	1.0	R	S	2.0	R	S	2.5
60 HP AND OVER:															
301 - 500 RPM	R	S	1.0	R	S	2.0	R	S	2.0	R	S	2.5	R	S	3.5
501 RPM & OVER	R	S	1.0	R	S	2.0	R	S	2.0	R	S	2.0	R	S	2.5



**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.

B. Definitions:

1. Basic TAB used in this Section: Chapter 38, "Testing, Adjusting and Balancing" of 2011 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.
5. Hydronic Systems: Includes chilled water, condenser water, heating hot 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 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANTS and STEAM GENERATION.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- D. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

- E. Section 23 07 11, HVAC, AND BOILER PLANT INSULATION:
- F. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS. Equipment Insulation.
- G. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC
- H. Section 23 31 00, HVAC DUCTS AND CASINGS
- G. Section 23 36 00, AIR TERMINAL UNITS:
- I. Section 23 64 00, PACKAGED WATER CHILLERS: Testing Refrigeration Equipment.
- J. Section 23 65 00, COOLING TOWERS.

### **1.3 QUALITY ASSURANCE**

- A. Refer to Articles, Quality Assurance and Submittals, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC, Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANTS and STEAM GENERATION, and Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- 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 Resident Engineer 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 Resident Engineer 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 Resident Engineer. 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. The lead technician shall be certified by AABC or NEBB
- 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 38, 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 2011 ASHRAE Handbook "HVAC Applications", Chapter 38, as a guideline. Air Filter resistance during tests, artificially imposed if necessary, shall be at least 100 percent of manufacturer recommended change over pressure drop 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. Exhaust hoods/cabinets: 0 percent to plus 10 percent.
    - d. Minimum outside air: 0 percent to plus 10 percent.
    - e. Individual room air outlets and inlets, and air flow rates not mentioned above: Minus 5 percent to plus 10 percent except if the air to a space is 100 CFM or less the tolerance would be minus 5 to plus 5 percent.
    - f. Heating hot water pumps and hot water coils: Minus 5 percent to plus 5 percent.
    - g. Chilled water and condenser water pumps: Minus 0 percent to plus 5 percent.
    - h. Chilled water coils: Minus 0 percent 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 Resident Engineer for one air distribution system (including all fans, three terminal units, three rooms randomly selected by the Resident Engineer) and one hydronic system (pumps and three coils) as follows:
    - a. When field TAB work begins.
    - b. During each partial final inspection and the final inspection for the project if requested by VA.

#### **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 Resident Engineer 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.
  - 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 or Partial 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):
  - 2011 .....HVAC Applications ASHRAE Handbook, Chapter 38, Testing, Adjusting, and Balancing and Chapter 48, 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

2nd Edition 2006 .....Procedural Standards for the Measurement of  
Sound and Vibration

3<sup>rd</sup> Edition 2009 .....Procedural Standards for Whole Building Systems  
Commissioning of New Construction

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**

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

### **2.2 INSULATION REPAIR MATERIAL**

See Section 23 07 11, HVAC and BOILER PLANT 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**

The TAB Specialist shall review the Contract Plans and specifications and advise the Resident Engineer 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**

TAB Agency shall perform the leakage test as outlined in "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. The TAB Contractor shall measure existing air and water flow rates associated with existing systems utilized to serve renovated areas as indicated on drawings. Submit report of findings to resident engineer.
- B. Inspect each System to ensure that it is complete including installation and operation of controls. Submit report to RE in standard format and forms prepared and or approved by the Commissioning Agent.
- C. Verify that all items such as ductwork piping, ports, terminals, connectors, etc., that is required for TAB are installed. Provide a report to the Resident Engineer.

#### **3.6 TAB REPORTS**

- A. Submit an intermediate report for 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 Resident Engineer 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 at no additional cost to the owner.
- D. Do not proceed with the remaining systems until intermediate report is approved by the Resident Engineer.

#### **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 existing systems and 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. Return existing areas outside the work area to pre constructed conditions.
- D. Allow \_\_\_ days 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, and I.T. room AC units.
  - 1. Artificially load air filters by partial blanking to produce air pressure drop of manufacturer's recommended 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. Variable air volume (VAV) systems:
    - a. Coordinate TAB, including system volumetric controls, with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
    - b. Section 23 36 00, AIR TERMINAL UNITS, specifies that maximum and minimum flow rates for air terminal units (ATU) be factory set. Check and readjust ATU flow rates if necessary. Balance air distribution from ATU on full cooling maximum scheduled cubic meters per minute (cubic feet per minute). Reset room thermostats and check ATU operation from maximum to minimum cooling, to the heating mode, and back to cooling. Record and report the heating coil leaving air temperature when the ATU is in the maximum heating mode. Record and report outdoor air flow rates under all operating conditions (The test shall demonstrate that the minimum outdoor air ventilation rate shall remain constant under all operating conditions).
    - c. Adjust operating pressure control setpoint to maintain the design flow to each space with the lowest setpoint.

5. Record final measurements for air handling equipment performance data sheets.
- F. Water Balance and Equipment Test: Include circulating pumps, convertors, coils, coolers and condensers:
1. Adjust flow rates for equipment. Set coils and evaporator to values on equipment submittals, if different from values on contract drawings.
  2. Tertiary (variable volume) systems: Coordinate TAB with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. Balance systems at design water flow and then verify that variable flow controls function as designed.
  3. Record final measurements for hydronic equipment on performance data sheets. Include entering and leaving water temperatures for heating and cooling coils, and for convertors. 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 centrifugal/screw compressors, cooling towers, pumps, fans and motors.
- B. Record initial measurements for each unit of equipment on test forms and submit a report to the Resident Engineer. 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 Resident Engineer.

### **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.
  1. Take readings in rooms, approximately ten percent of all rooms. The Resident Engineer may designate the specific rooms to be tested.

2. Provide cooling tower sound measurements. Refer to Section 23 65 00, COOLING TOWERS.
- 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 2011 ASHRAE Handbook, "HVAC Applications", Chapter 48, 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 13 meters (40 feet) for sound level location.

3. Where sound pressure levels are specified in terms of dB(A), as in Section 23 65 00, COOLING TOWERS, measure sound levels using the "A" scale of meter. Single value readings will be used instead of octave band analysis.
- E. Where measured sound levels exceed specified level, the installing contractor or equipment manufacturer shall take remedial action approved by the Resident Engineer and the necessary sound tests shall be repeated.
- F. Test readings for sound testing could go higher than 15 percent if determination is made by the Resident Engineer based on the recorded sound data.

### **3.10 MARKING OF SETTINGS**

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 Resident Engineer.

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

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.

### **3.12 PHASING**

- A. Phased Projects: Testing and Balancing Work to follow project with areas shall be completed per the project phasing. Upon completion of the project all areas shall have been tested and balanced per the contract documents.
- B. Existing Areas: Systems that serve areas outside of the project scope shall not be adversely affected. Measure existing parameters where shown to document system capacity.

### **3.13 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection,

start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

- - E N D - - -

**SECTION 23 07 11**  
**HVAC AND BOILER PLANT INSULATION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Field applied insulation for thermal efficiency and condensation control for
1. HVAC piping, ductwork and equipment.
  3. Re-insulation of HVAC piping, ductwork and equipment, 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 equipment or piping handling media above 41 degrees C (105 degrees F).
  8. Density: kg/m<sup>3</sup> - 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. Vapor Retarder (Vapor Barrier): A material which retards the transmission (migration) of water vapor. Performance of the vapor retarder is rated in terms of permeance (perms). For the purpose of this specification, vapor retarders shall have a maximum published permeance of 0.1 perms and vapor barriers shall have a maximum published permeance of 0.001 perms.
13. HPS: High pressure steam (415 kPa [60 psig] and above).
14. HPR: High pressure steam condensate return.
15. MPS: Medium pressure steam (110 kPa [16 psig] thru 414 kPa [59 psig]).
16. MPR: Medium pressure steam condensate return.
17. LPS: Low pressure steam (103 kPa [15 psig] and below).
18. LPR: Low pressure steam condensate gravity return.
19. PC: Pumped condensate.
20. HWH: Hot water heating supply.
21. HWHR: Hot water heating return.
22. GH: Hot glycol-water heating supply.
23. GHR: Hot glycol-water heating return.
24. FWPD: Feedwater pump discharge.
25. FWPS: Feedwater pump suction.
26. CTPD: Condensate transfer pump discharge.
27. CTPS: Condensate transfer pump suction.
28. VR: Vacuum condensate return.
29. CPD: Condensate pump discharge.
30. R: Pump recirculation.
31. FOS: Fuel oil supply.
32. FOR: Fuel oil return.
33. CW: Cold water.
34. SW: Soft water.
35. HW: Hot water.
36. CH: Chilled water supply.
37. CHR: Chilled water return.
38. GC: Chilled glycol-water supply.
39. GCR: Chilled glycol-water return.



40. RS: Refrigerant suction.

41. PVDC: Polyvinylidene chloride vapor retarder jacketing, white.

## 1.2 RELATED WORK

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.
- D. Section 07 84 00, FIRESTOPPING.
- E. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- F. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.
- G. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- H. Section 23 21 13, HYDRONIC PIPING.
- I. Section 23 22 13, STEAM and CONDENSATE HEATING PIPING
- J. Section 23 22 23, STEAM CONDENSATE PUMPS
- K. Section 23 50 11, BOILER PLANT MECHANICAL EQUIPMENT
- L. Section 23 51 00, BREECHINGS, CHIMNEYS, and STACKS

## 1.3 QUALITY ASSURANCE

A. Refer to article QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.

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, parts of which are quoted as follows:

**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 4.3.3.1.1 or 4.3.3.1.2., 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.

**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.)

**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.

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

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.

4.3.3.3.1 In no case shall the test temperature be below 121°C (250°F).

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.

4.3.3.5\* Air duct linings shall be interrupted at fire dampers to prevent interference with the operation of devices.

4.3.3.6 Air duct coverings shall not be installed so as to conceal or prevent the use of any service opening.

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.

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.

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.

4.3.10.2.6.6 Supplementary materials for air distribution systems shall be permitted when complying with the provisions of 4.3.3.

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.

C. Samples:

1. Each type of insulation: Minimum size 100 mm (4 inches) square for board/block/ blanket; 150 mm (6 inches) long, full diameter for round types.
2. Each type of facing and jacket: Minimum size 100 mm (4 inches square).
3. Each accessory material: Minimum 120 ML (4 ounce) liquid container or 120 gram (4 ounce) dry weight for adhesives / cement / mastic.

**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 (2)- 99 .....Plastic Sheet (Sheeting): Plastic Strip; Poly (Vinyl Chloride) and Poly (Vinyl Chloride - Vinyl Acetate), Rigid.
- C. Military Specifications (Mil. Spec.):
  - MIL-A-3316C (2)-90 .....Adhesives, Fire-Resistant, Thermal Insulation
  - MIL-A-24179A (1)-87 ....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):

- A167-99(2004) .....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
- C533-09 .....Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation
- 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
- C585-09 .....Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System) R (1998)
- C612-10 .....Standard Specification for Mineral Fiber Block and Board Thermal Insulation
- C1126-04 .....Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
- C1136-10 .....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

- E84-10 .....Standard Test Method for Surface Burning  
Characteristics of Building  
Materials
- E119-09c .....Standard Test Method for Fire Tests of Building  
Construction and Materials
- E136-09b .....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-09 .....Standard for the Installation of Air  
Conditioning and Ventilating Systems
- 96-08 .....Standards for Ventilation Control and Fire  
Protection of Commercial Cooking Operations
- 101-09 .....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):
- SP58-2009 .....Pipe Hangers and Supports Materials, Design,  
and Manufacture

**PART 2 - PRODUCTS**

**2.1 MINERAL FIBER OR FIBER GLASS**

- A. ASTM C612 (Board, Block), Class 1 or 2, density 48 kg/m<sup>3</sup> (3 pcf), k = 0.037 (0.26) at 24 degrees C (75 degrees F), external insulation for temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.
- B. ASTM C553 (Blanket, Flexible) Type I, Class B-3, Density 16 kg/m<sup>3</sup> (1 pcf), k = 0.045 (0.31) at 24 degrees C (75 degrees F), for use at temperatures up to 204 degrees C (400 degrees F) with foil scrim (FSK) facing.

- C. ASTM C547 (Pipe Fitting Insulation and Preformed Pipe Insulation), Class 1,  $k = 0.037$  (0.26) at 24 degrees C (75 degrees F), for use at temperatures up to 230 degrees C (450 degrees F) with an all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.

## **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) at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with all service vapor retarder jacket with polyvinyl chloride premolded fitting covering.
- B. Equipment and Duct Insulation, ASTM C 1126, type II, grade 1,  $k = 0.021$  (0.15) at 10 degrees C (50 degrees F), for use at temperatures up to 121 degrees C (250 degrees F) with rigid cellular phenolic insulation and covering, and all service vapor retarder 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 24 degrees C (75 degrees F).
- B. Pipe insulation for use at temperatures up to 200 degrees C (400 degrees F) with all service vapor retarder jacket.

## **2.5 POLYISOCYANURATE CLOSED-CELL RIGID**

- A. Preformed (fabricated) pipe insulation, ASTM C591, type IV,  $K=0.027$ (0.19) at 24 degrees C (75 degrees F), flame spread not over 25, smoke developed not over 50, for use at temperatures up to 149 degree C (300 degree F) with factory applied PVDC or all service vapor retarder jacket with polyvinyl chloride premolded fitting covers.
- B. Equipment and duct insulation, ASTM C 591, type IV,  $K=0.027$ (0.19) at 24 degrees C (75 degrees F), for use at temperatures up to 149 degrees C (300 degrees F) with PVDC or all service jacket vapor retarder jacket.

## **2.6 FLEXIBLE ELASTOMERIC CELLULAR THERMAL**

ASTM C177, C518,  $k = 0.039$  (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 DUCT WRAP FOR KITCHEN HOOD GREASE DUCTS**

- A. Light weight, high temperature mineral fiber or ceramic fiber insulating material with low thermal conductivity K value of 0.060 W/m<sup>2</sup> degrees C (0.417 Btu in/hr ft<sup>2</sup> degrees F) at mean temperature of 260 degrees C (500 degrees F).
- B. Material shall be fully encapsulated by UL classified aluminum foil and tested to ASTM E84 standard.
- C. Material shall be UL tested for internal grease fire to 1093 degrees C (2,000 degrees F) with zero clearance and for through-penetration firestop.
- D. Material shall be UL classified for 1 hour fire rating for grease duct enclosure, and meet NFPA 96 requirements for direct applied insulating material to grease ducts with zero clearance.
- E. Material flame spread and smoke developed ratings shall not be higher than 5, as per ASTM E 84/UL 723 Flammability Test.

**2.8 CALCIUM SILICATE**

- A. Preformed pipe Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- B. Premolded Pipe Fitting Insulation: ASTM C533, Type I and Type II with indicator denoting asbestos-free material.
- C. Equipment Insulation: ASTM C533, Type I and Type II
- D. Characteristics:

<b>Insulation Characteristics</b>		
<b>ITEMS</b>	<b>TYPE I</b>	<b>TYPE II</b>
Temperature, maximum degrees C (degrees F)	649 (1200)	927 (1700)
Density (dry), Kg/m <sup>3</sup> (lb/ ft3)	232 (14.5)	288 (18)
Thermal conductivity: Min W/ m K (Btu in/h ft <sup>2</sup> degrees F)@ mean temperature of 93 degrees C (200 degrees F)	0.059 (0.41)	0.078 (0.540)
Surface burning characteristics: Flame spread Index, Maximum	0	0
Smoke Density index, Maximum	0	0



## 2.9 INSULATION FACINGS AND JACKETS

- A. Vapor Retarder, higher strength with low water permeance  $\leq 0.02$  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 50 units, Suitable for painting without sizing. Jackets shall have minimum 40 mm (1-1/2 inch) lap on longitudinal joints and minimum 75 mm (3 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. Field applied vapor barrier jackets shall be provided, in addition to the specified facings and jackets, on all exterior piping and ductwork as well as on interior piping and ductwork exposed to outdoor air (i.e.; in ventilated attics, piping in ventilated (not air conditioned) spaces, etc.) in high humidity areas conveying fluids below ambient temperature. The vapor barrier jacket shall consist of a multi-layer laminated cladding with a maximum water vapor permeance of 0.001 perms. The minimum puncture resistance shall be 35 cm-kg (30 inch-pounds) for interior locations and 92 cm-kg (80 inch-pounds) for exterior or exposed locations or where the insulation is subject to damage.
- E. 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.
- F. Factory composite materials may be used provided that they have been tested and certified by the manufacturer.

- G. 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.
- H. Aluminum Jacket-Piping systems: 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 13 mm (0.5 inch) wide on 450 mm (18 inch) centers. System shall be weatherproof if utilized for outside service.

**2.10 REMOVABLE INSULATION JACKETS**

- A. Insulation and Jacket:
1. Non-Asbestos Glass mat, type E needled fiber.
  2. Temperature maximum of 450°F, Maximum water vapor transmission of 0.00 perm, and maximum moisture absorption of 0.2 percent by volume.
  3. Jacket Material: Silicon/fiberglass and LFP 2109 pure PTFE.
  4. Construction: One piece jacket body with three-ply braided pure Teflon or Kevlar thread and insulation sewn as part of jacket. Belt fastened.

**2.11 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).

<b>Nominal Pipe Size and Accessories Material (Insert Blocks)</b>	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
Up through 125 (5)	150 (6) long
150 (6)	150 (6) long
200 (8), 250 (10), 300 (12)	225 (9) long
350 (14), 400 (16)	300 (12) long

<b>Nominal Pipe Size and Accessories Material (Insert Blocks)</b>	
Nominal Pipe Size mm (inches)	Insert Blocks mm (inches)
450 through 600 (18 through 24)	350 (14) 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 or calcium silicate. 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).

**2.12 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.

**2.13 MECHANICAL FASTENERS**

- A. Pins, anchors: Welded pins, or metal or nylon anchors with galvanized steel-coated or fiber washer, or clips. Pin diameter shall be as recommended by the insulation manufacturer.
- B. Staples: Outward clinching galvanized 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: 13 mm (0.5 inch) nominal width, brass, galvanized steel, aluminum or stainless steel.

**2.14 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.

#### **2.15 FIRESTOPPING MATERIAL**

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

#### **2.16 FLAME AND SMOKE**

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. Where removal of insulation of piping, ductwork and equipment is required to comply with Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT and Section 02 82 13.13, GLOVEBAG ASBESTOS ABATEMENT, such areas shall be reinsulated to comply with this specification.
- D. 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 retarder 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).

- E. Install vapor stops at all insulation terminations on either side of valves, pumps and equipment and particularly in straight lengths of pipe insulation.
- F. 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.
- G. 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.
- H. 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.
- I. Insulate PRVs, flow meters, and steam traps.
  - I. 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, flash tanks, hot water pumps, steam condensate pumps.
    - 5. In hot piping: Unions, flexible connectors, control valves, PRVs, safety valves and discharge vent piping, vacuum breakers, thermostatic vent valves, steam traps 20 mm (3/4 inch) and smaller, exposed piping through floor for convectors and radiators. Insulate

- piping to within approximately 75 mm (3 inches) of uninsulated items.
- K. Apply insulation materials subject to the manufacturer's recommended temperature limits. Apply adhesives, mastic and coatings at the manufacturer's recommended minimum coverage.
- L. 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.
- M. 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. Freeze protection of above grade outdoor piping (over heat tracing tape): 26 mm (10 inch) thick insulation, for all pipe sizes 75 mm(3 inches) and smaller and 25 mm(1inch) thick insulation for larger pipes. Provide metal jackets for all pipes. Provide for cold water make-up to cooling towers and condenser water piping and chilled water piping as described in Section 2321 13, HYDRONIC PIPING (electrical heat tracing systems).
- O. Provide vapor barrier jackets over insulation as follows:
1. All piping and ductwork exposed to outdoor weather.
  
  2. All interior piping and ducts conveying fluids exposed to outdoor air (i.e. in attics, ventilated (not air conditioned) spaces, etc.) in high humidity areas.
- P. 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**

#### **A. Mineral Fiber Board:**

1. Faced board: Apply board on pins spaced not more than 300 mm (12 inches) on center each way, and not less than 75 mm (3 inches) from each edge of board. In addition to pins, apply insulation bonding adhesive to entire underside of horizontal metal surfaces. Butt insulation edges tightly and seal all joints with laps and butt strips. After applying speed clips cut pins off flush and apply vapor seal patches over clips.
2. Plain board:
  - a. Insulation shall be scored, beveled or mitered to provide tight joints and be secured to equipment with bands spaced 225 mm (9 inches) on center for irregular surfaces or with pins and clips on flat surfaces. Use corner beads to protect edges of insulation.
  - b. For hot equipment: Stretch 25 mm (1 inch) mesh wire, with edges wire laced together, over insulation and finish with insulating and finishing cement applied in one coat, 6 mm (1/4 inch) thick, trowel led to a smooth finish.
  - c. For cold equipment: Apply meshed glass fabric in a tack coat 1.5 to 1.7 square meter per liter (60 to 70 square feet per gallon) of vapor mastic and finish with mastic at 0.3 to 0.4 square meter per liter (12 to 15 square feet per gallon) over the entire fabric surface.
  - d. Chilled water pumps: Insulate with removable and replaceable 1 mm thick (20 gage) aluminum or galvanized steel covers lined with insulation. Seal closure joints/flanges of covers with gasket material. Fill void space in enclosure with flexible mineral fiber insulation.

3. Exposed, unlined ductwork and equipment in unfinished areas, mechanical and electrical equipment rooms and attics, and duct work exposed to outdoor weather:
    - a. 50 mm (2 inch) thick insulation faced with ASJ (white all service jacket): Supply air duct, unlined air handling units, and after filter housing.
    - b. 40 mm (1-1/2 inch) thick insulation faced with ASJ: Return air duct, mixed air plenums and prefilter housing.
    - c. Outside air intake ducts: no insulation required.
    - d. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a reinforcing membrane and two coats of vapor barrier mastic or multi-layer vapor barrier with a maximum water vapor permeability of 0.001 perms.
  4. Supply air duct in the warehouse and in the laundry: 25 mm (one inch) thick insulation faced with ASJ.
  5. Cold equipment: 40 mm (1-1/2inch) thick insulation faced with ASJ.
    - a. Chilled water pumps, water filter, chemical feeder pot or tank.
    - b. Pneumatic, cold storage water and surge tanks.
  6. Hot equipment: 40 mm (1-1/2 inch) thick insulation faced with ASJ.
    - a. Convertors, air separators, steam condensate pump receivers.
    - b. Reheat coil casing and separation chambers on steam humidifiers located above ceilings.
    - c. Domestic water heaters and hot water storage tanks (not factory insulated).
    - d. Booster water heaters for dietetics dish and pot washers and for washdown grease-extracting hoods.
  7. Laundry: Hot exhaust ducts from dryers and from ironers, where duct is exposed in the laundry.
- B. Flexible Mineral Fiber Blanket:
1. Adhere insulation to metal with 75 mm (3 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, in attics, and duct work exposed to outdoor weather: 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:
    - a. Above ceilings at a roof level, unconditioned areas, and in chases with external wall or containing steam piping; 40 mm (1-1/2 inch) thick, insulation faced with FSK.
    - b. Concealed return air ductwork in other locations need not be insulated.
  5. Concealed outside air duct: 40 mm (1-1/2 inch) thick insulation faced with FSK.
  6. Exhaust air branch duct from autopsy refrigerator to main 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 the schedule at the end of this section.
- 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.
  8. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a multi-layer vapor barrier with a maximum water vapor permeance of 0.00 perms.
  9. Condensation control insulation: Minimum 25 mm (1.0 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.
- E. Cellular Glass Insulation:

1. Pipe and tubing, covering nominal thickness in millimeters and inches as specified in the schedule at the end of this section.
  2. Underground Piping Other than or in lieu of that Specified in Section 23 21 13, HYDRONIC PIPING and Section 33 63 00, STEAM ENERGY DISTRIBUTION: Type II, factory jacketed with a 3 mm laminate jacketing consisting of 3000 mm x 3000 mm (10 ft x 10 ft) asphalt impregnated glass fabric, bituminous mastic and outside protective plastic film.
    - a. 75 mm (3 inches) thick for hot water piping.
    - b. As scheduled at the end of this section for chilled water piping.
    - c. Underground piping: Apply insulation with joints tightly butted. Seal longitudinal self-sealing lap. Use field fabricated or factory made fittings. Seal butt joints and fitting with jacketing as recommended by the insulation manufacturer. Use 100 mm (4 inch) wide strips to seal butt joints.
    - d. Provide expansion chambers for pipe loops, anchors and wall penetrations as recommended by the insulation manufacturer.
    - e. Underground insulation shall be inspected and approved by the Resident Engineer as follows:
      - 1) Insulation in place before coating.
      - 2) After coating.
    - f. Sand bed and backfill: Minimum 75 mm (3 inches) all around insulated pipe or tank, applied after coating has dried.
  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.
  4. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a reinforcing membrane and two coats of vapor barrier mastic or multi-layer vapor barrier with a water vapor permeability of 0.00 perms.
- 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 and Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.
    - 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 the schedule at the end of this section.
  5. Minimum 20 mm (0.75 inch) thick insulation for pneumatic control lines for a minimum distance of 6 m (20 feet) from discharge side of the refrigerated dryer.
  6. Use Class S (Sheet), 20 mm (3/4 inch) thick for the following:
    - a. Chilled water pumps
    - b. Bottom and sides of metal basins for winterized cooling towers (where basin water is heated).
    - c. Chillers, insulate any cold chiller surfaces subject to condensation which has not been factory insulated.
    - d. Piping inside refrigerators and freezers: Provide heat tape under insulation.
  7. Exposed, unlined supply and return ductwork exposed to outdoor weather: 50 mm (2 inch) thick insulation faced with a multi-layer vapor barrier with a water vapor permeance of 0.00 perms.
- H. Duct Wrap for Kitchen Hood Grease Ducts:
1. The insulation thickness, layers and installation method shall be as per recommendations of the manufacturer to maintain the fire integrity and performance rating.

2. Provide stainless steel jacket for all exterior and exposed interior ductwork.

I. Calcium Silicate:

1. Minimum thickness in millimeter (inches) specified in the schedule at the end of this section for piping other than in boiler plant. See paragraphs 3.3 through 3.7 for Boiler Plant Applications.

2. Engine Exhaust Insulation for Emergency Generator and Diesel Driven Fire Pump: Type II, Class D, 65 mm (2 1/2 inch) nominal thickness. Cover exhaust completely from engine through roof or wall construction, including muffler. Secure with 16 AWG galvanized annealed wire or 0.38 x 12 mm 0.015 x 1/2 IN wide galvanized bands on 300 mm 12 IN maximum centers. Anchor wire and bands to welded pins, clips or angles. Apply 25 mm 1 IN hex galvanized wire over insulation. Fill voids with 6 mm 1/4 IN insulating cement.

3. ETO Exhaust (High Temperature): Type II, class D, 65 mm (2.5 inches) nominal thickness. Cover duct for entire length. Provide sheet aluminum jacket for all exterior ductwork.

4. Kitchen Exhaust Duct work: Type II, class D, 65 mm (2.5 inches) nominal thickness. Wire insulation in place with 12 gauge galvanized wire.

5. MRI Quench Vent Insulation: Type I, class D, 150 mm (6 inch) nominal thickness.

**3.7 COMMISSIONING**

A. Provide commissioning documentation in accordance with the requirements of section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

B. Components provided under this section of the specification will be tested as part of a larger system. Refer to section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

**3.8 PIPE INSULATION SCHEDULE**

Provide insulation for piping systems as scheduled below:

Insulation Thickness Millimeters (Inches)
-------------------------------------------

		Nominal Pipe Size Millimeters (Inches)			
Operating Temperature Range/Service	Insulation Material	Less than 25 (1)	25 - 32 (1 - 1¼)	38 - 75 (1½ - 3)	100 (4) and Above
122-177 degrees C (251-350 degrees F) (HPS, MPS)	Mineral Fiber (Above ground piping only)	75 (3)	100 (4)	113 (4.5)	113 (4.5)
93-260 degrees C (200-500 degrees F) (HPS, HPR)	Calcium Silicate	100 (4)	125 (5)	150 (6)	150 (6)
100-121 degrees C (212-250 degrees F) (HPR, MPR, LPS, vent piping from PRV Safety Valves, Condensate receivers and flash tanks)	Mineral Fiber (Above ground piping only)	62 (2.5)	62 (2.5)	75 (3.0)	75 (3.0)
100-121 degrees C (212-250 degrees F) (HPR, MPR, LPS, vent piping from PRV Safety Valves, Condensate receivers and flash tanks)	Rigid Cellular Phenolic Foam	50 (2.0)	50 (2.0)	75 (3.0)	75 (3.0)
38-94 degrees C (100-200 degrees F) (LPR, PC, HWH, HWHR, GH and GHR)	Mineral Fiber (Above ground piping only)	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
38-99 degrees C (100-211 degrees F) (LPR, PC, HWH, HWHR, GH and GHR)	Rigid Cellular Phenolic Foam	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
39-99 degrees C (100-211 degrees F) (LPR, PC, HWH, HWHR, GH and GHR)	Polyiso-cyanurate Closed-Cell Rigid (Exterior Locations only)	38 (1.5)	38 (1.5)	-----	-----

38-94 degrees C (100-200 degrees F) (LPR, PC, HWH, HWHR, GH and GHR)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	----	----
4-16 degrees C (40-60 degrees F) (CH, CHR, GC, GCR and RS for DX refrigeration)	Rigid Cellular Phenolic Foam	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)
4-16 degrees C (40-60 degrees F) (CH and CHR within chiller room and pipe chase and underground)	Cellular Glass Closed- Cell	50 (2.0)	50 (2.0)	75 (3.0)	75 (3.0)
4-16 degrees C (40-60 degrees F) (CH, CHR, GC, GCR and RS for DX refrigeration)	Cellular Glass Closed- Cell	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)
4-16 degrees C (40-60 degrees F) (CH, CHR, GC and GCR (where underground)	Polyiso- cyanurate Closed-Cell Rigid	38 (1.5)	38 (1.5)	50 (2.0)	50 (2.0)
4-16 degrees C (40-60 degrees F) (CH, CHR, GC, GCR and RS for DX refrigeration)	Polyiso- cyanurate Closed-Cell Rigid (Exterior Locations only)	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)
(40-60 degrees F) (CH, CHR, GC, GCR and RS for DX refrigeration)	Flexible Elastomeric Cellular Thermal (Above ground piping only)	38 (1.5)	38 (1.5)	38 (1.5)	38 (1.5)

- - - E N D - - -





**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. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the VA will manage the commissioning process.

**1.2 RELATED WORK**

- A. Section 01 00 00 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

**1.3 SUMMARY**

- A. This Section includes requirements for commissioning the Facility exterior closure, related subsystems and related equipment. This Section supplements the general requirements specified in Section 01 91 00 General Commissioning Requirements.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

**1.4 DEFINITIONS**

- A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

**1.5 COMMISSIONED SYSTEMS**

- A. Commissioning of a system or systems specified in Division 23 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel in accordance with the requirements of Section 01 91 00 and of Division 23, is required in cooperation with the VA and the Commissioning Agent.

- B. The Facility exterior closure systems commissioning will include the systems listed in Section 01 91 00 General Commissioning Requirements:

#### **1.6 SUBMITTALS**

- A. The commissioning process requires review of selected Submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.
- B. The commissioning process requires Submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

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

#### **PART 3 - EXECUTION**

##### **3.1 CONSTRUCTION INSPECTIONS**

- A. Commissioning of HVAC systems will require inspection of individual elements of the HVAC systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 91 00 and the Commissioning plan to schedule HVAC systems inspections as required to support the Commissioning Process.

##### **3.2 PRE-FUNCTIONAL CHECKLISTS**

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the

Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to SECTION 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

### **3.3 CONTRACTORS TESTS**

- A. Contractor tests as required by other sections of Division 23 shall be scheduled and documented in accordance with Section 01 00 00 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

### **3.4 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 Functional Performance Test procedures for review and approval by the Resident Engineer. 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. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS, for additional details.

### **3.5 TRAINING OF VA PERSONNEL**

- A. Training of the VA operation and maintenance personnel is required in cooperation with the Resident Engineer and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 91 00. The instruction shall be

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scheduled in coordination with the VA Resident Engineer after  
submission and approval of formal training plans. Refer to Section 01  
91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 23 Sections for  
additional Contractor training requirements.

----- END -----

**SECTION 23 09 23**  
**DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Provide (a) direct-digital control system(s) as indicated on the project documents, point list, interoperability tables, drawings and as described in these specifications. Include a complete and working direct-digital control system. Include all engineering, programming, controls and installation materials, installation labor, commissioning and start-up, training, final project documentation and warranty.
1. The direct-digital control system(s) shall consist of high-speed, peer-to-peer network of DDC controllers, a control system server, and an Engineering Control Center. Provide a remote user using a standard web browser to access the control system graphics and change adjustable setpoints with the proper password.
  2. The direct-digital control system(s) shall be native BACnet. All new workstations, controllers, devices and components shall be listed by BACnet Testing Laboratories. All new workstations, controller, devices and components shall be accessible using a Web browser interface and shall communicate exclusively using the ASHRAE Standard 135 BACnet communications protocol without the use of gateways, unless otherwise allowed by this Section of the technical specifications, specifically shown on the design drawings and specifically requested otherwise by the VA.
    - a. If used, gateways shall support the ASHRAE Standard 135 BACnet communications protocol.
    - b. If used, gateways shall provide all object properties and read/write services shown on VA-approved interoperability schedules.
  3. The work administered by this Section of the technical specifications shall include all labor, materials, special tools, equipment, enclosures, power supplies, software, software licenses, Project specific software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, submittals, testing, verification, training services, permits and licenses, transportation, shipping, handling,

administration, supervision, management, insurance, Warranty, specified services and items required for complete and fully functional Controls Systems.

4. The control systems shall be designed such that each mechanical system shall operate under stand-alone mode. The contractor administered by this Section of the technical specifications shall provide controllers for each mechanical system. In the event of a network communication failure, or the loss of any other controller, the control system shall continue to operate independently. Failure of the ECC shall have no effect on the field controllers, including those involved with global strategies.
  5. The control system shall accommodate 2 Engineering Control Center(s) and the control system shall accommodate 10 web-based Users simultaneously, and the access to the system should be limited only by operator password.
- B. Some products are furnished but not installed by the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical specifications shall formally coordinate in writing and receive from other contractors formal acknowledgements in writing prior to submission the installation of the products. These products include the following:
1. Control valves.
  2. Flow switches.
  3. Flow meters.
  4. Sensor wells and sockets in piping.
  5. Terminal unit controllers.
- C. Some products are installed but not furnished by the contractor administered by this Section of the technical specifications. The contractor administered by this Section of the technical specifications shall formally coordinate in writing and receive from other contractors formal acknowledgements in writing prior to submission the procurement of the products. These products include the following:
1. Factory-furnished accessory thermostats and sensors furnished with unitary equipment.
- D. Some products are not provided by, but are nevertheless integrated with the work executed by, the contractor administered by this Section of the technical specifications. The contractor administered by this

Section of the technical specifications shall formally coordinate in writing and receive from other contractors formal acknowledgements in writing prior to submission the particulars of the products. These products include the following:

1. Fire alarm systems. If zoned fire alarm is required by the project-specific requirements, this interface shall require multiple relays, which are provided and installed by the fire alarm system contractor, to be monitored.
2. /Advanced utility metering systems. These systems may take information from the control system or its component meters and sensors. There is no command or control action from the advanced utility monitoring system on the control system however.
3. Terminal units' velocity sensors
4. Unitary HVAC equipment (rooftop air conditioning units, split systems, packaged pumping stations) controls. These include:
  - a. Discharge temperature control.
  - b. Economizer control.
  - c. Flowrate control.
  - d. Setpoint reset.
  - e. Time of day indexing.
  - f. Status alarm.
5. Variable frequency drives. These controls, if not native BACnet, will require a BACnet Gateway.
6. The following systems have limited control (as individually noted below) from the ECC:
  - a. Constant temperature rooms: temperature out of acceptable range and status alarms.
  - b. Process and food service coolers, refrigerators and freezers: in patient nutrition kitchens, blood banks, mortuaries, and pharmacies: high temperature, trending and status alarms.
  - c. Medical gas systems (if not bottled at point of use): low pressure and status alarms.
  - d. Emergency generators: status alarms.
  - e. Domestic water heating systems: low temperature, high temperature and status alarms.
  - f. Building lighting systems: on/off and scene control.
  - g. Stormwater removal pumps: status alarm.

- h. Sanitary sewage pumps: status alarm.
- i. Fume hoods and biological safety cabinets: status alarms
- j. Isolation rooms: pressure outside of acceptable limit alarms.

E. Responsibility Table:

<b>Work/Item/System</b>	<b>Furnish</b>	<b>Install</b>	<b>Low Voltage Wiring</b>	<b>Line Power</b>
Control system low voltage and communication wiring	23 09 23	23 09 23	23 09 23	N/A
Terminal units	23	23	N/A	26
Controllers for terminal units	23 09 23	23	23 09 23	16
LAN conduits and raceway	23 09 23	23 09 23	N/A	N/A
Automatic dampers (not furnished with equipment)	23 09 23	23	N/A	N/A
Automatic damper actuators	23 09 23	23 09 23	23 09 23	23 09 23
Manual valves	23	23	N/A	N/A
Automatic valves	23 09 23	23	23 09 23	23 09 23
Pipe insertion devices and taps, flow and pressure stations.	23	23	N/A	N/A
Thermowells	23 09 23	23	N/A	N/A
Current Switches	23 09 23	23 09 23	23 09 23	N/A
Control Relays	23 09 23	23 09 23	23 09 23	N/A
Power distribution system monitoring interfaces	23 09 23	23 09 23	23 09 23	26
Interface with chiller/boiler controls	23 09 23	23 09 23	23 09 23	26
All control system nodes, equipment, housings, enclosures and panels.	23 09 23	23 09 23	23 09 23	26
Smoke detectors	28 31 00	28 31 00	28 31 00	28 31 00
Fire/Smoke Dampers	23	23	28 31 00	28 31 00
Smoke Dampers	23	23	28 31 00	28 31 00
Fire Dampers	23	23	N/A	N/A
Water treatment system	23	23	23	26
VFDs	23 09 23	26	23 09 23	26
Refrigerant monitors	23	23 09 23	23 09 23	26



<b>Work/Item/System</b>	<b>Furnish</b>	<b>Install</b>	<b>Low Voltage Wiring</b>	<b>Line Power</b>
Medical gas panels	23	23	26	26
Computer Room A/C Unit field-mounted controls	23	23	16	26
Control system interface with CRU A/C controls	23 09 23	23 09 23	23 09 23	26
CRU A/C unit controls interface with control system	23	23 09 23	23 09 23	26
Fire Alarm shutdown relay interlock wiring	28	28	28	26
Control system monitoring of fire alarm smoke control relay	28	28	23 09 23	28
Fan Coil Unit controls (not furnished with equipment)	23 09 23	23 09 23	23 09 23	26
Unit Heater controls (not furnished with equipment)	23 09 23	23 09 23	23 09 23	26
Packaged RTU space-mounted controls (not furnished with equipment)	23 09 23	23 09 23	23 09 23	26
Packaged RTU unit-mounted controls (not furnished with equipment)	23 09 23	23 09 23	23 09 23	26
Starters, HOA switches	23	23	N/A	26

F. This facility's existing direct-digital control system is manufactured by Johnson Controls, Inc. (JCI)- Topeka. Coordinate the ECC location with the contracting officer's representative. The existing system's top-end communications is via BACnet. The contractor administered by this Section of the technical specifications shall observe the capabilities, communication network, services, spare capacity of the existing control system and its ECC prior to beginning work.

1. Upgrade the existing direct-digital control system's ECC to include all properties and services required by an ASHRAE Standard 135 BACnet B-AWS Profile. The upgraded ECC shall continue to communicate with the existing direct-digital control system's devices. The upgraded ECC shall communicate directly with the new native-BACnet devices over the existing control system's communications network without the

use of a gateway. Provide programming converting the existing non-BACnet devices, objects and services to ASHRAE Standard 135 BACnet-complaint BIBBs. The contractor administered by this Section of the technical specifications shall provide all necessary investigation and site-specific programming to execute the interoperability schedules.

- a. The combined system shall operate and function as one complete system including one database of control point objects and global control logic capabilities. Facility operators shall have limited operations and control capability over the legacy systems, as described in the VA-approved interoperability schedules.
- G. This campus has standardized on an existing standard ASHRAE Standard 135, BACnet/IP Control System supported by a preselected controls service company. This entity is referred to as the "Control System Integrator" in this Section of the technical specifications. The Control system integrator is responsible for ECC system graphics and expansion. It also prescribes control system-specific commissioning/verification procedures to the contractor administered by this Section of the technical specification. It lastly provides limited assistance to the contractor administered by this Section of the technical specification in its commissioning/verification work.
1. The General Contractor of this project shall directly hire the Control System Integrator in a contract separate from the contract procuring the controls contractor administered by this Section of the technical specifications.
  2. The contractor administered by this Section of the technical specifications shall coordinate all work with the Control System Integrator. The contractor administered by this Section of the technical specifications shall integrate the ASHRAE Standard 135, BACnet/IP control network(s) with the Control System Integrator's area control through an Ethernet connection provided by the Control System Integrator.
  3. The contractor administered by this Section of the technical specifications shall provide a peer-to-peer networked, stand-alone, distributed control system. This direct digital control (DDC) system shall include one portable operator terminal - laptop, one digital display unit, microprocessor-based controllers, instrumentation, end

control devices, wiring, piping, software, and related systems. This contractor is responsible for all device mounting and wiring.

4. Responsibility Table:

Item/Task	Section 23 09 23 contractor	Control system integrator	VA
ECC expansion		X	
ECC programming		X	
Devices, controllers, control panels and equipment	X		
Point addressing: all hardware and software points including setpoint, calculated point, data point (analog/binary), and reset schedule point	X		
Point mapping		X	
Network Programming	X		
ECC Graphics		X	
Controller programming and sequences	X		
Integrity of LAN communications	X		
Electrical wiring	X		
Operator system training		X	
LAN connections to devices	X		
LAN connections to ECC		X	
IP addresses			X
Overall system verification		X	
Controller and LAN system verification	X		

H. Unitary standalone systems including Unit Heaters, Cabinet Unit Heaters, Fan Coil Units, Base Board Heaters, thermal comfort ventilation fans, and similar units for control of room environment conditions may be equipped with integral controls furnished and installed by the equipment manufacturer or field mounted. Refer to equipment specifications and as indicated in project documents. Application of standalone unitary controls is limited to at least those systems wherein remote monitoring, alarm and start-up are not necessary. Examples of such systems include:

1. Light-switch-operated toilet exhaust
2. Vestibule heater
3. Exterior stair heater
4. Attic heating and ventilation
5. Mechanical or electrical room heating and ventilation.

I The direct-digital control system shall start and stop equipment, move (position) damper actuators and valve actuators, and vary speed of equipment to execute the mission of the control system. Use

electricity as the motive force for all damper and valve actuators,  
unless use of pneumatics as motive force is specifically granted by the  
VA.

## **1.2 RELATED WORK**

- A. Section 21 05 11, Common Work Results for Fire Suppression.
- B. Section 21 10 00, Water-Based Fire-Suppression Systems.
- C. Section 22 11 23, Domestic Water Pumps.
- D. Section 22 35 00, Domestic Water Heat Exchangers.
- E. Section 22 63 00, Gas Systems for Laboratory and Healthcare Facilities.
- F. Section 23 21 13, Hydronic Piping.
- G. Section 23 22 13, Steam and Condensate Heating Piping.
- H. Section 23 31 00, HVAC Ducts and Casings.
- I. Section 23 36 00, Air Terminal Units.
- J. Section 23 38 13, Commercial-Kitchen Hoods.
- K. Section 23 74 13 Packaged Outdoor Central-Station Air-Handling Units.
- L. Section 23 81 00, Decentralized Unitary HVAC Equipment.
- M. Section 23 81 23, Computer-Room Air-Conditioners.
- N. Section 23 81 43, Air-Source Unitary Heat Pumps.
- O. Section 23 81 46, Water-Source Unitary Heat Pumps.
- P. Section 23 84 00, Humidity Control Equipment.
- Q. Section 26 05 11, Requirements for Electrical Installations.
- R. Section 26 05 21, Low-Voltage Electrical Power Conductors and Cables  
(600 Volts and Below).
- S. Section 26 05 26, Grounding and Bonding for Electrical Systems.
- T. Section 26 05 33, Raceway and Boxes for Electrical Systems.
- U. Section 26 09 23, Lighting Controls.
- V. Section 26 22 21, Specialty Transformers.
- W. Section 26 27 26, Wiring Devices.
- X. Section 26 29 11, Motor Starters.
- Y. Section 27 15 00, Communications Horizontal Cabling
- Z. Section 28 31 00, Fire Detection and Alarm.

## **1.2 DEFINITION**

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem; A prescribed set of well-defined rules or processes for the solution of a problem in a finite number of steps.

- B. ARCNET: ANSI/ATA 878.1 - Attached Resource Computer Network. ARCNET is a deterministic LAN technology; meaning it's possible to determine the maximum delay before a device is able to transmit a message.
- C. Analog: A continuously varying signal value (e.g., temperature, current, velocity etc).
- D. BACnet: A Data Communication Protocol for Building Automation and Control Networks, ANSI/ASHRAE Standard 135. This communications protocol allows diverse building automation devices to communicate data over and services over a network.
- E. BACnet/IP: Annex J of Standard 135. It defines and allows for using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP sub-networks that share the same BACnet network number.
- F. BACnet Internetwork: Two or more BACnet networks connected with routers. The two networks may use different LAN technologies.
- G. BACnet Network: One or more BACnet segments that have the same network address and are interconnected by bridges at the physical and data link layers.
- H. BACnet Segment: One or more physical segments of BACnet devices on a BACnet network, connected at the physical layer by repeaters.
- I. BACnet Broadcast Management Device (BBMD): A communications device which broadcasts BACnet messages to all BACnet/IP devices and other BBMDs connected to the same BACnet/IP network.
- J. BACnet Interoperability Building Blocks (BIBBs): BACnet Interoperability Building Blocks (BIBBs) are collections of one or more BACnet services. These are prescribed in terms of an "A" and a "B" device. Both of these devices are nodes on a BACnet internetwork.
- K. BACnet Testing Laboratories (BTL). The organization responsible for testing products for compliance with the BACnet standard, operated under the direction of BACnet International.
- L. Baud: It is a signal change in a communication link. One signal change can represent one or more bits of information depending on type of transmission scheme. Simple peripheral communication is normally one bit per Baud. (e.g., Baud rate = 78,000 Baud/sec is 78,000 bits/sec, if one signal change = 1 bit).
- M. Binary: A two-state system where a high signal level represents an "ON" condition and an "OFF" condition is represented by a low signal level.

- N. BMP or bmp: Suffix, computerized image file, used after the period in a DOS-based computer file to show that the file is an image stored as a series of pixels.
- O. Bus Topology: A network topology that physically interconnects workstations and network devices in parallel on a network segment.
- P. Control Unit (CU): Generic term for any controlling unit, stand-alone, microprocessor based, digital controller residing on secondary LAN or Primary LAN, used for local controls or global controls
- Q. Deadband: A temperature range over which no heating or cooling is supplied, i.e., 22-25 degrees C (72-78 degrees F), as opposed to a single point change over or overlap).
- R. Device: a control system component that contains a BACnet Device Object and uses BACnet to communicate with other devices.
- S. Device Object: Every BACnet device requires one Device Object, whose properties represent the network visible properties of that device. Every Device Object requires a unique Object Identifier number on the BACnet internetwork. This number is often referred to as the device instance.
- T. Device Profile: A specific group of services describing BACnet capabilities of a device, as defined in ASHRAE Standard 135-2008, Annex L. Standard device profiles include BACnet Operator Workstations (B-OWS), BACnet Building Controllers (B-BC), BACnet Advanced Application Controllers (B-AAC), BACnet Application Specific Controllers (B-ASC), BACnet Smart Actuator (B-SA), and BACnet Smart Sensor (B-SS). Each device used in new construction is required to have a PICS statement listing which service and BIBBs are supported by the device.
- U. Diagnostic Program: A software test program, which is used to detect and report system or peripheral malfunctions and failures. Generally, this system is performed at the initial startup of the system.
- V. Direct Digital Control (DDC): Microprocessor based control including Analog/Digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices in order to achieve a set of predefined conditions.
- W. Distributed Control System: A system in which the processing of system data is decentralized and control decisions can and are made at the

subsystem level. System operational programs and information are provided to the remote subsystems and status is reported back to the Engineering Control Center. Upon the loss of communication with the Engineering Control center, the subsystems shall be capable of operating in a stand-alone mode using the last best available data.

- X. Download: The electronic transfer of programs and data files from a central computer or operation workstation with secondary memory devices to remote computers in a network (distributed) system.
- Y. DXF: An AutoCAD 2-D graphics file format. Many CAD systems import and export the DXF format for graphics interchange.
- Z. Electrical Control: A control circuit that operates on line or low voltage and uses a mechanical means, such as a temperature sensitive bimetal or bellows, to perform control functions, such as actuating a switch or positioning a potentiometer.
- AA. Electronic Control: A control circuit that operates on low voltage and uses a solid-state components to amplify input signals and perform control functions, such as operating a relay or providing an output signal to position an actuator.
- BB. Engineering Control Center (ECC): The centralized control point for the intelligent control network. The ECC comprises of personal computer and connected devices to form a single workstation.
- CC. Ethernet: A trademark for a system for exchanging messages between computers on a local area network using coaxial, fiber optic, or twisted-pair cables.
- DD. Firmware: Firmware is software programmed into read only memory (ROM) chips. Software may not be changed without physically altering the chip.
- EE. Gateway: Communication hardware connecting two or more different protocols. It translates one protocol into equivalent concepts for the other protocol. In BACnet applications, a gateway has BACnet on one side and non-BACnet (usually proprietary) protocols on the other side.
- FF. GIF: Abbreviation of Graphic interchange format.
- GG. Graphic Program (GP): Program used to produce images of air handler systems, fans, chillers, pumps, and building spaces. These images can be animated and/or color-coded to indicate operation of the equipment.
- HH. Graphic Sequence of Operation: It is a graphical representation of the sequence of operation, showing all inputs and output logical blocks.

- II. I/O Unit: The section of a digital control system through which information is received and transmitted. I/O refers to analog input (AI, digital input (DI), analog output (AO) and digital output (DO). Analog signals are continuous and represent temperature, pressure, flow rate etc, whereas digital signals convert electronic signals to digital pulses (values), represent motor status, filter status, on-off equipment etc.
- JJ. I/P: a method for conveying and routing packets of information over LAN paths. User Datagram Protocol (UDP) conveys information to "sockets" without confirmation of receipt. Transmission Control Protocol (TCP) establishes "sessions", which have end-to-end confirmation and guaranteed sequence of delivery.
- KK. JPEG: A standardized image compression mechanism stands for Joint Photographic Experts Group, the original name of the committee that wrote the standard.
- LL. Local Area Network (LAN): A communication bus that interconnects operator workstation and digital controllers for peer-to-peer communications, sharing resources and exchanging information.
- MM. Network Repeater: A device that receives data packet from one network and rebroadcasts to another network. No routing information is added to the protocol.
- NN. MS/TP: Master-slave/token-passing (ISO/IEC 8802, Part 3). It is not an acceptable LAN option for VA health-care facilities. It uses twisted-pair wiring for relatively low speed and low-cost communication.
- OO. Native BACnet Device: A device that uses BACnet as its primary method of communication with other BACnet devices without intermediary gateways. A system that uses native BACnet devices at all levels is a native BACnet system.
- PP. Network Number: A site-specific number assigned to each network segment to identify for routing. This network number must be unique throughout the BACnet internetwork.
- QQ. Object: The concept of organizing BACnet information into standard components with various associated properties. Examples include analog input objects and binary output objects.
- RR. Object Identifier: An object property used to identify the object, including object type and instance. Object Identifiers must be unique within a device.



- SS. Object Properties: Attributes of an object. Examples include present value and high limit properties of an analog input object. Properties are defined in ASHRAE 135; some are optional and some are required. Objects are controlled by reading from and writing to object properties.
- TT. Operating system (OS): Software, which controls the execution of computer application programs.
- UU. PCX: File type for an image file. When photographs are scanned onto a personal computer they can be saved as PCX files and viewed or changed by a special application program as Photo Shop.
- VV. Peripheral: Different components that make the control system function as one unit. Peripherals include monitor, printer, and I/O unit.
- WW. Peer-to-Peer: A networking architecture that treats all network stations as equal partners- any device can initiate and respond to communication with other devices.
- XX. PICS: Protocol Implementation Conformance Statement, describing the BACnet capabilities of a device. All BACnet devices have published PICS.
- YY. PID: Proportional, integral, and derivative control, used to control modulating equipment to maintain a setpoint.
- ZZ. Repeater: A network component that connects two or more physical segments at the physical layer.
- AAA. Router: a component that joins together two or more networks using different LAN technologies. Examples include joining a BACnet Ethernet LAN to a BACnet MS/TP LAN.
- BBB. Sensors: devices measuring state points or flows, which are then transmitted back to the DDC system.
- CCC. Thermostats: devices measuring temperatures, which are used in control of standalone or unitary systems and equipment not attached to the DDC system.

#### **1.4 QUALITY ASSURANCE**

##### **A. Criteria:**

1. Single Source Responsibility of subcontractor: The Contractor shall obtain hardware and software supplied under this Section and delegate the responsibility to a single source controls installation subcontractor. The controls subcontractor shall be responsible for the complete design, installation, and commissioning of the system.

The controls subcontractor shall be in the business of design, installation and service of such building automation control systems similar in size and complexity.

2. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.
3. The controls subcontractor shall provide a list of no less than five similar projects which have building control systems as specified in this Section. These projects must be on-line and functional such that the Department of Veterans Affairs (VA) representative would observe the control systems in full operation.
4. The controls subcontractor shall have in-place facility within 50 miles with technical staff, spare parts inventory for the next five (5) years, and necessary test and diagnostic equipment to support the control systems.
5. The controls subcontractor shall have minimum of three years experience in design and installation of building automation systems similar in performance to those specified in this Section. Provide evidence of experience by submitting resumes of the project manager, the local branch manager, project engineer, the application engineering staff, and the electronic technicians who would be involved with the supervision, the engineering, and the installation of the control systems. Training and experience of these personnel shall not be less than three years. Failure to disclose this information will be a ground for disqualification of the supplier.
6. Provide a competent and experienced Project Manager employed by the Controls Contractor. The Project Manager shall be supported as necessary by other Contractor employees in order to provide professional engineering, technical and management service for the work. The Project Manager shall attend scheduled Project Meetings as required and shall be empowered to make technical, scheduling and related decisions on behalf of the Controls Contractor.

B. Codes and Standards:

1. All work shall conform to the applicable Codes and Standards.

2. Electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference, and be so labeled.

#### **1.5 PERFORMANCE**

- A. The system shall conform to the following:
  1. Graphic Display: The system shall display up to four (4) graphics on a single screen with a minimum of twenty (20) dynamic points per graphic. All current data shall be displayed within ten (10) seconds of the request.
  2. Graphic Refresh: The system shall update all dynamic points with current data within eight (8) seconds. Data refresh shall be automatic, without operator intervention.
  3. Object Command: The maximum time between the command of a binary object by the operator and the reaction by the device shall be two (2) seconds. Analog objects shall start to adjust within two (2) seconds.
  4. Object Scan: All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or work-station will be current, within the prior six (6) seconds.
  5. Alarm Response Time: The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed (10) seconds.
  6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every (5) seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
  7. Multiple Alarm Annunciations: All workstations on the network shall receive alarms within five (5) seconds of each other.
  8. Performance: Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every one (1) second. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
  9. Reporting Accuracy: Listed below are minimum acceptable reporting end-to-end accuracies for all values reported by the specified system:

Measured Variable	Reported Accuracy
Space temperature	±0.5°C (±1°F)
Ducted air temperature	±0.5°C [±1°F]
Outdoor air temperature	±1.0°C [±2°F]
Dew Point	±1.5°C [±3°F]
Water temperature	±0.5°C [±1°F]
Relative humidity	±2% RH
Water flow	±1% of reading
Air flow (terminal)	±10% of reading
Air flow (measuring stations)	±5% of reading
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO <sub>2</sub> )	±50 ppm
Air pressure (ducts)	±25 Pa [±0.1"w.c.]
Air pressure (space)	±0.3 Pa [±0.001"w.c.]
Water pressure	±2% of full scale *Note 1
Electrical Power	±0.5% of reading

Note 1: for both absolute and differential pressure

10. Control stability and accuracy: Control sequences shall maintain measured variable at setpoint within the following tolerances:

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±50 Pa (±0.2 in. w.g.)	0-1.5 kPa (0-6 in. w.g.)
Air Pressure	±3 Pa (±0.01 in. w.g.)	-25 to 25 Pa (-0.1 to 0.1 in. w.g.)
Airflow	±10% of full scale	
Space Temperature	±1.0°C (±2.0°F)	
Duct Temperature	±1.5°C (±3°F)	
Humidity	±5% RH	
Fluid Pressure	±10 kPa (±1.5 psi)	0-1 MPa (1-150 psi)
Fluid Pressure	±250 Pa (±1.0 in. w.g.)	0-12.5 kPa (0-50 in. w.g.) differential

11. Extent of direct digital control: control design shall allow for at least the points indicated on the points lists on the drawings.

#### **1.6 WARRANTY**

- A. Labor and materials for control systems shall be warranted for a period as specified under Warranty in FAR clause 52.246-21.
- B. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no cost or reduction in service to the owner. The system includes all computer equipment, transmission equipment, and all sensors and control devices.
- C. The on-line support service shall allow the Controls supplier to dial out over telephone lines to or connect via (through password-limited access) VPN through the internet monitor and control the facility's building automation system. This remote connection to the facility shall be within two (2) hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekend and holidays. If the problem cannot be resolved with on-line support services, the Controls supplier shall dispatch the qualified personnel to the job site to resolve the problem within 24 hours after the problem is reported.
- D. Controls and Instrumentation subcontractor shall be responsible for temporary operations and maintenance of the control systems during the construction period until final commissioning, training of facility operators and acceptance of the project by VA.

#### **1.7 SUBMITTALS**

- A. Submit shop drawings in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's literature and data for all components including the following:
  - 1. A wiring diagram for each type of input device and output device including DDC controllers, modems, repeaters, etc. Diagram shall show how the device is wired and powered, showing typical connections at the digital controllers and each power supply, as well as the device itself. Show for all field connected devices, including but not limited to, control relays, motor starters, electric or electronic actuators, and temperature pressure, flow and humidity sensors and transmitters.
  - 2. A diagram of each terminal strip, including digital controller terminal strips, terminal strip location, termination numbers and the associated point names.

3. Control dampers and control valves schedule, including the size and pressure drop.
4. Control air-supply components, and computations for sizing compressors, receivers and main air-piping, if pneumatic controls are furnished.
5. Catalog cut sheets of all equipment used. This includes, but is not limited to software (by manufacturer and by third parties), DDC controllers, panels, peripherals, airflow measuring stations and associated components, and auxiliary control devices such as sensors, actuators, and control dampers. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted. Each submitted piece of literature and drawings should clearly reference the specification and/or drawings that it supposed to represent.
6. Sequence of operations for each HVAC system and the associated control diagrams. Equipment and control labels shall correspond to those shown on the drawings.
7. Color prints of proposed graphics with a list of points for display.
8. Furnish a BACnet Protocol Implementation Conformance Statement (PICS) for each BACnet-compliant device.
9. Schematic wiring diagrams for all control, communication and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
10. An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.
11. Riser diagrams of wiring between central control unit and all control panels.
12. Scaled plan drawings showing routing of LAN and locations of control panels, controllers, routers, gateways, ECC, and larger controlled devices.

13. Construction details for all installed conduit, cabling, raceway, cabinets, and similar. Construction details of all penetrations and their protection.
  14. Quantities of submitted items may be reviewed but are the responsibility of the contractor administered by this Section of the technical specifications.
- C. Product Certificates: Compliance with Article, QUALITY ASSURANCE.
- D. Licenses: Provide licenses for all software residing on and used by the Controls Systems and transfer these licenses to the Owner prior to completion.
- E. As Built Control Drawings:
1. Furnish three (3) copies of as-built drawings for each control system. The documents shall be submitted for approval prior to final completion.
  2. Furnish one (1) stick set of applicable control system prints for each mechanical system for wall mounting. The documents shall be submitted for approval prior to final completion.
  3. Furnish one (1) CD-ROM in CAD DWG and/or .DXF format for the drawings noted in subparagraphs above.
- F. Operation and Maintenance (O/M) Manuals):
1. Submit in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS.
  2. Include the following documentation:
    - a. General description and specifications for all components, including logging on/off, alarm handling, producing trend reports, overriding computer control, and changing set points and other variables.
    - b. Detailed illustrations of all the control systems specified for ease of maintenance and repair/replacement procedures, and complete calibration procedures.
    - c. One copy of the final version of all software provided including operating systems, programming language, operator workstation software, and graphics software.
    - d. Complete troubleshooting procedures and guidelines for all systems.
    - e. Complete operating instructions for all systems.

- f. Recommended preventive maintenance procedures for all system components including a schedule of tasks for inspection, cleaning and calibration. Provide a list of recommended spare parts needed to minimize downtime.
  - g. Training Manuals: Submit the course outline and training material to the Owner for approval three (3) weeks prior to the training to VA facility personnel. These persons will be responsible for maintaining and the operation of the control systems, including programming. The Owner reserves the right to modify any or all of the course outline and training material.
  - h. Licenses, guaranty, and other pertaining documents for all equipment and systems.
- G. Submit Performance Report to Resident Engineer prior to final inspection.

#### **1.8 INSTRUCTIONS**

- A. Instructions to VA operations personnel: Perform in accordance with Article, INSTRUCTIONS, in Specification Section 01 00 00, GENERAL REQUIREMENTS, and as noted below.
- 1. First Phase: Formal instructions to the VA facilities personnel for a total of 16 hours, given in multiple training sessions (each no longer than four hours in length), conducted sometime between the completed installation and prior to the performance test period of the control system, at a time mutually agreeable to the Contractor and the VA.
  - 2. Second Phase: This phase of training shall comprise of on the job training during start-up, checkout period, and performance test period. VA facilities personnel will work with the Contractor's installation and test personnel on a daily basis during start-up and checkout period. During the performance test period, controls subcontractor will provide 16 hours of instructions, given in multiple training sessions (each no longer than four hours in length), to the VA facilities personnel.
  - 3. The O/M Manuals shall contain approved submittals as outlined in Article 1.7, SUBMITTALS. The Controls subcontractor will review the manual contents with VA facilities personnel during second phase of training.



4. Training shall be given by direct employees of the controls system subcontractor.

**1.9 PROJECT CONDITIONS (ENVIRONMENTAL CONDITIONS OF OPERATION)**

- A. The ECC and peripheral devices and system support equipment shall be designed to operate in ambient condition of 20 to 35°C (65 to 90°F) at a relative humidity of 20 to 80% non-condensing.
- B. The CUs used outdoors shall be mounted in NEMA 4 waterproof enclosures, and shall be rated for operation at -40 to 65°C (-40 to 150°F).
- C. All electronic equipment shall operate properly with power fluctuations of plus 10 percent to minus 15 percent of nominal supply voltage.
- D. Sensors and controlling devices shall be designed to operate in the environment, which they are sensing or controlling.

**1.10 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 (ASHRAE):
  - Standard 135-10 .....BACNET Building Automation and Control Networks
- C. American Society of Mechanical Engineers (ASME):
  - B16.18-01 .....Cast Copper Alloy Solder Joint Pressure Fittings.
  - B16.22-01 .....Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- D. American Society of Testing Materials (ASTM):
  - B32-08 .....Standard Specification for Solder Metal
  - B88-09 .....Standard Specifications for Seamless Copper Water Tube
  - B88M-09 .....Standard Specification for Seamless Copper Water Tube (Metric)
  - B280-08 .....Standard Specification for Seamless Copper Tube for Air-Conditioning and Refrigeration Field Service
  - D2737-03 .....Standard Specification for Polyethylene (PE) Plastic Tubing
- E. Federal Communication Commission (FCC):
  - Rules and Regulations Title 47 Chapter 1-2001 Part 15: Radio Frequency Devices.
- F. Institute of Electrical and Electronic Engineers (IEEE):

802.3-11 .....Information Technology-Telecommunications and  
Information Exchange between Systems-Local and  
Metropolitan Area Networks- Specific  
Requirements-Part 3: Carrier Sense Multiple  
Access with Collision Detection (CSMA/CD)  
Access method and Physical Layer Specifications

G. National Fire Protection Association (NFPA):

70-11 .....National Electric Code  
90A-09 .....Standard for Installation of Air-Conditioning  
and Ventilation Systems

H. Underwriter Laboratories Inc (UL):

94-10 .....Tests for Flammability of Plastic Materials for  
Parts and Devices and Appliances  
294-10 .....Access Control System Units  
486A/486B-10 .....Wire Connectors  
555S-11 .....Standard for Smoke Dampers  
916-10 .....Energy Management Equipment  
1076-10 .....Proprietary Burglar Alarm Units and Systems

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

A. Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Spare parts shall be available for at least five years after completion of this contract.

**2.2 CONTROLS SYSTEM ARCHITECTURE**

A. General

1. The Controls Systems shall consist of multiple Nodes and associated equipment connected by industry standard digital and communication network arrangements.
2. The ECC, building controllers and principal communications network equipment shall be standard products of recognized major manufacturers available through normal PC and computer vendor channels - not "Clones" assembled by a third-party subcontractor.
3. The networks shall, at minimum, comprise, as necessary, the following:
  - a. A fixed ECC and a portable operator's terminal.
  - b. Network computer processing, data storage and BACnet-compliant communication equipment including Servers and digital data processors.

- c. BACnet-compliant routers, bridges, switches, hubs, modems, gateways, interfaces and similar communication equipment.
  - d. Active processing BACnet-compliant building controllers connected to other BACNet-compliant controllers together with their power supplies and associated equipment.
  - e. Addressable elements, sensors, transducers and end devices.
  - f. Third-party equipment interfaces and gateways as described and required by the Contract Documents.
  - g. Other components required for a complete and working Control Systems as specified.
- B. The Specifications for the individual elements and component subsystems shall be minimum requirements and shall be augmented as necessary by the Contractor to achieve both compliance with all applicable codes, standards and to meet all requirements of the Contract Documents.
- C. Network Architecture
- 1. The Controls communication network shall utilize BACnet communications protocol operating over a standard Ethernet LAN and operate at a minimum speed of 100 Mb/sec.
  - 2. The networks shall utilize only copper and optical fiber communication media as appropriate and shall comply with applicable codes, ordinances and regulations. They may also utilize digital wireless technologies as appropriate to the application and if approved by the VA.
  - 3. All necessary telephone lines, ISDN lines and internet Service Provider services and connections will be provided by the VA.
- D. Third Party Interfaces:
- 1. The contractor administered by this Section of the technical specifications shall include necessary hardware, equipment, software and programming to allow data communications between the controls systems and building systems supplied by other trades.
  - 2. Other manufacturers and contractors supplying other associated systems and equipment shall provide their necessary hardware, software and start-up at their cost and shall cooperate fully with the contractor administered by this Section of the technical specifications in a timely manner and at their cost to ensure complete functional integration.
- E. Servers:

1. Provide data storage server(s) to archive historical data including trends, alarm and event histories and transaction logs.
2. Equip these server(s) with the same software tool set that is located in the BACnet building controllers for system configuration and custom logic definition and color graphic configuration.
3. Access to all information on the data storage server(s) shall be through the same browser functionality used to access individual nodes. When logged onto a server the operator will be able to also interact with any other controller on the control system as required for the functional operation of the controls systems. The contractor administered by this Section of the technical specifications shall provide all necessary digital processor programmable data storage server(s).
4. These server(s) shall be utilized for controls systems application configuration, for archiving, reporting and trending of data, for operator transaction archiving and reporting, for network information management, for alarm annunciation, for operator interface tasks, for controls application management and similar. These server(s) shall utilize IT industry standard data base platforms which utilize a database declarative language designed for managing data in relational database management systems (RDBMS) such as SQL.

### **2.3 COMMUNICATION**

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-2008, BACnet.
  1. The Data link / physical layer protocol (for communication) acceptable to the VA throughout its facilities is Ethernet (ISO 8802-3) and BACnet/IP.
  2. The ARCNET data link / physical protocol may be used in new BACnet sub-networks in VA non-healthcare and non-lab (i.e., business and cemetery) facilities.
- B. Each controller shall have a communication port for connection to an operator interface.

- C. Project drawings indicate remote buildings or sites to be connected by a nominal 56,000 baud modem over voice-grade telephone lines. In each remote location a modem and field device connection shall allow communication with each controller on the internetwork as specified in Paragraph D.
- D. Internetwork operator interface and value passing shall be transparent to internetwork architecture.
  - 1. An operator interface connected to a controller shall allow the operator to interface with each internetwork controller as if directly connected. Controller information such as data, status, reports, system software, and custom programs shall be viewable and editable from each internetwork controller.
  - 2. Inputs, outputs, and control variables used to integrate control strategies across multiple controllers shall be readable by each controller on the internetwork. Program and test all cross-controller links required to execute specified control system operation. An authorized operator shall be able to edit cross-controller links by typing a standard object address.
- E. System shall be expandable to at least twice the required input and output objects with additional controllers, associated devices, and wiring. Expansion shall not require operator interface hardware additions or software revisions.
- F. ECCs and Controllers with real-time clocks shall use the BACnet Time Synchronization service. The system shall automatically synchronize system clocks daily from an operator-designated device via the internetwork. The system shall automatically adjust for daylight savings and standard time as applicable.

#### **2.4 ENGINEERING CONTROL CENTER (ECC)**

- A. The ECC shall reside on a high-speed network with controllers as shown on system drawings. The ECC and each standard browser connected to server shall be able to access all system information.
- B. ECC and controllers shall communicate using BACnet protocol. ECC and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ASHRAE/ANSI 135-2008, BACnet Annex J.
- C. Hardware: ECC shall conform to the BACnet Advanced Workstation (B-AWS) Profile and shall be BTL-Listed as a B-AWS device.

1. ECC shall be commercial standard with supporting 32- or 64-bit hardware (as required by the direct-digital control system software) and software enterprise server. Internet Explorer v6.0 SP1 or higher, Windows Script Hosting version 5.6 or higher, Windows Message Queuing, Windows Internet Information Services (IIS) v5.0 or higher, minimum 2.8 GHz processor, minimum 4GB DDR3 SDRAM (minimum 1333 Mhz) memory, 512 MB video card, and 16 speed high density DVD-RW+/- optical drive.
  - a. The hard drive shall be at the minimum 1 TB 7200 rpm SATA hard drive with 16 MB cache, and shall have sufficient memory to store:
    - 1) All required operator workstation software
    - 2) A DDC database at least twice the size of the delivered system database
    - 3) One year of trend data based on the points specified to be trended at their specified trend intervals.
  - b. Real-time clock:
    - 1) Accuracy: Plus or minus 1 minute per month.
    - 2) Time Keeping Format: 24-hour time format including seconds, minutes, hours, date, day, and month; automatic reset by software.
    - 3) Clock shall function for one year without power.
    - 4) Provide automatic time correction once every 24 hours by synchronizing clock with the Time Service Department of the U.S. Naval Observatory.
  - c. Serial ports: Four USB ports and two RS-232-F serial ports for general use, with additional ports as required. Data transmission rates shall be selectable under program control.
  - d. Parallel port: Enhanced.
  - e. Sound card: For playback and recording of digital WAV sound files associated with audible warning and alarm functions.
  - f. Color monitor: PC compatible, not less than 22 inches, LCD type, with a minimum resolution of 1280 by 1024 pixels, non-interlaced, and a maximum dot pitch of 0.28 mm.
  - g. Keyboard: Minimum of 64 characters, standard ASCII character set based on ANSI INCITS 154.
  - h. Mouse: Standard, compatible with installed software.

- i. Removable disk storage: Include the following, each with appropriate controller:
  - 1) Minimum 1 TB removable hard disk, maximum average access time of 10 ms.
- j. Network interface card (NIC): integrated 10-100-1000 Base-TX Ethernet NIC with an RJ45 connector or a 100Base-FX Ethernet NIC with an SC/ST connector.
- 2. Cable modem: 42.88 MBit/s, DOCSIS 2.0 Certified, also backwards compatible with DOCSIS 1.1/1.0 standards. Provide Ethernet or USB connectivity.
- 3. Optical modem: full duplex link, for use on 10 GBase-R single-mode and multi-mode fiber with a XENPAK module.
- 4. Auto-dial modem: 56,600 bps, full duplex for asynchronous communications. With error detection, auto answer/autodial, and call-in-progress detection. Modem shall comply with requirements in ITU-T v.34, ITU-T v.42, ITU-T v.42 Appendix VI for error correction, and ITU-T v.42 BIS for data compression standards; and shall be suitable for operating on unconditioned voice-grade telephone lines complying with 47 CFR 68.
- 5. Audible Alarm: Manufacturer's standard.
- 6. Printers:
  - a. Provide a dedicated, minimum resolution 600 dpi, color laser printer, connected to the ECC through a USB interface.
    - 1) If a network printer is used instead of this dedicated printer, it shall have a 100Base-T interface with an RJ45 connection and shall have a firmware print spooler compatible with the Operating System print spooler.
    - 2) RAM: 512 MB, minimum.
    - 3) Printing Speed: Minimum twenty six pages per minute (color); minimum 30 pages per minute (black/white).
    - 4) Paper Handling: Automatic sheet feeder with 250-sheet x 8.5 inch x 11 inch paper cassette and with automatic feed.
  - b. Provide a dedicated black/white tractor-feed dot matrix printer for status/alarm message printing, minimum 10 characters per inch, minimum 160 characters per second, connected to the ECC through a USB interface.

- 1) Paper: One box of 2000 sheets of 8-1/2x11 multi-fold type printer paper.
7. RS-232 ASCII Interface
- a. ASCII interface shall allow RS-232 connections to be made between a meter or circuit monitor operating as the host PC and any equipment that will accept RS-232 ASCII command strings, such as local display panels, dial-up modems, and alarm transmitters.
  - b. Pager System Interface: Alarms shall be able to activate a pager system with customized message for each input alarm.
  - c. Alarm System Interface: RS-232 output shall be capable of transmitting alarms from other monitoring and alarm systems to workstation software.
  - d. RS-232 output shall be capable of connection to a pager interface that can be used to call a paging system or service and send a signal to a portable pager. System shall allow an individual alphanumeric message per alarm input to be sent to paging system. This interface shall support both numeric and alphanumeric pagers.
  - e. Cables: provide Plenum-Type, RS-232 Cable: Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
    - 1) NFPA 70, Type CMP.
    - 2) Flame Resistance: NFPA 262, Flame Test.
8. Self-contained uninterruptible power supply (UPS):
- a. Size: Provide a minimum of six hours of operation of ECC equipment, including two hours of alarm printer operation.
  - b. Batteries: Sealed, valve regulated, recombinant, lead calcium.
  - c. Accessories:
    - 1) Transient voltage suppression.
    - 2) Input-harmonics reduction.
    - 3) Rectifier/charger.
    - 4) Battery disconnect device.
    - 5) Static bypass transfer switch.
    - 6) Internal maintenance bypass/isolation switch.



- 7) External maintenance bypass/isolation switch.
- 8) Output isolation transformer.
- 9) Remote UPS monitoring.
- 10) Battery monitoring.
- 11) Remote battery monitoring.

D. ECC Software:

1. Provide for automatic system database save and restore on the ECC's hard disk a copy of the current database of each Controller. This database shall be updated whenever a change is made in any system panel. In the event of a database loss in a building management panel, the ECC shall automatically restore the database for that panel. This capability may be disabled by the operator.
2. Provide for manual database save and restore. An operator with proper clearance shall be able to save the database from any system panel. The operator also shall be able to clear a panel database and manually initiate a download of a specified database to any panel in the system.
3. Provide a method of configuring the system. This shall allow for future system changes or additions by users with proper clearance.
4. Operating System. Furnish a concurrent multi-tasking operating system. The operating system also shall support the use of other common software applications. Acceptable operating systems are Windows XP, Windows System 7, Linux, and UNIX.
5. System Graphics. The operator workstation software shall be graphically oriented. The system shall allow display of up to 10 graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on-line. An operator with the proper password level shall be able to add, delete, or change dynamic objects on a graphic. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the object.
6. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The

- graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in industry standard formats such as PCX, TIFF, and GEM. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Designer or AutoCAD.
7. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.
  8. The Controls Systems Operator Interfaces shall be user friendly, readily understood and shall make maximum use of colors, graphics, icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and understanding of the displays by authorized users at the ECC. The operating system shall be Windows XP or better, and shall support the third party software.
  9. Provide graphical user software, which shall minimize the use of keyboard through the use of the mouse and "point and click" approach to menu selection.
  10. The software shall provide a multi-tasking type environment that will allow the user to run several applications simultaneously. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able automatically export data to and work in Microsoft Word, Excel, and other Windows based software programs, while concurrently on-line system alarms and monitoring information.
  11. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
  12. User access shall be protected by a flexible and Owner re-definable software-based password access protection. Password protection shall be multi-level and partition able to accommodate the varied access

- requirements of the different user groups to which individual users may be assigned. Provide the means to define unique access privileges for each individual authorized user. Provide the means to on-line manage password access control under the control of a project specific Master Password. Provide an audit trail of all user activity on the Controls Systems including all actions and changes.
13. The system shall be completely field-programmable from the common operator's keyboard thus allowing hard disk storage of all data automatically. All programs for the CUs shall be able to be downloaded from the hard disk. The software shall provide the following functionality as a minimum:
    - a. Point database editing, storage and downloading of controller databases.
    - b. Scheduling and override of building environmental control systems.
    - c. Collection and analysis of historical data.
    - d. Alarm reporting, routing, messaging, and acknowledgement.
    - e. Definition and construction of dynamic color graphic displays.
    - f. Real-time graphical viewing and control of environment.
    - g. Scheduling trend reports.
    - h. Program editing.
    - i. Operating activity log and system security.
    - j. Transfer data to third party software.
  14. Provide functionality such that using the least amount of steps to initiate the desired event may perform any of the following simultaneously:
    - a. Dynamic color graphics and graphic control.
    - b. Alarm management.
    - c. Event scheduling.
    - d. Dynamic trend definition and presentation.
    - e. Program and database editing.
    - f. Each operator shall be required to log on to the system with a user name and password to view, edit or delete the data. System security shall be selectable for each operator, and the password shall be able to restrict the operator's access for viewing and changing the system programs. Each operator shall automatically

be logged off the system if no keyboard or mouse activity is detected for a selected time.

15. Graphic Displays:

- a. The workstation shall allow the operator to access various system schematics and floor plans via a graphical penetration scheme, menu selection, or text based commands. Graphic software shall permit the importing of AutoCAD or scanned pictures in the industry standard format (such as PCX, BMP, GIF, and JPEG) for use in the system.
- b. System Graphics shall be project specific and schematically correct for each system. (ie: coils, fans, dampers located per equipment supplied with project.) Standard system graphics that do not match equipment or system configurations are not acceptable. Operator shall have capability to manually operate the entire system from each graphic screen at the ECC. Each system graphic shall include a button/tab to a display of the applicable sequence of operation.
- c. Dynamic temperature values, humidity values, flow rates, and status indication shall be shown in their locations and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh values.
- d. Color shall be used to indicate status and change in status of the equipment. The state colors shall be user definable.
- e. A clipart library of HVAC equipment, such as chillers, boilers, air handling units, fans, terminal units, pumps, coils, standard ductwork, piping, valves and laboratory symbols shall be provided in the system. The operator shall have the ability to add custom symbols to the clipart library.
- f. A dynamic display of the site-specific architecture showing status of the controllers, the ECC and network shall be provided.
- g. The windowing environment of the workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of graphic associated with an alarm to be viewed without interrupting work in progress. The graphic system software shall also have the capability to split screen, half portion of the screen with

graphical representation and the other half with sequence of operation of the same HVAC system.

16. Trend reports shall be generated on demand or pre-defined schedule and directed to monitor display, printers or disk. As a minimum, the system shall allow the operator to easily obtain the following types of reports:
  - a. A general list of all selected points in the network.
  - b. List of all points in the alarm.
  - c. List of all points in the override status.
  - d. List of all disabled points.
  - e. List of all points currently locked out.
  - f. List of user accounts and password access levels.
  - g. List of weekly schedules.
  - h. List of holiday programming.
  - i. List of limits and dead bands.
  - j. Custom reports.
  - k. System diagnostic reports, including, list of digital controllers on the network.
  - l. List of programs.
17. ASHRAE Standard 147 Report: Provide a daily report that shows the operating condition of each chiller as recommended by ASHRAE Standard 147. At a minimum, this report shall include:
  - a. Chilled water (or other secondary coolant) inlet and outlet temperature
  - b. Chilled water (or other secondary coolant) flow
  - c. Chilled water (or other secondary coolant) inlet and outlet pressures
  - d. Evaporator refrigerant pressure and temperature
  - e. Condenser refrigerant pressure and liquid temperature
  - f. Condenser water inlet and outlet temperatures
  - g. Condenser water flow
  - h. Refrigerant levels
  - i. Oil pressure and temperature
  - j. Oil level
  - k. Compressor refrigerant discharge temperature
  - l. Compressor refrigerant suction temperature
  - m. Addition of refrigerant

- n. Addition of oil
  - o. Vibration levels or observation that vibration is not excessive
  - p. Motor amperes per phase
  - q. Motor volts per phase
  - r. PPM refrigerant monitor level
  - s. Purge exhaust time or discharge count
  - t. Ambient temperature (dry-bulb and wet-bulb)
  - u. Date and time logged
18. Electrical, Gas, and Weather Reports
- a. Electrical Meter Report: Provide a monthly report showing the daily electrical consumption and peak electrical demand with time and date stamp for each building meter.
  - b. Provide an annual (12-month) summary report showing the monthly electrical consumption and peak demand with time and date stamp for each meter.
  - c. Gas Meter Report: Provide a monthly report showing the daily natural gas consumption for each meter. Provide an annual (12-month) report that shows the monthly consumption for each meter.
  - d. Weather Data Report: Provide a monthly report showing the daily minimum, maximum, and average outdoor air temperature, as well as the number of heating and cooling degree-days for each day. Provide an annual (12-month) report showing the minimum, maximum, and average outdoor air temperature for the month, as well as the number of heating and cooling degree-days for the month.
19. Scheduling and Override:
- a. Provide override access through menu selection from the graphical interface and through a function key.
  - b. Provide a calendar type format for time-of-day scheduling and overrides of building control systems. Schedules reside in the ECC. The digital controllers shall ensure equipment time scheduling when the ECC is off-line. The ECC shall not be required to execute time scheduling. Provide the following spreadsheet graphics as a minimum:
    - 1) Weekly schedules.
    - 2) Zone schedules, minimum of 100 zones.
    - 3) Scheduling up to 365 days in advance.
    - 4) Scheduled reports to print at workstation.

20. Collection and Analysis of Historical Data:

- a. Provide trending capabilities that will allow the operator to monitor and store records of system activity over an extended period of time. Points may be trended automatically on time based intervals or change of value, both of which shall be user definable. The trend interval could be five (5) minutes to 120 hours. Trend data may be stored on hard disk for future diagnostic and reporting. Additionally trend data may be archived to network drives or removable disk media for off-site retrieval.
- b. Reports may be customized to include individual points or predefined groups of at least six points. Provide additional functionality to allow pre-defined groups of up to 250 trended points to be easily accessible by other industry standard word processing and spreadsheet packages. The reports shall be time and date stamped and shall contain a report title and the name of the facility.
- c. System shall have the set up to generate spreadsheet reports to track energy usage and cost based on weekly or monthly interval, equipment run times, equipment efficiency, and/or building environmental conditions.
- d. Provide additional functionality that will allow the operator to view real time trend data on trend graph displays. A minimum of 20 points may be graphed regardless of whether they have been predefined for trending. In addition, the user may pause the graph and take snapshots of the screens to be stored on the workstation disk for future reference and trend analysis. Exact point values may be viewed and the graph may be printed. Operator shall be able to command points directly on the trend plot by double clicking on the point.

21. Alarm Management:

- a. Alarm routing shall allow the operator to send alarm notification to selected printers or operator workstation based on time of day, alarm severity, or point type.
- b. Alarm notification shall be provided via two alarm icons, to distinguish between routine, maintenance type alarms and critical alarms. The critical alarms shall display on the screen at the

time of its occurrence, while others shall display by clicking on their icon.

- c. Alarm display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message in English language. The operator shall be able to sort out the alarms.
  - d. Alarm messages shall be customized for each point to display detailed instructions to the operator regarding actions to take in the event of an alarm.
  - e. An operator with proper security level access may acknowledge and clear the alarm. All that have not been cleared shall be archived at workstation disk.
22. Remote Communications: The system shall have the ability to dial out in the event of an alarm. Receivers shall include operator workstations, e-mail addresses, and alpha-numeric pagers. The alarm message shall include the name of the calling location, the device that generated the alarm, and the alarm message itself.
23. System Configuration:
- a. Network control strategies shall not be restricted to a single digital controller, but shall be able to include data from all other network devices to allow the development of global control strategies.
  - b. Provide automatic backup and restore of all digital controller databases on the workstation hard disk. In addition to all backup data, all databases shall be performed while the workstation is on-line without disturbing other system operations.

#### **2.5 PORTABLE OPERATOR'S TERMINAL (POT)**

- A. Provide a portable operator's terminal (POT) that shall be capable of accessing all system data. POT may be connected to any point on the system network or may be connected directly to any controller for programming, setup, and troubleshooting. POT shall communicate using BACnet protocol. POT may be connected to any point on the system network or it may be connected directly to controllers using the BACnet PTP (Point-To-Point) Data Link/ Physical layer protocol. The terminal shall use the Read (Initiate) and Write (Execute) BACnet Services. POT



shall be an IBM-compatible notebook-style PC including all software and hardware required.

B. Hardware: POT shall conform to the BACnet Advanced Workstation (B-AWS) Profile and shall be BTL-Listed as a B-AWS device.

1. POT shall be commercial standard with supporting 32- or 64-bit hardware (as limited by the direct-digital control system software) and software enterprise server. Internet Explorer v6.0 SP1 or higher, Windows Script Hosting version 5.6 or higher, Windows Message Queuing, Windows Internet Information Services (IIS) v5.0 or higher, minimum 2.8 GHz processor, minimum 500 GB 7200 rpm SATA hard drive with 16 MB cache, minimum 2GB DDR3 SDRAM (minimum 1333 Mhz) memory, 512 MB video card, minimum 16 inch (diagonal) screen, 10-100-1000 Base-TX Ethernet NIC with an RJ45 connector or a 100Base-FX Ethernet NIC with an SC/ST connector, 56,600 bps modem, an ASCII RS-232 interface, and a 16 speed high density DVD-RW+/- optical drive.

C. Software: POT shall include software equal to the software on the ECC.

## **2.6 BACNET PROTOCOL ANALYZER**

A. For ease of troubleshooting and maintenance, provide a BACnet protocol analyzer. Provide its associated fittings, cables and appurtenances, for connection to the communications network. The BACnet protocol analyzer shall be able to, at a minimum: capture and store to a file all data traffic on all network levels; measure bandwidth usage; filter out (ignore) selected traffic.

## **2.7 NETWORK AND DEVICE NAMING CONVENTION**

A. Network Numbers

1. BACnet network numbers shall be based on a "facility code, network" concept. The "facility code" is the VAMC's or VA campus' assigned numeric value assigned to a specific facility or building. The "network" typically corresponds to a "floor" or other logical configuration within the building. BACnet allows 65535 network numbers per BACnet internet work.

2. The network numbers are thus formed as follows: "Net #" = "FFFNN" where:

a. FFF = Facility code (see below)

b. NN = 00-99 This allows up to 100 networks per facility or building

B. Device Instances

1. BACnet allows 4194305 unique device instances per BACnet internet work. Using Agency's unique device instances are formed as follows:  
"Dev #" = "FFFNDD" where
  - a. FFF and N are as above and
  - b. DD = 00-99, this allows up to 100 devices per network.
2. Note Special cases, where the network architecture of limiting device numbering to DD causes excessive subnet works. The device number can be expanded to DDD and the network number N can become a single digit. In NO case shall the network number N and the device number D exceed 4 digits.
3. Facility code assignments:
4. 000-400 Building/facility number
5. Note that some facilities have a facility code with an alphabetic suffix to denote wings, related structures, etc. The suffix will be ignored. Network numbers for facility codes above 400 will be assigned in the range 000-399.

#### C. Device Names

1. Name the control devices based on facility name, location within a facility, the system or systems that the device monitors and/or controls, or the area served. The intent of the device naming is to be easily recognized. Names can be up to 254 characters in length, without embedded spaces. Provide the shortest descriptive, but unambiguous, name. For example, in building #123 prefix the number with a "B" followed by the building number, if there is only one chilled water pump "CHWP-1", a valid name would be "B123.CHWP.1.STARTSTOP". If there are two pumps designated "CHWP-1", one in a basement mechanical room (Room 0001) and one in a penthouse mechanical room (Room PH01), the names could be "B123.R0001.CHWP.1.STARTSTOP" or "B123.RPH01.CHWP.1.STARTSTOP". In the case of unitary controllers, for example a VAV box controller, a name might be "B123.R101.VAV". These names should be used for the value of the "Object\_Name" property of the BACnet Device objects of the controllers involved so that the BACnet name and the EMCS name are the same.

## 2.8 BACNET DEVICES

- A. All BACnet Devices - controllers, gateways, routers, actuators and sensors shall conform to BACnet Device Profiles and shall be BACnet

Testing Laboratories (BTL) -Listed as conforming to those Device Profiles. Protocol Implementation Conformance Statements (PICSs), describing the BACnet capabilities of the Devices shall be published and available of the Devices through links in the BTL website.

1. BACnet Building Controllers, historically referred to as NACs, shall conform to the BACnet B-BC Device Profile, and shall be BTL-Listed as conforming to the B-BC Device Profile. The Device's PICS shall be submitted.
2. BACnet Advanced Application Controllers shall conform to the BACnet B-AAC Device Profile, and shall be BTL-Listed as conforming to the B-AAC Device Profile. The Device's PICS shall be submitted.
3. BACnet Application Specific Controllers shall conform to the BACnet B-ASC Device Profile, and shall be BTL-Listed as conforming to the B-ASC Device Profile. The Device's PICS shall be submitted.
4. BACnet Smart Actuators shall conform to the BACnet B-SA Device Profile, and shall be BTL-Listed as conforming to the B-SA Device Profile. The Device's PICS shall be submitted.
5. BACnet Smart Sensors shall conform to the BACnet B-SS Device Profile, and shall be BTL-Listed as conforming to the B-SS Device Profile. The Device's PICS shall be submitted.
6. BACnet routers and gateways shall conform to the BACnet B-OTH Device Profile, and shall be BTL-Listed as conforming to the B-OTH Device Profile. The Device's PICS shall be submitted.

## **2.9 CONTROLLERS**

- A. General. Provide an adequate number of BTL-Listed B-BC building controllers and an adequate number of BTL-Listed B-AAC advanced application controllers to achieve the performance specified in the Part 1 Article on "System Performance." Each of these controllers shall meet the following requirements.
  1. The controller shall have sufficient memory to support its operating system, database, and programming requirements.
  2. The building controller shall share data with the ECC and the other networked building controllers. The advanced application controller shall share data with its building controller and the other networked advanced application controllers.
  3. The operating system of the controller shall manage the input and output communication signals to allow distributed controllers to

- share real and virtual object information and allow for central monitoring and alarms.
4. Controllers that perform scheduling shall have a real-time clock.
  5. The controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
    - a. assume a predetermined failure mode, and
    - b. generate an alarm notification.
  6. The controller shall communicate with other BACnet devices on the internetwork using the BACnet Read (Execute and Initiate) and Write (Execute and Initiate) Property services.
  7. Communication.
    - a. Each controller shall reside on a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol for its communications. Each building controller also shall perform BACnet routing if connected to a network of custom application and application specific controllers.
    - b. The controller shall provide a service communication port using BACnet Data Link/Physical layer protocol for connection to a portable operator's terminal.
  8. Keypad. A local keypad and display shall be provided for each controller. The keypad shall be provided for interrogating and editing data. Provide a system security password shall be available to prevent unauthorized use of the keypad and display.
  9. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
  10. Memory. The controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.
  11. The controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Controller operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m (3 ft).
- B. Provide BTL-Listed B-ASC application specific controllers for each piece of equipment for which they are constructed. Application

specific controllers shall communicate with other BACnet devices on the internetwork using the BACnet Read (Execute) Property service.

1. Each B-ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.

2. Each B-ASC will contain sufficient I/O capacity to control the target system.

3. Communication.

a. Each controller shall reside on a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol for its communications. Each building controller also shall perform BACnet routing if connected to a network of custom application and application specific controllers.

b. Each controller shall have a BACnet Data Link/Physical layer compatible connection for a laptop computer or a portable operator's tool. This connection shall be extended to a space temperature sensor port where shown.

4. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

5. Memory. The application specific controller shall use nonvolatile memory and maintain all BIOS and programming information in the event of a power loss.

6. Immunity to power and noise. Controllers shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m (3 ft).

7. Transformer. Power supply for the ASC must be rated at a minimum of 125% of ASC power consumption and shall be of the fused or current limiting type.

C. Direct Digital Controller Software

1. The software programs specified in this section shall be commercially available, concurrent, multi-tasking operating system and support the use of software application that operates under DOS or Microsoft Windows.

2. All points shall be identified by up to 30-character point name and 16-character point descriptor. The same names shall be used at the ECC.
3. All control functions shall execute within the stand-alone control units via DDC algorithms. The VA shall be able to customize control strategies and sequences of operations defining the appropriate control loop algorithms and choosing the optimum loop parameters.
4. All controllers shall be capable of being programmed to utilize stored default values for assured fail-safe operation of critical processes. Default values shall be invoked upon sensor failure or, if the primary value is normally provided by the central or another CU, or by loss of bus communication. Individual application software packages shall be structured to assume a fail-safe condition upon loss of input sensors. Loss of an input sensor shall result in output of a sensor-failed message at the ECC. Each ACU and RCU shall have capability for local readouts of all functions. The UCUs shall be read remotely.
5. All DDC control loops shall be able to utilize any of the following control modes:
  - a. Two position (on-off, slow-fast) control.
  - b. Proportional control.
  - c. Proportional plus integral (PI) control.
  - d. Proportional plus integral plus derivative (PID) control. All PID programs shall automatically invoke integral wind up prevention routines whenever the controlled unit is off, under manual control of an automation system or time initiated program.
  - e. Automatic tuning of control loops.
6. System Security: Operator access shall be secured using individual password and operator's name. Passwords shall restrict the operator to the level of object, applications, and system functions assigned to him. A minimum of six (6) levels of security for operator access shall be provided.
7. Application Software: The controllers shall provide the following programs as a minimum for the purpose of optimizing energy consumption while maintaining comfortable environment for occupants. All application software shall reside and run in the system digital controllers. Editing of the application shall occur at the ECC or

via a portable operator's terminal, when it is necessary, to access directly the programmable unit.

- a. Power Demand Limiting (PDL): Power demand limiting program shall monitor the building power consumption and limit the consumption of electricity to prevent peak demand charges. PDL shall continuously track the electricity consumption from a pulse input generated at the kilowatt-hour/demand electric meter. PDL shall sample the meter data to continuously forecast the electric demand likely to be used during successive time intervals. If the forecast demand indicates that electricity usage will likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads. Once the demand load has met, loads that have been shed shall be restored and returned to normal mode. Control system shall be capable of demand limiting by resetting the HVAC system set points to reduce load while maintaining indoor air quality.
- b. Economizer: An economizer program shall be provided for VAV systems. This program shall control the position of air handler relief, return, and outdoors dampers. The operator shall be able to override the economizer cycle and return to minimum outdoor air operation at any time.
- c. Night Setback/Morning Warm up Control: The system shall provide the ability to automatically adjust set points for this mode of operation.
- d. Optimum Start/Stop (OSS): Optimum start/stop program shall automatically be coordinated with event scheduling. The OSS program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by the time of occupancy, and it shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period and still maintain desired comfort conditions. The OSS program shall consider both outside weather conditions and inside zone conditions. The program shall automatically assign longer lead times for weekend and holiday shutdowns. The program shall poll all zones served by the associated AHU and shall select the warmest and coolest zones. These shall be used in the start time calculation. It shall be

possible to assign occupancy start times on a per air handler unit basis. The program shall meet the local code requirements for minimum outdoor air while the building is occupied. Modification of assigned occupancy start/stop times shall be possible via the ECC.

- e. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or a group of points according to a stored time. This program shall provide the capability to individually command a point or group of points. When points are assigned to one common load group it shall be possible to assign variable time advances/delays between each successive start or stop within that group. Scheduling shall be calendar based and advance schedules may be defined up to one year in advance. Advance schedule shall override the day-to-day schedule. The operator shall be able to define the following information:
  - 1) Time, day.
  - 2) Commands such as on, off, auto.
  - 3) Time delays between successive commands.
  - 4) Manual overriding of each schedule.
  - 5) Allow operator intervention.
- f. Alarm Reporting: The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the ECC based on time and events. An alarm shall be able to start programs, login the event, print and display the messages. The system shall allow the operator to prioritize the alarms to minimize nuisance reporting and to speed operator's response to critical alarms. A minimum of six (6) priority levels of alarms shall be provided for each point.
- g. Remote Communications: The system shall have the ability to dial out in the event of an alarm to the ECC and alpha-numeric pagers. The alarm message shall include the name of the calling location, the device that generated the alarm, and the alarm message itself. The operator shall be able to remotely access and operate the system using dial up communications. Remote access shall allow the operator to function the same as local access.



- h. Maintenance Management (PM): The program shall monitor equipment status and generate maintenance messages based upon the operators defined equipment run time, starts, and/or calendar date limits. A preventative maintenance alarm shall be printed indicating maintenance requirements based on pre-defined run time. Each preventive message shall include point description, limit criteria and preventative maintenance instruction assigned to that limit. A minimum of 480-character PM shall be provided for each component of units such as air handling units.

#### **2.10 SPECIAL CONTROLLERS**

- A. Laboratory rooms and the fume hoods in those rooms shall be controlled to allow for a variable flow of conditioned air into the room, general exhaust from the room, and exhaust through the fume hood while maintaining a safe face velocity at the hood sash opening and proper space pressurization.
- B. Fume Hood Exhaust Air Controller: The air flow through the open face of the hood, regardless of sash position, shall be controlled at a face velocity between 30 to 36 meter per minute (100 fpm and 120 fpm). A velocity sensor controller located in a sampling tube in the side wall of the hood shall control a damper in the hood discharge to maintain the face velocity.
- C. Room Differential Pressure Controller: The differential pressure in laboratory rooms, operating rooms and isolation rooms shall be maintained by controlling the quantity of air exhausted from or supplied to the room. A sensor-controller shall measure and control the velocity of air flowing into or out of the room through a sampling tube installed in the wall separating the room from the adjacent space, and display the value on its monitor. The sensor-controller shall meet the following as a minimum:
1. Operating range: -0.25 to +0.25 inches of water column
  2. Resolution: 5 percent of reading
  3. Accuracy: +/- 10 percent of reading +/- 0.005 inches of water column
  4. Analog output: 0-10 VDC or 4-20 ma
  5. Operating temperature range: 32°F-120°F

#### **2.11 SENSORS (AIR, WATER AND STEAM)**

- A. Sensors' measurements shall be read back to the DDC system, and shall be visible by the ECC.

- B. Temperature and Humidity Sensors shall be electronic, vibration and corrosion resistant for wall, immersion, and/or duct mounting. Provide all remote sensors as required for the systems.
1. Temperature Sensors: thermistor type for terminal units and Resistance Temperature Device (RTD) with an integral transmitter type for all other sensors.
    - a. Duct sensors shall be rigid or averaging type as shown on drawings. Averaging sensor shall be a minimum of 1 linear ft of sensing element for each sq ft of cooling coil face area.
    - b. Immersion sensors shall be provided with a separable well made of stainless steel, bronze or monel material. Pressure rating of well is to be consistent with the system pressure in which it is to be installed.
    - c. Space sensors shall be equipped with in-space User set-point adjustment, override switch, numerical temperature display on sensor cover, and communication port. Match room thermostats. Provide a tooled-access cover.
      - 1) Public space sensor: setpoint adjustment shall be only through the ECC or through the DDC system's diagnostic device/laptop. Do not provide in-space User set-point adjustment. Provide an opaque keyed-entry cover if needed to restrict in-space User set-point adjustment.
      - 2) Psychiatric patient room sensor: sensor shall be flush with wall, shall not include an override switch, numerical temperature display on sensor cover, shall not include a communication port and shall not allow in-space User set-point adjustment. Setpoint adjustment shall be only through the ECC or through the DDC system's diagnostic device/laptop. Provide a stainless steel cover plate with an insulated back and security screws.
    - d. Outdoor air temperature sensors shall have watertight inlet fittings and be shielded from direct sunlight.
    - e. Room security sensors shall have stainless steel cover plate with insulated back and security screws.
    - f. Wire: Twisted, shielded-pair cable.
    - g. Output Signal: 4-20 ma.
  2. Humidity Sensors: Bulk polymer sensing element type.

- a. Duct and room sensors shall have a sensing range of 20 to 80 percent with accuracy of  $\pm 2$  to  $\pm 5$  percent RH, including hysteresis, linearity, and repeatability.
  - b. Outdoor humidity sensors shall be furnished with element guard and mounting plate and have a sensing range of 0 to 100 percent RH.
  - c. 4-20 ma continuous output signal.
- C. Static Pressure Sensors: Non-directional, temperature compensated.
1. 4-20 ma output signal.
  2. 0 to 5 inches wg for duct static pressure range.
  3. 0 to 0.25 inch wg for Building static pressure range.
- D. Water flow sensors:
1. Type: Insertion vortex type with retractable probe assembly and 2 inch full port gate valve.
    - a. Pipe size: 3 to 24 inches.
    - b. Retractor: ASME threaded, non-rising stem type with hand wheel.
    - c. Mounting connection: 2 inch 150 PSI flange.
    - d. Sensor assembly: Design for expected water flow and pipe size.
    - e. Seal: Teflon (PTFE).
  2. Controller:
    - a. Integral to unit.
    - b. Locally display flow rate and total.
    - c. Output flow signal to BMCS: Digital pulse type.
  3. Performance:
    - a. Turndown: 20:1
    - b. Response time: Adjustable from 1 to 100 seconds.
    - c. Power: 24 volt DC
  4. Install flow meters according to manufacturer's recommendations. Where recommended by manufacturer because of mounting conditions, provide flow rectifier.
- E. Water Flow Sensors: shall be insertion turbine type with turbine element, retractor and preamplifier/transmitter mounted on a two-inch full port isolation valve; assembly easily removed or installed as a single unit under line pressure through the isolation valve without interference with process flow; calibrated scale shall allow precise positioning of the flow element to the required insertion depth within plus or minute 1 mm (0.05 inch); wetted parts shall be constructed of

stainless steel. Operating power shall be nominal 24 VDC. Local instantaneous flow indicator shall be LED type in NEMA 4 enclosure with 3-1/2 digit display, for wall or panel mounting.

1. Performance characteristics:

- a. Ambient conditions: -40°C to 60°C (-40°F to 140°F), 5 to 100% humidity.
- b. Operating conditions: 850 kPa (125 psig), 0°C to 120°C (30°F to 250°F), 0.15 to 12 m per second (0.5 to 40 feet per second) velocity.
- c. Nominal range (turn down ratio): 10 to 1.
- d. Preamplifier mounted on meter shall provide 4-20 ma divided pulse output or switch closure signal for units of volume or mass per a time base. Signal transmission distance shall be a minimum of 1,800 meters (6,000 feet).
- e. Pressure Loss: Maximum 1 percent of the line pressure in line sizes above 100 mm (4 inches).
- f. Ambient temperature effects, less than 0.005 percent calibrated span per °C (°F) temperature change.
- g. RFI effect - flow meter shall not be affected by RFI.
- h. Power supply effect less than 0.02 percent of span for a variation of plus or minus 10 percent power supply.

F. Steam Flow Sensor/Transmitter:

1. Sensor: Vortex shedder incorporating wing type sensor and amplification technology for high signal-to-noise ratio, carbon steel body with 316 stainless steel working parts, 24 VDC power, NEMA 4 enclosure.
  - a. Ambient conditions, -40°C to 80°C (-40°F to 175°F).
  - b. Process conditions, 900 kPa (125 psig) saturated steam.
  - c. Turn down ratio, 20 to 1.
  - d. Output signal, 4-20 ma DC.
  - e. Processor/Transmitter, NEMA 4 enclosure with keypad program selector and six digit LCD output display of instantaneous flow rate or totalized flow, solid state switch closure signal shall be provided to the nearest DDC panel for totalization.
    - 1) Ambient conditions, -20°C to 50°C (0°F-120°F), 0 95 percent non-condensing RH.

- 2) Power supply, 120 VAC, 60 hertz or 24 VDC.
  - 3) Internal battery, provided for 24-month retention of RAM contents when all other power sources are removed.
  - f. Sensor on all steam lines shall be protected by pigtail siphons installed between the sensor and the line, and shall have an isolation valve installed between the sensor and pressure source.
- G. Flow switches:
1. Shall be either paddle or differential pressure type.
    - a. Paddle-type switches (liquid service only) shall be UL Listed, SPDT snap-acting, adjustable sensitivity with NEMA 4 enclosure.
    - b. Differential pressure type switches (air or water service) shall be UL listed, SPDT snap acting, NEMA 4 enclosure, with scale range and differential suitable for specified application.
- H. Current Switches: Current operated switches shall be self powered, solid state with adjustable trip current as well as status, power, and relay command status LED indication. The switches shall be selected to match the current of the application and output requirements of the DDC systems.

## **2.12 CONTROL CABLES**

- A. General:
1. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Comply with Sections 27 05 26 and 26 05 26.
  2. Cable conductors to provide protection against induction in circuits. Crosstalk attenuation within the System shall be in excess of -80 dB throughout the frequency ranges specified.
  3. Minimize the radiation of RF noise generated by the System equipment so as not to interfere with any audio, video, data, computer main distribution frame (MDF), telephone customer service unit (CSU), and electronic private branch exchange (EPBX) equipment the System may service.
  4. The as-installed drawings shall identify each cable as labeled, used cable, and bad cable pairs.
  5. Label system's cables on each end. Test and certify cables in writing to the VA before conducting proof-of-performance testing. Minimum cable test requirements are for impedance compliance,

inductance, capacitance, signal level compliance, opens, shorts, cross talk, noise, and distortion, and split pairs on all cables in the frequency ranges used. Make available all cable installation and test records at demonstration to the VA. All changes (used pair, failed pair, etc.) shall be posted in these records as the change occurs.

6. Power wiring shall not be run in conduit with communications trunk wiring or signal or control wiring operating at 100 volts or less.
- B. Analogue control cabling shall be not less than No. 18 AWG solid, with thermoplastic insulated conductors as specified in Section 26 05 21.
- C. Copper digital communication cable between the ECC and the B-BC and B-AAC controllers shall be 100BASE-TX Ethernet, Category 5e or 6, not less than minimum 24 American Wire Gauge (AWG) solid, Shielded Twisted Pair (STP) or Unshielded Twisted Pair (UTP), with thermoplastic insulated conductors, enclosed in a thermoplastic outer jacket, as specified in Section 27 15 00.
  1. Other types of media commonly used within IEEE Std 802.3 LANs (e.g., 10Base-T and 10Base-2) shall be used only in cases to interconnect with existing media.
- D. Optical digital communication fiber, if used, shall be Multimode or Singlemode fiber, 62.5/125 micron for multimode or 10/125 micron for singlemode micron with SC or ST connectors as specified in TIA-568-C.1. Terminations, patch panels, and other hardware shall be compatible with the specified fiber and shall be as specified in Section 27 15 00. Fiber-optic cable shall be suitable for use with the 100Base-FX or the 100Base-SX standard (as applicable) as defined in IEEE Std 802.3.

### **2.13 THERMOSTATS AND HUMIDISTATS**

- A. Room thermostats controlling unitary standalone heating and cooling devices not connected to the DDC system shall have three modes of operation (heating - null or dead band - cooling). Thermostats for patient bedrooms shall have capability of being adjusted to eliminate null or dead band. Wall mounted thermostats shall have polished or brushed aluminum satin chrome manufacturer's recommendation finish to match recently renovated portions of the building, setpoint range and temperature display and external adjustment:
  1. Electronic Thermostats: Solid-state, microprocessor based, programmable to daily, weekend, and holiday schedules.

- a. Public Space Thermostat: Public space thermostat shall have a thermistor sensor and shall not have a visible means of set point adjustment. Adjustment shall be via the digital controller to which it is connected.
  - b. Patient Room Thermostats: thermistor with in-space User set point adjustment and an on-casing room temperature numerical temperature display.
  - c. Psychiatric Patient Room Sensors: Electronic duct sensor as noted under Article 2.4.
  - d. Battery replacement without program loss.
- B. Strap-on thermostats shall be enclosed in a dirt-and-moisture proof housing with fixed temperature switching point and single pole, double throw switch.
- C. Freezestats shall have a minimum of 300 mm (one linear foot) of sensing element for each 0.093 square meter (one square foot) of coil area. A freezing condition at any increment of 300 mm (one foot) anywhere along the sensing element shall be sufficient to operate the thermostatic element. Freezestats shall be manually reset.
- D. Room Humidistats: Provide fully proportioning humidistat with adjustable throttling range for accuracy of settings and conservation. The humidistat shall have set point scales shown in percent of relative humidity located on the instrument. Systems showing moist/dry or high/low are not acceptable.

#### **2.14 FINAL CONTROL ELEMENTS AND OPERATORS**

- A. Fail Safe Operation: Control valves and dampers shall provide "fail safe" operation in either the normally open or normally closed position as required for freeze, moisture, and smoke or fire protection.
- B. Spring Ranges: Range as required for system sequencing and to provide tight shut-off.
- C. Power Operated Control Dampers (other than VAV Boxes): Factory fabricated, balanced type dampers. All modulating dampers shall be opposed blade type and gasketed. Blades for two-position, duct-mounted dampers shall be parallel, airfoil (streamlined) type for minimum noise generation and pressure drop.
  - 1. Leakage: maximum leakage in closed position shall not exceed 7 L/S (15 CFMs) differential pressure for outside air and exhaust dampers

- and 200 L/S/ square meter (40 CFM/sq. ft.) at 50 mm (2 inches) differential pressure for other dampers.
2. Frame shall be galvanized steel channel with seals as required to meet leakage criteria.
  3. Blades shall be galvanized steel or aluminum, 200 mm (8 inch) maximum width, with edges sealed as required.
  4. Bearing shall be nylon, bronze sleeve or ball type.
  5. Hardware shall be zinc-plated steel. Connected rods and linkage shall be non-slip. Working parts of joints shall be brass, bronze, nylon or stainless steel.
  6. Maximum air velocity and pressure drop through free area the dampers:
    - a. Smoke damper in air handling unit: 305 meter per minute (1000 fpm).
    - b. Duct mounted damper: 600 meter per minute (2000 fpm).
    - c. Maximum static pressure loss: 50 Pascal (0.20 inches water gage).
- D. Smoke Dampers and Combination Fire/Smoke Dampers: Dampers and operators are specified in Section 23 31 00, HVAC DUCTS AND CASINGS. Control of these dampers is specified under this Section.
- E. Control Valves:
1. Valves shall be rated for a minimum of 150 percent of system operating pressure at the valve location but not less than 900 kPa (125 psig).
  2. Valves 50 mm (2 inches) and smaller shall be bronze body with threaded or flare connections.
  3. Valves 60 mm (2 1/2 inches) and larger shall be bronze or iron body with flanged connections.
  4. Brass or bronze seats except for valves controlling media above 100 degrees C (210 degrees F), which shall have stainless steel seats.
  5. Flow characteristics:
    - a. Three way modulating valves shall be globe pattern. Position versus flow relation shall be linear relation for steam or equal percentage for water flow control.
    - b. Two-way modulating valves shall be globe pattern. Position versus flow relation shall be linear for steam and equal percentage for water flow control.
    - c. Two-way 2-position valves shall be ball, gate or butterfly type.



6. Maximum pressure drop:
    - a. Two position steam control: 20 percent of inlet gauge pressure.
    - b. Modulating Steam Control: 80 percent of inlet gauge pressure (acoustic velocity limitation).
    - c. Modulating water flow control, greater of 3 meters (10 feet) of water or the pressure drop through the apparatus.
  7. Two position water valves shall be line size.
- F. Damper and Valve Operators and Relays:
1. Electric operator shall provide full modulating control of dampers and valves. A linkage and pushrod shall be furnished for mounting the actuator on the damper frame internally in the duct or externally in the duct or externally on the duct wall, or shall be furnished with a direct-coupled design. Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel. Provide actuator heads which allow for electrical conduit attachment. The motors shall have sufficient closure torque to allow for complete closure of valve or damper under pressure. Provide multiple motors as required to achieve sufficient close-off torque.
    - a. Minimum valve close-off pressure shall be equal to the system pump's dead-head pressure, minimum 50 psig for valves smaller than 4 inches.
  3. Electronic damper operators: Metal parts shall be aluminum, mill finish galvanized steel, or zinc plated steel or stainless steel. Provide actuator heads which allow for electrical conduit attachment. The motors shall have sufficient closure torque to allow for complete closure of valve or damper under pressure. Provide multiple motors as required to achieve sufficient close-off torque.
    - a. VAV Box actuator shall be mounted on the damper axle or shall be of the air valve design, and shall provide complete modulating control of the damper. The motor shall have a closure torque of 35-inch pounds minimum with full torque applied at close off to attain minimum leakage.
  4. See drawings for required control operation.

## **2.15 AIR FLOW CONTROL**

- A. Airflow and static pressure shall be controlled via digital controllers with inputs from airflow control measuring stations and static pressure

inputs as specified. Controller outputs shall be analog or pulse width modulating output signals. The controllers shall include the capability to control via simple proportional (P) control, proportional plus integral (PI), proportional plus integral plus derivative (PID), and on-off. The airflow control programs shall be factory-tested programs that are documented in the literature of the control manufacturer.

**B. Air Flow Measuring Station -- Electronic Thermal Type:**

**1. Air Flow Sensor Probe:**

- a. Each air flow sensor shall contain two individual thermal sensing elements. One element shall determine the velocity of the air stream while the other element shall compensate for changes in temperature. Each thermal flow sensor and its associated control circuit and signal conditioning circuit shall be factory calibrated and be interchangeable to allow replacement of a sensor without recalibration of the entire flow station. The sensor in the array shall be located at the center of equal area segment of the duct and the number of sensors shall be adequate to accommodate the expected velocity profile and variation in flow and temperature. The airflow station shall be of the insertion type in which sensor support structures are inserted from the outside of the ducts to make up the complete electronic velocity array.
- b. Thermal flow sensor shall be constructed of hermetically sealed thermistors or nickel chromium or reference grade platinum wire, wound over an epoxy, stainless steel or ceramic mandrel and coated with a material suitable for the conditions to be encountered. Each dual sensor shall be mounted in an extruded aluminum alloy strut.

**2. Air Flow Sensor Grid Array:**

- a. Each sensor grid shall consist of a lattice network of temperature sensors and linear integral controllers (ICs) situated inside an aluminum casing suitable for mounting in a duct. Each sensor shall be mounted within a strut facing downstream of the airflow and located so that it is protected on the upstream side. All wiring shall be encased (out of the air stream) to protect against mechanical damage.

- b. The casing shall be made of welded aluminum of sufficient strength to prevent structural bending and bowing. Steel or iron composite shall not be acceptable in the casing material.
  - c. Pressure drop through the flow station shall not exceed 4 Pascal (0.015" W.G.) at 1,000 meter per minute (3,000 FPM).
3. Electronics Panel:
- a. Electronics Panel shall consist of a surface mounted enclosure complete with solid-state microprocessor and software.
  - b. Electronics Panel shall be A/C powered 120 VAC and shall have the capability to transmit signals of 0-5 VDC, 0-10 VCD or 4-20 ma for use in control of the HVAC Systems. The electronic panel shall have the capability to accept user defined scaling parameters for all output signals.
  - c. Electronics Panel shall have the capability to digitally display airflow in CFM and temperature in degrees F. The displays shall be provided as an integral part of the electronics panel. The electronic panel shall have the capability to totalize the output flow in CFM for two or more systems, as required. A single output signal may be provided which will equal the sum of the systems totalized. Output signals shall be provided for temperature and airflow. Provide remote mounted air flow or temperature displays where indicated on the plans.
  - d. Electronics Panel shall have the following:
    - 1) Minimum of 12-bit A/D conversion.
    - 2) Field adjustable digital primary output offset and gain.
    - 3) Airflow analog output scaling of 100 to 10,000 FPM.
    - 4) Temperature analog output scaling from -45°C to 70°C (-50°F to 160°F).
    - 5) Analog output resolution (full scale output) of 0.025%.
  - e. All readings shall be in I.P. units.
4. Thermal flow sensors and its electronics shall be installed as per manufacturer's instructions. The probe sensor density shall be as follows:

Probe Sensor Density	
Area (sq.ft.)	Qty. Sensors
<=1	2

>1 to <4	4
4 to <8	6
8 to <12	8
12 to <16	12
>=16	16

- a. Complete installation shall not exhibit more than  $\pm 2.0\%$  error in airflow measurement output for variations in the angle of flow of up to 10 percent in any direction from its calibrated orientation. Repeatability of readings shall be within  $\pm 0.25\%$ .
- D. Static Pressure Measuring Station: shall consist of one or more static pressure sensors and transmitters along with relays or auxiliary devices as required for a complete functional system. The span of the transmitter shall not exceed two times the design static pressure at the point of measurement. The output of the transmitter shall be true representation of the input pressure with plus or minus 25 Pascal (0.1 inch) W.G. of the true input pressure:
1. Static pressure sensors shall have the same requirements as Airflow Measuring Devices except that total pressure sensors are optional, and only multiple static pressure sensors positioned on an equal area basis connected to a network of headers are required.
  2. For systems with multiple major trunk supply ducts, furnish a static pressure transmitter for each trunk duct. The transmitter signal representing the lowest static pressure shall be selected and this shall be the input signal to the controller.
  3. The controller shall receive the static pressure transmitter signal and CU shall provide a control output signal to the supply fan capacity control device. The control mode shall be proportional plus integral (PI) (automatic reset) and where required shall also include derivative mode.
  4. In systems with multiple static pressure transmitters, provide a switch located near the fan discharge to prevent excessive pressure during abnormal operating conditions. High-limit switches shall be manually reset.
- E. Constant Volume Control Systems shall consist of an air flow measuring station along with such relays and auxiliary devices as required to produce a complete functional system. The transmitter shall receive its

air flow signal and static pressure signal from the flow measuring station and shall have a span not exceeding three times the design flow rate. The CU shall receive the transmitter signal and shall provide an output to the fan volume control device to maintain a constant flow rate. The CU shall provide proportional plus integral (PI) (automatic reset) control mode and where required also inverse derivative mode. Overall system accuracy shall be plus or minus the equivalent of 2 Pascal (0.008 inch) velocity pressure as measured by the flow station.

F. Airflow Synchronization:

1. Systems shall consist of an air flow measuring station for each supply and return duct, the CU and such relays, as required to provide a complete functional system that will maintain a constant flow rate difference between supply and return air to an accuracy of  $\pm 10\%$ . In systems where there is no suitable location for a flow measuring station that will sense total supply or return flow, provide multiple flow stations with a differential pressure transmitter for each station. Signals from the multiple transmitters shall be added through the CU such that the resultant signal is a true representation of total flow.
2. The total flow signals from supply and return air shall be the input signals to the CU. This CU shall track the return air fan capacity in proportion to the supply air flow under all conditions.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

A. General:

1. Examine project plans for control devices and equipment locations; and report any discrepancies, conflicts, or omissions to Resident Engineer for resolution before proceeding for installation.
2. Install equipment, piping, wiring /conduit parallel to or at right angles to building lines.
3. Install all equipment and piping in readily accessible locations. Do not run tubing and conduit concealed under insulation or inside ducts.
4. Mount control devices, tubing and conduit located on ducts and apparatus with external insulation on standoff support to avoid interference with insulation.

5. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
  6. Run tubing and wire connecting devices on or in control cabinets parallel with the sides of the cabinet neatly racked to permit tracing.
  7. Install equipment level and plum.
- A. Electrical Wiring Installation:
1. All wiring cabling shall be installed in conduits. Install conduits and wiring in accordance with Specification Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS. Conduits carrying control wiring and cabling shall be dedicated to the control wiring and cabling: these conduits shall not carry power wiring. Provide plastic end sleeves at all conduit terminations to protect wiring from burrs.
  2. Install analog signal and communication cables in conduit and in accordance with Specification Section 26 05 21. Install digital communication cables in conduit and in accordance with Specification Section 27 15 00, Communications Horizontal Cabling.
  3. Install conduit and wiring between operator workstation(s), digital controllers, electrical panels, indicating devices, instrumentation, miscellaneous alarm points, thermostats, and relays as shown on the drawings or as required under this section.
  4. Install all electrical work required for a fully functional system and not shown on electrical plans or required by electrical specifications. Where low voltage (less than 50 volt) power is required, provide suitable Class B transformers.
  5. Install all system components in accordance with local Building Code and National Electric Code.
    - a. Splices: Splices in shielded and coaxial cables shall consist of terminations and the use of shielded cable couplers. Terminations shall be in accessible locations. Cables shall be harnessed with cable ties.
    - b. Equipment: Fit all equipment contained in cabinets or panels with service loops, each loop being at least 300 mm (12 inches) long. Equipment for fiber optics system shall be rack mounted, as applicable, in ventilated, self-supporting, code gauge steel enclosure. Cables shall be supported for minimum sag.

- c. Cable Runs: Keep cable runs as short as possible. Allow extra length for connecting to the terminal board. Do not bend flexible coaxial cables in a radius less than ten times the cable outside diameter.
  - d. Use vinyl tape, sleeves, or grommets to protect cables from vibration at points where they pass around sharp corners, through walls, panel cabinets, etc.
  - 6. Conceal cables, except in mechanical rooms and areas where other conduits and piping are exposed.
  - 7. Permanently label or code each point of all field terminal strips to show the instrument or item served. Color-coded cable with cable diagrams may be used to accomplish cable identification.
  - 8. Grounding: ground electrical systems per manufacturer's written requirements for proper and safe operation.
- C. Install Sensors and Controls:
- 1. Temperature Sensors:
    - a. Install all sensors and instrumentation according to manufacturer's written instructions. Temperature sensor locations shall be readily accessible, permitting quick replacement and servicing of them without special skills and tools.
    - b. Calibrate sensors to accuracy specified, if not factory calibrated.
    - c. Use of sensors shall be limited to its duty, e.g., duct sensor shall not be used in lieu of room sensor.
    - d. Install room sensors permanently supported on wall frame. They shall be mounted at 1.5 meter (5.0 feet) above the finished floor.
    - e. Mount sensors rigidly and adequately for the environment within which the sensor operates. Separate extended-bulb sensors form contact with metal casings and coils using insulated standoffs.
    - f. Sensors used in mixing plenum, and hot and cold decks shall be of the averaging of type. Averaging sensors shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip.
    - g. All pipe mounted temperature sensors shall be installed in wells.

- h. All wires attached to sensors shall be air sealed in their conduits or in the wall to stop air transmitted from other areas affecting sensor reading.
  - i. Permanently mark terminal blocks for identification. Protect all circuits to avoid interruption of service due to short-circuiting or other conditions. Line-protect all wiring that comes from external sources to the site from lightning and static electricity.
2. Pressure Sensors:
- a. Install duct static pressure sensor tips facing directly downstream of airflow.
  - b. Install high-pressure side of the differential switch between the pump discharge and the check valve.
  - c. Install snubbers and isolation valves on steam pressure sensing devices.
3. Actuators:
- a. Mount and link damper and valve actuators according to manufacturer's written instructions.
  - b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed position.
  - c. Check operation of valve/actuator combination to confirm that actuator modulates valve smoothly in both open and closed position.
4. Flow Switches:
- a. Install flow switch according to manufacturer's written instructions.
  - b. Mount flow switch a minimum of 5 pipe diameters up stream and 5 pipe diameters downstream or 600 mm (2 feet) whichever is greater, from fittings and other obstructions.
  - c. Assure correct flow direction and alignment.
  - d. Mount in horizontal piping-flow switch on top of the pipe.
- D. Installation of network:
1. Ethernet:
- a. The network shall employ Ethernet LAN architecture, as defined by IEEE 802.3. The Network Interface shall be fully Internet



Protocol (IP) compliant allowing connection to currently installed IEEE 802.3, Compliant Ethernet Networks.

- b. The network shall directly support connectivity to a variety of cabling types. As a minimum provide the following connectivity: 100 Base TX (Category 5e cabling) for the communications between the ECC and the B-BC and the B-AAC controllers.
  2. Third party interfaces: Contractor shall integrate real-time data from building systems by other trades and databases originating from other manufacturers as specified and required to make the system work as one system.
- E. Installation of digital controllers and programming:
1. Provide a separate digital control panel for each major piece of equipment, such as air handling unit, chiller, pumping unit etc. Points used for control loop reset such as outdoor air, outdoor humidity, or space temperature could be located on any of the remote control units.
  2. Provide sufficient internal memory for the specified control sequences and trend logging. There shall be a minimum of 25 percent of available memory free for future use.
  3. System point names shall be modular in design, permitting easy operator interface without the use of a written point index.
  4. Provide software programming for the applications intended for the systems specified, and adhere to the strategy algorithms provided.
  5. Provide graphics for each piece of equipment and floor plan in the building. This includes each chiller, cooling tower, air handling unit, fan, terminal unit, boiler, pumping unit etc. These graphics shall show all points dynamically as specified in the point list.

### **3.2 SYSTEM VALIDATION AND DEMONSTRATION**

- A. As part of final system acceptance, a system demonstration is required (see below). Prior to start of this demonstration, the contractor is to perform a complete validation of all aspects of the controls and instrumentation system.
- B. Validation
  1. Prepare and submit for approval a validation test plan including test procedures for the performance verification tests. Test Plan shall address all specified functions of the ECC and all specified sequences of operation. Explain in detail actions and expected

results used to demonstrate compliance with the requirements of this specification. Explain the method for simulating the necessary conditions of operation used to demonstrate performance of the system. Test plan shall include a test check list to be used by the Installer's agent to check and initial that each test has been successfully completed. Deliver test plan documentation for the performance verification tests to the owner's representative 30 days prior to start of performance verification tests. Provide draft copy of operation and maintenance manual with performance verification test.

2. After approval of the validation test plan, installer shall carry out all tests and procedures therein. Installer shall completely check out, calibrate, and test all connected hardware and software to ensure that system performs in accordance with approved specifications and sequences of operation submitted. Installer shall complete and submit Test Check List.

C. Demonstration

1. System operation and calibration to be demonstrated by the installer in the presence of the Architect or VA's representative on random samples of equipment as dictated by the Architect or VA's representative. Should random sampling indicate improper commissioning, the owner reserves the right to subsequently witness complete calibration of the system at no addition cost to the VA.
2. Demonstrate to authorities that all required safeties and life safety functions are fully functional and complete.
3. Make accessible, personnel to provide necessary adjustments and corrections to systems as directed by balancing agency.
4. The following witnessed demonstrations of field control equipment shall be included:
  - a. Observe HVAC systems in shut down condition. Check dampers and valves for normal position.
  - b. Test application software for its ability to communicate with digital controllers, operator workstation, and uploading and downloading of control programs.
  - c. Demonstrate the software ability to edit the control program off-line.

- d. Demonstrate reporting of alarm conditions for each alarm and ensure that these alarms are received at the assigned location, including operator workstations.
  - e. Demonstrate ability of software program to function for the intended applications-trend reports, change in status etc.
  - f. Demonstrate via graphed trends to show the sequence of operation is executed in correct manner, and that the HVAC systems operate properly through the complete sequence of operation, e.g., seasonal change, occupied/unoccupied mode, and warm-up condition.
  - g. Demonstrate hardware interlocks and safeties functions, and that the control systems perform the correct sequence of operation after power loss and resumption of power loss.
  - h. Prepare and deliver to the VA graphed trends of all control loops to demonstrate that each control loop is stable and the set points are maintained.
  - i. Demonstrate that each control loop responds to set point adjustment and stabilizes within one (1) minute. Control loop trend data shall be instantaneous and the time between data points shall not be greater than one (1) minute.
5. Witnessed demonstration of ECC functions shall consist of:
- a. Running each specified report.
  - b. Display and demonstrate each data entry to show site specific customizing capability. Demonstrate parameter changes.
  - c. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
  - d. Execute digital and analog commands in graphic mode.
  - e. Demonstrate DDC loop precision and stability via trend logs of inputs and outputs (6 loops minimum).
  - f. Demonstrate EMS performance via trend logs and command trace.
  - g. Demonstrate scan, update, and alarm responsiveness.
  - h. Demonstrate spreadsheet/curve plot software, and its integration with database.
  - i. Demonstrate on-line user guide, and help function and mail facility.
  - j. Demonstrate digital system configuration graphics with interactive upline and downline load, and demonstrate specified diagnostics.

- k. Demonstrate multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
- l. Demonstrate class programming with point options of beep duration, beep rate, alarm archiving, and color banding.

----- END -----

**SECTION 23 21 13**  
**HYDRONIC PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Water piping to connect HVAC equipment, including the following:
  - 1. Chilled water, condenser water, heating hot water and drain piping.
  - 2. Extension of domestic water make-up piping for HVAC systems.
- B. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic restraints for piping.
- F. 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.
- G. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- H. Section 23 07 11, HVAC AND BOILER PLANT INSULATION: Piping insulation.
- I. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- J. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Temperature and pressure sensors and valve operators.
- K. Section 23 21 23, HYDRONIC PUMPS: Pumps.
- L. Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING.
- M. Section 23 25 00, HVAC WATER TREATMENT: Water treatment for open and closed systems.
- N. Section 23 82 00, CONVECTION HEATING AND COOLING UNITS: VAV and CV units and fan coil units.

**1.3 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. Where conflicts occur these specifications and the VHA standard will govern.

B. American Society of Mechanical Engineers (ASME):

- B1.20.1-2013 .....Pipe Threads, General Purpose (Inch)
- B16.3-2011 .....Malleable Iron Threaded Fittings: Classes 150  
and 300
- B16.4-2011 .....Gray Iron Threaded Fittings: (Classes 125 and  
250)
- B16.5-2013 .....Pipe Flanges and Flanged Fittings: NPS 1/2  
through NPS 24 Metric/Inch Standard
- B16.9-2012 .....Factory Made Wrought Buttwelding Fittings
- B16.11-2011 .....Forged Fittings, Socket-Welding and Threaded
- B16.18-2012 .....Cast Copper Alloy Solder Joint Pressure  
Fittings
- B16.22-2013 .....Wrought Copper and Copper Alloy Solder-Joint  
Pressure Fittings
- B16.24-2011 .....Cast Copper Alloy Pipe Flanges and Flanged  
Fittings: Classes 150, 300, 600, 900, 1500, and  
2500
- B16.39-2014 .....Malleable Iron Threaded Pipe Unions: Classes  
150, 250, and 300
- B16.42-06 .....Ductile Iron Pipe Flanges and Flanged Fittings
- B31.9-2014 .....Building Services Piping
- B40.100-2013 .....Pressure Gauges and Gauge Attachments
- ASME Boiler and Pressure Vessel Code:  
BPVC Section VIII-2015 .Rules for Construction of Pressure Vessels

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

- A47/A47M-1999 (R2014) ..Standard Specification for Ferritic Malleable  
Iron Castings
- A53/A53M-2012 .....Standard Specification for Pipe, Steel, Black  
and Hot-Dipped, Zinc-Coated, Welded and  
Seamless
- A106/A106M-2015 .....Standard Specification for Seamless Carbon  
Steel Pipe for High-Temperature Service
- A126-2004 (R2014) .....Standard Specification for Gray Iron Castings  
for Valves, Flanges, and Pipe Fittings
- A183-2014 .....Standard Specification for Carbon Steel Track  
Bolts and Nuts

- A216/A216M-2014e1 .....Standard Specification for Steel Castings,  
Carbon, Suitable for Fusion Welding, for High-  
Temperature Service
- A307-2014 .....Standard Specification for Carbon Steel Bolts,  
Studs, and Threaded Rod 60,000 PSI Tensile  
Strength
- A536-1984 (R2014) .....Standard Specification for Ductile Iron  
Castings
- B62-2015 .....Standard Specification for Composition Bronze  
or Ounce Metal Castings
- B88-2014 .....Standard Specification for Seamless Copper  
Water Tube
- F439-2013 .....Standard Specification for Chlorinated Poly  
(Vinyl Chloride) (CPVC) Plastic Pipe Fittings,  
Schedule 80
- F441/F441M-2015 .....Standard Specification for Chlorinated Poly  
(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules  
40 and 80
- D. American Welding Society (AWS):
- B2.1/B2.1M-2014 .....Standard for Welding Procedure and Performance  
Specification
- E. Expansion Joint Manufacturer's Association, Inc. (EJMA):
- EJMA .....Expansion Joint Manufacturer's Association  
Standards, Tenth Edition
- F. Manufacturers Standardization Society (MSS) of the Valve and Fitting  
Industry, Inc.:
- SP-67-2011 .....Butterfly Valves
- SP-70-2011 .....Gray Iron Gate Valves, Flanged and Threaded  
Ends
- SP-71-2011 .....Gray Iron Swing Check Valves, Flanged and  
Threaded Ends
- SP-80-2013 .....Bronze Gate, Globe, Angle, and Check Valves
- SP-85-2011 .....Gray Iron Globe and Angle Valves, Flanged and  
Threaded Ends
- SP-110-2010 .....Ball Valves Threaded, Socket-Welding, Solder  
Joint, Grooved and Flared Ends

SP-125-2010 .....Gray Iron and Ductile Iron In-line, Spring-  
Loaded, Center-Guided Check Valves

G. Tubular Exchanger Manufacturers Association (TEMA):  
TEMA Standards-2007 ....9th Edition

#### 1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 21 13, HYDRONIC PIPING", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Pipe and equipment supports.
  - 2. Pipe and tubing, with specification, class or type, and schedule.
  - 3. Pipe fittings, including miscellaneous adapters and special fittings.
  - 4. Flanges, gaskets and bolting.
  - 5. Couplings and fittings.
  - 6. Valves of all types.
  - 7. Strainers.
  - 8. Flexible connectors for water service.
  - 9. Pipe alignment guides.
  - 10. Expansion joints.
  - 11. Expansion compensators.
  - 12. All specified hydronic system components.
  - 13. Water flow measuring devices.
  - 14. Gauges.
  - 15. Thermometers and test wells.
  - 16. Electric heat tracing systems.
  - 17. Seismic bracing details for piping.
- D. Manufacturer's certified data report, Form No. U-1, for ASME pressure vessels:
  - 1. Heat Exchangers (Steam to Water).
  - 2. Air separators.



3. Expansion tanks.
- E. Submit the welder's qualifications in the form of a current (less than one-year old) and formal certificate.
- F. Coordination Drawings: Refer to paragraph, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- G. As-Built Piping Diagrams: Provide drawing as follows for chilled water, condenser water, and heating hot water system and other piping systems and equipment.
  1. One wall-mounted stick file with complete set of prints. Mount stick file in the chiller plant or control room along with control diagram stick file.
  2. One complete set of reproducible drawings.
  3. One complete set of drawings in electronic AutoCAD and pdf format.
- H. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
  1. Include complete list indicating all components of the systems.
  2. Include complete diagrams of the internal wiring for each item of equipment.
  3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- I. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- J. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

#### **1.5 QUALITY ASSURANCE**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC, which includes welding qualifications.
- B. Submit prior to welding of steel piping a certificate of Welder's certification. The certificate shall be current and not more than one-year old.
- C. All couplings, fittings, valves, and specialties shall be the products of a single manufacturer.
  1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

**1.6 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD and inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
  - 1. As-built drawings are to be provided, with a copy of them in three-dimensional Building Information Modeling (BIM) software version 2019 provided on CD or DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that

all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

#### **1.7 SPARE PARTS**

- A. For mechanical pressed sealed fittings provide tools required for each pipe size used at the facility.

### **PART 2 - PRODUCTS**

#### **2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES**

- A. Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

#### **2.2 PIPE AND TUBING**

- A. Chilled Water, Condenser Water, Heating Hot Water Piping:
  - 1. Steel: ASTM A53/A53M Grade B, seamless or ERW, Schedule 40.
  - 2. Copper water tube option: ASTM B88, Type K or L, hard drawn.
- B. Extension of Domestic Water Make-up Piping: ASTM B88, Type K or L, hard drawn copper tubing.
- C. Cooling Coil Condensate Drain Piping:
  - 1. From air handling units: Copper water tube, ASTM B88, Type M, or Schedule 40 PVC plastic piping.
  - 2. From fan coil or other terminal units: Copper water tube, ASTM B88, Type M for runouts and Type L for mains.
- D. Chemical Feed Piping for Condenser Water Treatment: CPVC, Schedule 80, ASTM F441/F441M.
- E. Pipe supports, including insulation shields, for above ground piping: Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

#### **2.3 FITTINGS FOR STEEL PIPE**

- A. 50 mm (2 inches) and Smaller: Screwed or welded joints.
  - 1. Butt welding: ASME B16.9 with same wall thickness as connecting piping.
  - 2. Forged steel, socket welding or threaded: ASME B16.11.

3. Screwed: 150-pound malleable iron, ASME B16.3. 125-pound cast iron, ASME B16.4, may be used in lieu of malleable iron. Bushing reduction of a single pipe size, or use of close nipples, is not acceptable.
  4. Unions: ASME B16.39.
  5. Water hose connection adapter: Brass, pipe thread to 20 mm (3/4 inch) garden hose thread, with hose cap nut.
- B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints.
1. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
  2. Welding flanges and bolting: ASME B16.5:
    - a. Water service: Weld neck or slip-on, plain face, with 3.2 mm (1/8 inch) thick full-face neoprene gasket suitable for 104 degrees C (220 degrees F).
      - 1) Contractor's option: Convuluted, cold formed 150-pound steel flanges, with Teflon gaskets, may be used for water service.
    - b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.
- C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gauge connections.

#### **2.4 FITTINGS FOR COPPER TUBING**

- A. Joints:
1. Solder Joints: Joints shall be made up in accordance with recommended practices of the materials applied. Apply 95/5 tin and antimony on all copper piping.
  2. Mechanically formed tee connection in water and drain piping: Form mechanically extracted collars in a continuous operation by drilling pilot hole and drawing out tube surface to form collar, having a height of not less than three times the thickness of tube wall. Adjustable collaring device shall ensure proper tolerance and complete uniformity of the joint. Notch and dimple joining branch tube in a single process to provide free flow where the branch tube penetrates the fitting.
- B. Bronze Flanges and Flanged Fittings: ASME B16.24.
- C. Fittings: ASME B16.18 cast copper or ASME B16.22 solder wrought copper.

## **2.5 FITTINGS FOR PLASTIC PIPING**

- A. Schedule 40, socket type for solvent welding.
- B. Schedule 40 PVC drain piping: Drainage pattern.
- C. Chemical feed piping for condenser water treatment: CPVC, Schedule 80, ASTM F439.

## **2.6 DIELECTRIC FITTINGS**

- A. Provide where copper tubing and ferrous metal pipe are joined.
- B. 50 mm (2 inches) and Smaller: Threaded dielectric union, ASME B16.39.
- C. 65 mm (2-1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42. Dielectric gasket material shall be compatible with hydronic medium.
- D. Temperature Rating, 99 degrees C (210 degrees F).
- E. Contractor's option: On pipe sizes 50 mm (2 inch) and smaller, screwed end brass ball valves may be used in lieu of dielectric unions.

## **2.7 SCREWED JOINTS**

- A. Pipe Thread: ASME B1.20.1.
- B. Lubricant or Sealant: Oil and graphite or other compound approved for the intended service.

## **2.8 VALVES**

- A. Asbestos packing is not acceptable.
- B. All valves of the same type shall be products of a single manufacturer.
- C. Provide chain operators for valves 150 mm (6 inches) and larger when the centerline is located 2.4 m (8 feet) or more above the floor or operating platform.
- D. Shut-Off Valves:
  - 1. Ball Valves (Pipe sizes 50 mm (2 inch) and smaller): MSS SP-110, screwed or solder connections, brass or bronze body with chrome-plated ball with full port and Teflon seat at 2758 kPa (400 psig) working pressure rating. Provide stem extension to allow operation without interfering with pipe insulation.
  - 2. Butterfly Valves (Pipe Sizes 65 mm (2-1/2 inch) and larger): Provide stem extension to allow 50 mm (2 inches) of pipe insulation without interfering with valve operation. MSS SP-67, flange lug type rated 1200 kPa (175 psig) working pressure at 93 degrees C (200 degrees F). Valves shall be ANSI Leakage Class VI and rated for bubble tight shut-off to full valve pressure rating. Valve shall be rated for dead end service and bi-directional flow capability to full rated

- pressure. Butterfly valves are prohibited for direct buried pipe applications.
- a. Body: Cast iron, ASTM A126, Class B. Malleable iron, ASTM A47/A47M electro-plated, or ductile iron, ASTM A536, Grade 65-45-12 electro-plated.
  - b. Trim: Bronze, aluminum bronze, or 300 series stainless steel disc, bronze bearings, 316 stainless steel shaft and manufacturer's recommended resilient seat. Resilient seat shall be field replaceable, and fully line the body to completely isolate the body from the product. A phosphate coated steel shaft or stem is acceptable, if the stem is completely isolated from the product.
  - c. Actuators: Field interchangeable. Valves for balancing service shall have adjustable memory stop to limit open position.
    - 1) Valves 150 mm (6 inches) and smaller: Lever actuator with minimum of seven locking positions, except where chain wheel is required.
    - 2) Valves 200 mm (8 inches) and larger: Enclosed worm gear with handwheel, and where required, chain-wheel operator.
    - 3) Gate Valves:
      - a) 50 mm (2 inches) and smaller: MSS SP-80, Bronze, 1035 kPa (150 psig), wedge disc, rising stem, union bonnet.
      - b) 65 mm (2-1/2 inches) and larger: Flanged, outside screw and yoke. MSS SP-70, iron body, bronze mounted, 861 kPa (125 psig) wedge disc.
- E. Globe and Angle Valves:
1. Globe Valves:
    - a. 50 mm (2 inches) and smaller: MSS SP-80, bronze, 1035 kPa (150 psig) Globe valves shall be union bonnet with metal plug type disc.
    - b. 65 mm (2-1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS SP-85 for globe valves.
  2. Angle Valves:
    - a. 50 mm (2 inches) and smaller: MSS SP-80, bronze, 1035 kPa (150 psig) Angle valves shall be union bonnet with metal plug type disc.

- b. 65 mm (2-1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS SP-85 for angle.
- F. Check Valves:
- 1. Swing Check Valves:
    - a. 50 mm (2 inches) and smaller: MSS SP-80, bronze, 1035 kPa (150 psig), 45-degree swing disc.
    - b. 65 mm (2-1/2 inches) and larger: 861 kPa (125 psig), flanged, iron body, bronze trim, MSS SP-71 for check valves.
  - 2. Non-Slam or Silent Check Valve: Spring loaded double disc swing check or internally guided flat disc lift type check for bubble tight shut-off. Provide where check valves are shown in chilled water and hot water piping. Check valves incorporating a balancing feature may be used.
    - a. Body: MSS SP-125 cast iron, ASTM A126, Class B, or steel, ASTM A216/A216M, Class WCB, or ductile iron, ASTM 536, flanged or wafer type.
    - b. Seat, disc and spring: 18-8 stainless steel, or bronze, ASTM B62. Seats may be elastomer material.
- G. Water Flow Balancing Valves: For flow regulation and shut-off. Valves shall be line size rather than reduced to control valve size.
- 1. Globe style valve.
  - 2. A dual-purpose flow balancing valve and adjustable flow meter, with bronze or cast-iron body, calibrated position pointer, valve pressure taps or quick disconnects with integral check valves and preformed polyurethane insulating enclosure.
  - 3. Provide a readout kit including flow meter, readout probes, hoses, flow charts or calculator, and carrying case.
- H. Automatic Balancing Control Valves: Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of 27 to 393 kPa (4 to 57 psig). Provide standard pressure taps and four sets of capacity charts. Valves shall be line size and be one of the following designs:
- 1. Gray iron ASTM A126 or brass body rated 1200 kPa (175 psig) at 93 degrees C (200 degrees F), with stainless steel piston and spring.
  - 2. Brass or ferrous body designed for 2070 kPa (300 psig) service at 121 degrees C (250 degrees F), with corrosion resistant, tamper

- proof, self-cleaning piston/spring assembly that is easily removable for inspection or replacement.
3. Combination assemblies containing ball type shut-off valves, unions, flow regulators, strainers with blowdown valves and pressure temperature ports shall be acceptable.
  4. Provide a readout kit including flow meter, probes, hoses, flow charts and carrying case.
- I. Manual Radiator/Convactor Valves: Brass, packless, with position indicator.

## **2.9 WATER FLOW MEASURING DEVICES**

- A. Minimum overall accuracy plus or minus three percent over a range of 70 to 110 percent of design flow. Select devices for not less than 110 percent of design flow rate.
- B. Venturi Type: Bronze, steel, or cast iron with bronze throat, with valved pressure sensing taps upstream and at the throat.
- C. Wafer Type Circuit Sensor: Cast iron wafer-type flow meter equipped with readout valves to facilitate the connecting of a differential pressure meter. Each readout valve shall be fitted with an integral check valve designed to minimize system fluid loss during the monitoring process.
- D. Self-Averaging Annular Sensor Type: Brass or stainless-steel metering tube, shutoff valves and quick-coupling pressure connections. Metering tube shall be rotatable so all sensing ports may be pointed down-stream when unit is not in use.
- E. Insertion Turbine Type Sensor: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- F. Flow Measuring Device Identification:
  1. Metal tag attached by chain to the device.
  2. Include meter or equipment number, manufacturer's name, meter model, flow rate factor and design flow rate in gpm.
- G. Portable Water Flow Indicating Meters:
  1. Minimum 150 mm (6 inch) diameter dial, forged brass body, beryllium-copper bellows, designed for 1200 kPa (175 psig) working pressure at 121 degrees C (250 degrees F).
  2. Bleed and equalizing valves.
  3. Vent and drain hose and two 3 m (10 feet) lengths of hose with quick disconnect connections.



4. Factory-fabricated carrying case with hose compartment and a bound set of capacity curves showing flow rate versus pressure differential.
  5. Provide one portable meter for each range of differential pressure required for the installed flow devices.
- H. Permanently Mounted Water Flow Indicating Meters: Minimum 150 mm (6 inch) diameter, or 457 mm (18 inch) long scale, for 120 percent of design flow rate, direct reading in gpm, with three valve manifold and two shut-off valves.

#### **2.10 STRAINERS**

- A. Basket Type.
1. Screens: Bronze, Monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows: 1.1 mm (0.045 inch) diameter perforations for 100 mm (4 inches) and larger: 3.2 mm (1/8 inch) diameter perforations.
- B. Suction Diffusers: Specified in Section 23 21 23, HYDRONIC PUMPS.

#### **2.11 FLEXIBLE CONNECTORS FOR WATER SERVICE**

- A. Flanged Spool Connector:
1. Single arch or multiple arch type. Tube and cover shall be constructed of chlorobutyl elastomer with full faced integral flanges to provide a tight seal without gaskets. Connectors shall be internally reinforced with high strength synthetic fibers impregnated with rubber or synthetic compounds as recommended by connector manufacturer, and steel reinforcing rings.
  2. Working pressures and temperatures shall be as follows:
    - a. Connector sizes 50 mm to 100 mm (2 inches to 4 inches), 1137 kPa (165 psig) at 121 degrees C (250 degrees F).
    - b. Connector sizes 125 mm to 300 mm (5 inches to 12 inches), 965 kPa (140 psig) at 121 degrees C (250 degrees F).
  3. Provide ductile iron retaining rings and control units.

#### **2.12 EXPANSION JOINTS**

- A. Factory built devices, inserted in the pipe lines, designed to absorb axial cyclical pipe movement which results from thermal expansion and contraction. This includes factory-built or field-fabricated guides located along the pipe lines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.

- B. Manufacturing Quality Assurance: Conform to Expansion Joints Manufacturers Association (EJMA) Standards.
- C. Bellows - Internally Pressurized Type:
1. Multiple corrugations of Type 304 or Type A240-321 stainless steel.
  2. Internal stainless-steel sleeve entire length of bellows.
  3. External cast iron equalizing rings for services exceeding 345 kPa (50 psig).
  4. Welded ends.
  5. Design shall conform to standards of EJMA and ASME B31.9.
  6. External tie rods designed to withstand pressure thrust force upon anchor failure if one or both anchors for the joint are at change in direction of pipeline.
  7. Integral external cover.
- D. Bellows - Externally Pressurized Type:
1. Multiple corrugations of Type 304 stainless steel.
  2. Internal and external guide integral with joint.
  3. Design for external pressurization of bellows to eliminate squirm.
  4. Welded ends.
  5. Conform to the standards of EJMA and ASME B31.9.
  6. Threaded connection at bottom, 25 mm (1 inch) minimum, for drain or drip point.
  7. Integral external cover and internal sleeve.
- E. Expansion Compensators:
1. Corrugated bellows, externally pressurized, stainless steel or bronze.
  2. Internal guides and anti-torque devices.
  3. Threaded ends.
  4. External shroud.
  5. Conform to standards of EJMA.
- F. Expansion Joint (Contractor's Option): 2413 kPa (350 psig) maximum working pressure, steel pipe fitting consisting of telescoping body and slip-pipe sections, PTFE modified polyphenylene sulfide coated slide section, with welded or flanged ends, suitable for axial end movement to 75 mm (3 inch).
- G. Expansion Joint Identification: Provide stamped brass or stainless-steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and temperature,

date of manufacture, and identifying the expansion joint by the identification number on the contract drawings.

- H. Guides: Provide factory-built guides along the pipe line to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings.
- I. Supports: Provide saddle supports and frame or hangers for heat exchanger. Mounting height shall be adjusted to facilitate gravity return of steam condensate. Construct supports from steel, weld joints.

### **2.13 HYDRONIC SYSTEM COMPONENTS**

- A. Heat Exchanger (Water to Water): Shell and tube type, U-bend removable tube bundle, heating fluid in shell, heated fluid in tubes, equipped with support cradles.
  - 1. Maximum tube velocity: 2.3 m/s (7.5 f/s).
  - 2. Tube fouling factor: TEMA Standards, but not less than 0.001.
  - 3. Materials:
    - a. Shell: Steel.
    - b. Tube sheet and tube supports: Steel or brass.
    - c. Tubes: 20 mm (3/4 inch) OD copper.
    - d. Head or bonnet: Cast iron or steel.
  - 4. Construction: In accordance with ASME BPVC Section VIII for 861 kPa (125 psig) working pressure for shell and tubes. Provide manufacturer's certified data report, Form No. U-1.
- B. Optional Heat Transfer Package (where access allows): In lieu of field erected individual components, the Contractor may provide a factory or shop assembled package of converters, pumps, and other components, pre-piped and pre-wired supported on a welded steel frame or skid. Refer to Section 23 22 13, STEAM AND CONDENSATE HEATING PIPING, for additional requirements.
- C. Air Purger: Cast iron or fabricated steel, 861 kPa (125 psig) water working pressure, for in-line installation.
- D. Tangential Air Separator: ASME BPVC Section VIII construction for 861 kPa (125 psig) working pressure, flanged tangential inlet and outlet connection, internal perforated stainless-steel air collector tube designed to direct released air into expansion tank, bottom blowdown connection. Provide Form No. U-1. If scheduled on the drawings, provide

a removable stainless-steel strainer element having 5 mm (3/16 inch) perforations and free area of not less than five times the cross-sectional area of connecting piping.

- E. Diaphragm Type Pre-Pressurized Expansion Tank: ASME BPVC Section VIII construction for 861 kPa (125 psig) working pressure, welded steel shell, rustproof coated, with a flexible elastomeric diaphragm suitable for a maximum operating temperature of 115 degrees C (240 degrees F). Provide Form No. U-1. Tank shall be equipped with system connection, drain connection, standard air fill valve and be factory pre-charged to a minimum of 83 kPa (12 psig).
- F. Pressure Reducing Valve (Water): Diaphragm or bellows operated, spring loaded type, with minimum adjustable range of 28 kPa (4 psig) above and below set point. Bronze, brass or iron body and bronze, brass or stainless-steel trim, rated 861 kPa (125 psig) working pressure at 107 degrees C (225 degrees F).
- G. Pressure Relief Valve: Bronze or iron body and bronze or stainless-steel trim, with testing lever. Comply with ASME BPVC Section VIII and bear ASME stamp.
- H. Automatic Air Vent Valves (where shown on drawings): Cast iron or semi-steel body, 1035 kPa (150 psig) working pressure, stainless steel float, valve, valve seat and mechanism, minimum 15 mm (1/2 inch) water connection and 6 mm (1/4 inch) air outlet. Air outlet shall be piped to the nearest floor drain.

#### **2.14 WATER FILTERS AND POT CHEMICAL FEEDERS**

- A. See Section 23 25 00, HVAC WATER TREATMENT, paragraph, CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS.

#### **2.15 GAUGES, PRESSURE AND COMPOUND**

- A. ASME B40.100, Accuracy Grade 1A, (pressure, vacuum, or compound for air, oil or water), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 115 mm (4-1/2 inches) in diameter, 6 mm (1/4 inch) NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.
- B. Provide brass lever handle union cock. Provide brass/bronze pressure snubber for gauges in water service.

C. Range of Gauges: Provide range equal to at least 130 percent of normal operating range.

1. For condenser water suction (compound): 101 kPa (30 inches Hg) to 690 kPa (100 psig).

#### **2.16 PRESSURE/TEMPERATURE TEST PROVISIONS**

A. Pete's Plug: 6 mm (1/4 inch) MPT by 75 mm (3 inches) long, brass body and cap, with retained safety cap, nordel self-closing valve cores, permanently installed in piping where shown, or in lieu of pressure gauge test connections shown on the drawings.

B. Provide one each of the following test items to the COR:

1. 6 mm (1/4 inch) FPT by 3.2 mm (1/8 inch) diameter stainless steel pressure gauge adapter probe for extra-long test plug.
2. 90 mm (3-1/2 inch) diameter, one percent accuracy, compound gauge, 101 kPa (30 inches Hg) to 690 kPa (100 psig) range.
3. 0 to 104 degrees C (32 to 220 degrees F) pocket thermometer one-half degree accuracy, 25 mm (1 inch) dial, 125 mm (5 inch) long stainless-steel stem, plastic case.

#### **2.17 THERMOMETERS**

A. Mercury or organic liquid filled type, red or blue column, clear plastic window, with 150 mm (6 inch) brass stem, straight, fixed or adjustable angle as required for each in reading.

B. Case: Chrome plated brass or aluminum with enamel finish.

C. Scale: Not less than 225 mm (9 inches), range as described below, two-degree graduations.

D. Separable Socket (Well): Brass, extension neck type to clear pipe insulation.

E. Scale ranges:

1. Chilled Water : 0 to 38 degrees C (32 to 100 degrees F).
2. Hot Water: 38 to 93 degrees C (100 to 200 degrees F).

#### **2.18 FIRESTOPPING MATERIAL**

A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

#### **2.19 ELECTRICAL HEAT TRACING SYSTEMS**

A. Systems shall meet requirements of NFPA 70.

B. Provide tracing for outdoor piping subject to freezing temperatures below 3.3 degrees C (38 degrees F) as follows:

1. Chilled water piping at units and all other areas exposed to the weather.

2. Domestic water lines exposed to weather.
- C. Heat tracing shall be provided to the extent shown on the drawings (Floor plans and Elevations). Heat tracing shall extend below grade to below the defined frost line.
- D. Heating Cable: Flexible, parallel circuit construction consisting of a continuous self-limiting resistance, conductive inner core material between two parallel copper bus wires, designed for cut-to-length at the job site and for wrapping around valves and complex fittings. Self-regulation shall prevent overheating and burnouts even where the cable overlaps itself.
1. Provide end seals at ends of circuits. Wire at the ends of the circuits is not to be tied together.
  2. Provide sufficient cable, as recommended by the manufacturer, to keep the pipe surface at 2.2 degrees C (36 degrees F) minimum during winter outdoor design temperature, but not less than the following:
    - a. 75 mm (3 inch) pipe and smaller with 25 mm (1 inch) thick insulation: 4 watts per foot of pipe.
    - b. 100 mm (4 inch) pipe and larger 40 mm (1-1/2 inch) thick insulation: 8 watts per feet of pipe.
- E. Electrical Heating Tracing Accessories:
1. Power supply connection fitting and stainless-steel mounting brackets. Provide stainless steel worm gear clamp to fasten bracket to pipe.
  2. 15 mm (1/2 inch) wide fiberglass reinforced pressure sensitive cloth tape to fasten cable to pipe at 300 mm (12 inch) intervals.
  3. Pipe surface temperature control thermostat: Cast aluminum, NEMA 4 (watertight) enclosure, 15 mm (1/2 inch) NPT conduit hub, SPST switch rated 20 amps at 480 volts ac, with capillary and copper bulb sensor. Set thermostat to maintain pipe surface temperature at not less than 1 degrees C (34 degrees F).
  4. Signs: Manufacturer's standard (NFPA 70), stamped "ELECTRIC TRACED" located on the insulation jacket at 3 m (10 feet) intervals along the pipe on alternating sides.

**PART 3 - EXECUTION**

**3.1 GENERAL**

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.
- B. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost or time to the Government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.
- C. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
- D. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Install heat exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.
- E. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (1 inch) minimum clearance between adjacent piping or other surface. Unless shown otherwise, slope drain piping down in the direction of flow not less than 25 mm (1 inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.
- F. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally, locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing. Install butterfly valves with the valve open as recommended by the manufacturer to prevent binding of the disc in the seat.

- G. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.
- H. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.
- I. Provide manual or automatic air vent at all piping system high points and drain valves at all low points. Install piping to floor drains from all automatic air vents.
- J. Connect piping to equipment as shown on the drawings. Install components furnished by others such as:
  - 1. Water treatment pot feeders and condenser water treatment systems.
  - 2. Flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.
- K. Thermometer Wells: In pipes 65 mm (2-1/2 inches) and smaller increase the pipe size to provide free area equal to the upstream pipe area.
- L. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- M. Where copper piping is connected to steel piping, provide dielectric connections.

### **3.2 PIPE JOINTS**

- A. Welded: Beveling, spacing and other details shall conform to ASME B31.9 and AWS B2.1/B2.1M. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Screwed: Threads shall conform to ASME B1.20.1; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.
- C. 125 Pound Cast Iron Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast iron flange.
- D. Solvent Welded Joints: As recommended by the manufacturer.



**3.3 EXPANSION JOINTS (BELLOWS AND SLIP TYPE)**

- A. Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown. A professional engineer shall verify in writing that anchors and guides are properly designed for forces and moments which will be imposed.
- B. Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.
- C. Preparation for Service: Remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.
- D. Access: Expansion joints must be located in readily accessible space. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding.

**3.4 SEISMIC BRACING ABOVEGROUND PIPING**

- A. Provide in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

**3.5 LEAK TESTING ABOVEGROUND PIPING**

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the COR. Tests may be either of those below, or a combination, as approved by the COR.
- B. An operating test at design pressure, and for hot systems, design maximum temperature.
- C. A hydrostatic test at 1.5 times design pressure. For water systems, the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Isolate equipment where necessary to avoid excessive pressure on mechanical seals and safety devices.

**3.6 FLUSHING AND CLEANING PIPING SYSTEMS**

- A. Water Piping: Clean systems as recommended by the suppliers of chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.
- B. Initial Flushing: Remove loose dirt, mill scale, metal chips, weld beads, rust, and like deleterious substances without damage to any system component. Provide temporary piping or hose to bypass coils, control valves, exchangers and other factory cleaned equipment unless

acceptable means of protection are provided, and subsequent inspection of hide-out areas takes place. Isolate or protect clean system components, including pumps and pressure vessels, and remove any component which may be damaged. Open all valves, drains, vents and strainers at all system levels. Remove plugs, caps, spool pieces, and components to facilitate early debris discharge from system. Sectionalize system to obtain debris carrying velocity of 1.8 m/s (5.9 f/s), if possible. Connect dead-end supply and return headers as necessary. Flush bottoms of risers. Install temporary strainers where necessary to protect down-stream equipment. Supply and remove flushing water and drainage by various type hose, temporary and permanent piping and Contractor's booster pumps. Flush until clean as approved by the COR.

- C. Cleaning: Using products supplied in Section 23 25 00, HVAC WATER TREATMENT, circulate systems at normal temperature to remove adherent organic soil, hydrocarbons, flux, pipe mill varnish, pipe joint compounds, iron oxide, and like deleterious substances not removed by flushing, without chemical or mechanical damage to any system component. Removal of tightly adherent mill scale is not required. Keep isolated equipment which is "clean" and where dead-end debris accumulation cannot occur. Sectionalize system if possible, to circulate at velocities not less than 1.8 m/s (5.9 f/s). Circulate each section for not less than 4 hours. Blow-down all strainers or remove and clean as frequently as necessary. Drain and prepare for final flushing.
- D. Final Flushing: Return systems to conditions required by initial flushing after all cleaning solution has been displaced by clean make-up. Flush all dead ends and isolated clean equipment. Gently operate all valves to dislodge any debris in valve body by throttling velocity. Flush for not less than one hour.

### **3.7 WATER TREATMENT**

- A. Install water treatment equipment and provide water treatment system piping.
- B. Close and fill system as soon as possible after final flushing to minimize corrosion.
- C. Charge systems with chemicals specified in Section 23 25 00, HVAC WATER TREATMENT.

- D. Utilize this activity, by arrangement with the COR, for instructing VA operating personnel.

**3.8 ELECTRIC HEAT TRACING**

- A. Install tracing as recommended by the manufacturer.
- B. Coordinate electrical connections.

**3.9 STARTUP AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.
- D. Adjust red set hand on pressure gauges to normal working pressure.

**3.10 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

**3.11 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

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**SECTION 23 21 23**  
**HYDRONIC PUMPS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Hydronic pumps for Heating, Ventilating and Air Conditioning.
- B. Definitions:
  - 1. Capacity: Gallons per minute (gpm) of the fluid pumped.
  - 2. Head: Total dynamic head in kPa (feet) of the fluid pumped.
  - 3. Flat head-capacity curve: Where the shutoff head is less than 1.16 times the head at the best efficiency point.
- C. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- F. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
- G. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- H. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
- I. Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
- J. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- K. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- L. Section 23 21 13, HYDRONIC PIPING.
- M. Section 26 29 11, MOTOR CONTROLLERS.

**1.3 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. Where conflicts occur these specifications and the VHA standard will govern.

- B. American Society of Mechanical Engineers (ASME):  
B16.1-2015 .....Cast Iron Pipe Flanges and Flanged Fittings:  
Classes 25, 125, and 250
- C. American Society for Testing and Materials (ASTM):  
A48/48M-2003 (R2012) ...Standard Specification for Gray Iron Castings  
B62-2015 .....Standard Specification for Composition Bronze  
or Ounce Metal Castings

**1.4 SUBMITTALS**

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 21 23, HYDRONIC PUMPS", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
  - 1. Pumps and accessories.
  - 2. Motors and drives.
  - 3. Variable speed motor controllers.
- D. Characteristic Curves: Head-capacity, efficiency-capacity, brake horsepower-capacity, and NPSHR-capacity for each pump and for combined pumps in parallel or series service. Identify pump and show fluid pumped, specific gravity, pump speed and curves plotted from zero flow to maximum for the impeller being furnished and at least the maximum diameter impeller that can be used with the casing.
- E. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
  - 1. Include complete list indicating all components of the systems.
  - 2. Include complete diagrams of the internal wiring for each item of equipment.
  - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- F. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician

and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

- G. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

### **1.5 QUALITY ASSURANCE**

A. Design Criteria:

1. Pumps design and manufacturer shall conform to Hydraulic Institute Standards.
2. Pump sizes, capacities, pressures, operating characteristics and efficiency shall be as scheduled.
3. Head-capacity curves shall slope up to maximum head at shut-off. Curves shall be relatively flat for closed systems. Select pumps near the midrange of the curve, so the design capacity falls to the left of the best efficiency point, to allow a cushion for the usual drift to the right in operation, without approaching the pump curve end point and possible cavitation and unstable operation. Select pumps for open systems so that required net positive suction head (NPSHR) does not exceed the net positive head available (NPSHA).
4. Pump Driver: Furnish with pump. Size shall be non-overloading at any point on the head-capacity curve, including in a parallel or series pumping installation with one pump in operation.
5. Provide all pumps with motors, impellers, drive assemblies, bearings, coupling guard and other accessories specified. Statically and dynamically balance all rotating parts.
6. Furnish each pump and motor with a nameplate giving the manufacturers name, serial number of pump, capacity in gpm and head in feet at design condition, horsepower, voltage, frequency, speed and full load current and motor efficiency.
7. Test all pumps before shipment. The manufacturer shall certify all pump ratings.
8. After completion of balancing, provide replacement of impellers or trim impellers to provide specified flow at actual pumping head, as installed.

- B. Allowable Vibration Tolerance for Pump Units: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.

#### 1.6 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD and inserted into a three ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:
  1. /As-built drawings are to be provided, with a copy of them in three-dimensional Building Information Modeling (BIM) software version 2019 provided on CD or DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that



all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

#### **1.7 SPARE MATERIALS**

- A. Furnish one spare seal and casing gasket for each pump to the COR.

### **PART 2 - PRODUCTS**

#### **2.1 CENTRIFUGAL PUMPS, BRONZE FITTED**

##### A. General:

1. Provide pumps that will operate continuously without overheating bearings or motors at every condition of operation on the pump curve, or produce noise audible outside the room or space in which installed.
2. Provide pumps of size, type and capacity as indicated, complete with electric motor and drive assembly, unless otherwise indicated. Design pump casings for the indicated working pressure and factory test at 1-1/2 times the designed pressure.
3. Provide pumps of the same type, the product of a single manufacturer, with pump parts of the same size and type interchangeable.
4. General Construction Requirements
  - a. Balance: Rotating parts, statically and dynamically.
  - b. Construction: To permit servicing without breaking piping or motor connections.
  - c. Pump Motors: Provide high efficiency motors, inverter duty for variable speed service. Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT. Motors shall be open drip proof and operate at 1750 RPM unless noted otherwise.
  - d. Heating pumps shall be suitable for handling water to 107 degrees C (225 degrees F).
  - e. Provide coupling guards that meet OSHA requirements.
  - f. Pump Connections: Flanged.

- g. Pump shall be factory tested.
  - h. Performance: As scheduled on the Contract Drawings.
5. Variable Speed Pumps:
- a. The pumps shall be the type shown on the drawings and specified herein flex coupled to an open drip proof motor.
  - b. Variable Speed Motor Controllers: Refer to Section 26 29 11, MOTOR CONTROLLERS and to Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION paragraph, VARIABLE SPEED MOTOR CONTROLLERS. Furnish controllers with pumps and motors.
  - c. Pump operation and speed control shall be as shown on the drawings.
  - d. Direct drive pumps with integrated variable frequency drive (VFD) utilizing the design pump curve programmed on board the built-in controller (also known as sensor-less, or self-sensing). Pump to comply with paragraphs in this section. VFD and motor to comply with Section 26 29 11, MOTOR CONTROLLERS and Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
- B. In-Line Type, Base Mounted End Suction or Double Suction Type:
- 1. Casing and Bearing Housing: Close-grained cast iron, ASTM A48/A48M.
  - 2. Casing Wear Rings: Bronze.
  - 3. Suction and Discharge: Plain face flange, 861 kPa (125 psig), ASME B16.1.
  - 4. Casing Vent: Manual brass cock at high point.
  - 5. Casing Drain and Gauge Taps: 15 mm (1/2 inch) plugged connections minimum size.
  - 6. Impeller: Bronze, ASTM B62, enclosed type, keyed to shaft.
  - 7. Shaft: Steel, Type 1045 or stainless steel.
  - 8. Shaft Seal: Manufacturer's standard mechanical type to suit pressure and temperature and fluid pumped.
  - 9. Shaft Sleeve: Bronze or stainless steel.
  - 10. Motor: Furnish with pump. Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC AND STEAM GENERATION EQUIPMENT.
  - 11. Base Mounted Pumps:
    - a. Designed for disassembling for service or repair without disturbing the piping or removing the motor.
    - b. Impeller Wear Rings: Bronze.

- c. Shaft Coupling: Non-lubricated steel flexible type or spacer type with coupling guard, bolted to the baseplate.
  - d. Bearings (Double-Suction pumps): Greaseable ball or roller type.
  - e. Provide lip seal and slinger outboard of each bearing.
  - f. Base: Cast iron or fabricated steel for common mounting to a concrete base.
12. Provide line sized shut-off valve and suction strainer, maintain manufacturer recommended straight pipe length on pump suction (with blow down valve). Contractor option: Provide suction diffuser as follows:
- a. Body: Cast iron with steel inlet vanes and combination diffuser-strainer-orifice cylinder with 5 mm (3/16 inch) diameter openings for pump protection. Provide taps for strainer blowdown and gauge connections.
  - b. Provide adjustable foot support for suction piping.
  - c. Strainer free area: Not less than five times the suction piping.
  - d. Provide disposable startup strainer.

## **2.2 VERTICAL TURBINE PUMP**

- A. Pump Bowls: Close-grained cast iron, flanged and bolted type, reinforced with four ribs (minimum), which are at least one-half the flange metal thickness. Number of stages as indicated on drawings.
- B. Impellers: Bronze, enclosed type, secured to the shaft with steel tempered keys.
- C. Replaceable Wear Rings: Bronze.
- D. Pump Shaft: Type 416, stainless steel.
- E. Suction Bell: Cast iron, belled to reduce entrance losses.
- F. Suction Strainer: Bronze, basket type, with net open area at least twice the calculated area at the suction bell lip.
- G. Sleeve Bearings: Bronze provided in each bowl and in the suction bell, to be lubricated by the pumped fluid. Suction bell bearing shall be packed permanently with non-soluble grease and fitted with a bronze sand collar.
- H. Discharge Column Pipe: Steel with threaded or flanged connections.
- I. Line-shaft: Type 1045, steel connected through steel threaded couplings. Shaft (and column) sections shall not exceed 3 m (10 feet) in length. Provide the necessary length of column and shaft as required to mount pump with the distances shown.

- J. Replaceable Shaft Sleeves: Stainless steel "shrunkfit" on the line-shaft at each bearing location.
- K. Column Connection Bearings: Fluted rubber supported by non-threaded "spider" type retainers butted between the machined faces of the discharge column. "Spider" shall be made of nickel-iron with a minimum Brinell hardness number of 170.
- L. Surface Discharge Head Assembly: Close-grained cast iron with integral 861 kPa (125 psig) flat face flange, ASME B16.1. Provide two lifting lugs with capacity to support the weight of the entire pump. Provide steel base plate and hardware for securing the discharge head to the base plate.
- M. Stuffing Box: Manufacturer's standard, two Teflon seal cages, and split type packing gland.
- N. Stuffing Box Bearing Housing: Cast iron, one piece, with bronze sleeve bearings.
- O. Motor: Vertical, hollow shaft type, direct connected.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.
- B. Follow manufacturer's written instructions for pump mounting and startup. Access/Service space around pumps shall not be less than minimum space recommended by pumps manufacturer.
- C. Provide drains for bases and seals for base mounted pumps, piped to and discharging into floor drains.
- D. Coordinate location of thermometer and pressure gauges as per Section 23 21 13, HYDRONIC PIPING.

#### **3.2 STARTUP AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.

- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.
- D. Verify that the piping system has been flushed, cleaned and filled.
- E. Lubricate pumps before startup.
- F. Prime the pump, vent all air from the casing and verify that the rotation is correct. To avoid damage to mechanical seals, never start or run the pump in dry condition.
- G. Verify that correct size heaters-motor over-load devices are installed for each pump controller unit.
- H. Field modifications to the bearings and or impeller (including trimming) are prohibited. If the pump does not meet the specified vibration tolerance send the pump back to the manufacturer for a replacement pump. All modifications to the pump shall be performed at the factory.
- I. Ensure the disposable strainer is free of debris prior to testing and balancing of the hydronic system.
- J. After several days of operation, replace the disposable startup strainer with a regular strainer in the suction diffuser.

### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

### **3.4 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

- - - E N D - - -



**SECTION 23 22 13**  
**STEAM AND CONDENSATE HEATING PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Steam, condensate and vent piping inside buildings.
- B. Boiler plant and outside steam distribution piping is covered in specification Section 33 63 00, STEAM ENERGY DISTRIBUTION and Section 23 21 11, BOILER PLANT PIPING SYSTEMS.
- C. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- D. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 09 91 00, PAINTING.
- F. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- G. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.
- H. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- I. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC.
- J. Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- K. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- L. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- M. Section 23 22 23, STEAM CONDENSATE PUMPS.
- N. Section 23 25 00, HVAC WATER TREATMENT.

**1.3 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. Where conflicts occur these specifications and the VHA standard will govern.
- B. American Society of Mechanical Engineers (ASME):
  - B1.20.1-2013 .....Pipe Threads, General Purpose (Inch)
  - B16.5-2013 .....Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard

- B16.9-2012 .....Factory Made Wrought Buttwelding Fittings
- B16.11-2011 .....Forged Fittings, Socket-Welding and Threaded
- B16.42-2011 .....Ductile Iron Pipe Flanges and Flanged Fittings:  
Classes 150 and 300
- B31.1-2014 .....Power Piping
- B31.9-2014 .....Building Services Piping
- B40.100-2013 .....Pressure Gauges and Gauge Attachments
- ASME Boiler and Pressure Vessel Code -
- BPVC Section II-2015 ...Materials
- BPVC Section VIII-2015 .Rules for Construction of Pressure Vessels,  
Division 1
- BPVC Section IX-2015 ...Welding, Brazing, and Fusing Qualifications
- C. American Society for Testing and Materials (ASTM):
- A53/A53M-2012 .....Standard Specification for Pipe, Steel, Black  
and Hot-Dipped, Zinc-Coated, Welded and  
Seamless
- A106/A106M-2015 .....Standard Specification for Seamless Carbon  
Steel Pipe for High-Temperature Service
- A216/A216M-2014e1 .....Standard Specification for Steel Castings,  
Carbon, Suitable for Fusion Welding, for High-  
Temperature Service
- A285/A285M-2012 .....Standard Specification for Pressure Vessel  
Plates, Carbon Steel, Low-and Intermediate-  
Tensile Strength
- A307-2014 .....Standard Specification for Carbon Steel Bolts,  
Studs, and Threaded Rod 60,000 PSI Tensile  
Strength
- A516/A516M-2010 (R2015) Standard Specification for Pressure Vessel  
Plates, Carbon Steel, for Moderate- and Lower-  
Temperature Service
- A536-1984 (R2014) .....Standard Specification for Ductile Iron  
Castings
- B62-2015 .....Standard Specification for Composition Bronze  
or Ounce Metal Castings
- D. American Welding Society (AWS):
- B2.1/B2.1M-2014 .....Specification for Welding Procedure and  
Performance Qualifications



Z49.1-2012 .....Safety in Welding and Cutting and Allied  
Processes

E. Manufacturers Standardization Society (MSS) of the Valve and Fitting  
Industry, Inc.:

SP-80-2013 .....Bronze Gate, Globe, Angle, and Check Valves

F. Military Specifications (Mil. Spec.):

MIL-S-901D-1989 .....Shock Tests, H.I. (High Impact) Shipboard  
Machinery, Equipment, and Systems

G. National Board of Boiler and Pressure Vessel Inspectors (NB):

Relieving Capacities of Safety Valves and Relief Valves

H. Tubular Exchanger Manufacturers Association (TEMA):

TEMA Standards-2007 ....9th Edition

#### **1.4 SUBMITTALS**

A. Submittals, including number of required copies, shall be submitted in  
accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND  
SAMPLES.

B. Information and material submitted under this section shall be marked  
"SUBMITTED UNDER SECTION 23 22 13, STEAM AND CONDENSATE HEATING  
PIPING", with applicable paragraph identification.

C. Manufacturer's Literature and Data including: Full item description and  
optional features and accessories. Include dimensions, weights,  
materials, applications, standard compliance, model numbers, size, and  
capacity.

1. Pipe and equipment supports.

2. Pipe and tubing, with specification, class or type, and schedule.

3. Pipe fittings, including miscellaneous adapters and special  
fittings.

4. Flanges, gaskets and bolting.

5. Valves of all types.

6. Strainers.

7. Pipe alignment guides.

8. Expansion joints.

9. Expansion compensators.

10. Flexible ball joints: Catalog sheets, performance charts,  
schematic drawings, specifications and installation instructions.

11. All specified steam system components.

12. Gauges.

13. Thermometers and test wells.
  14. Electric heat tracing systems.
  15. Seismic bracing details for piping.
- D. Manufacturer's certified data report, Form No. U-1, for ASME pressure vessels:
1. Heat Exchangers (Steam-to-Hot Water).
- E. Coordination Drawings: Refer to paragraph, SUBMITTALS of Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- F. As-Built Piping Diagrams: Provide drawing as follows for steam and steam condensate piping and other central plant equipment.
1. One wall-mounted stick file for prints. Mount stick file in the chiller plant or adjacent control room along with control diagram stick file.
  2. One set of reproducible drawings.
- G. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
1. Include complete list indicating all components of the systems.
  2. Include complete diagrams of the internal wiring for each item of equipment.
  3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- H. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- I. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

#### **1.5 QUALITY ASSURANCE**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC, which includes welding qualifications.
- B. The products and execution of work specified in this section shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments shall be enforced, along with requirements of local utility companies. The most stringent requirements of these specifications, local codes, or utility company

requirements shall always apply. Any conflicts shall be brought to the attention of the COR.

- C. **Welding Qualifications:** 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 BPVC Section IX, AWS Z49.1 and AWS B2.1/B2.1M.
  2. Comply with provisions in ASME B31.9.
  3. Certify that each welder and welding operator has passed AWS qualification tests for welding processes involved and that certification is current and recent. Submit documentation to the COR.
  4. All welds shall be stamped according to the provisions of the American Welding Society.
- D. **ASME Compliance:** Comply with ASME B31.9 for materials, products, and installation. Safety valves and pressure vessels shall bear appropriate ASME labels.

#### **1.6 AS-BUILT DOCUMENTATION**

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD and inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. Should the

installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement. Provide record drawings as follows:

1. As-built drawings are to be provided, with a copy of them in three-dimensional Building Information Modeling (BIM) software version 2019 provided on CD or DVD.
- D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
- E. Certification documentation shall be provided to COR 21 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

## **PART 2 - PRODUCTS**

### **2.1 PIPE AND EQUIPMENT SUPPORTS, PIPE SLEEVES, AND WALL AND CEILING PLATES**

- A. Provide in accordance with Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

### **2.2 PIPE AND TUBING**

- A. Steam Piping: Steel, ASTM A53/A53M, Grade B, seamless or ERW; ASTM A106/A106M Grade B, seamless; Schedule 40.
- B. Steam Condensate and Pumped Condensate Piping: Steel, ASTM A53/A53M, Grade B, seamless or ERW; or ASTM A106/A106M Grade B, seamless, Schedule 80.
- C. Vent Piping: Steel, ASTM A53/A53M, Grade B, seamless or ERW; ASTM A106/A106M Grade B, seamless; Schedule 40, galvanized.

### **2.3 FITTINGS FOR STEEL PIPE**

- A. 50 mm (2 inches) and Smaller: Screwed or welded.
  - 1. Cast iron fittings or piping is not acceptable for steam and steam condensate piping. Bushing reduction or use of close nipples is not acceptable.
  - 2. Forged steel, socket welding or threaded: ASME B16.11, 13,790 kPa (2000 psig) class with ASME B1.20.1 threads. Use Schedule 80 pipe and fittings for threaded joints. Lubricant or sealant shall be oil and graphite or other compound approved for the intended service.
  - 3. Unions: Forged steel, 13,790 kPa (2000 psig) class or 20,685 kPa (3000 psig) class on piping 50 mm (2 inches) and under.
  - 4. Steam line drip station and strainer quick-couple blowdown hose connection: Straight through, plug and socket, screw or cam locking type for 15 mm (1/2 inch) ID hose. No integral shut-off is required.
- B. 65 mm (2-1/2 inches) and Larger: Welded or flanged joints.
  - 1. Cast iron fittings or piping is not acceptable for steam and steam condensate piping.
  - 2. Butt welding fittings: ASME B16.9 with same wall thickness as connecting piping. Elbows shall be long radius type, unless otherwise noted.
  - 3. Welding flanges and bolting: ASME B16.5:
    - a. Steam service: Weld neck or slip-on, raised face, with non-asbestos gasket. Non-asbestos gasket shall either be stainless steel spiral wound strip with flexible graphite filler or compressed inorganic fiber with nitrile binder rated for saturated and superheated steam service 400 degrees C (750 degrees F) and 10,342 kPa (1500 psig).
    - b. Flange bolting: Carbon steel machine bolts or studs and nuts, ASTM A307, Grade B.
- C. Welded Branch and Tap Connections: Forged steel weldolets, or branchlets and threadolets may be used for branch connections up to one pipe size smaller than the main. Forged steel half-couplings, ASME B16.11 may be used for drain, vent and gauge connections.

### **2.4 DIELECTRIC FITTINGS**

- A. Provide where dissimilar metal pipe are joined.
- B. 50 mm (2 inches) and Smaller: Threaded dielectric union.

- C. 65 mm (2-1/2 inches) and Larger: Flange union with dielectric gasket and bolt sleeves, ASME B16.42.
- D. Temperature Rating, 121 degrees C (250 degrees F) for steam condensate and as required for steam service.
- E. Contractor's option: On pipe sizes 50 mm (2 inches) and smaller, screwed end steel gate valves may be used in lieu of dielectric unions.

## 2.5 VALVES

- A. Asbestos packing is not acceptable.
- B. All valves of the same type shall be products of a single manufacturer.
- C. Provide chain operators for valves 150 mm (6 inches) and larger when the centerline is located 2.1 m (7 feet) or more above the floor or operating platform.
- D. Shut-Off Valves:
  - 1. Gate Valves:
    - a. 50 mm (2 inches) and smaller: Forged steel body, rated for 1380 kPa (200 psig) saturated steam, 2758 kPa (400 psig) WOG, bronze wedges and Monel or stainless-steel seats, threaded ends, rising stem, and union bonnet.
    - b. 65 mm (2-1/2 inches) and larger: Flanged, outside screw and yoke.
      - 1) High pressure steam 110 kPa (16 psig) and above system): Cast steel body, ASTM A216/A216M grade WCB, 1035 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel solid disc and seats. Provide 25 mm (1 inch) factory installed bypass with globe valve on valves 100 mm (4 inches) and larger.
      - 2) All other services: Forged steel body, Class B, rated for 850 kPa (123 psig) saturated steam, 1380 kPa (200 psig) WOG, bronze or bronze face wedge and seats, 850 kPa (123 psig) ASME flanged ends, OS&Y, rising stem, bolted bonnet, and renewable seat rings.
- E. Globe and Angle Valves:
  - 1. Globe Valves:
    - a. 50 mm (2 inches) and smaller: Forged steel body, rated for 1380 kPa (200 psig) saturated steam, 2758 kPa (400 psig) WOG, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, and renewable seat rings.

- b. 65 mm (2-1/2 inches) and larger:
  - 1) Globe valves for high pressure steam 110 kPa (16 psig): Cast steel body, ASTM A216/A216M grade WCB, flanged, OS&Y, 1035 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
  - 2) All other services: Steel body, rated for 850 kPa (123 psig) saturated steam, 1380 kPa (200 psig) WOG, bronze or bronze-faced disc (Teflon or composition facing permitted) and seat, 850 kPa (123 psig) ASME flanged ends, OS&Y, rising stem, bolted bonnet, and renewable seat rings.
- 2. Angle Valves:
  - a. 50 mm (2 inches) and smaller: Cast steel 1035 kPa (150 psig), union bonnet with metal plug type disc.
  - b. 65 mm (2-1/2 inches) and larger:
    - 1) Angle valves for high pressure steam 110 kPa (16 psig): Cast steel body, ASTM A216/A216M grade WCB, flanged, OS&Y, 1035 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
    - 2) All other services: 861 kPa (125 psig), flanged, cast steel body, and bronze trim.
- F. Swing Check Valves:
  - 1. 50 mm (2 inches) and smaller: Cast steel, 1035 kPa (150 psig), 45-degree swing disc.
  - 2. 65 mm (2-1/2 inches) and Larger:
    - a. Check valves for high pressure steam 110 kPa (16 psig) and above system: Cast steel body, ASTM A216/A216M grade WCB, flanged, OS&Y, 1035 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chrome stainless steel disc and renewable seat rings.
    - b. All other services: 861 kPa (125 psig), flanged, cast steel body, and bronze trim.
- G. Manual Radiator/Convactor Valves: Brass, packless, with position indicator.

## 2.6 STRAINERS

- A. Basket or Y Type. Tee type is acceptable for gravity flow and pumped steam condensate service.

- B. High Pressure Steam: Rated 1035 kPa (150 psig) saturated steam.
  - 1. 50 mm (2 inches) and smaller: Cast steel, rated for saturated steam at 1034 kPa (150 psig) threaded ends.
  - 2. 65 mm (2-1/2 inches) and larger: Cast steel rated for 1034 kPa (150 psig) saturated steam with 1034 kPa (150 psig) ASME flanged ends or forged steel with 1724 kPa (250 psig) ASME flanged ends.
- C. All Other Services: Rated 861 kPa (125 psig) saturated steam.
  - 1. 50 mm (2 inches) and smaller: Cast steel body.
  - 2. 65 mm (2-1/2 inches) and larger: Flanged, cast steel body.
- D. Screens: Bronze, Monel metal or 18-8 stainless steel, free area not less than 2-1/2 times pipe area, with perforations as follows:
  - 1. 75 mm (3 inches) and smaller: 20 mesh for steam and 1.1 mm (0.045 inch) diameter perforations for liquids.
  - 2. 100 mm (4 inches) and larger: 1.1 mm (0.045) inch diameter perforations for steam and 3.2 mm (1/8 inch) diameter perforations for liquids.

## **2.7 PIPE ALIGNMENT**

- A. Guides: Provide factory-built guides along the pipe line to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand a minimum of 15 percent of the axial force which will be imposed on the expansion joints and anchors. Field-built guides may be used if detailed on the contract drawings.

## **2.8 EXPANSION JOINTS**

- A. Factory built devices, inserted in the pipe lines, designed to absorb axial cyclical pipe movement which results from thermal expansion and contraction. This includes factory-built or field-fabricated guides located along the pipe lines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.
- B. Minimum Service Requirements:
  - 1. Pressure Containment:
    - a. Steam Service 35-200 kPa (5-29 psig): Rated 345 kPa (50 psig) at 148 degrees C (298 degrees F).
    - b. Steam Service 214-850 kPa (31-123 psig): Rated 1035 kPa (150 psig) at 186 degrees C (366 degrees F).
    - c. Steam Service 869-1035 kPa (126-150 psig): Rated 1380 kPa (200 psig) at 194 degrees C (381 degrees F).



- d. Condensate Service: Rated 690 kPa (100 psig) at 154 degrees C (309 degrees F).
  2. Number of Full Reverse Cycles without failure: Minimum 1000.
  3. Movement: As shown on drawings plus recommended safety factor of manufacturer.
- C. Manufacturing Quality Assurance: Conform to Expansion Joints Manufacturers Association Standards.
- D. Bellows - Internally Pressurized Type:
1. Multiple corrugations of Type 304 or Type A240-321 stainless steel.
  2. Internal stainless-steel sleeve entire length of bellows.
  3. External cast iron equalizing rings for services exceeding 345 kPa (50 psig).
  4. Welded ends.
  5. Design shall conform to standards of EJMA and ASME B31.1.
  6. External tie rods designed to withstand pressure thrust force upon anchor failure if one or both anchors for the joint are at change in direction of pipeline.
  7. Integral external cover.
- E. Bellows - Externally Pressurized Type:
1. Multiple corrugations of Type 304 stainless steel.
  2. Internal and external guide integral with joint.
  3. Design for external pressurization of bellows to eliminate squirm.
  4. Welded ends.
  5. Conform to the standards of EJMA and ASME B31.1.
  6. Threaded connection at bottom, 25 mm (1 inch) minimum, for drain or drip point.
  7. Integral external cover and internal sleeve.
- F. Expansion Joint Identification: Provide stamped brass or stainless-steel nameplate on each expansion joint listing the manufacturer, the allowable movement, flow direction, design pressure and temperature, date of manufacture, and identifying the expansion joint by the identification number on the contract drawings.

## **2.9 FLEXIBLE BALL JOINTS**

- A. Design and Fabrication: One-piece component construction, fabricated from steel with welded ends, designed for a working steam pressure of 1725 kPa (250 psig) and a temperature of 232 degrees C (450 degrees F). Each joint shall provide for 360 degrees rotation in addition to a

minimum angular flexible movement of 30 degrees for sizes 6 mm (1/4 inch) to 150 mm (6 inch) inclusive, and 15 degrees for sizes 65 mm (2-1/2 inches) to 762 mm (30 inches). Joints through 355 mm (14 inches) shall have forged pressure retaining members; while size 406 mm (16 inches) through 762 mm (30 inches) shall be of one-piece construction.

B. Material:

1. Cast or forged steel pressure containing parts and bolting in accordance with ASME BPVC Section II or ASME B31.1. Retainer may be ductile iron ASTM A536, Grade 65-45-12, or ASME BPVC Section II SA 515, Grade 70.
2. Gaskets: Steam pressure molded composition design for a temperature range of from minus 10 degrees C (50 degrees F) to plus 274 degrees C (525 degrees F).

C. Certificates: Submit qualifications of ball joints in accordance with the following test data:

1. Low pressure leakage test: 41 kPa (6 psig) saturated steam for 60 days.
2. Flex cycling: 800 Flex cycles at 3447 kPa (500 psig) saturated steam.
3. Thermal cycling: 100 saturated steam pressure cycles from atmospheric pressure to operating pressure and back to atmospheric pressure.
4. Environmental shock tests: Forward certificate from a recognized test laboratory, that ball joints of the type submitted has passed shock testing in accordance with Mil. Spec MIL-S-901.
5. Vibration: 170 hours on each of three mutually perpendicular axes at 25 to 125 Hz; 1.3 mm to 2.5 mm (0.05 inch to 0.10 inch) double amplitude on a single ball joint and 3 ball joint off set.

**2.10 STEAM SYSTEM COMPONENTS**

- A. Heat Exchanger (Steam to Hot Water): Shell and tube type, U-bend removable tube bundle, steam in shell, water in tubes, equipped with support cradles.
1. Maximum tube velocity: 2.3 m/s (7.5 f/s).
  2. Tube fouling factor: TEMA Standards, but not less than 0.00018 m<sup>2</sup>K/W (0.001 ft<sup>2</sup>hrF/Btu).
  3. Materials:
    - a. Shell: Steel.

- b. Tube sheet and tube supports: Steel or brass.
  - c. Tubes: 20 mm (3/4 inch) OD copper.
  - d. Head or bonnet: Steel.
4. Construction: In accordance with ASME Pressure Vessel Code for 861 kPa (125 psig) working pressure for shell and tubes. Provide manufacturer's certified data report, Form No. U-1.
- B. Optional Heat Transfer Package: In lieu of field erected individual components, the Contractor may provide a factory or shop assembled package of heat exchangers, pumps, and other components, pre-piped and pre-wired and supported on a welded steel frame or skid.
- C. Safety Valves and Accessories: Comply with ASME BPVC Section VIII. Capacities shall be certified by National Board of Boiler and Pressure Vessel Inspectors, maximum accumulation 10 percent. Provide lifting lever. Provide drip pan elbow where shown. Valve shall have stainless steel seats and trim.
- D. Steam PRV for Individual Equipment: Cast steel body, screwed or flanged ends, rated 861 kPa (125 psig), or 20 percent above the working pressure, whichever is greater. Single-seated, diaphragm operated, spring loaded, adjustable range, all parts renewable.
- E. Steam Trap: Each type of trap shall be the product of a single manufacturer. Provide trap sets at all low points and at 61 m (200 feet) intervals on the horizontal main lines.
- 1. Floats and linkages shall provide sufficient force to open trap valve over full operating pressure range available to the system. Unless otherwise indicated on the drawings, traps shall be sized for capacities indicated at minimum pressure drop as follows:
    - a. For equipment with modulating control valve: 1.7 kPa (1/4 psig), based on a condensate leg of 300 mm (12 inches) at the trap inlet and gravity flow to the receiver.
    - b. For main line drip trap sets and other trap sets at steam pressure: Up to 70 percent of design differential pressure. Condensate may be lifted to the return line.
  - 2. Trap bodies: Steel, constructed to permit ease of removal and servicing working parts without disturbing connecting piping. The use of 4 bolt raised face flange is required. The use of unions is unacceptable for steam trap maintenance. For systems without relief

- valve traps shall be rated for the pressure upstream of the steam supplying the system.
3. Balanced pressure thermostatic elements: Phosphor bronze, stainless steel or Monel metal.
  4. Valves and seats: Suitable hardened corrosion resistant alloy.
  5. Mechanism: Brass, stainless steel or corrosion resistant alloy.
  6. Floats: Stainless steel.
  7. Inverted bucket traps: Provide bi-metallic thermostatic element for rapid release of non-condensables.
- F. Thermostatic Air Vent (Steam): Steel body, balanced pressure bellows, stainless steel (renewable) valve and seat, rated 861 kPa (125 psig) working pressure, 20 mm (3/4 inch) screwed connections. Air vents shall be balanced pressure type that responds to steam pressure-temperature curve and vents air at any pressure.
- G. Steam Humidifiers:
1. Fabrication requirements:
    - a. As scheduled on the drawings.
  2. Mounting: See drawings
  3. Water requirements: The humidifier shall be capable of generating steam from tap, softened, or DI/RO water.
  4. Drain: Positive drainage/blow-down using a drain pump, drawing water from the bottom of the tank, maximizing mineral evacuation.
  5. Controls: Control subpanel shall be factory-attached to humidifier with all wiring completed at factory. A wiring diagram shall be included. The controller shall be microprocessor based and shall have the following features or functions:
    - a. Web interface shall have same functionality as the unit keypad/display and shall allow multiple remotely located users to simultaneously view system operation and/or change system parameters. Web interface shall have password-protected secure access and shall be compatible with standard Internet browsers. Web interface shall connect directly to a personal computer or through a system network via Ethernet cable and shall be interoperable with any communication network.
    - b. Redundant low water safety control.
    - c. Fully modulating (0 to 100 percent) control of humidifier outputs.

- d. Water level control: Automatic refill, low water cutoff, field adjustable skimmer bleed off functions and automatic drain-down of humidifier.
- e. USB port on the control board for software updates, data backups, and data restoration.
- f. Up-time optimizer function to keep humidifier(s) operating through conditions such as fill, drain, or run-time faults, as long as safety conditions are met, minimizing production down-time.
- g. Real-time clock to allow time-stamped alarm/message tracking, and scheduled events.
- h. Factory commissioning of humidifier and control board, including system configuration as-ordered, factory unit testing, and operation with water before shipping.
- i. Unit-mounted keypad/display operable within a temperature range of 0 to 70 degrees C (32 to 158 degrees F), and provides backlighting for viewing in low light.
- j. Alarms, unit configuration, and usage timer values shall remain in nonvolatile memory indefinitely during a power outage.
- k. The controls shall monitor, control, and/or adjust the following parameters:
  - 1) Relative humidity (RH) set point, actual conditions in the space (from humidity transmitter), RH offset.
  - 2) Dew point set point, actual conditions in the space (from dew point transmitter), dew point offset.
  - 3) Total system demand in % of humidifier capacity.
  - 4) Total system output in kg/hr (lb/hr).
  - 5) Drain/flush duration, allowed days, and frequency based on usage.
  - 6) End-of-season drain status (on standard water systems and if ordered as a DI water option) and hours humidifier is idle before end of season draining occurs.
  - 7) Air temperature or other auxiliary temperature monitoring with programmable offset.
  - 8) System alarms and system messages, current and previous.
  - 9) Adjustable water skim duration.

1. Programmable outputs for remote signaling of alarms and/or messages, device activation (such as a fan), or for signaling tank heating and/or steam production.
- m. System diagnostics that include:
  - 1) Test outputs function to verify component operation.
  - 2) Test humidifier function by simulating demand to validate performance.
  - 3) Data collection of RH, air temperature, water use, energy use, alarms, and service messages for viewing from the keypad/display or Web interface.
  - 4) Service notification scheduling.
  - 5) Password-protected system parameters.
  - 6) Keypad/display or Web interface displays in English.
  - 7) Numerical units displayed in inch-pound or SI units.
6. Other humidifier control features:
  - a. Interoperability using BACnet MS/TP.
  - b. Water level control for DI/RO water: System shall provide for continuous control of water level and will accommodate the use of deionized or reverse osmosis water with resistance up to 18 M-ohm/cm. System shall include:
    - 1) Water level sensing unit comprised of a float operated stainless steel valve for water makeup.
    - 2) Low water cutoff float switch.
    - 3) Operation within inlet water supply pressure range of 170 to 550 kPa (25 to 80 psig).
  - c. Access panel interlock switch: The control subpanel shall have an interlock control switch with manual override to remove control voltage when access panel is opened.
  - d. Removable keypad/display: Provide a keypad/display with cable for remote use.
    - 1) =Airflow proving switch, pressure type: Airflow proving switch shall be diaphragm-operated with pitot tube for field installation. Switch shall have an adjustable control point range of 12.5 to 2988 Pa (0.05 to 12 inch WG) Operating temperature range -40 to 82 degrees C (-40 to 180 degrees F). Compatible with 24, 120, and 240 VAC.

7. Distribution Manifold: Stainless steel, composed of dispersion pipe and surrounding steam jacket, manifold shall span the width of duct or air handler, and shall be multiple manifold type under any of the following conditions:
- a. Duct section height exceeds 900 mm (36 inches).
  - b. Duct air velocity exceeds 5.1 m/s (1000 feet per minute).
  - c. If within 900 mm (3 feet) upstream of fan, damper or pre-filter.
  - d. If within 3 m (10 feet) upstream of after-filter.
- H. Steam Flow Meter/Recorder: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

#### **2.11 GAUGES, PRESSURE AND COMPOUND**

- A. ASME B40.100, Accuracy Grade 1A, (pressure, vacuum, or compound), initial mid-scale accuracy 1 percent of scale (Qualify grade), metal or phenolic case, 115 mm (4-1/2 inches) in diameter, 6 mm (1/4 inch) NPT bottom connection, white dial with black graduations and pointer, clear glass or acrylic plastic window, suitable for board mounting. Provide red "set hand" to indicate normal working pressure.
- B. Provide steel, lever handle union cock. Provide steel or stainless-steel pressure snubber for gauges in water service. Provide steel pigtail syphon for steam gauges.
- C. Pressure gauge ranges shall be selected such that the normal operating pressure for each gauge is displayed near the midpoint of each gauge's range. Gauges with ranges selected such that the normal pressure is displayed at less than 30 percent or more than 70 percent of the gauge's range are prohibited. The units of pressure shall be psig.

#### **2.12 PRESSURE/TEMPERATURE TEST PROVISIONS**

- A. Provide one each of the following test items to the COR:
  1. 6 mm (1/4 inch) FPT by 3.2 mm (1/8 inch) diameter stainless steel pressure gauge adapter probe for extra-long test plug. Pressure/temperature plug is an example.
  2. 90 mm (3-1/2 inch) diameter, one percent accuracy, compound gauge, 762 mm (30 inches) Hg to 690 kPa (100 psig) range.
  3. 0 to 104 degrees C (32 to 220 degrees F) pocket thermometer one-half degree accuracy, 25 mm (1 inch) dial, 125 mm (5 inch) long stainless-steel stem, plastic case.

#### **2.13 FIRESTOPPING MATERIAL**

- A. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**PART 3 - EXECUTION**

**3.1 GENERAL**

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.
- B. The drawings show the general arrangement of pipe and equipment but do not show all required fittings and offsets that may be necessary to connect pipes to equipment, fan-coils, coils, radiators, etc., and to coordinate with other trades. Provide all necessary fittings, offsets and pipe runs based on field measurements and at no additional cost or time to the Government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories to be connected on ceiling grid. Pipe location on the drawings shall be altered by contractor where necessary to avoid interferences and clearance difficulties.
- C. Store materials to avoid excessive exposure to weather or foreign materials. Keep inside of piping relatively clean during installation and protect open ends when work is not in progress.
- D. Support piping securely. Refer to PART 3, Section 23 05 11, COMMON WORK RESULTS FOR HVAC. Install convertors and other heat exchangers at height sufficient to provide gravity flow of condensate to the flash tank and condensate pump.
- E. Install piping generally parallel to walls and column center lines, unless shown otherwise on the drawings. Space piping, including insulation, to provide 25 mm (1 inch) minimum clearance between adjacent piping and another surface. Unless shown otherwise, slope steam, condensate and drain piping down in the direction of flow not less than 25 mm (1 inch) in 12 m (40 feet). Provide eccentric reducers to keep bottom of sloped piping flat.
- F. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally, locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing.
- G. Offset equipment connections to allow valving off for maintenance and repair with minimal removal of piping. Provide flexibility in equipment



connections and branch line take-offs with 3-elbow swing joints where noted on the drawings.

- H. Tee water piping runouts or branches into the side of mains or other branches. Avoid bull-head tees, which are two return lines entering opposite ends of a tee and exiting out the common side.
- I. Connect piping to equipment as shown on the drawings. Install components furnished by others such as flow elements (orifice unions), control valve bodies, flow switches, pressure taps with valve, and wells for sensors.
- J. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC AND BOILER PLANT INSULATION.
- K. Pipe vents to the exterior. Where a combined vent is provided, the cross-sectional area of the combined vent shall be equal to sum of individual vent areas. Slope vent piping 25 mm (1 inch) in 12 m (40 feet) 0.25 percent in direction of flow. Provide a drip pan elbow on relief valve outlets if the vent rises to prevent backpressure. Terminate vent minimum 300 mm (12 inches) above the roof or through the wall minimum 2.4 m (8 feet) above grade with down turned elbow.

### **3.2 WELDING**

- A. The contractor is entirely responsible for the quality of the welding and shall:
  - 1. Conduct tests of the welding procedures used on the project, verify the suitability of the procedures used, verify that the welds made will meet the required tests, and also verify that the welding operators have the ability to make sound welds under standard conditions.
  - 2. Perform all welding operations required for construction and installation of the piping systems.
- B. Qualification of Welders: Rules of procedure for qualification of all welders and general requirements for fusion welding shall conform with the applicable portions of ASME B31.1, AWS B2.1/B2.1M, AWS Z49.1, and also as outlined below.
- C. Examining Welder: Examine each welder at job site, in the presence of the COR, to determine the ability of the welder to meet the qualifications required. Test welders for piping for all positions,

including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder shall be allowed to weld only in the position in which he has qualified and shall be required to identify his welds with his specific code marking signifying his name and number assigned.

- D. Examination Results: Provide the COR with a list of names and corresponding code markings. Retest welders who fail to meet the prescribed welding qualifications. Disqualify welders, who fail the second test, for work on the project.
- E. Beveling: Field bevels and shop bevels shall be done by mechanical means or by flame cutting. Where beveling is done by flame cutting, surfaces shall be thoroughly cleaned of scale and oxidation just prior to welding. Conform to specified standards.
- F. Alignment: Provide approved welding method for joints on all pipes greater than 50 mm (2 inches) to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe.
- G. Erection: Piping shall not be split, bent, flattened, or otherwise damaged before, during, or after installation. If the pipe temperature falls to 0 degrees C (32 degrees F) or lower, the pipe shall be heated to approximately 38 degrees C (100 degrees F) for a distance of 300 mm (1 foot) on each side of the weld before welding, and the weld shall be finished before the pipe cools to 0 degrees C (32 degrees F).
- H. Non-Destructive Examination of Piping Welds:
  - 1. Perform radiographic examination of 50 percent of the first 10 welds made and 10 percent of all additional welds made. The COR reserves the right to identify individual welds for which the radiographic examination must be performed. All welds will be visually inspected by the COR. The VA reserves the right to require testing on additional welds up to 100 percent if more than 25 percent of the examined welds fail the inspection.
  - 2. An approved independent testing firm regularly engaged in radiographic testing shall perform the radiographic examination of pipe joint welds. All radiographs shall be reviewed and interpreted by an ASNT Certified Level III radiographer, employed by the testing firm, who shall sign the reading report.
  - 3. Comply with ASME B31.1. Furnish a set of films showing each weld inspected, a reading report evaluating the quality of each weld, and

a location plan showing the physical location where each weld is to be found in the completed project. The COR and the commissioning agent shall be given a copy of all reports to be maintained as part of the project records and shall review all inspection records.

- I. Defective Welds: Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening are prohibited. Welders responsible for defective welds must be requalified prior to resuming work on the project.
- J. Electrodes: Electrodes shall be stored in a dry heated area and be kept free of moisture and dampness during the fabrication operations. Discard electrodes that have lost part of their coating.

### **3.3 PIPE JOINTS**

- A. Welded: Beveling, spacing and other details shall conform to ASME B31.1 and AWS B2.1/B2.1M. See Welder's qualification requirements under "Quality Assurance" in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Screwed: Threads shall conform to ASME B1.20.1; joint compound shall be applied to male threads only and joints made up so no more than three threads show. Coat exposed threads on steel pipe with joint compound, or red lead paint for corrosion protection.
- C. 125 Pound Cast Steel Flange (Plain Face): Mating flange shall have raised face, if any, removed to avoid overstressing the cast steel flange.

### **3.4 EXPANSION JOINTS (BELLOWS AND SLIP TYPE)**

- A. Anchors and Guides: Provide type, quantity and spacing as recommended by manufacturer of expansion joint and as shown. A professional engineer shall verify in writing that anchors and guides are properly designed for forces and moments which will be imposed.
- B. Cold Set: Provide setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.
- C. Preparation for Service: Remove all apparatus provided to restrain joint during shipping or installation. Representative of manufacturer shall visit the site and verify that installation is proper.
- D. Access: Expansion joints must be located in readily accessible space. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to

permit access to devices for inspection of all surfaces and for adding packing.

### **3.5 STEAM TRAP PIPING**

- A. Install to permit gravity flow to the trap. Provide gravity flow (avoid lifting condensate) from the trap where modulating control valves are used. Support traps weighing over 11 kg (24 pounds) independently of connecting piping.

### **3.6 SEISMIC BRACING**

- A. Provide in accordance with Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

### **3.7 LEAK TESTING**

- A. Inspect all joints and connections for leaks and workmanship and make corrections as necessary, to the satisfaction of the COR in accordance with the specified requirements. Testing shall be performed in accordance with the specification requirements.
- B. An operating test at design pressure, and for hot systems, design maximum temperature.
- C. A hydrostatic test at 1.5 times design pressure. For water systems, the design maximum pressure would usually be the static head, or expansion tank maximum pressure, plus pump head. Factory tested equipment (convertors, exchangers, coils, etc.) need not be field tested. Avoid excessive pressure on mechanical seals and safety devices.
- D. Prepare and submit test and inspection reports to the COR within 5 working days of test completion and prior to covering the pipe.
- E. All tests shall be witnessed by the COR, their representative, or the Commissioning Agent and be documented by each section tested, date tested, and list of personnel present.

### **3.8 FLUSHING AND CLEANING PIPING SYSTEMS**

- A. Steam, Condensate and Vent Piping: The piping system shall be flushed clean prior to equipment connection. Cleaning includes pulling all strainer screens and cleaning all scale/dirt legs during startup operation. Contractor shall be responsible for damage caused by inadequately cleaned/flushed systems.

### **3.9 STARTUP AND TESTING**

- A. Perform tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the

various items of equipment shall be performed simultaneously with the system of which each item is an integral part.

- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.
- D. Adjust red set hand on pressure gauges to normal working pressure.

**3.10 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.

**3.11 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for 4 hours to instruct each VA personnel responsible in operation and maintenance of the system.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.

- - - E N D - - -



**SECTION 23 23 00**  
**REFRIGERANT PIPING**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Field refrigerant piping for direct expansion HVAC systems. Field refrigerant piping and associated drain and condenser water piping for laboratory refrigerators, including required pipe insulation.
- B. Refrigerant piping shall be sized, selected, and designed either by the equipment manufacturer or in strict accordance with the manufacturer's published instructions. The schematic piping diagram shall show all accessories such as, stop valves, level indicators, liquid receivers, oil separator, gauges, thermostatic expansion valves, solenoid valves, moisture separators and driers to make a complete installation.
- C. Definitions:
  - 1. Refrigerating system: Combination of interconnected refrigerant-containing parts constituting one closed refrigeration circuit in which a refrigerant is circulated for the purpose of extracting heat.
    - a. Low side means the parts of a refrigerating system subjected to evaporator pressure.
    - b. High side means the parts of a refrigerating system subjected to condenser pressure.
  - 2. Brazed joint: A gas-tight joint obtained by the joining of metal parts with alloys which melt at temperatures higher than 449 degrees C (840 degrees F) but less than the melting temperatures of the joined parts.

**1.2 RELATED WORK**

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- D. Section 23 07 11, HVAC, and BOILER PLANT INSULATION.
- E. Section 23 21 13, HYDRONIC PIPING.

**1.3 QUALITY ASSURANCE**

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

- B. Comply with ASHRAE Standard 15, Safety Code for Mechanical Refrigeration. The application of this Code is intended to assure the safe design, construction, installation, operation, and inspection of every refrigerating system employing a fluid which normally is vaporized and liquefied in its refrigerating cycle.
- C. Comply with ASME B31.5: Refrigerant Piping and Heat Transfer Components.
- D. Products shall comply with UL 207 "Refrigerant-Containing Components and Accessories, "Nonelectrical"; or UL 429 "Electrical Operated Valves."

#### **1.4 SUBMITTALS**

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Shop Drawings:
  - 1. Complete information for components noted, including valves and refrigerant piping accessories, clearly presented, shall be included to determine compliance with drawings and specifications for components noted below:
    - a. Tubing and fittings
    - b. Valves
    - c. Strainers
    - d. Moisture-liquid indicators
    - e. Filter-driers
    - f. Flexible metal hose
    - g. Liquid-suction interchanges
    - h. Oil separators (when specified)
    - i. Gages
    - j. Pipe and equipment supports
    - k. Refrigerant and oil
    - l. Pipe/conduit roof penetration cover
    - m. Soldering and brazing materials
  - 2. Layout of refrigerant piping and accessories, including flow capacities, valves locations, and oil traps slopes of horizontal runs, floor/wall penetrations, and equipment connection details.
- C. Certification: Copies of certificates for welding procedure, performance qualification record and list of welders' names and symbols.



- D. Design Manual: Furnish two copies of design manual of refrigerant valves and accessories.

**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, Heating, and Refrigeration Institute (ARI/AHRI):
- 495-1999 (R2002) .....Standard for Refrigerant Liquid Receivers
  - 730-2005 .....Flow Capacity Rating of Suction-Line Filters and Suction-Line Filter-Driers
  - 750-2007 .....Thermostatic Refrigerant Expansion Valves
  - 760-2007 .....Performance Rating of Solenoid Valves for Use with Volatile Refrigerants
- C. American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE):
- ANSI/ASHRAE 15-2007 ....Safety Standard for Refrigeration Systems (ANSI)
  - ANSI/ASHRAE 17-2008 ....Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves (ANSI)
  - 63.1-95 (RA 01) .....Method of Testing Liquid Line Refrigerant Driers (ANSI)
- D. American National Standards Institute (ANSI):
- ASME (ANSI)A13.1-2007 ..Scheme for Identification of Piping Systems
  - Z535.1-2006 .....Safety Color Code
- E. American Society of Mechanical Engineers (ASME):
- ANSI/ASME B16.22-2001 (R2005)
  - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings (ANSI)
  - ANSI/ASME B16.24-2006 Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500 (ANSI)
  - ANSI/ASME B31.5-2006 ...Refrigeration Piping and Heat Transfer Components (ANSI)
  - ANSI/ASME B40.100-2005 .Pressure Gauges and Gauge Attachments
  - ANSI/ASME B40.200-2008 .Thermometers, Direct Reading and Remote Reading
- F. American Society for Testing and Materials (ASTM)

- A126-04 .....Standard Specification for Gray Iron Castings  
for Valves, Flanges, and Pipe Fittings B32-08  
Standard Specification for Solder Metal
- B88-03 .....Standard Specification for Seamless Copper  
Water Tube
- B88M-05 .....Standard Specification for Seamless Copper  
Water Tube (Metric)
- B280-08 .....Standard Specification for Seamless Copper Tube  
for Air Conditioning and Refrigeration Field  
Service

G. American Welding Society, Inc. (AWS):

Brazing Handbook

- A5.8/A5.8M-04 .....Standard Specification for Filler Metals for  
Brazing and Braze Welding

H. Federal Specifications (Fed. Spec.)

Fed. Spec. GG

I. Underwriters Laboratories (U.L.):

- U.L.207-2009 .....Standard for Refrigerant-Containing Components  
and Accessories, Nonelectrical

U.L.429-99 (Rev.2006) ..Standard for Electrically Operated Valves

**PART 2 - PRODUCTS**

**2.1 PIPING AND FITTINGS**

- A. Refrigerant Piping: For piping up to 100 mm (4 inch) use Copper refrigerant tube, ASTM B280, cleaned, dehydrated and sealed, marked ACR on hard temper straight lengths. Coils shall be tagged ASTM B280 by the manufacturer. For piping over 100 mm (4 inch) use A53 Black SML steel.
- B. Water and Drain Piping: Copper water tube, ASTM B88M, Type B or C (ASTM B88, Type M or L). Optional drain piping material: Schedule 80 flame retardant Polypropylene plastic.
- C. Fittings, Valves and Accessories:
  - 1. Copper fittings: Wrought copper fittings, ASME B16.22.
    - a. Brazed Joints, refrigerant tubing: Cadmium free, AWS A5.8/A5.8M, 45 percent silver brazing alloy, Class BAg-5.
    - b. Solder Joints, water and drain: 95-5 tin-antimony, ASTM B32 (95TA).
  - 3. Flanges and flanged fittings: ASME B16.24.
  - 4. Refrigeration Valves:

- a. Stop Valves: Brass or bronze alloy, packless, or packed type with gas tight cap, frost proof, back seating.
  - b. Pressure Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; UL listed. Forged brass with nonferrous, corrosion resistant internal working parts of high strength, cast iron bodies conforming to ASTM A126, Grade B. Set valves in accordance with ASHRAE Standard 15.
  - d. Thermostatic Expansion Valves: Comply with ARI 750. Brass body with stainless-steel or non-corrosive non ferrous internal parts, diaphragm and spring-loaded (direct-operated) type with sensing bulb and distributor having side connection for hot-gas bypass and external equalizer. Size and operating characteristics as recommended by manufacturer of evaporator and factory set for superheat requirements. Solder-end connections. Testing and rating in accordance with ASHRAE Standard 17.
  - e. Check Valves: Brass or bronze alloy with swing or lift type, with tight closing resilient seals for silent operation; designed for low pressure drop, and with solder-end connections. Direction of flow shall be legibly and permanently indicated on the valve body.
5. Strainers: Designed to permit removing screen without removing strainer from piping system, and provided with screens 80 to 100 mesh in liquid lines DN 25 (NPS 1) and smaller, 60 mesh in liquid lines larger than DN 25 (NPS 1), and 40 mesh in suction lines. Provide strainers in liquid line serving each thermostatic expansion valve, and in suction line serving each refrigerant compressor not equipped with integral strainer.
  6. Refrigerant Moisture/Liquid Indicators: Double-ported type having heavy sight glasses sealed into forged bronze body and incorporating means of indicating refrigerant charge and moisture indication. Provide screwed brass seal caps.
  7. Refrigerant Filter-Dryers: UL listed, angle or in-line type, as shown on drawings. Conform to ARI Standard 730 and ASHRAE Standard 63.1. Heavy gage steel shell protected with corrosion-resistant paint; perforated baffle plates to prevent desiccant bypass. Size as recommended by manufacturer for service and capacity of system with connection not less than the line size in which installed. Filter

driers with replaceable filters shall be furnished with one spare element of each type and size.

8. Flexible Metal Hose: Seamless bronze corrugated hose, covered with bronze wire braid, with standard copper tube ends. Provide in suction and discharge piping of each compressor.
9. Water Piping Valves and Accessories: Refer to specification Section 23 21 13, HYDRONIC PIPING.

## **2.2 GAGES**

- A. Temperature Gages: Comply with ASME B40.200. Industrial-duty type and in required temperature range for service in which installed. Gages shall have Celsius scale in 1-degree (Fahrenheit scale in 2-degree) graduations and with black number on a white face. The pointer shall be adjustable. Rigid stem type temperature gages shall be provided in thermal wells located within 1525 mm (5 feet) of the finished floor. Universal adjustable angle type or remote element type temperature gages shall be provided in thermal wells located 1525 to 2135 mm (5 to 7 feet) above the finished floor. Remote element type temperature gages shall be provided in thermal wells located 2135 mm (7 feet) above the finished floor.
- B. Vacuum and Pressure Gages: Comply with ASME B40.100 and provide with throttling type needle valve or a pulsation dampener and shut-off valve. Gage shall be a minimum of 90 mm (3-1/2 inches) in diameter with a range from 0 kPa (0 psig) to approximately 1.5 times the maximum system working pressure. Each gage range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range.
  1. Suction: 101 kPa (30 inches Hg) vacuum to 1723 kPa (gage) (250 psig).
  2. Discharge: 0 to 3445 kPa (gage) (0 to 500 psig).

## **2.3 THERMOMETERS AND WELLS**

- A. Refer to specification Section 23 21 13, HYDRONIC PIPING.

## **2.4 PIPE SUPPORTS**

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

## **2.5 ELECTRICAL HEAT TRACING SYSTEM**

- A. Refer to specification Section 23 21 13, HYDRONIC PIPING. Provide for freezer unit cooler drain piping.

## **2.6 REFRIGERANTS AND OIL**

- A. Provide EPA approved refrigerant and oil for proper system operation.

## **2.7 PIPE/CONDUIT ROOF PENETRATION COVER**

- A. Prefabricated Roof Curb: Galvanized steel or extruded aluminum 300 mm (12 inches) overall height, continuous welded corner seams, treated wood nailer, 38 mm (1-1/2 inch) thick, 48 kg/cu.m (3 lb/cu.ft.) density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.
- B. Penetration Cover: Galvanized sheet metal with flanged removable top. Provide 38 mm (1-1/2 inch) thick mineral fiber board insulation.
- C. Flashing Sleeves: Provide sheet metal sleeves for conduit and pipe penetrations of the penetration cover. Seal watertight penetrations.

## **2.8 PIPE INSULATION FOR DX HVAC SYSTEMS**

Refer to specification Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.

## **2.9 PIPE INSULATION FOR WALK-IN COOLERS AND FREEZERS AND LABORATORY REFRIGERATORS AND MORTUARY REFRIGERATORS**

- A. Flexible elastomeric: Refer to specification Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION.
- B. Insulate refrigerant suction piping from unit cooler to condensing unit. Use 20 mm (3/4-inch) thick insulation on piping inside the refrigerator or freezer and 40 mm (1-1/2 inch) thick insulation (double layer required) on piping outside the refrigerated space.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install refrigerant piping and refrigerant containing parts in accordance with ASHRAE Standard 15 and ASME B31.5
  - 1. Install piping as short as possible, with a minimum number of joints, elbow and fittings.
  - 2. Install piping with adequate clearance between pipe and adjacent walls and hangers to allow for service and inspection. Space piping, including insulation, to provide 25 mm (1 inch) minimum clearance between adjacent piping or other surface. Use pipe sleeves through

- walls, floors, and ceilings, sized to permit installation of pipes with full thickness insulation.
3. Locate and orient valves to permit proper operation and access for maintenance of packing, seat and disc. Generally locate valve stems in overhead piping in horizontal position. Provide a union adjacent to one end of all threaded end valves. Control valves usually require reducers to connect to pipe sizes shown on the drawing.
  4. Use copper tubing in protective conduit when installed below ground.
  5. Install hangers and supports per ASME B31.5 and the refrigerant piping manufacturer's recommendations.
- B. Joint Construction:
1. Brazed Joints: Comply with AWS "Brazing Handbook" and with filler materials complying with AWS A5.8/A5.8M.
    - a. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper tubing.
    - b. Use Type BA9, cadmium-free silver alloy for joining copper with bronze or steel.
    - c. Swab fittings and valves with manufacturer's recommended cleaning fluid to remove oil and other compounds prior to installation.
    - d. Pass nitrogen gas through the pipe or tubing to prevent oxidation as each joint is brazed. Cap the system with a reusable plug after each brazing operation to retain the nitrogen and prevent entrance of air and moisture.
  - C. Protect refrigerant system during construction against entrance of foreign matter, dirt and moisture; have open ends of piping and connections to compressors, condensers, evaporators and other equipment tightly capped until assembly.
  - D. Pipe relief valve discharge to outdoors for systems containing more than 45 kg (100 lbs) of refrigerant.
  - E. Firestopping: Fill openings around uninsulated piping penetrating floors or fire walls, with firestop material. For firestopping insulated piping refer to Section 23 07 11, HVAC, and BOILER PLANT INSULATION.
  - F. Seismic Bracing: Refer to specification Section 13 05 41, SEISMIC RESTRAINTS REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS, for bracing of piping in seismic areas.

### **3.2 PIPE AND TUBING INSULATION**

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Apply two coats of weather-resistant finish as recommended by the manufacturer to insulation exposed to outdoor weather.

### **3.3 SIGNS AND IDENTIFICATION**

- A. Each refrigerating system erected on the premises shall be provided with an easily legible permanent sign securely attached and easily accessible, indicating thereon the name and address of the installer, the kind and total number of pounds of refrigerant required in the system for normal operations, and the field test pressure applied.
- B. Systems containing more than 50 kg (110 lb) of refrigerant shall be provided with durable signs, in accordance with ANSI A13.1 and ANSI Z535.1, having letters not less than 13 mm (1/2 inch) in height designating:
  - 1. Valves and switches for controlling refrigerant flow, the ventilation and the refrigerant compressor(s).
  - 2. Signs on all exposed high pressure and low pressure piping installed outside the machinery room, with name of the refrigerant and the letters "HP" or "LP."

### **3.4 FIELD QUALITY CONTROL**

Prior to initial operation examine and inspect piping system for conformance to plans and specifications and ASME B31.5. Correct equipment, material, or work rejected because of defects or nonconformance with plans and specifications, and ANSI codes for pressure piping.

- A. After completion of piping installation and prior to initial operation, conduct test on piping system according to ASME B31.5. Furnish materials and equipment required for tests. Perform tests in the presence of Resident Engineer. If the test fails, correct defects and perform the test again until it is satisfactorily done and all joints are proved tight.
  - 1. Every refrigerant-containing parts of the system that is erected on the premises, except compressors, condensers, evaporators, safety devices, pressure gages, control mechanisms and systems that are factory tested, shall be tested and proved tight after complete installation, and before operation.

2. The high and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure-relief device protecting the high or low side of the system, respectively, except systems erected on the premises using non-toxic and non-flammable Group A1 refrigerants with copper tubing not exceeding DN 18 (NPS 5/8). This may be tested by means of the refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 20 degrees C (68 degrees F) minimum.
- B. Test Medium: A suitable dry gas such as nitrogen or shall be used for pressure testing. The means used to build up test pressure shall have either a pressure-limiting device or pressure-reducing device with a pressure-relief device and a gage on the outlet side. The pressure relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system components.
- C. Refrigerator/Freezer Start-up and Performance Tests: Specification Section 11 53 23, LABORATORY REFRIGERATORS .

### **3.5 SYSTEM TEST AND CHARGING**

- A. System Test and Charging: As recommended by the equipment manufacturer or as follows:
  1. Connect a drum of refrigerant to charging connection and introduce enough refrigerant into system to raise the pressure to 70 kPa (10 psi) gage. Close valves and disconnect refrigerant drum. Test system for leaks with halide test torch or other approved method suitable for the test gas used. Repair all leaking joints and retest.
  2. Connect a drum of dry nitrogen to charging valve and bring test pressure to design pressure for low side and for high side. Test entire system again for leaks.
  3. Evacuate the entire refrigerant system by the triplicate evacuation method with a vacuum pump equipped with an electronic gage reading in mPa (microns). Pull the system down to 665 mPa (500 microns) 665 mPa (2245.6 inches of mercury at 60 degrees F) and hold for four hours then break the vacuum with dry nitrogen (or refrigerant). Repeat the evacuation two more times breaking the third vacuum with the refrigeration to be charged and charge with the proper volume of refrigerant.

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**SECTION 23 25 00**  
**HVAC WATER TREATMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies cleaning and treatment of circulating HVAC water systems, including the following.
  - 1. Cleaning compounds.
  - 2. Chemical treatment for closed loop heat transfer systems.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- D. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- E. Section 23 21 13, HYDRONIC PIPING.
- F. Section 23 22 13, STEAM and CONDENSATE HEATING PIPING.

**1.3 QUALITY ASSURANCE**

- A. Refer to paragraph, QUALITY ASSURANCE in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Technical Services: Provide the services of an experienced water treatment chemical engineer or technical representative to direct flushing, cleaning, pre-treatment, training, debugging, and acceptance testing operations; direct and perform chemical limit control during construction period and monitor systems for a period of 12 months after acceptance, including not less than 6 service calls and written status reports. Emergency calls are not included. Minimum service during construction/start-up shall be 6 hours.
- C. Field Quality Control and Certified Laboratory Reports: During the one year guarantee period, the water treatment laboratory shall provide not less than 12 reports based on on-site periodic visits, as stated in paragraph 1.3.B, sample taking and testing, and review with VA personnel, of water treatment control for the previous period. In addition to field tests, the water treatment laboratory shall provide certified laboratory test reports. These monitoring reports shall assess chemical treatment accuracy, scale formation, fouling and corrosion control, and shall contain instructions for the correction of any out-of-control condition.

- D. Log Forms: Provide one-year supply of preprinted water treatment test log forms.
- E. Chemicals: Chemicals shall be non-toxic approved by local authorities and meeting applicable EPA requirements.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data including:
  - 1. Cleaning compounds and recommended procedures for their use.
  - 2. Chemical treatment for closed systems, including installation and operating instructions.
  - 3. Chemical treatment for open loop systems, including installation and operating instructions.
- C. Water analysis verification.
- D. Materials Safety Data Sheet for all proposed chemical compounds, based on U.S. Department of Labor Form No. L5B-005-4.
- E. Maintenance and operating instructions in accordance with Section 01 00 00, GENERAL REQUIREMENTS.

**1.5 APPLICABLE PUBLICATIONS**

- A. The publication 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. National Fire Protection Association (NFPA):  
70-2008 .....National Electric Code (NEC)
- C. American Society for Testing and Materials (ASTM):  
F441/F441M-02 (2008) ....Standard Specification for Chlorinated Poly  
(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules  
40 and 80

**PART 2 - PRODUCTS**

**2.1 CLEANING COMPOUNDS**

- A. Alkaline phosphate or non-phosphate detergent/surfactant/specific to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals without deleterious effects.
- B. All chemicals to be acceptable for discharge to sanitary sewer.

- C. Refer to Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING, PART 3, for flushing and cleaning procedures.

## **2.2 CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS**

- A. Inhibitor: Provide sodium nitrite/borate, molybdate-based inhibitor or other approved compound suitable for make-up quality and make-up rate and which will cause or enhance bacteria/corrosion problems or mechanical seal failure due to excessive total dissolved solids. Shot feed manually. Maintain inhibitor residual as determined by water treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.
- B. pH Control: Inhibitor formulation shall include adequate buffer to maintain pH range of 8.0 to 10.5.
- C. Performance: Protect various wetted, coupled, materials of construction including ferrous, and red and yellow metals. Maintain system essentially free of scale, corrosion, and fouling. Corrosion rate of following metals shall not exceed specified mills per year penetration; ferrous, 0-2; brass, 0-1; copper, 0-1. Inhibitor shall be stable at equipment skin surface temperatures and bulk water temperatures of not less than 121 degrees C (250 degrees F) and 52 degrees C (125 degrees Fahrenheit) respectively. Heat exchanger fouling and capacity reduction shall not exceed that allowed by fouling factor 0.0005.
- D. Pot Feeder: By-pass type, complete with necessary shut off valves, drain and air release valves, and system connections, for introducing chemicals into system, cast iron or steel tank with funnel or large opening on top for easy chemical addition. Feeders shall be 18.9 L (five gallon) minimum capacity at 860 kPa (125 psig) minimum working pressure.

## **2.5 EQUIPMENT AND MATERIALS IDENTIFICATION**

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Delivery and Storage: Deliver all chemicals in manufacturer's sealed shipping containers. Store in designated space and protect from deleterious exposure and hazardous spills.

- B. Install equipment furnished by the chemical treatment supplier and charge systems according to the manufacturer's instructions and as directed by the Technical Representative.
- C. Refer to Section 23 21 13 HYDRONIC PIPING for chemical treatment piping, installed as follows:
  - 1. Provide a by-pass line around water meters and bleed off piping assembly. Provide ball valves to allow for bypassing, isolation, and servicing of components.
  - 2. Bleed off water piping with bleed off piping assembly shall be piped from pressure side of circulating water piping to a convenient drain. Bleed off connection to main circulating water piping shall be upstream of chemical injection nozzles.
  - 3. Provide piping for the flow assembly piping to the main control panel and accessories.
    - a. The inlet piping shall connect to the discharge side of the circulating water pump.
    - b. The outlet piping shall connect to the water piping serving the cooling tower downstream of the heat source.
    - c. Provide inlet Y-strainer and ball valves to isolate and service main control panel and accessories.
  - 4. Install injection nozzles with corporation stops in the water piping serving the cooling tower downstream of the heat source.
  - 5. Provide piping for corrosion monitor rack per manufacturer's installation instructions. Provide ball valves to isolate and service rack.
  - 7. Provide installation supervision, start-up and operating instruction by manufacturer's technical representative.
- D. Before adding cleaning chemical to the closed system, all air handling coils and fan coil units should be isolated by closing the inlet and outlet valves and opening the bypass valves. This is done to prevent dirt and solids from lodging the coils.
- E. Do not valve in or operate system pumps until after system has been cleaned.
- F. After chemical cleaning is satisfactorily completed, open the inlet and outlet valves to each coil and close the by-pass valves. Also, clean all strainers.

- G. Perform tests and report results in accordance with Section 01 00 00,  
GENERAL REQUIREMENTS.
- H. After cleaning is complete, and water PH is acceptable to manufacturer  
of water treatment chemical, add manufacturer-recommended amount of  
chemicals to systems.
- I. Instruct VA personnel in system maintenance and operation in accordance  
with Section 01 00 00, GENERAL REQUIREMENTS.

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**SECTION 23 31 00  
HVAC DUCTS AND CASINGS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Ductwork and accessories for HVAC including the following:
  - 1. Supply air, return air, outside air, exhaust, make-up air, and relief systems.
  - 3. Exhaust duct for kitchen hood exhaust (grease).
- B. Definitions:
  - 1. SMACNA Standards as used in this specification means the HVAC Duct Construction Standards, Metal and Flexible.
  - 2. Seal or Sealing: Use of liquid or mastic sealant, with or without compatible tape overlay, or gasketing of flanged joints, to keep air leakage at duct joints, seams and connections to an acceptable minimum.
  - 3. Duct Pressure Classification: SMACNA HVAC Duct Construction Standards, Metal and Flexible.
  - 4. Exposed Duct: Exposed to view in a finished room, exposed to weather.

**1.2 RELATED WORK**

- A. Fire Stopping Material: Section 07 84 00, FIRESTOPPING.
- B. Outdoor and Exhaust Louvers: Section 08 90 00, LOUVERS and VENTS.
- C. Kitchen Hoods: Section 23 38 13, COMMERCIAL-KITCHEN HOODS.
- D. Seismic Reinforcing: Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- E. General Mechanical Requirements: Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- F. Noise Level Requirements: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- G. Duct Insulation: Section 23 07 11, HVAC, PLUMBING, and BOILER PLANT INSULATION
- H. Plumbing Connections: Section 22 11 00, FACILITY WATER DISTRIBUTION
- I. Air Flow Control Valves and Terminal Units: Section 23 36 00, AIR TERMINAL UNITS.
- J. Duct Mounted Coils: Section 23 82 16, AIR COILS.
- K. Supply Air Fans: Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.

- L. Return Air and Exhaust Air Fans: Section 23 34 00, HVAC FANS.
- M. Air Filters and Filters' Efficiencies: Section 23 40 00, HVAC AIR CLEANING DEVICES.
- N. Duct Mounted Instrumentation: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- O. Testing and Balancing of Air Flows: Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.
- P. Smoke Detectors: Section 28 31 00, FIRE DETECTION and ALARM.

### **1.3 QUALITY ASSURANCE**

- A. Refer to article, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Fire Safety Code: Comply with NFPA 90A.
- C. Duct System Construction and Installation: Referenced SMACNA Standards are the minimum acceptable quality.
- D. Duct Sealing, Air Leakage Criteria, and Air Leakage Tests: Ducts shall be sealed as per duct sealing requirements of SMACNA HVAC Air Duct Leakage Test Manual for duct pressure classes shown on the drawings.
- E. Duct accessories exposed to the air stream, such as dampers of all types (except smoke dampers) and access openings, shall be of the same material as the duct or provide at least the same level of corrosion resistance.

### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Rectangular ducts:
    - a. Schedules of duct systems, materials and selected SMACNA construction alternatives for joints, sealing, gage and reinforcement.
    - b. Duct liner.
    - c. Sealants and gaskets.
    - d. Access doors.
  - 2. Round and flat oval duct construction details:
    - a. Manufacturer's details for duct fittings.
    - b. Duct liner.
    - c. Sealants and gaskets.
    - d. Access sections.



- e. Installation instructions.
- 3. Volume dampers, back draft dampers.
- 4. Upper hanger attachments.
- 5. Fire dampers, fire doors, and smoke dampers with installation instructions.
- 6. Sound attenuators, including pressure drop and acoustic performance.
- 7. Flexible ducts and clamps, with manufacturer's installation instructions.
- 8. Flexible connections.
- 9. Instrument test fittings.
- 10 Details and design analysis of alternate or optional duct systems.
- C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 230511 Common Work Results for HVAC and Steam Generation.

**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 Civil Engineers (ASCE):
  - ASCE7-05 .....Minimum Design Loads for Buildings and Other Structures
- C. American Society for Testing and Materials (ASTM):
  - A167-99(2009) .....Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
  - A653-09 .....Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy coated (Galvannealed) by the Hot-Dip process
  - A1011-09a .....Standard Specification for Steel, Sheet and Strip, Hot rolled, Carbon, structural, High-Strength Low-Alloy, High Strength Low-Alloy with Improved Formability, and Ultra-High Strength
  - B209-07 .....Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
  - C1071-05e1 .....Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)

- E84-09a .....Standard Test Method for Surface Burning  
Characteristics of Building Materials
- D. National Fire Protection Association (NFPA):
- 90A-09 .....Standard for the Installation of Air  
Conditioning and Ventilating Systems
- 96-08 .....Standard for Ventilation Control and Fire  
Protection of Commercial Cooking Operations
- E. Sheet Metal and Air Conditioning Contractors National Association  
(SMACNA):
- 2nd Edition - 2005 .....HVAC Duct Construction Standards, Metal and  
Flexible
- 1st Edition - 1985 .....HVAC Air Duct Leakage Test Manual
- 6th Edition - 2003 .....Fibrous Glass Duct Construction Standards
- F. Underwriters Laboratories, Inc. (UL):
- 181-08 .....Factory-Made Air Ducts and Air Connectors
- 555-06 .....Standard for Fire Dampers
- 555S-06 .....Standard for Smoke Dampers

**PART 2 - PRODUCTS**

**2.1 DUCT MATERIALS AND SEALANTS**

- A. General: Except for systems specified otherwise, construct ducts, casings, and accessories of galvanized sheet steel, ASTM A653, coating G90; or, aluminum sheet, ASTM B209, alloy 1100, 3003 or 5052.
- B. Specified Corrosion Resistant Systems: Stainless steel sheet, ASTM A167, Class 302 or 304, Condition A (annealed) Finish No. 4 for exposed ducts and Finish No. 2B for concealed duct or ducts located in mechanical rooms.
- C. Optional Duct Materials:
1. Grease Duct: Double wall factory-built grease duct, UL labeled and complying with NFPA 96 may be furnished in lieu of specified materials for kitchen and grill hood exhaust duct. Installation and accessories shall comply with the manufacturers catalog data. Outer jacket of exposed ductwork shall be stainless steel. Square and rectangular duct shown on the drawings will have to be converted to equivalent round size.
- D. Joint Sealing: Refer to SMACNA HVAC Duct Construction Standards, paragraph S1.9.

1. Sealant: Elastomeric compound, gun or brush grade, maximum 25 flame spread, and 50 smoke developed (dry state) compounded specifically for sealing ductwork as recommended by the manufacturer. Generally, provide liquid sealant, with or without compatible tape, for low clearance slip joints and heavy, permanently elastic, mastic type where clearances are larger. Oil base caulking and glazing compounds are not acceptable because they do not retain elasticity and bond.
2. Tape: Use only tape specifically designated by the sealant manufacturer and apply only over wet sealant. Pressure sensitive tape shall not be used on bare metal or on dry sealant.
3. Gaskets in Flanged Joints: Soft neoprene.

E. Approved factory-made joints may be used.

## **2.2 DUCT CONSTRUCTION AND INSTALLATION**

- A. Regardless of the pressure classifications outlined in the SMACNA Standards, fabricate and seal the ductwork in accordance with the following pressure classifications:
- B. Duct Pressure Classification:
  - 0 to 50 mm (2 inch)
  - > 50 mm to 75 mm (2 inch to 3 inch)
  - > 75 mm to 100 mm (3 inch to 4 inch)Show pressure classifications on the floor plans.
- C. Seal Class: All ductwork shall receive Class A Seal
- D. Operating Room/Cystoscopy Room Supply Air: All supply air ductwork on the downstream side of the terminal final HEPA filter serving an operating room or cystoscopy room shall be fabricated from welded stainless steel, including all components of the air distribution system up to and including the supply air outlet.
- E. Wet Air Exhaust Ducts and Accessories: Ducts for dishwashers, scullery hood, cart washers, manual cart washers, cage washers, steam sterilizer hoods and orthotics hoods shall be 1.3 mm (18 gage) stainless steel made liquid tight with continuous external weld for all seams and joints. Provide neoprene gaskets at flanged connections. Where ducts are not self-draining back to the equipment, provide low point drain pocket with copper drainpipe to sanitary sewer. Provide access door inside of duct at drain pockets.

- F. Provide a welded stainless-steel duct section for housing the duct-mounted terminal humidifiers. Ductwork shall be at least 3 feet long on the upstream side and 6 feet long on the downstream side. Slope the ductwork against the direction of airflow and provide drain connections.
- G. Kitchen and Grill Hood (Ventilator) Exhaust Ducts: Comply with NFPA 96.
1. Material: 1.6 mm (16 gage) steel sheet (black iron), ASTM A1011, or 1.3 mm (18 gage) stainless steel. Use stainless steel for exposed duct in occupied areas. See Optional Duct Materials.
  2. Construction: Liquid tight with continuous external weld for all seams and joints. Where ducts are not self-draining back to the equipment, provide low point drain pocket with copper drain pipe to sanitary sewer. Provide access doors or panels for duct cleaning inside of horizontal duct at drain pockets, at 6 m (20 feet) intervals, and at each change of direction.
  3. Access doors or panels shall be of the same material and thickness of the duct with gaskets and sealants that are rated 815 degrees C (1500 degrees F) and shall be grease-tight.
  4. Grease Duct: Double-wall factory-built grease duct, UL labeled and complying with NFPA 96 may be furnished in lieu of specified materials for kitchen and grill hood exhaust. Installation and accessories shall comply with the manufacturers catalog data. Outer jacket of exposed ductwork shall be stainless steel. Square and rectangular duct shown in the drawings will have to be converted to equivalent round size.
- L. Duct for Negative Pressure Up to 750 Pa (3 inch W.G.): Provide for exhaust duct between HEPA filters and exhaust fan inlet including systems for Autopsy Suite exhaust.
1. Round Duct: Galvanized steel, spiral lock seam construction with standard slip joints.
  2. Rectangular Duct: Galvanized steel, minimum 1.0 mm (20 gage), Pittsburgh lock seam, companion angle joints 32 mm by 3.2 mm (1-1/4 by 1/8 inch) minimum at not more than 2.4 m (8 feet) spacing. Approved pre-manufactured joints are acceptable in lieu of companion angles.
- M. Round and Flat Oval Ducts: Furnish duct and fittings made by the same manufacturer to insure good fit of slip joints. When submitted and

approved in advance, round and flat oval duct, with size converted on the basis of equal pressure drop, may be furnished in lieu of rectangular duct design shown on the drawings.

1. Elbows: Diameters 80 through 200 mm (3 through 8 inches) shall be two sections die stamped, all others shall be gored construction, maximum 18 degree angle, with all seams continuously welded or standing seam. Coat galvanized areas of fittings damaged by welding with corrosion resistant aluminum paint or galvanized repair compound.
  2. Provide bell mouth, conical tees or taps, laterals, reducers, and other low loss fittings as shown in SMACNA HVAC Duct Construction Standards.
  3. Ribbed Duct Option: Lighter gage round/oval duct and fittings may be furnished provided certified tests indicating that the rigidity and performance is equivalent to SMACNA standard gage ducts are submitted.
    - a. Ducts: Manufacturer's published standard gage, G90 coating, spiral lock seam construction with an intermediate standing rib.
    - b. Fittings: May be manufacturer's standard as shown in published catalogs, fabricated by spot welding and bonding with neoprene base cement or machine formed seam in lieu of continuous welded seams.
  4. Provide flat side reinforcement of oval ducts as recommended by the manufacturer and SMACNA HVAC Duct Construction Standard S3.13. Because of high pressure loss, do not use internal tie-rod reinforcement unless approved by the Resident Engineer.
- P. Casings and Plenums: Construct in accordance with SMACNA HVAC Duct Construction Standards Section 6, including curbs, access doors, pipe penetrations, eliminators and drain pans. Access doors shall be hollow metal, insulated, with latches and door pulls, 500 mm (20 inches) wide by 1200 - 1350 mm (48 - 54 inches) high. Provide view port in the doors where shown. Provide drain for outside air louver plenum. Outside air plenum shall have exterior insulation. Drain piping shall be routed to the nearest floor drain.
- Q. Volume Dampers: Single blade or opposed blade, multi-louver type as detailed in SMACNA Standards. Refer to SMACNA Detail Figure 2-12 for Single Blade and Figure 2.13 for Multi-blade Volume Dampers.

- R. Duct Hangers and Supports: Refer to SMACNA Standards Section IV. Avoid use of trapeze hangers for round duct.

### **2.3 DUCT LINER (WHERE INDICATED ON DRAWINGS)**

- A. Duct sizes shown on drawings for lined duct are clear opening inside lining.
- B. Duct liner is only permitted to be used for return, relief and general exhaust ducts. Duct liner is not permitted for outside air ducts, supply air ducts or any other positive pressure ductwork (provide exterior insulation only).
- C. Rectangular Duct or Casing Liner: ASTM C1071, Type I (flexible), or Type II (board), 25 mm (one inch) minimum thickness, applied with mechanical fasteners and 100 percent coverage of adhesive in conformance with SMACNA, Duct Liner Application Standard.
- D. Round and Oval Duct Liner: Factory fabricated double-walled with (one inch) thick sound insulation and inner perforated galvanized metal liner. Construction shall comply with flame and smoke rating required by NFPA 90A. Metal liner shall be 1.0 to 0.60 mm (20 to 24 gage) having perforations not exceeding 2.4 mm (3/32 inch) diameter and approximately 22 percent free area. Metal liner for fittings need not be perforated. Assemblies shall be complete with continuous sheet Mylar liner, 2 mil thickness, between the perforated liner and the insulation to prevent erosion of the insulation. Provide liner couplings/spacer for metal liner. At the end of insulated sections, provide insulation end fittings to reduce outer shell to liner size. Provide liner spacing/concentricity leaving airway unobstructed.

### **2.4 DUCT ACCESS DOORS, PANELS AND SECTIONS**

- A. Provide access doors, sized and located for maintenance work, upstream, in the following locations:
1. Each duct mounted coil and humidifier.
  2. Each fire damper (for link service), smoke damper and automatic control damper.
  3. Each duct mounted smoke detector.
  4. For cleaning operating room supply air duct and kitchen hood exhaust duct, locate access doors at 6 m (20 feet) intervals and at each change in duct direction.
- B. Openings shall be as large as feasible in small ducts, 300 mm by 300 mm (12 inch by 12 inch) minimum where possible. Access sections in

insulated ducts shall be double-wall, insulated. Transparent shatterproof covers are preferred for uninsulated ducts.

1. For rectangular ducts: Refer to SMACNA HVAC Duct Construction Standards (Figure 2-12).
2. For round and flat oval duct: Refer to SMACNA HVAC duct Construction Standards (Figure 2-11).

## **2.5 FIRE DAMPERS**

- A. Galvanized steel, interlocking blade type, UL listing and label, 1-1/2 hour rating, 70 degrees C (160 degrees F) fusible line, 100 percent free opening with no part of the blade stack or damper frame in the air stream.
- B. Fire dampers in wet air exhaust shall be of stainless steel construction, all others may be galvanized steel.
- C. Minimum requirements for fire dampers:
  1. The damper frame may be of design and length as to function as the mounting sleeve, thus eliminating the need for a separate sleeve, as allowed by UL 555. Otherwise provide sleeves and mounting angles, minimum 1.9 mm (14 gage), required to provide installation equivalent to the damper manufacturer's UL test installation.
  2. Submit manufacturer's installation instructions conforming to UL rating test.

## **2.6 SMOKE DAMPERS**

- A. Maximum air velocity, through free area of open damper, and pressure loss: Low pressure and medium pressure duct (supply, return, exhaust, outside air): 450 m/min (1500 fpm). Maximum static pressure loss: 32 Pa (0.13 inch W.G.).
- B. Maximum air leakage, closed damper: 0.32 cubic meters /min/square meter (4.0 CFM per square foot) at 750 Pa (3 inch W.G.) differential pressure.
- C. Minimum requirements for dampers:
  1. Shall comply with requirements of Table 6-1 of UL 555S, except for the Fire Endurance and Hose Stream Test.
  2. Frame: Galvanized steel channel with side, top and bottom stops or seals.
  3. Blades: Galvanized steel, parallel type preferably, 300 mm (12 inch) maximum width, edges sealed with neoprene, rubber or felt, if required to meet minimum leakage. Airfoil (streamlined) type for

- minimum noise generation and pressure drop are preferred for duct mounted dampers.
4. Shafts: Galvanized steel.
  5. Bearings: Nylon, bronze sleeve or ball type.
  6. Hardware: Zinc plated.
  7. Operation: Automatic open/close. No smoke damper that requires manual reset or link replacement after actuation is acceptable. See drawings for required control operation.
- D. Motor operator (actuator): Provide pneumatic or electric as required by the automatic control system, externally mounted on stand-offs to allow complete insulation coverage.

## **2.7 COMBINATION FIRE AND SMOKE DAMPERS**

Combination fire and smoke dampers: Multi-blade type units meeting all requirements of both fire dampers and smoke dampers shall be used where shown and may be used at the Contractor's option where applicable.

## **2.8 FIRE DOORS**

Galvanized steel, interlocking blade type, UL listing and label, 71 degrees C (160 degrees F) fusible link, 3 hour rating and approved for openings in Class A fire walls with rating up to 4 hours, 100 percent free opening with no part of the blade stack or damper frame in the air stream.

## **2.9 FLEXIBLE AIR DUCT**

- A. General: Factory fabricated, complying with NFPA 90A for connectors not passing through floors of buildings. Flexible ducts shall not penetrate any fire or smoke barrier which is required to have a fire resistance rating of one hour or more. Flexible duct length shall not exceed 1.5 m (5 feet). Provide insulated acoustical air duct connectors in supply air duct systems and elsewhere as shown.
- B. Flexible ducts shall be listed by Underwriters Laboratories, Inc., complying with UL 181. Ducts larger than 200 mm (8 inches) in diameter shall be Class 1. Ducts 200 mm (8 inches) in diameter and smaller may be Class 1 or Class 2.
- C. Insulated Flexible Air Duct: Factory made including mineral fiber insulation with maximum C factor of 0.25 at 24 degrees C (75 degrees F) mean temperature, encased with a low permeability moisture barrier outer jacket, having a puncture resistance of not less than 50 Beach Units. Acoustic insertion loss shall not be less than 3 dB per 300 mm



(foot) of straight duct, at 500 Hz, based on 150 mm (6 inch) duct, of 750 m/min (2500 fpm).

D. Application Criteria:

1. Temperature range: -18 to 93 degrees C (0 to 200 degrees F) internal.
2. Maximum working velocity: 1200 m/min (4000 feet per minute).
3. Minimum working pressure, inches of water gage: 2500 Pa (10 inches) positive, 500 Pa (2 inches) negative.

E. Duct Clamps: 100 percent nylon strap, 80 kg (175 pounds) minimum loop tensile strength manufactured for this purpose or stainless steel strap with cadmium plated worm gear tightening device. Apply clamps with sealant and as approved for UL 181, Class 1 installation.

**2.10 FLEXIBLE DUCT CONNECTIONS**

Where duct connections are made to fans, air terminal units, and air handling units, install a non-combustible flexible connection of 822 g (29 ounce) neoprene coated fiberglass fabric approximately 150 mm (6 inches) wide. For connections exposed to sun and weather provide hypalon coating in lieu of neoprene. Burning characteristics shall conform to NFPA 90A. Securely fasten flexible connections to round ducts with stainless steel or zinc-coated iron draw bands with worm gear fastener. For rectangular connections, crimp fabric to sheet metal and fasten sheet metal to ducts by screws 50 mm (2 inches) on center. Fabric shall not be stressed other than by air pressure. Allow at least 25 mm (one inch) slack to insure that no vibration is transmitted.

**2.11 SOUND ATTENUATING UNITS**

- A. Casing, not less than 1.0 mm (20 gage) galvanized sheet steel, or 1.3 mm (18 gage) aluminum fitted with suitable flanges to make clean airtight connections to ductwork. Sound-absorbent material faced with glass fiber cloth and covered with not less than 0,6 mm (24 gage) or heavier galvanized perforated sheet steel, or 0.85 mm (22 gage) or heavier perforated aluminum. Perforations shall not exceed 4 mm (5/32-inch) diameter, approximately 25 percent free area. Sound absorbent material shall be long glass fiber acoustic blanket meeting requirements of NFPA 90A.
- B. Entire unit shall be completely air tight and free of vibration and buckling at internal static pressures up to 2000 Pa (8 inches W.G.) at operating velocities.

- C. Pressure drop through each unit: Not to exceed indicated value at design air quantities indicated.
- D. Submit complete independent laboratory test data showing pressure drop and acoustical performance.
- E. Cap open ends of attenuators at factory with plastic, heavy duty paper, cardboard, or other appropriate material to prevent entrance of dirt, water, or any other foreign matter to inside of attenuator. Caps shall not be removed until attenuator is installed in duct system.

**2.12 PREFABRICATED ROOF CURBS**

Galvanized steel or extruded aluminum 300 mm (12 inches) above finish roof service, continuous welded corner seams, treated wood nailer, 40 mm (1-1/2 inch) thick, 48 kg/cubic meter (3 pound/cubic feet) density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting as required to keep top of curb level.

**2.13 FIRESTOPPING MATERIAL**

Refer to Section 07 84 00, FIRESTOPPING.

**2.14 SEISMIC RESTRAINT FOR DUCTWORK**

Refer to Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.

**2.15 DUCT MOUNTED THERMOMETER (AIR)**

- A. Stem Type Thermometers: ASTM E1, 7 inch scale, red appearing mercury, lens front tube, cast aluminum case with enamel finish and clear glass or polycarbonate window, brass stem, 2 percent of scale accuracy to ASTM E77 scale calibrated in degrees Fahrenheit.
- B. Thermometer Supports:
  - 1. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
  - 2. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

**2.16 DUCT MOUNTED TEMPERATURE SENSOR (AIR)**

Refer to Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

**2.17 INSTRUMENT TEST FITTINGS**

- A. Manufactured type with a minimum 50 mm (two inch) length for insulated duct, and a minimum 25 mm (one inch) length for duct not insulated.

Test hole shall have a flat gasket for rectangular ducts and a concave gasket for round ducts at the base, and a screw cap to prevent air leakage.

- B. Provide instrument test holes at each duct or casing mounted temperature sensor or transmitter, and at entering and leaving side of each heating coil, cooling coil, and heat recovery unit.

#### **2.18 AIR FLOW CONTROL VALVES (AFCV)**

Refer to Section 23 36 00 / 23 82 00, AIR TERMINAL UNITS / CONVECTION HEATING and COOLING UNITS.

#### **2.19 LEAD COVERED DUCT**

- A. Sheet Lead: 3.1 mm (1/8 inch) thick, securely installed, free of waves, lumps or wrinkles and with as few joints as possible.
- B. Joints shall be made to obtain X-ray absorption equivalent to adjacent sheet lead, and finished smooth and neat.

#### **2.20 ELECTROSTATIC SHIELDING**

- A. At the point of penetration of shielded rooms ducts shall be made electrically discontinuous by means of a flexible, nonconductive connection outside shielded room.
- B. Metallic duct portion inside shielded room shall be electrically bonded to shielding.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION, particularly regarding coordination with other trades and work in existing buildings.
- B. Fabricate and install ductwork and accessories in accordance with referenced SMACNA Standards:
  - 1. Drawings show the general layout of ductwork and accessories but do not show all required fittings and offsets that may be necessary to connect ducts to equipment, boxes, diffusers, grilles, etc., and to coordinate with other trades. Fabricate ductwork based on field measurements. Provide all necessary fittings and offsets at no additional cost to the government. Coordinate with other trades for space available and relative location of HVAC equipment and accessories on ceiling grid. Duct sizes on the drawings are inside dimensions which shall be altered by Contractor to other dimensions

- with the same air handling characteristics where necessary to avoid interferences and clearance difficulties.
2. Provide duct transitions, offsets and connections to dampers, coils, and other equipment in accordance with SMACNA Standards, Section II. Provide streamliner, when an obstruction cannot be avoided and must be taken in by a duct. Repair galvanized areas with galvanizing repair compound.
  3. Provide bolted construction and tie-rod reinforcement in accordance with SMACNA Standards.
  4. Construct casings, eliminators, and pipe penetrations in accordance with SMACNA Standards, Chapter 6. Design casing access doors to swing against air pressure so that pressure helps to maintain a tight seal.
- C. Install duct hangers and supports in accordance with SMACNA Standards, Chapter 4.
- D. Install fire dampers, smoke dampers and combination fire/smoke dampers in accordance with the manufacturer's instructions to conform to the installation used for the rating test. Install fire dampers, smoke dampers and combination fire/smoke dampers at locations indicated and where ducts penetrate fire rated and/or smoke rated walls, shafts and where required by the Resident Engineer. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges per UL and NFPA. Demonstrate re-setting of fire dampers and operation of smoke dampers to the Resident Engineer.
- E. Seal openings around duct penetrations of floors and fire rated partitions with fire stop material as required by NFPA 90A.
- F. Flexible duct installation: Refer to SMACNA Standards, Chapter 3. Ducts shall be continuous, single pieces not over 1.5 m (5 feet) long (NFPA 90A), as straight and short as feasible, adequately supported. Centerline radius of bends shall be not less than two duct diameters. Make connections with clamps as recommended by SMACNA. Clamp per SMACNA with one clamp on the core duct and one on the insulation jacket. Flexible ducts shall not penetrate floors, or any chase or partition designated as a fire or smoke barrier, including corridor partitions fire rated one hour or two hour. Support ducts SMACNA Standards.

- G. Where diffusers, registers and grilles cannot be installed to avoid seeing inside the duct, paint the inside of the duct with flat black paint to reduce visibility.
- H. Control Damper Installation:
1. Provide necessary blank-off plates required to install dampers that are smaller than duct size. Provide necessary transitions required to install dampers larger than duct size.
  2. Assemble multiple sections dampers with required interconnecting linkage and extend required number of shafts through duct for external mounting of damper motors.
  3. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation, and affix and seal permanently in place, only after stratification problem has been eliminated.
  4. Install all damper control/adjustment devices on stand-offs to allow complete coverage of insulation.
- I. Air Flow Measuring Devices (AFMD): Install units with minimum straight run distances, upstream and downstream as recommended by the manufacturer.
- J. Low Pressure Duct Liner: Install in accordance with SMACNA, Duct Liner Application Standard.
- K. Protection and Cleaning: Adequately protect equipment and materials against physical damage. Place equipment in first class operating condition, or return to source of supply for repair or replacement, as determined by Resident Engineer. Protect equipment and ducts during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting. When new ducts are connected to existing ductwork, clean both new and existing ductwork by mopping and vacuum cleaning inside and outside before operation.

### **3.2 DUCT LEAKAGE TESTS AND REPAIR**

- A. Ductwork leakage testing shall be performed by the Testing and Balancing Contractor directly contracted by the General Contractor and independent of the Sheet Metal Contractor.
- B. Ductwork leakage testing shall be performed for the entire air distribution system (including all supply, return, exhaust and relief ductwork), section by section, including fans, coils and filter

sections. Based upon satisfactory initial duct leakage test results, the scope of the testing may be reduced by the Resident Engineer on ductwork constructed to the 500 Pa (2" WG) duct pressure classification. In no case shall the leakage testing of ductwork constructed above the 500 Pa (2" WG) duct pressure classification or ductwork located in shafts or other inaccessible areas be eliminated.

- C. Test procedure, apparatus and report shall conform to SMACNA Leakage Test manual. The maximum leakage rate allowed is 4 percent of the design air flow rate.
- D. All ductwork shall be leak tested first before enclosed in a shaft or covered in other inaccessible areas.
- E. All tests shall be performed in the presence of the Resident Engineer and the Test and Balance agency. The Test and Balance agency shall measure and record duct leakage and report to the Resident Engineer and identify leakage source with excessive leakage.
- F. If any portion of the duct system tested fails to meet the permissible leakage level, the Contractor shall rectify sealing of ductwork to bring it into compliance and shall retest it until acceptable leakage is demonstrated to the Resident Engineer.
- G. All tests and necessary repairs shall be completed prior to insulation or concealment of ductwork.
- H. Make sure all openings used for testing flow and temperatures by TAB Contractor are sealed properly.

#### **3.4 TESTING, ADJUSTING AND BALANCING (TAB)**

Refer to Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

#### **3.5 OPERATING AND PERFORMANCE TESTS**

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION

- - - E N D - - -

**SECTION 23 34 00**  
**HVAC FANS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Fans for heating, ventilating and air conditioning.
- B. Product Definitions: AMCA Publication 99, Standard 1-66.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- C. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- D. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- E. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
- F. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- G. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.
- H. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- I. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.
- J. Section 23 82 16, AIR COILS.
- K. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS.

**1.3 QUALITY ASSURANCE**

- A. Refer to paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Fans and power ventilators shall be listed in the current edition of AMCA 261 and shall bear the AMCA performance seal.
- C. Operating Limits for Centrifugal Fans: AMCA 99 (Class I, II, and III).
- D. Fans and power ventilators shall comply with the following standards:
  - 1. Testing and Rating: AMCA 210.
  - 2. Sound Rating: AMCA 300.
- E. Vibration Tolerance for Fans and Power Ventilators: Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- F. Performance Criteria:
  - 1. The fan schedule shall show the design air volume and static pressure. Select the fan motor HP by increasing the fan BHP by 10 percent to account for the drive losses and field conditions.
  - 2. Select the fan operating point as follows:

- a. Forward Curve and Axial Flow Fans: Right hand side of peak pressure point
  - b. Air Foil, Backward Inclined, or Tubular: At or near the peak static efficiency
- G. Safety Criteria: Provide manufacturer's standard screen on fan inlet and discharge where exposed to operating and maintenance personnel.
- H. Corrosion Protection:
- 1. Except for fans in fume hood exhaust service, all steel shall be mill-galvanized, or phosphatized and coated with minimum two coats, corrosion resistant enamel paint. Manufacturers paint and paint system shall meet the minimum specifications of ASTM D1735 water fog; ASTM B117 salt spray; ASTM D3359 adhesion; and ASTM G152 and G153 for carbon arc light apparatus for exposure of non-metallic material.
  - 2. Fans for general purpose fume hoods, or chemical hoods, and radioisotope hoods shall be constructed of materials compatible with the chemicals being transported in the air through the fan.
- I. Spark resistant construction: If flammable gas, vapor or combustible dust is present in concentrations above 20% of the Lower Explosive Limit (LEL), the fan construction shall be as recommended by AMCA's Classification for Spark Resistant Construction. Drive set shall be comprised of non-static belts for use in an explosive.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturers Literature and Data:
  - 1. Fan sections, motors and drives.
  - 2. Centrifugal fans, motors, drives, accessories and coatings.
    - a. Up-blast kitchen hood exhaust fans.
  - 3. Prefabricated roof curbs.
  - 4. Power roof ventilators.
- C. Certified Sound power levels for each fan.
- D. Motor ratings types, electrical characteristics and accessories.
- E. Roof curbs.
- F. Belt guards.
- G. Maintenance and Operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS.



- H. Certified fan performance curves for each fan showing cubic feet per minute (CFM) versus static pressure, efficiency, and horsepower for design point of operation.

**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 Movement and Control Association International, Inc. (AMCA):
  - 99-86 .....Standards Handbook
  - 210-06 .....Laboratory Methods of Testing Fans for  
Aerodynamic Performance Rating
  - 261-09 .....Directory of Products Licensed to bear the AMCA  
Certified Ratings Seal - Published Annually
  - 300-08 .....Reverberant Room Method for Sound Testing of  
Fans
- C. American Society for Testing and Materials (ASTM):
  - B117-07a .....Standard Practice for Operating Salt Spray  
(Fog) Apparatus
  - D1735-08 .....Standard Practice for Testing Water Resistance  
of Coatings Using Water Fog Apparatus
  - D3359-08 .....Standard Test Methods for Measuring Adhesion by  
Tape Test
  - G152-06 .....Standard Practice for Operating Open Flame  
Carbon Arc Light Apparatus for Exposure of Non-  
Metallic Materials
  - G153-04 .....Standard Practice for Operating Enclosed Carbon  
Arc Light Apparatus for Exposure of Non-  
Metallic Materials
- D. National Fire Protection Association (NFPA):
  - NFPA 96-08 .....Standard for Ventilation Control and Fire  
Protection of Commercial Cooking Operations
- E. National Sanitation Foundation (NSF):
  - 37-07 .....Air Curtains for Entrance Ways in Food and Food  
Service Establishments
- F. Underwriters Laboratories, Inc. (UL):
  - 181-2005 .....Factory Made Air Ducts and Air Connectors

**1.6 EXTRA MATERIALS**

- A. Provide one additional set of belts for all belt-driven fans.

**PART 2 - PRODUCTS**

**2.1 FAN SECTION (CABINET FAN)**

Refer to specification Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.

**2.2 CENTRIFUGAL FANS**

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE. Record factory vibration test results on the fan or furnish to the Contractor.
- B. Fan arrangement, unless noted or approved otherwise:
1. DWD1 fans: Arrangement 3.
  2. SWS1 fans: Arrangement 1, 3, 9 or 10.
- C. Construction: Wheel diameters and outlet areas shall be in accordance with AMCA standards.
1. Housing: Low carbon steel, arc welded throughout, braced and supported by structural channel or angle iron to prevent vibration or pulsation, flanged outlet, inlet fully streamlined. Provide lifting clips, and casing drain. Provide manufacturer's standard access door. Provide 12.5 mm (1/2 inches) wire mesh screens for fan inlets without duct connections.
  2. Wheel: Steel plate with die formed blades welded or riveted in place, factory balanced statically and dynamically.
  3. Shaft: Designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fans class.
  4. Bearings: Heavy duty ball or roller type sized to produce a B10 life of not less than 50,000 hours, and an average fatigue life of 200,000 hours. Extend filled lubrication tubes for interior bearings or ducted units to outside of housing.
  5. Belts: Oil resistant, non-sparking and non-static.
  6. Belt Drives: Factory installed with final alignment belt adjustment made after installation.
  7. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15HP, fixed pitch for use with motors larger than 15HP. Select pulleys so that pitch adjustment is at the middle of the adjustment range at fan design conditions.

8. Motor, adjustable motor base, drive and guard: Furnish from factory with fan. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION for specifications. Provide protective sheet metal enclosure for fans located outdoors.
9. Furnish variable speed fan motor controllers where shown on the drawings. Refer to Section, MOTOR STARTERS. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION for controller/motor combination requirements.
- H. Spark Resistant/Explosion Proof Fans: If flammable gas, vapor or combustible dust is present in concentrations above 20% of the Lower Explosive Limit (LEL), provide AMCA construction option: A, B or C as indicated. Drive set shall be comprised of non-static belts for use in an explosive atmosphere. Motor shall be explosion proof type if located in air stream.

### **2.3 POWER ROOF VENTILATOR**

- A. Standards and Performance Criteria: Refer to Paragraph, QUALITY ASSURANCE.
- B. Type: Centrifugal fan, backward inclined blades. Provide down-blast or up-blast type as indicated.
- C. Construction: Steel or aluminum, completely weatherproof, for curb mounting, exhaust cowl or entire drive assembly readily removable for servicing, aluminum bird screen on discharge, UL approved safety disconnect switch, conduit for wiring, vibration isolators for wheel, motor and drive assembly. Provide self-acting back draft damper.
- D. Motor and Drive: Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION. Bearings shall be pillow block ball type with a minimum L-50 life of 200,000 hours. Motor shall be located out of air stream.
- E. Prefabricated Roof Curb: As specified in paragraph 2.3 of this section.
- F. Up-blast Type: Top discharge exhauster, motor out of air stream. For kitchen hood exhaust applications, provide grease trough on base and threaded drain. The mounting height of the kitchen up-blast exhaust fan shall be in compliance with NFPA 96. (Provide vented curb extension if required to maintain required clearances.)

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Install fan, motor and drive in accordance with manufacturer's instructions.
- B. Align fan and motor sheaves to allow belts to run true and straight.
- C. Bolt equipment to curbs with galvanized lag bolts.
- D. Install vibration control devices as shown on drawings and specified in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

**3.2 PRE-OPERATION MAINTENANCE**

- A. Lubricate bearings, pulleys, belts and other moving parts with manufacturer recommended lubricants.
- B. Rotate impeller by hand and check for shifting during shipment and check all bolts, collars, and other parts for tightness.
- C. Clean fan interiors to remove foreign material and construction dirt and dust.

**3.3 START-UP AND INSTRUCTIONS**

- A. Verify operation of motor, drive system and fan wheel according to the drawings and specifications.
- B. Check vibration and correct as necessary for air balance work.
- C. After air balancing is complete and permanent sheaves are in place perform necessary field mechanical balancing to meet vibration tolerance in Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.

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**SECTION 23 36 00**  
**AIR TERMINAL UNITS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

A. Air terminal units, air flow control valves.

**1.2 RELATED WORK**

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- D. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- E. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.
- F. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- G. Section 23 31 00, HVAC DUCTS and CASINGS.
- H. Section 23 82 16, AIR COILS.

**1.3 QUALITY ASSURANCE**

A. Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Air Terminal Units: Submit test data.
  - 2. Air flow control valves.
- C. Samples: Provide one typical air terminal unit for approval by the Resident Engineer. This unit will be returned to the Contractor after all similar units have been shipped and deemed acceptable at the job site.
- D. Certificates:
  - 1. Compliance with paragraph, QUALITY ASSURANCE.
  - 2. Compliance with specified standards.
- E. Operation and Maintenance Manuals: Submit in accordance with paragraph, INSTRUCTIONS, in Section 01 00 00, GENERAL REQUIREMENTS.

**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 (AHRI)/(ARI):  
880-08 .....Air Terminals Addendum to ARI 888-98  
incorporated into standard posted 15<sup>th</sup> December  
2002
- C. National Fire Protection Association (NFPA):  
90A-09 .....Standard for the Installation of Air  
Conditioning and Ventilating Systems
- D. Underwriters Laboratories, Inc. (UL):  
181-08 .....Standard for Factory-Made Air Ducts and Air  
Connectors
- E. American Society for Testing and Materials (ASTM):  
C 665-06 .....Standard Specification for Mineral-Fiber  
Blanket Thermal Insulation for Light Frame  
Construction and Manufactured Housing

**1.6 GUARANTY**

In accordance with the GENERAL CONDITIONS

**PART 2 - PRODUCTS**

**2.1 GENERAL**

- A. Coils:
  - 1. All Air-Handling Units: Provide aluminum fins and copper coils for all hot water reheat coils.
  - 2. Water Heating Coils:
    - a. ARI certified, continuous plate or spiral fin type, leak tested at 2070 kPa (300 PSI).
    - b. Capacity: As indicated, based on scheduled entering water temperature.
    - c. Headers: Copper or Brass.
    - d. Fins: Aluminum, maximum 315 fins per meter (8 fins per inch).
    - e. Tubes: Copper, arrange for counter-flow of heating water.
    - f. Water Flow Rate: Minimum 0.032 Liters/second (0.5 GPM).
    - g. Provide vent and drain connection at high and low point, respectively of each coil.
    - h. Coils shall be guaranteed to drain.

3. Electric Heating Coils:

- a. ARI certified, spiral fin type.
  - b. Capacity: As indicated, based on scheduled data.
  - c. Coil: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material. Exposed helical coil of nickel-chrome resistance wire with refractory ceramic support bushings will not be allowed.
- B. Labeling: Control box shall be clearly marked with an identification label that lists such information as nominal CFM, maximum and minimum factory-set airflow limits, coil type and coil connection orientation, where applicable.
- C. Factory calibrate air terminal units to air flow rate indicated. All settings including maximum and minimum air flow shall be field adjustable.
- D. Dampers with internal air volume control: See section 23 31 00 HVAC DUCTS and CASINGS.
- E. Terminal Sound Attenuators: See Section 23 31 00 HVAC DUCTS and CASINGS.

**2.2 AIR TERMINAL UNITS (BOXES)**

- A. General: Factory built, pressure independent units, factory set-field adjustable air flow rate, suitable for single duct applications. Use of dual-duct air terminal units is not permitted. Clearly show on each unit the unit number and factory set air volumes corresponding to the contract drawings. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC work assumes factory set air volumes. Coordinate flow controller sequence and damper operation details with the drawings and Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. All air terminal units shall be brand new products of the same manufacturer.
- B. Capacity and Performance: The Maximum Capacity of a single terminal unit shall not exceed 566 Liters/second (1,200 CFM) with the exception of operating rooms and Cystoscopy rooms, which shall be served by a single air terminal unit at a maximum of 1,250 Liters/second (3,000 CFM).
- C. Sound Power Levels:

- D. Casing: Unit casing shall be constructed of galvanized steel no lighter than 0.85 mm (22 Gauge). Provide hanger brackets for attachment of supports.
1. Lining material: Suitable to provide required acoustic performance, thermal insulation and prevent sweating. Meet the requirements of NFPA 90A and comply with UL 181 for erosion as well as ASTM C 665 antimicrobial requirements. Insulation shall consist of 13 mm (1/2 IN) thick non-porous foil faced rigid fiberglass insulation of 4-lb/cu.ft, secured by full length galvanized steel z-strips which enclose and seal all edges. Tape and adhesives shall not be used. Materials shall be non-friable and with surfaces, including all edges, fully encapsulated and faced with perforated metal or coated so that the air stream will not detach material. No lining material is permitted in the boxes serving operating rooms and Cystoscopy rooms.
  2. Access panels (or doors): Provide panels large enough for inspection, adjustment and maintenance without disconnecting ducts, and for cleaning heating coils attached to unit, even if there are no moving parts. Panels shall be insulated to same standards as the rest of the casing and shall be secured and gasketed airtight. It shall require no tool other than a screwdriver to remove.
  3. Total leakage from casing: Not to exceed 2 percent of the nominal capacity of the unit when subjected to a static pressure of 750 Pa (3-inch WG), with all outlets sealed shut and inlets fully open.
  4. Octopus connector: Factory installed, lined air distribution terminal. Provide where flexible duct connections are shown on the drawings connected directly to terminals. Provide butterfly-balancing damper, with locking means in connectors with more than one outlet. Octopus connectors and flexible connectors are not permitted in the Surgical Suite.
- E. Construct dampers and other internal devices of corrosion resisting materials which do not require lubrication or other periodic maintenance.
1. Damper Leakage: Not greater than 2 percent of maximum rated capacity, when closed against inlet static pressure of 1 kPa (4-inch WG).



- F. Provide multi-point velocity pressure sensors with external pressure taps.
  - 1. Provide direct reading air flow rate table pasted to box.
- G. Provide static pressure tubes.
- H. Externally powered DDC variable air volume controller and damper actuator to be furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC for factory mounting on air terminal units. The DDC controller shall be electrically actuated.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.
- B. Handle and install units in accordance with manufacturer's written instructions.
- C. Support units rigidly so they always remain stationary. Cross-bracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and malfunction of units cannot occur.
- D. Locate air terminal units to provide a straight section of inlet duct for proper functioning of volume controls. See VA Standard Detail.

**3.2 OPERATIONAL TEST**

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

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**SECTION 23 37 00**  
**AIR OUTLETS AND INLETS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Roof Curbs
- B. Air Outlets and Inlets: Diffusers, Registers, and Grilles.

**1.2 RELATED WORK**

- A. Section 08 90 00, LOUVERS and VENTS.
- B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- D. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- E. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.
- F. Section 23 38 13, COMMERCIAL-KITCHEN HOODS.

**1.3 QUALITY ASSURANCE**

- A. Refer to article, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.
- B. Fire Safety Code: Comply with NFPA 90A.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Air intake/exhaust hoods.
  - 2. Diffusers, registers, grilles and accessories.
- C. Coordination Drawings: Refer to article, SUBMITTALS, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

**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 Diffusion Council Test Code:
  - 1062 GRD-84 .....Certification, Rating, and Test Manual 4<sup>th</sup> Edition
- C. American Society of Civil Engineers (ASCE):

ASCE7-05 .....Minimum Design Loads for Buildings and Other  
Structures

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

A167-99 (2004) .....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

E. National Fire Protection Association (NFPA):

90A-09 .....Standard for the Installation of Air  
Conditioning and Ventilating Systems

F. Underwriters Laboratories, Inc. (UL):

181-08 .....UL Standard for Safety Factory-Made Air Ducts  
and Connectors

**PART 2 - PRODUCTS**

**2.1 GRAVITY INTAKE/EXHAUST VENTILATORS (ROOF MOUNTED)**

A. Aluminum, ASTM B209, louvered, spun, or fabricated using panel sections with roll-formed edges, 13 mm (1/2 inch) mesh aluminum welded wire bird screen, with gravity or motorized dampers where shown, accessible interior, designed for wind velocity specified in Paragraph 3.3.

1. Spun Intake/Exhaust Ventilators: Spun aluminum structural components shall be constructed of minimum 1.3 mm (16 Gauge) marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have continuously welded curb cap corners for maximum leak protection. The spun aluminum baffle shall have a rolled bead for added strength.

2. Louvered Intake/Exhaust Hoods: Louvered hood constructed from 0.081 Gauge extruded aluminum tiers welded to a minimum 3.3 mm (8 Gauge) aluminum support structure. The aluminum hood shall be constructed of a minimum 0.064 marine alloy aluminum and provided with a layer of anti-condensate coating. The aluminum base shall have continuously welded curb cap corners for maximum leak protection.

3. Low Silhouette Intake/Exhaust Ventilator: The unit shall be of bolted and welded construction utilizing corrosion resistant fasteners. The aluminum hood shall be constructed of minimum 1.60 mm (14 Gauge) marine alloy aluminum, bolted to a minimum 3.25 mm (8 Gauge) aluminum support structure. The aluminum base shall have

continuously welded curb cap corners for maximum leak protection.  
Birdscreen constructed of 13 mm (1/2 inch) mesh shall be mounted  
across the relief opening.

- B. See ventilator schedule on the drawings. Sizes shown on the drawings designate throat size. Area of ventilator perimeter opening shall be not less than the throat area.
- C. Dampers for Gravity Ventilators without Duct Connection: Construct damper of the same material as the ventilator and of the design to completely close opening or remain wide open. Hold damper in closed position by a brass chain and catch. Extend chains 300 mm (12 inches) below and engage catch when damper is closed.
- D. See paragraph 3.3 for Intake/Exhaust exposed to high wind velocities.
- E. Provide Roof Curb by unit manufacturer. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION for additional requirements.

## **2.2 EQUIPMENT SUPPORTS**

Refer to Section 21 05 11, COMMON WORK RESULTS FOR FIRE SUPPRESSION, Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING, and Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION.

## **2.3 AIR OUTLETS AND INLETS**

- A. Materials:
  - 1. Steel or aluminum except that all supply air outlets installed in operating rooms and Cystoscopy rooms (see Article 2.3C.3) shall be stainless steel. Use aluminum air outlets and inlets for facilities located in high-humidity areas. Exhaust air registers located in combination toilets and shower stalls shall be constructed from aluminum. Provide manufacturer's standard gasket.
  - 2. Exposed Fastenings: The same material as the respective inlet or outlet. Fasteners for aluminum may be stainless steel.
  - 3. Contractor shall review all ceiling drawings and details and provide all ceiling mounted devices with appropriate dimensions and trim for the specific locations.
- B. Performance Test Data: In accordance with Air Diffusion Council Code 1062GRD. Refer to Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT for NC criteria.

C. Air Supply Outlets:

1. Ceiling Diffusers: Suitable for surface mounting, exposed T-bar or special tile ceilings, off-white finish, square or round neck connection as shown on the drawings. Provide plaster frame for units in plaster ceilings.
  - a. Square, louver, fully adjustable pattern: Round neck, surface mounting unless shown otherwise on the drawings. Provide equalizing or control grid and volume control damper.
  - b. Louver face type: Square or rectangular, removable core for 1, 2, 3, or 4 way directional pattern. Provide equalizing or control grid and opposed blade damper.
  - c. Perforated face type: Manual adjustment for one-, two-, three-, or four-way horizontal air distribution pattern without change of air volume or pressure. Provide equalizing or control grid and opposed blade over overlapping blade damper. Perforated face diffusers for VAV systems shall have the pattern controller on the inner face, rather than in the neck and designed to discharge air horizontally at the ceiling maintaining a Coanda effect.
  - d. Slot diffuser/plenum:
    - 1) Diffuser: Frame and support bars shall be constructed of heavy gauge extruded aluminum. Form slots or use adjustable pattern controllers, to provide stable, horizontal air flow pattern over a wide range of operating conditions.
    - 2) Galvanized steel boot lined with 13 mm (1/2 inch) thick fiberglass conforming to NFPA 90A and complying with UL 181 for erosion. The internal lining shall be factory-fabricated, anti-microbial, and non-friable.
    - 3) Provide inlet connection diameter equal to duct diameter shown on drawings or provide transition coupling if necessary. Inlet duct and plenum size shall be as recommended by the manufacturer.
    - 4) Maximum pressure drop at design flow rate: 37 Pa (0.15 inch W.G.)
4. Supply Registers: Double deflection type with horizontal face bars and opposed blade damper with removable key operator.
  - a. Margin: Flat, 30 mm (1-1/4 inches) wide.

- b. Bar spacing: 20 mm (3/4 inch) maximum.
  - c. Finish: Off white baked enamel for ceiling mounted units. Wall units shall have a prime coat for field painting, or shall be extruded with manufacturer's standard finish.
5. Supply Grilles: Same as registers but without the opposed blade damper.
- DESIGNER'S NOTE:
6. Drum Louvers: Aluminum construction, drum louver, with pivoted blades and rotating drum to adjust length of throw and direction.
- a. Register shall have integral; face adjustable, opposed blade damper constructed of heavy gauge steel. Damper shall be operable from the face of the register. Units shall be nozzle type with adjustable discharge pattern.
7. Jet Diffusers: Aluminum construction (nozzle and frame) suitable for wall or ceiling mounting or direct mounting on ducts.
- D. Return and Exhaust Registers and Grilles: Provide opposed blade damper without removable key operator for registers.
- 1. Finish: Off-white baked enamel for ceiling mounted units. Wall units shall have a prime coat for field painting, or shall be extruded aluminum with manufacturer's standard aluminum finish.
  - 2. Standard Type: Fixed horizontal face bars set at 30 to 45 degrees, approximately 30 mm (1-1/4 inch) margin.
  - 3. Perforated Face Type: To match supply units.
  - 4. Grid Core Type: 13 mm by 13 mm (1/2 inch by 1/2 inch) core with 30 mm (1-1/4 inch) margin.
  - 5. Linear Type: To match supply units.
  - 6. Door Grilles: Are furnished with the doors.
  - 7. Egg Crate Grilles: Aluminum or Painted Steel 1/2 by 1/2 by 1/2 inch grid providing 90% free area.
    - a. Heavy extruded aluminum frame shall have countersunk screw mounting. Unless otherwise indicated, register blades and frame shall have factory applied white finish.
    - b. Grille shall be suitable for duct or surface mounting as indicated on drawings. All necessary appurtenances shall be provided to allow for mounting.
- E. Supply Registers in Psychiatric Rooms: Supply air registers shall be security type, steel with perforated faceplate, flat surface margin, extension sleeve, opposed blade damper and back mounting flanges.

Faceplate shall be 5 mm (3/16 inch) (minimum) with 5x5 mm holes on 7 mm (3/16 by 3/16 inch holes on 9/32 inch) spacing and a minimum free area of 45 percent. Wall sleeve shall be 5 mm (3/16 inch) thick (minimum).

- F. Air Inlet Registers in Psychiatric Rooms: Return, exhaust, transfer and relief air registers shall be security type, steel with perforated faceplate, flat surface margin, wall sleeve, opposed blade damper and back mounting flanges. Faceplate shall be 5 mm (3/16 inch) (minimum) with 5x5 mm holes on 7 mm (3/16 by 3/16 inch holes on 9/32 inch) spacing and a minimum free area of 45 percent. Wall sleeve shall be 5 mm (3/16 inch) thick (minimum).
- G. Acoustic Transfer Grille: Aluminum, suitable for partition or wall mounting.

#### **2.4 WIRE MESH GRILLE**

- A. Fabricate grille with 2 x 2 mesh 13 mm (1/2 inch) galvanized steel or aluminum hardware cloth in a spot welded galvanized steel frame with approximately 40 mm (1-1/2 inch) margin.
- B. Use grilles where shown in unfinished areas such as mechanical rooms.

#### **2.5 FILTER RETURN/EXHAUST GRILLE**

- A. Provide grille with in stream 1-inch deep MERV 4 filter and removable face.
  - 1. Finish: Off-white baked enamel for ceiling mounted units. Wall units shall have a prime coat for field painting, or shall be extruded aluminum with manufacturer's standard aluminum finish. Stainless Steel shall be No. 4 finish.
  - 2. Standard Type: Fixed horizontal face bars set at 30 to 45 degrees, approximately 30 mm (1-1/4 inch) margin.
  - 3. Steel, Aluminum, or Stainless steel as scheduled.
  - 4. Standard face connected to a mounting frame with space for a throwaway filter. Hold face closed by a locking screw. Provide retaining clips to hold filter in place. Provide fiberglass throwaway filter.



**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Comply with provisions of Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, particularly regarding coordination with other trades and work in existing buildings.
- B. Protection and Cleaning: Protect equipment and materials against physical damage. Place equipment in first class operating condition or return to source of supply for repair or replacement, as determined by Resident Engineer. Protect equipment during construction against entry of foreign matter to the inside and clean both inside and outside before operation and painting.

**3.2 INTAKE/ EXHAUST HOODS EXPOSED TO WIND VELOCITY**

Provide additional support and bracing to all exposed ductwork installed on the roof or outside the building to withstand wind velocity of 145 km/h (90 mph).

**3.3 TESTING, ADJUSTING AND BALANCING (TAB)**

Refer to Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC.

**3.4 OPERATING AND PERFORMANCE TESTS**

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC and STEAM GENERATION

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**SECTION 23 38 13**  
**COMMERCIAL-KITCHEN HOODS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies food service, grease-extracting, energy saving, exhaust ventilators.

**1.2 DEFINITIONS**

- A. Ventilator, kitchen hood, hood and canopy; for purposes of this specification section, these terms all have the same definition.
- B. UL Listed grease extractor: a slotted (not mesh) type grease extractor that has been tested and rated by Underwriters Laboratories.
- C. Eyebrow, compensating, short circuit, short cycle types are not allowed.

**1.3 RELATED WORK**

- A. Section 05 50 00, METAL FABRICATIONS: Supports for Ventilators.
- B. Section 11 44 00, FOOD COOKING EQUIPMENT: Cooking Equipment.
- C. Section 11 40 21, FOOD SERVICE EQUIPMENT-UTILITY DISTRIBUTION SYSTEM: Utility Distribution Systems.
- D. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic Restraint of Equipment.
- E. Section 22 11 00, FACILITY WATER DISTRIBUTION: Plumbing Connections.
- F. Section 21 13 13, WET-PIPE SPRINKLER SYSTEMS: Building Fire-Protection System.
- G. Section 23 34 00, HVAC FANS: Up-blast kitchen hood exhaust fans.
- H. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Remote monitoring of the kitchen ventilation system.
- I. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Electrical Connections.

**1.4 QUALITY CONTROL**

- A. Installer Qualifications: Experienced in food service equipment installation or supervised by an experienced food service equipment installer.
  - 1. Where required to complete equipment installation, electrician and plumber shall be licensed in jurisdiction where project is located.
- B. NSF Compliance: Equipment bears NSF Certification Mark or UL Classification Mark indicating compliance with applicable NSF standards, including NSF/ANSI 2, NSF 2-Supplement, and NSF/ANSI 4.

- C. UL Listing: Equipment has been evaluated according to UL 710, is listed in UL "Heating, Cooling, Ventilating and Cooking Equipment Directory," and is labeled for intended use.
- D. Fire-Protection Systems: Comply with NFPA 96 and NFPA 17A.
- E. Welding: Perform welding according to AWS D9.1M/D9.1.
- F. Seismic Restraint:
  - 1. Comply with requirements in Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
  - 2. Comply with applicable guidelines for seismic restraint of kitchen equipment contained in SMACNA's "Kitchen Ventilation Systems and Food Service Equipment Guidelines," Appendix A.
- G. In-Use Service: At least one factory-authorized service agency for equipment shall be in the geographical area of the installation and shall have the ability to provide service within 24 hours after receiving a service call.

#### **1.5 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Include manufacturer's address and telephone number.
  - 2. Include catalog or model numbers, and illustrations and descriptions of ventilators and accessories.
- C. Installation Drawings: Show dimensions; method of assembly; and details of installation, adjoining construction, coordination with service utilities, and other work required for a complete installation.
- D. Field Test Reports: Indicate dates and times of tests and certify test results.
- E. Operating Instructions: Include operating instructions covering operation of all components and maintenance procedures covering proper cleaning and necessary lubrication or adjustments to controls.

#### **1.6 WARRANTY**

- A. Warrant food service equipment to be free from defects in materials and workmanship in accordance with requirements of "Warranty of Construction" article in FAR clause 52.246-21.

**1.7 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 Welding Society (AWS):  
D9.1M/D9.1-2006 .....Sheet Metal Welding Code
- C. ASTM International (ASTM):  
A666-03 .....Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
- D. National Association of Architectural Metal Manufacturers (NAAMM):  
AMP500-06 .....Metal Finishes Manual for Architectural and Metal Products, 2006
- E. NFPA International (NFPA):  
#96-2008 .....Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations
- F. NSF International/American National Standards Institute (NSF/ANSI):  
Standard #2-2009 .....Food Service Equipment  
Standard #4-2009 .....Commercial Cooking, Rethermalization, and Powered Hot Food Holding and Transport Equipment
- G. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):  
1767-2001 .....Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines
- H. Underwriters Laboratories Inc. (UL):  
#710-06 .....Exhaust Hoods for Commercial Cooking Equipment

**PART 2 - PRODUCTS**

**2.1 EXHAUST HOODS**

- A. The hood shall be constructed of a minimum of 18 gauge, (type 304) stainless steel with a #3 finish. Hood shall be constructed using the standing seam method for optimum strength. The seams on the canopy shall be welded liquid tight, and all exposed external welds shall be ground and polished to match the original finish of the metal. Lighter material gauges, alternate material types and finishes (400 series stainless steel, cold rolled steel, etc.) and non-liquid tight welding

(tack weld, spot weld, etc.) is not acceptable. Construction shall include corrosion-resistant steel framing members for strength. Short circuit style hoods are not allowed. Hood shall be of a design to lower the CFM requirements by at least 20 to 30 percent. This can be accomplished by various internal configurations or air deflectors.

B. Designer to verify CFM and pressure drop with manufacturer.

<b>INTERNATIONAL MECHANICAL REQUIREMENTS PER LINEAR FOOT</b>	
<b>TYPE OF HOOD</b>	<b>CFM</b>
<b>LIGHT-DUTY COOKING APPLIANCES</b>	
Wall-Mounted Canopy	200

C. Hood shall include UL listed and NSF certified grease extractor type, high efficiency cartridge style baffle filters of adequate number and sizes to ensure optimum performance in accordance with manufacturer's published information. The filter housing shall terminate in a pitched, full length grease trough, which shall drain into a removable grease container. Hood shall be provided with one (1) filter removal tool.

D. Vapor proof, UL Listed, recessed light fixtures shall be prewired to a junction box situated at the top of the hood for field connection. Wiring shall conform to the requirements of the National Electrical Code (NEC #70).

F. Fire protection systems: Wet chemical with wall-mounted stainless-steel cabinet.

1. Fire-protection system to provide duct, plenum, and surface protection for ventilator and equipment located below ventilator.
2. System interlocked with shunt trip breaker and shutdown of power and fuel for the equipment located below ventilator during system actuation.

G. Options

1. See kitchen hood scheduled on the drawings for additional requirements.
2. Enclosure Panels: 1.3 mm (0.05 inch) thick stainless steel shall be installed; locate between ventilator top and ceiling on all exposed sides.
3. All exposed areas of hood to be finished.
4. Stainless-steel wall flashing shall be installed on wall behind and on the side(s) of ventilator from wall curb to bottom of ventilator.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Install ventilators level and plumb with access clearances required for operation, maintenance and cleaning and in accordance with the manufacturer's published documentation.
- B. Coordinate installation of ventilators with overhead supports; see Section 05 50 00, METAL FABRICATIONS.
- C. Interconnect ventilators to service utilities.
- D. Install seismic restraints for equipment.

**3.2 FIELD TESTING**

- A. Field Testing, General: Following installation, test ventilators for compliance with specified requirements and those of authorities having jurisdiction. Perform testing after air-handling systems have been balanced and adjusted.
- B. Smoke Test:
  - 1. Test Conditions:
    - a. Perform tests with cooking equipment served by ventilator turned off.
    - b. Perform tests with supply and exhaust fans serving the food service kitchen area turned on.
  - 2. Test Procedure: Move a smoke bomb around the perimeter of cooking equipment at the top surface.
  - 3. Test-Performance Requirements: No visible smoke shall escape from the ventilator canopy into the room.
- C. Demand Ventilator Control Test:
  - 1. Test Conditions:
    - a. Perform tests with cooking equipment served by exhaust ventilator turned off.
    - b. Perform tests with air-handling units serving food service kitchen turned on.
  - 2. Test Procedure: Turn on equipment and measure speed of exhaust fan(s) as equipment heats up. Move a smoke bomb around the perimeter of the cooking equipment at the top surface and continue to measure speed of exhaust fan(s).
  - 3. Test-Performance Requirements: Speed of fan(s) should increase/decrease with the severity of the heat or smoke.

- D. Wet Fire Extinguishing System: Test system to verify that equipment operation complies with NFPA 96 and NFPA 17A.

**3.3 CLEAN-UP**

- A. At completion of the installation, clean and adjust equipment as required to produce ready-for-use condition.
- B. Where stainless-steel surfaces are damaged during installation procedures, repair finishes to match adjoining undamaged surfaces.

**3.4 INSTRUCTIONS**

Instruct personnel and transmit operating instructions in accordance with requirements.

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**SECTION 23 40 00**

**HVAC AIR CLEANING DEVICES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Air filters for heating, ventilating and air conditioning.
- B. Definitions: Refer to ASHRAE Standard 52.2 for definitions of face velocity, net effective filtering area, media velocity, initial resistance (pressure drop), MERV (Minimum Efficiency Reporting Value), PSE (Particle Size Efficiency), particle size ranges for each MERV number, dust holding capacity and explanation of electrostatic media based filtration products versus mechanical filtration products. Refer to ASHRAE Standard 52.2 Appendix J for definition of MERV-A.

**1.2 RELATED WORK**

- A. Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION: General mechanical requirements and items, which are common to more than one section of Division 23.
- B. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS: Filter housing and racks.
- C. Section 23 73 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS: Filter housing and racks.
- D. Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

**1.3 QUALITY ASSURANCE**

- A. Air Filter Performance Report for Extended Surface Filters:
  - 1. Submit a test report for each Grade of filter being offered. The report shall not be more than three (3) years old and prepared by using test equipment, method and duct section as specified by ASHRAE Standard 52.2 for type filter under test and acceptable to Resident Engineer, indicating that filters comply with the requirements of this specification. Filters utilizing partial or complete synthetic media will be tested in compliance with pre-conditioning steps as stated in Appendix J. All testing is to be conducted on filters with a nominal 24 inch by 24-inch face dimension. Test for 150 m/min (500 fpm) will be accepted for lower velocity rated filters provided the test report of an independent testing laboratory complies with all the requirements of this specification.

3. **Guarantee Performance:** The manufacturer shall supply ASHRAE 52.2 test reports on each filter type submitted. Any filter supplied will be required to maintain the minimum efficiency shown on the ASHRAE Standard 52.2 report throughout the time the filter is in service. Within the first 6-12 weeks of service a filter may be pulled out of service and sent to an independent laboratory for ASHRAE Standard 52.2 testing for initial efficiency only. If this filter fails to meet the minimum level of efficiency shown in the previously submitted reports, the filter manufacturer/distributor shall take back all filters and refund the owner all monies paid for the filters, cost of installation, cost of freight and cost of testing.
- B. **Filter Warranty for Extended Surface Filters:** Guarantee the filters against leakage, blow-outs, and other deficiencies during their normal useful life, up to the time that the filter reaches the final pressure drop. Defective filters shall be replaced at no cost to the Government.
- C. Comply with UL Standard 900 for flame test.
- D. **Nameplates:** Each filter shall bear a label or name plate indicating manufacturer's name, filter size, rated efficiency, UL classification, and file number.

#### **1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. **Manufacturer's Literature and Data:**
  1. Extended surface filters.
  2. Holding frames. Identify locations.
  3. Side access housings. Identify locations, verify insulated doors.
  4. Magnehelic gages.
- C. Air Filter performance reports.
- D. Suppliers warranty.
- E. Field test results for HEPA filters as per paragraph 2.3.E.3.

#### **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 basic designation only.

- B. American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE):  
 52.2-2007.....Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size, including Appendix J
- C. American Society of Mechanical Engineers (ASME):  
 NQA-1-2008 .....Quality Assurance Requirements for Nuclear Facilities Applications
- D. Underwriters Laboratories, Inc. (UL):  
 900;Revision 15 July 2009      Test Performance of Air Filter Units

**PART 2 - PRODUCTS**

**2.1 REPLACEMENT FILTER ELEMENTS TO BE FURNISHED**

- A. To allow temporary use of HVAC systems for testing and in accordance with Paragraph, TEMPORARY USE OF MECHANICAL AND ELECTRICAL SYSTEMS in Section 01 00 00, GENERAL REQUIREMENTS, provide one complete set of additional filters to the Resident Engineer.
- B. The Resident Engineer will direct whether these additional filters will either be installed as replacements for dirty units or turned over to VA for future use as replacements.

**2.2 EXTENDED SURFACE AIR FILTERS**

- A. Use factory assembled air filters of the extended surface type with supported or non-supported cartridges for removal of particulate matter in air conditioning, heating and ventilating systems. Filter units shall be of the extended surface type fabricated for disposal when the contaminant load limit is reached as indicated by maximum (final) pressure drop.
- B. Filter Classification: UL listed and approved conforming to UL Standard 900.
- C. HVAC Filter Types

HVAC Filter Types Table 2.2C				
MERV Value ASHRAE 52.2	MERV-A Value ASHRAE 62.2 Appendix J	Application	Particle Size	Thickness /Type
8	8-A	Pre-Filter	3 to 10 Microns	50 mm (2-inch) Throwaway
11	11-A	After-Filter	1 to 3 Microns	150 mm (6-inch) or 300 mm (12-inch) Rigid

				Cartridge
13	13-A	After-Filter	0.3 to 1 Microns	150 mm (6-inch) or 300 mm (12-inch) Rigid Cartridge
14	14-A	After-Filter	0.3 to 1 Microns	150 mm (6-inch) or 300 mm (12-inch) Rigid Cartridge

D. HEPA Filters

**2.3 MEDIUM EFFICIENCY PLEATED PANEL PRE-FILTERS (2"; MERV 8; UL 900 CLASS 2):**

A. Construction: Air filters shall be medium efficiency ASHRAE pleated panels consisting of cotton and synthetic or 100% virgin synthetic media, self-supporting media with required media stabilizers, and beverage board enclosing frame. Filter media shall be lofted to a uniform depth and formed into a uniform radial pleat. The media stabilizers shall be bonded to the downstream side of the media to maintain radial pleats and prevent media oscillation. An enclosing frame of no less than 28-point high wet-strength beverage board shall provide a rigid and durable enclosure. The frame shall be bonded to the media on all sides to prevent air bypass. Integral diagonal support members on the air entering and air exiting side shall be bonded to the apex of each pleat to maintain uniform pleat spacing in varying airflows.

B. Performance: The filter shall have a Minimum Efficiency Reporting Value of MERV 8 when evaluated under the guidelines of ASHRAE Standard 52.2. It shall also have a MERV-A of 8 when tested per Appendix J of the same standard. The media shall maintain or increase in efficiency over the life of the filter. Pertinent tolerances specified in Section 7.4 of the Air-Conditioning and Refrigeration Institute (ARI) Standard 850-93 shall apply to the performance ratings. All testing is to be conducted on filters with a nominal 24" x 24" face dimension.

Minimum Efficiency Reporting (MERV)	8
Dust Holding Capacity (Grams)	105
Nominal Size (Width x Height x Depth)	24x24x2
Rated Air Flow Capacity (Cubic Feet per Minute)	2,000
Rated Air Flow Rate (Feet per Minute)	500

Final Resistance (Inches w.g.)	1.0
Maximum Recommended Change-Out Resistance (Inches w.g.)	0.66
Rated Initial Resistance (Inches w.g.)	0.33

C. The filters shall be approved and listed by Underwriters' Laboratories, Inc. as Class 2 when tested according to U. L. Standard 900 and CAN 4-5111.

**2.4 HIGH EFFICIENCY EXTENDED SURFACE (INTERMEDIATE/AFTER (FINAL)) CARTRIDGE FILTERS (12"; MERV 14/13/11; UL 900 CLASS 2):**

- A. Construction: Air filters shall consist of 8 pleated media packs assembled into 4 V-banks within a totally plastic frame. The filters shall be capable of operating at temperatures up to 80 degrees C (176 degrees F). The filters must either fit without modification or be adaptable to the existing holding frames. The molded end panels are to be made of high impact polystyrene plastic. The center support members shall be made of ABS plastic. No metal components are to be used.
- B. Media: The media shall be made of micro glass fibers with a water repellent binder. The media shall be a dual density construction, with coarser fibers on the air entering side and finer fibers on the air leaving side. The media shall be pleated using separators made of continuous beads of low profile thermoplastic material. The media packs shall be bonded to the structural support members at all points of contact, this improves the rigidity as well as eliminates potential air bypass in the filter
- C. Performance: Filters of the size, air flow capacity and nominal efficiency (MERV) shall meet the following rated performance specifications based on the ASHRAE 52.2-1999 test method. Where applicable, performance tolerance specified in Section 7.4 of the Air-Conditioning and Refrigeration Institute (ARI) Standard 850-93 shall apply to the performance ratings. All testing is to be conducted on filters with a nominal 24"x24" header dimension.

Minimum Efficiency Reporting Value (MERV)	14	13	11
Gross Media Area (Sq. Ft.)	197	197	197
Dust Holding Capacity (Grams)	486	430	465
Nominal Size (Width x Height x Depth)	24x24x12	24x24x12	24x24x12

Rated Air Flow Capacity (cubic feet per minute)	2,000	2,000	2,000
Rated Air Flow Rate (feet per minute)	500	500	500
Final Resistance (inches w.g.)	2.0	2.0	2.0
Maximum Recommended Change-Out Resistance (Inches w.g.)	0.74	0.68	0.54
Rated Initial Resistance (inches w.g.)	0.37	0.34	0.27

**2.7 FILTER HOUSINGS/SUPPORT FRAMES**

A. Side Servicing Housings (HVAC Grade)

1. Filter housing shall be two-stage filter system consisting of 16-gauge galvanized steel enclosure, aluminum filter mounting track, universal filter holding frame, insulated dual-access doors, static pressure tap, filter gaskets and seals. In-line housing depth shall not exceed 21". Sizes shall be as noted on enclosed drawings or other supporting materials.
2. Construction: The housing shall be constructed of 16-gauge galvanized steel with pre-drilled standing flanges to facilitate attachment to other system components. Corner posts of Z-channel construction shall ensure dimensional adherence. Where installed outdoors, the housing shall be weatherproof and suitable for rooftop/outdoor installation. The housing shall incorporate the capability of two stages of filtration without modification to the housing. A filter track, of aluminum construction shall be an integral component of housing construction. The track shall accommodate a 2" deep prefilter, a 6" or 12" deep rigid final filter, or a pocket filter with header. Insulated dual access doors, swing-open type, shall include high-memory sponge neoprene gasket to facilitate a door-to-filter seal. Each door shall be equipped with adjustable and replaceable positive sealing UV-resistant star-style knobs and replaceable door hinges. A universal holding frame constructed of 18-gauge galvanized steel, equipped with centering dimples, multiple fastener lances, and polyurethane filter sealing gasket, shall be included to facilitate installation of high-efficiency filters. The housing shall include a pneumatic fitting to allow the installation of a static pressure gauge to evaluate

- pressure drop across a single filter or any combination of installed filters.
3. Performance: Leakage at rated airflow, upstream to downstream of filter, holding frame, and slide mechanism shall be less than 1% at 3.0" w.g. Leakage in to or out of the housing shall be less than one half of 1% at 3.0" w.g. Accuracy of pneumatic pressure fitting, when to evaluate a single-stage, or multiple filter stages, shall be accurate within  $\pm 3\%$  at 0.6" w.g.
  4. Manufacturer shall provide evidence of facility certification to ISO 9001:2000.
- C. Side-Access Housing (HEPA Grade)
1. Filter housing shall be two-stage filter system consisting of 14-gauge galvanized steel enclosure, spring-loaded crank-type sealing assembly for gasket seal type final filters, insulated dual-access doors with gasketing and positive sealing doorknobs. In-line housing depth shall not exceed 25". Sizes shall be as noted on enclosed drawings or other supporting materials.
  2. Construction: The housing shall be constructed of 14-gauge galvanized steel with mating flanges to facilitate attachment to other system components. All pressure boundaries shall be of all welded construction. The housing shall be weatherproof and suitable for rooftop/outdoor installation. A prefilter track to accommodate nominal 2" deep prefilters, shall be an integral component of the housing. The housing shall incorporate a spring-loaded crank-type final filter sealing mechanism. The mechanism shall be geared to exert 700 pounds of pressure against each filter. The clamping frame shall have a continuous flat surface seal to compress all four downstream gasketed surfaces of the downstream seal filter. The final filter locking mechanism shall include a 3/4" socket adapter to facilitate opening or closing the mechanism. Insulated dual access doors shall include high-memory sponge neoprene gasket to facilitate a door-to-filter seal. Each door shall be equipped with adjustable and replaceable UV-resistant positive sealing knobs. The access doors shall be both hinged for swing open operation or designed to be completely removable. The housing shall include static pressure ports (1/8" NPT male) to facilitate pressure drop measurements across prefilter, final filter, or combination thereof.

3. Performance: Manufacturer shall provide evidence of facility certification to ISO 9001:2008.

provide evidence of facility certification to ISO 9001:2000.

F. Equipment Identification: Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION.

#### **2.11 INSTRUMENTATION**

- A. Magnehelic Differential Pressure Filter Gages: Nominal 100 mm (four inch) diameter, zero to 500 Pa (zero to two inch water gage), three inch for HEPA) range, except for MERV 17 HEPA Final Filters, where the range shall be zero to 750 Pa (zero to three inch water gage) Gauges shall be flush-mounted in aluminum panel board, complete with static tips, copper or aluminum tubing, and accessory items to provide zero adjustment.
- B. DDC static (differential) air pressure measuring station. Refer to Specification Section 23 09 23 DIRECT DIGITAL CONTROL SYSTEM FOR HVAC
- C. Provide one DDC sensor across each extended surface filter. Provide Petcocks for each gauge or sensor.
- D. Provide one common filter gauge for two-stage filter banks with isolation valves to allow differential pressure measurement.

#### **2.12 HVAC EQUIPMENT FACTORY FILTERS**

- A. Manufacturer standard filters within fabricated packaged equipment should be specified with the equipment and should adhere to industry standard.
- B. Cleanable filters are not permitted.
- C. Automatic Roll Type filters are not permitted.

#### **2.13 FILTER RETURN GRILLES**

- A. Refer to Section 23 37 00 AIR OUTLETS AND INLETS.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install supports, filters and gages in accordance with manufacturer's instructions.
- B. Label clearly with words "Contaminated Air" on exhaust ducts leading to the HEPA filter housing.

#### **3.2 START-UP AND TEMPORARY USE**

- A. Clean and vacuum air handling units and plenums prior to starting air handling systems.



- B. Replace Pre-filters and install clean filter units prior to final inspection as directed by the Resident Engineer.

### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

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**SECTION 23 72 00**  
**AIR-TO-AIR ENERGY RECOVERY EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This Section specifies rotary air-to-air heat exchangers and air-to-air plate heat exchangers.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS: Requirements for pre-test of equipment.
- B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment.
- 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 21 23, HYDRONIC PUMPS: Requirements for pumping equipment.
- E. Section 23 07 11, HVAC and BOILER PLANT INSULATION: Requirements for piping insulation.
- F. Section 23 21 13, HYDRONIC PIPING: Requirements for piping for expansion tanks.
- G. Section 23 82 16, AIR COILS: Requirements for run-around system coils.
- H. Section 23 31 00, HVAC DUCTS and CASINGS: Requirements for sheet metal ducts and fittings.
- I. Section 23 40 00, HVAC AIR CLEANING DEVICES: Requirements for filters used before heat recovery coils.
- J. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Requirements for controls and instrumentation.
- K. Section 23 05 93, TESTING, ADJUSTING and BALANCING FOR HVAC: Requirements for testing, adjusting and balancing of HVAC system.
- L. Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- M. Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

**1.3 QUALITY ASSURANCE**

- A. Refer to paragraph, GUARANTEE in specification Section 00 72 00, GENERAL CONDITIONS.

- B. Refer to specification Section 01 00 00, GENERAL REQUIREMENTS for performance tests and instructions to VA personnel.
- C. Refer to paragraph QUALITY ASSURANCE in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- D. Performance Criteria: Heat recovery equipment shall be provided by a manufacturer who has been manufacturing such equipment and the equipment has a good track record for at least 3 years.
- E. Performance Test: In accordance with PART 3.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Rotary Heat Exchanger
- C. Certificate: Submit, simultaneously with shop drawings, an evidence of satisfactory service of the equipment on three similar installations.
- D. Submit type, size, arrangement and performance details. Present application ratings in the form of tables, charts or curves.
- E. Provide installation, operating and maintenance instructions, in accordance with Article, INSTRUCTIONS, in Section 01 00 00, GENERAL REQUIREMENTS.
- F. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

**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, Heating, and Refrigeration Institute (AHRI)  
AHRI 1060-2005 .....Performance Rating of Air-to-Air Heat  
Exchangers for Energy Recovery Ventilation  
Equipment
- C. American Society of Heating, Refrigeration and Air Conditioning  
Engineers (ASHRAE):  
15-10 .....Safety Standard for Refrigeration Systems  
(ANSI)

- 52.1-92 .....Gravimetric and Dust-Spot Procedures for  
Testing Air-Cleaning Devices Used in General  
Ventilation for Removing Particulate Matter
- 52.2-07 .....Method of Testing General Ventilation Air-  
Cleaning Devices for Removal Efficiency by  
Particle Size
- 84-08 .....Method of Testing Air-to-Air Heat/Energy  
Exchangers
- D. American Society for Testing and materials (ASTM)
  - D635-10 .....Standard Test Method for Rate of Burning and/or  
Extent and Time of Burning of Plastics in a  
Horizontal Position
  - E84-10 .....Standard Test Method for Surface Burning  
Characteristics of Building Materials
- E. American Society of Civil Engineers (ASCE)
  - ASCE 7-10 .....Minimum Design Loads for Buildings and Other  
Structures
- F. Underwriters Laboratories, Inc (UL)
  - 1812-2009 .....Standard for Ducted Heat Recovery Ventilators
  - 1815-2009 .....Standard for Nonducted Heat Recovery  
Ventilators

**PART 2 - PRODUCTS**

**2.2 ROTARY AIR-TO-AIR HEAT EXCHANGER:**

- A. Exchanger Rotor or Wheel: Aluminum transfer media with a flame spread rating of 25 and less and smoke developed rating of 50 and less, and independently tested in accordance with ASTM standard E-84. Rotor media shall be independently tested in accordance with ASHRAE Standard 84. It shall allow laminar flow (but not radial) when operating within published operating airflow ranges and prevent leakage, bypassing and cross contamination by cross flow within wheel. Size the transfer media to allow passage of 600 micrometers particles without fouling or clogging. When latent heat transfer is required, treat media with non-degrading desiccant coating that is bacteriostatic non-corroding and non-toxic. No asbestos material will be allowed. Wheel shall not condense water directly or require a condensate drain for summer or

winter operation. Performance rating shall be in accordance with AHRI Standard 1060.

- B. Rotor: wheel strengthened impregnated with non-migrating, water-selected, 3 Angstrom molecular-sieve desiccant coating.
  - 1. Maximum Solid Size for media to pass: 600 micrometers.
- C. Casings shall be sealed on periphery of rotor as well as on duct divider and purge section. Seals shall be adjustable, of extended life materials and effective in limiting air leakage.
- D. Wheel shall be supported by ball or roller bearings and belt driven by a fractional horsepower, totally enclosed, NEMA Standard motor through a close coupled positively lubricated speed reducer, or gear/chain speed reduction. Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
  - 1. Motors for constant speed exchanger wheels shall be an AC motor.
  - 2. Variable-speed exchanger wheels shall have exchanger wheel speed and leaving-air temperature controlled by means of a variable-speed motor controller. // The speed shall be controlled as noted in paragraph G below. // Operation shall be from 115/1/60 and by a proportioning temperature controller which shall vary output voltage of a silicon controlled rectifier (SCR) to a rectified power motor which will change speed in proportion to changes of voltage to its armature.// Automatic changeover for summer-winter operations shall be controlled by an adjustable thermostwitch. Set point of adjustable proportioning temperature controller and thermostwitch shall be indicated on visible scale. System shall be capable of speed reduction down to 5 percent of capacity while maintaining adequate torque at any point of operation to rotate wheel.
- E. An automatic, factory-fabricated, field-adjustable purge unit shall limit exhaust air carry-over to less than 1.0 percent of rated volume. Purge shall be effective when static pressure difference between supply and exhaust is 125 Pa (one-half, inch wg) or greater, and it shall have provision for restriction or adjustment to limit purge air volume to not over five percent of rated air flow when a static pressure difference up to 2.5 kPa (10 inch wg) exists.
- F. Unit shall be constructed of heavy gage steel to insure rigidity and stability. Casing side panels shall be removable to insure easy access

to internal parts and have integral flanges for flanged duct connection and lifting holes or lugs.

- G. Controls starting relay shall be factory mounted and wired, and include a manual motor starter for field wiring. Variable frequency controller shall be factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing air differential temperature above set point. When exhaust-air temperature is less than outdoor-air temperature, the rotor shall be at maximum speed.
1. Pilot-Light Indicator: Display rotor rotation and speed. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
- H. Filters: MERV 7, 2-inch throw-away type. Refer to Section 23 40 00 HVAC Air Cleaning Devices.

## **2.5 AIR FILTERS**

Air Filters: Disposable air filters, with a MERV rating of 7, shall be provided standard on all air entering sides of air-to-air heat exchangers, upstream of outdoor air and exhaust run-around loop air coils and as indicated on the drawings. Comply with requirements in specification Section 23 40 00, HVAC AIR CLEANING DEVICES.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Follow the equipment manufacturer's instructions for handling and installation, and setting up of ductwork for makeup and exhaust air steamers for maximum efficiency.
- B. Rotary Air-to-Air Exchanger: Adjust seals and purge as recommended by the manufacturer. Verify correct installation of controls.
- C. Seal ductwork tightly to avoid air leakage.
- D. Install units with adequate spacing and access for cleaning and maintenance of heat recovery coils as well as filters.
- E. Brace heat recovery equipment installed in projects in the Seismic area according to specification Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- F. Secure outdoor heat recovery equipment to withstand a wind velocity of \_\_\_90\_\_\_ mph.

### **3.2 FIELD QUALITY CONTROL**

- A. Operational Test: Perform tests as per manufacturer's written instructions for proper and safe operation of the heat recovery system.
  - 1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Adjust seals and purge.
  - 3. Test and adjust controls and safeties.
- B. Replace damaged and malfunctioning controls and equipment.
- C. Set initial temperature and humidity set points. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Prepare test and inspection reports to the Senior Resident Engineer in accordance with specification Section 01 00 00, GENERAL REQUIREMENTS.

### **3.3 INSTRUCTIONS**

Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of heat recovery equipment.

### **3.4 STARTUP AND TESTING**

- A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

### **3.5 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

### **3.6 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS.



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**SECTION 23 74 13**  
**PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Roof top air handling units including integral components specified herein.
- B. Definitions: Roof Top Air Handling Unit (Roof Top Units, RTU): A factory fabricated assembly consisting of fan, coils, filters, and other necessary equipment to perform one or more of the following functions of circulating, cleaning, heating, cooling, humidifying, dehumidifying, and mixing of air. Design capacities of units shall be as scheduled on the drawings.

**1.2 RELATED WORK**

- A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic restraints for equipment.
- 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 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT: Sound and vibration requirements.
- D. Section 23 07 11, HVAC and BOILER PLANT INSULATION: Piping and duct insulation.
- E. Section 23 21 13, HYDRONIC PIPING and Section 23 22 13, STEAM and CONDENSATE HEATING PIPING: Piping and valves.
- F. Section 23 82 16, AIR COILS: Heating and cooling coils and pressure requirements.
- G. Section 23 34 00, HVAC FANS: Return and exhaust fans.
- H. Section 23 31 00, HVAC DUCTS and CASINGS: Requirements for flexible duct connectors, sound attenuators and sound absorbing duct lining.
- I. Section 23 40 00, HVAC AIR CLEANING DEVICES: Air filters and filters' efficiency.
- J. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: HVAC controls.
- K. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC: Testing, adjusting and balancing of air and water flows.
- L. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT: Types of motors.

- M. Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS: Types of motor starters.
- N. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS:
- O. Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.

### 1.3 QUALITY ASSURANCE

- A. Refer to Article, Quality Assurance, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Air Handling Units Certification
  - 1. Air Handling Units with Housed Centrifugal Fans: The air handling units shall be certified in accordance with AHRI 430 and tested/rated in accordance with AHRI 260.
  - 2. Air Handling Units with Plenum Fans:
    - a. Air Handling Units with a single Plenum Fan shall be certified in accordance with AHRI 430 and tested/rated in accordance with AHRI 260.
    - b. Air handling Units with Multiple Fans in an Array shall be tested and rated in accordance with AHRI 430 and AHRI 260.
- C. Heating, Cooling, and Air Handling Capacity and Performance Standards: AHRI 430, AHRI 410, ASHRAE 51, and AMCA 210.
- D. Performance Criteria:
  - 1. The fan BHP shall include all system effects for all fans and v-belt drive losses for housed centrifugal fans.
  - 2. The fan motor shall be selected within the rated nameplate capacity, without relying upon NEMA Standard Service Factor.
  - 3. Select the fan operating point as follows:
    - a. Forward Curve and Axial Flow Fans: Right hand side of peak pressure point.
    - b. Air Foil, Backward Inclined, or Tubular Fans Including Plenum Fans: At or near the peak static efficiency but at an appropriate distance from the stall line.
  - 4. Operating Limits: AMCA 99 and Manufacturer's Recommendations.
- E. Units shall be factory-fabricated, assembled, and tested by a manufacturer, in business of manufacturing similar air-handling units for at least five (5) years.

**1.4 SUBMITTALS:**

- A. The contractor shall, in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES, furnish a complete submission for all roof top units covered in the project. The submission shall include all information listed below. Partial and incomplete submissions shall be rejected without reviews.
- B. Manufacturer's Literature and Data:
1. Submittals for RTUs shall include fans, drives, motors, coils, sound attenuators, mixing box with outside/return air dampers, filter housings, , and all other related accessories. The contractor shall provide custom drawings showing total air handling unit assembly including dimensions, operating weight, access sections, , flexible connections, door swings, controls penetrations, electrical disconnect, lights, duplex receptacles, switches, wiring, utility connection points, unit support system, vibration isolators, drain pan, pressure drops through each component (filter, coil etc) and rigging points.
  2. Submittal drawings of section or component only, will not be acceptable. Contractor shall also submit performance data including performance test results, charts, curves or certified computer selection data; data sheets; fabrication and insulation details; if the unit cannot be shipped in one piece, the contractor shall indicate the number of pieces that each unit will have to be broken into to meet shipping and job site rigging requirements. This data shall be submitted in hard copies and in electronic version compatible to AutoCAD version used by the VA at the time of submission.
  3. Submit sound power levels in each octave band for fan and at entrance and discharge of RTUs at scheduled conditions. Include sound attenuator capacities and itemized internal component attenuation. Internal lining of supply air ductwork with sound absorbing material is not permitted. In absence of sound power ratings refer to Section 23 05 41, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT.
  4. Provide fan curves showing Liters/Second (cubic feet per minute), static pressure, efficiency, and horsepower for design point of

- operation and at maximum design Liters/Second (cubic feet per minute) and 110 percent of design static pressure.
5. Submit total fan static pressure, external static pressure, for RTU including total, inlet and discharge pressures, and itemized specified internal losses and unspecified internal losses. Refer to air handling unit schedule on drawings.
- C. Maintenance and operating manuals in accordance with Section 01 00 00, GENERAL REQUIREMENTS. Include instructions for lubrication, filter replacement, motor and drive replacement, spare part lists, and wiring diagrams.
- D. **Factory Testing** - Submit written test procedures two weeks prior to factory testing. Submit written results of factory tests for approval prior to shipping.
- a. **Structural Performance-Deflection**
  - b. **Casing Leakage Performance**
  - c. **Air Performance - over the entire operating range.**
  - d. **Sound Power Level Ratings**
- E. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.
- F. Submit shipping information that clearly indicates how the units will be shipped in compliance with the descriptions below.
1. Units shall be shipped in one (1) piece where possible and in shrink wrapping to protect the unit from dirt, moisture and/or road salt.
  2. If not shipped in one (1) piece, provide manufacturer approved shipping splits where required for installation or to meet shipping and/or job site rigging requirements in modular sections. Indicate clearly that the shipping splits shown in the submittals have been verified to accommodate the construction constraints for rigging as required to complete installation and removal of any section for replacement through available access without adversely affecting other sections.
  3. If shipping splits are provided, each component shall be individually shrink wrapped to protect the unit and all necessary hardware (e.g. bolts, gaskets etc.) will be included to assemble unit on site (see section 2.1.A4).

4. Lifting lugs will be provided to facilitate rigging on shipping splits and joining of segments. If the unit cannot be shipped in one piece, the contractor shall indicate the number of pieces that each unit will have to be broken into to meet shipping and job site rigging requirements.

**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, Heating, and Refrigeration Institute (AHRI):
  - 260-01 .....Sound Rating of Ducted Air Moving and Conditioning Equipment
  - 410-01 .....Standard for Forced-Circulation Air-Heating and Air-Cooling Coils
  - 430-09 .....Standard for Central Station Air Handling Units
  - AHRI-DCAACP .....Directory of Certified Applied Air Conditioning Products
- C. Air Moving and Conditioning Association (AMCA):
  - 210-07 .....Laboratory Methods of Testing Fans for Rating
- D. Anti-Friction Bearing Manufacturer's Association, Inc. (AFBMA):
  - 9-90 (R2008) .....Load Ratings and Fatigue life for Ball Bearings
- E. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
  - 51-2007 .....Laboratory Methods of Testing Fans for Rating
- F. American Society for Testing and Materials (ASTM):
  - A653/653M-02 .....Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  - B117-07a .....Salt Spray (Fog) Testing
  - C1071-05e1 .....Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
  - D1654-08 .....Standard Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
  - D1735-08 .....Water Resistance of Coatings Using Water Fog Apparatus

- D3359-08 .....Standard Test Methods for Measuring Adhesion by  
Tape Test
- E84-10 .....Standard Test Method for Surface Burning  
Characteristics of Building Materials
- G. Anti-Friction Bearing Manufacturer's Association, Inc. (AFBMA):  
9-90 .....Load Ratings and Fatigue life for Ball Bearings
- H. Military Specifications (Mil. Spec.):  
DOD-P-21035A-2003 .....Paint, High Zinc Dust Content, Galvanizing  
Repair
- I. National Fire Protection Association (NFPA):  
NFPA 90A .....Standard for Installation of Air Conditioning  
and Ventilating Systems, 2009
- J. Energy Policy Act of 2005 (P.L.109-58)

**PART 2 - PRODUCTS**

**2.1 ROOF TOP AIR HANDLING UNITS**

- A. General:
1. Roof top units (RTU) shall be fabricated from insulated, solid double-wall galvanized steel without any perforations in draw-through configuration. Casing is specified in paragraph 2.1.C. Galvanizing shall be hot dipped conforming to ASTM A525 and shall provide a minimum of 0.275 kg of zinc per square meter (0.90 oz. of zinc per square foot) (G90). Aluminum constructed units may be provided subject to VA approval and documentation that structural rigidity is equal or greater than the galvanized steel specified.
  2. The contractor and the RTU manufacturer shall be responsible for ensuring that the unit will not exceed the allocated space shown on the drawings, including required clearances for service and future overhaul or removal of unit components. All structural, piping, wiring, and ductwork alterations of units, which are dimensionally different than those specified, shall be the responsibility of the contractor at no additional cost to the government.
  3. RTUs shall be fully assembled by the manufacturer in the factory in accordance with the arrangement shown on the drawings. The unit shall be assembled into the largest sections possible subject to shipping and rigging restrictions. The correct fit of all components



- and casing sections shall be verified in the factory for all units prior to shipment. All units shall be fully assembled, tested and then split to accommodate shipment and job site rigging. On units not shipped fully assembled, the manufacturer shall tag each section and include air flow direction to facilitate assembly at the job site. Lifting lugs or shipping skids shall be provided for each section to allow for field rigging and final placement of unit.
4. The RTU manufacturer shall provide the necessary gasketing, caulking, and all screws, nuts, and bolts required for assembly. The manufacturer shall provide a local representative at the job site to supervise the assembly and to assure the units are assembled to meet manufacturer's recommendations and requirements noted on the drawings. Provide documentation that this representative has provided this service on similar jobs to the Contracting Officer. If a local representative cannot be provided, the manufacturer shall provide a factory representative.
  5. Gaskets: All door and casing and panel gaskets and gaskets between air handling unit components, if joined in the field, shall be high quality which seal air tight and retain their structural integrity and sealing capability after repeated assembly and disassembly of bolted panels and opening and closing of hinged components. Bolted sections may use a more permanent gasketing method provided they are not disassembled.
  6. Structural Rigidity: Provide structural reinforcement when required by span or loading so that the deflection of the assembled structure shall not exceed 1/200 of the span based on a differential static pressure of 1991 Pa (8 inches water gage) or higher.

B. Base:

1. Provide a heavy-duty steel base for supporting all major RTU components. Bases shall be constructed of wide-flange steel I-beams, channels, or minimum 125 mm (5 inch) high 3.5 mm (10 Gauge) steel base rails. Welded or bolted cross members shall be provided as required for lateral stability.

2. RTUs shall be completely self-supporting for installation on roof curb.
  3. The RTU bases not constructed of galvanized material shall be cleaned, primed with a rust inhibiting primer, and finished with rust inhibiting exterior enamel.
- C. Casing (including wall, floor and roof):
1. General: RTU casing shall be entirely double wall insulated panels, integral of or attached to a structural frame. Construction shall be such that removal of any panel shall not affect the structural integrity of the unit. Casing finished shall meet salt-spray test as specified in paragraph 2.1.C.10. All casing and panel sections shall be tightly butted and gasketed. No gaps of double wall construction will be allowed where panels bolt to air handling unit structural member. Structural members, not covered by the double wall panels, shall have equivalent insulated double wall construction.
  2. Double wall galvanized steel panels, minimum 51 mm (2 inches) thick, constructed //of outer skin and solid inner skin.// to limit wall, roof and floor deflection to not exceed an L/240 ratio when the unit casing is pressurized to ( $\pm 1245$  Pa ( $\pm 5$  in. w.g.)). Deflection shall be measured at the midpoint of the panel height. Total housing leakage shall not exceed 1% of rated cfm when the unit casing is pressurized to  $\pm 5$  in. w.g. ( $\pm 1245$  Pa). The outer (skin) and inner panels shall be solid.
  3. Blank-Off: Provide blank-offs as required to prevent air bypass between the AHU sections, around coils, and filters.
  4. Insulation: Insulation shall be injected CFC free foam encased in double-wall casing between exterior and interior panels such that no insulation can erode to the air stream. Insulation shall be 50 mm (2 inch) thick, and  $48 \text{ kg/m}^3$  ( $3.0 \text{ lb/ft}^3$ ) density with a total thermal resistance (R-value) of approximately  $2.3 \text{ m.K/W}$  ( $13.0 \text{ hr-ft}^2 \text{ }^\circ\text{F/BTU}$ ). Units with less than 50 mm (2 inch) of insulation in any part of the walls, floor, roof or drain pan shall not be acceptable. The insulation shall comply with NFPA 90-A for the flame and smoke generation requirements. Also, refer to specification Section 23 07 11, HVAC and BOILER PLANT INSULATION.

Table 2.1.C.4

Outer Panel	0.8 mm (22 Gage) Minimum
Inner Panel	0.8 mm (22 Gage) Minimum
Insulation	Foam
Thickness	50 mm (2 inch) Minimum
Density	<b>48 kg/m<sup>3</sup> (3.0 lb/ft<sup>3</sup>) Minimum</b>
Total R Value	2.3 m <sup>2</sup> .K/W (13.0 ft <sup>2</sup> .°F.hr/Btu) Minimum

5. The thickness of insulation, mode of application, and thermal breaks shall be such that there is no visible condensation on the exterior panels of the AHU.
6. Casing panels shall be secured to the support structure with stainless steel or zinc-chromate plated screws and gaskets installed around the panel perimeter. Panels shall be completely removable to allow removal of fan, coils, and other internal components for future maintenance, repair, or modifications. Welded exterior panels are not acceptable.
7. Access Doors: Provide in each access section and where shown on drawings. Show single-sided and double-sided access doors with door swings on the floor plans. Doors shall be a minimum of 50 mm (2 inches) thick with same double wall construction as the unit casing. Doors shall be a minimum of 600 mm (24 inches) wide, unless shown of different size on drawings, and shall be the full casing height up to a maximum of 1850 mm (6 feet). Doors shall be gasketed, hinged, and latched to provide an airtight seal. The access doors for fan section, mixing box, humidifier section, and coil section shall include a minimum 150 mm x 150 mm (6 inch x 6 inch) double thickness, with air space between glass panes tightly sealed, reinforced glass or Plexiglas window in a gasketed frame.
  - a. Hinges: Manufacturers standard, designed for door size, weight and pressure classifications. Hinges shall hold door completely rigid with minimum 45 kg (100 pound) weight hung on latch side of door.
  - b. Latches: Non-corrosive alloy construction, with operating levers for positive cam action, operable from either inside or outside. Doors that do not open against unit operating pressure shall allow the door to ajar and then require approximately 0.785

- radian (45 degrees) further movement of the handle for complete opening. Latch shall be capable of restraining explosive opening of door with a force not less than 1991 Pa (8 inches water gage).
- c. Gaskets: Neoprene, continuous around door, positioned for direct compression with no sliding action between the door and gasket. Secure with high quality mastic to eliminate possibility of gasket slipping or coming loose.
8. Provide sealed sleeves, metal or plastic escutcheons or grommets for penetrations through casing for power and temperature control wiring and pneumatic tubing. Coordinate with electrical and temperature control subcontractors for number and location of penetrations. Coordinate lights, switches, and duplex receptacles and disconnect switch location and mounting. All penetrations and equipment mounting may be provided in the factory or in the field. All field penetrations shall be performed neatly by drilling or saw cutting. No cutting by torches will be allowed. Neatly seal all openings airtight.
- a. Electrical and Lighting: Wiring and equipment specifications shall conform to Division 26, ELECTRICAL.
- b. Vapor-proof LED lights using cast aluminum base style with glass globe and cast aluminum guard shall be installed in access sections for fan, mixing box, humidifier, and any section over 300mm (12in) wide. A switch shall control the lights in each compartment with pilot light mounted outside the respective compartment access door. Wiring between switches and lights shall be factory installed. All wiring shall run in neatly installed electrical conduits and terminate in a junction box for field connection to the building system. Provide single point 115 volt / single phase connection junction box.
- c. Install LED fixture with 14-watt (1100 lumen minimum output).
- d. Provide (1) convenience duplex weatherproof receptacle per air handling unit next to the supply fan section access door adjacent to the supply fan section light switch.
9. Roof of the unit shall be sloped to have a minimum pitch of 1/4 inch per foot. The roof shall overhang the side panels by a minimum of three inches to prevent precipitation drainage from streaming down the unit side panels.

- D. Unit floor shall be level without offset space or gap and designed to support a minimum of 488 kg/square meter (100 pounds per square foot) distributed load without permanent deformation or crushing of internal insulation. Provide adequate structural base members beneath floor in service access sections to support typical service foot traffic and to prevent damage to unit floor or internal insulation. Unit floors in casing sections, which may contain water or condensate, shall be watertight with drain pan.
- E. Condensate Drain Pan: Drain pan shall be designed to extend entire length of cooling coils including headers and return bends. Depth of drain pan shall be at least 43 mm (1.7 inches) and shall handle all condensate without overflowing. Drain pan shall be double wall construction, Type 304 stainless steel and have a minimum of 50 mm (2 inch) insulation, and shall be sloped to drain. Drain pan shall be continuous metal or welded watertight. No mastic sealing of joints exposed to water will be permitted. Drain pan shall be placed on top of casing floor or integrated into casing floor assembly. Drain pan shall be pitched in all directions to drain line.
1. An intermediate condensate drip pan shall be provided on stacked cooling coils and shall be constructed of type 304 stainless steel with copper downspouts factory piped to main condensate pan. Use of intermediate condensate drain channel on upper casing of lower coil is permissible provided it is readily cleanable. Design of intermediate condensate drain shall prevent upper coil condensate from flowing across face of lower coil.
  2. Drain pan shall be piped to the exterior of the unit. Drain pan shall be readily cleanable.
  3. Installation, including frame, shall be designed and sealed to prevent blow-by.
- F. Plenum Fans -Multiple Fans in an Array
1. General: Fans shall be Class II (minimum) construction with single inlet, aluminum wheel and stamped air-foil aluminum bladed. The fan wheel shall be mounted on the directly-driven motor shaft in AMCA Arrangement 4. Fans shall be dynamically balanced and internally isolated to minimize the vibrations. Provide a steel inlet cone for each wheel to match with the fan inlet. Locate fan in the air

stream to assure proper flow. The fan performance shall be rated in accordance with AMCA 210 or ASHRAE 51.

2. Allowable vibration tolerances for fan shall not exceed a self-excited vibration maximum velocity of 0.005 m/s (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. After field installation, compliance to this requirement shall be demonstrated with field test in accordance with Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT and Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC. The fan wheel shall meet or exceed guidelines in AMCA 801-92 for dynamic balancing requirements. The complete fan assembly balance shall be tested using an electronic balance analyzer with a tunable filter and stroboscope. Vibration measurements shall be taken on each motor bearing housing in the vertical, horizontal, and axial planes (5 total measurements, 2 each motor bearing and 1 axial).
3. The plenum fans shall be driven by variable speed drives with at least one back-up drive as shown in the design documents. Use of a drive with bypass is not permitted. The fan array shall be selected and provided with partial redundancy to allow the unit to provide 85% of the scheduled supply airflow upon failure of one fan in the array. The fan's automatic isolation will be closed. Under normal operation - all fans in the array shall operate. The VFDs shall be provided with one VFD serving one fan in the fan array - the fans shall be controlled to operate together.
4. Multiple fans shall be installed in a pre-engineered structural frame to facilitate fan stacking. All fans shall modulate in unison, above or below the synchronous speed within the limits specified by the manufacturer, by a common control sequence. Staging of the fans is not permitted. Redundancy requirement shall be met by all operating fans in an array and without the provision of an idle standby fan.
5. Fan Accessories
  - a. Fan Isolation: Provide an actuator-controlled damper to isolate the fan not in operation due to failure.
  - b. Fan Airflow Measurement: Provide an airflow measuring device integral to the fan to measure air volume within +/- 5 percent

- accuracy. The probing device shall not be placed in the airflow path to stay clear of turbulence and avoid loss of performance.
6. Fan Motor, Drive and Mounting Assembly: Fan Motors shall be premium energy efficient type, as mandated by the Energy Policy Act of 2005, with efficiencies as shown in the Specifications Section 23 05 12 (General Motor Requirements For HVAC and Steam Equipment), on drawings and suitable for use in variable frequency drive applications. Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC AND STEAM GENERATION, for additional motor and drive specifications. Refer to Specification Section 26 29 11, LOW-VOLTAGE MOTOR STARTERS
- J. Mixing Boxes: Mixing box shall consist of casing and outdoor air and return air dampers in opposed blade arrangement with damper linkage for automatic operation. Coordinate damper operator with Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC. Dampers shall be of ultra-low leak design with metal compressible bronze jamb seals and extruded vinyl edge seals on all blades. Blades shall rotate on stainless steel sleeve bearings or bronze bushings. Leakage rate shall not exceed 1.6 cubic meters/min/square meter (5 cfm per square foot) at 250 Pa (1 inch water gage) and 2.8 cubic meters/min/square meter (9 cfm per square foot) at 995 Pa (4 inches water gage) Electronic damper operators shall be furnished and mounted in an accessible and easily serviceable location by the air handling unit manufacturer at the factory. Damper operators shall be of same manufacturer as controls furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.
- L. Filter Section: Refer to Section 23 40 00, HVAC AIR CLEANING DEVICES, for filter requirements.
1. Filters including one complete set for temporary use at site shall be provided independent of the RTU. The RTU manufacturer shall install filter housings and racks in filter section compatible with filters furnished. The RTU manufacturer shall be responsible for furnishing temporary filters (pre-filters and after-filters, as shown on drawings) required for RTU testing.
  2. Factory-fabricated filter section shall be of the same construction and finish as the RTU casing including filter racks and hinged double wall access doors. Filter housings shall be constructed in

accordance with side service or holding frame housing requirements  
in Section 23 40 00, HVAC AIR CLEANING DEVICES.

N. Coils: Coils shall be mounted on hot dipped galvanized steel supports to assure proper anchoring of coil and future maintenance. Coils shall be face or side removable for future replacement thru the access doors or removable panels. Each coil shall be removable without disturbing adjacent coil. Cooling coils shall be designed and installed to ensure no condensate carry over. Provide factory installed extended supply, return, drain, and vent piping connections. Refer to Drawings and Section 23 82 16, AIR COILS, for additional coil requirements.

1. Water Coils.

P. Sound Attenuators: Refer to Drawings, Specification Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT, and Section 23 31 00, HVAC DUCTS AND CASINGS, for additional unit mounted sound attenuator requirements. RTU sound attenuators shall be factory installed as an integral part of RTU.

Q. Discharge Section: Provide aerodynamically designed framed discharge openings or spun bellmouth fittings to minimize pressure loss.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install roof top unit in conformance with ARI 435.
- B. Assemble roof top unit components following manufacturer's instructions for handling, testing and operation. Repair damaged galvanized areas with paint in accordance with Military Spec. DOD-P-21035A. Repair painted units by touch up of all scratches with finish paint material. Vacuum the interior of air-handling units clean prior to operation.
- C. Install seismic restraints for roof top units. Refer to specification Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- D. Leakage and test requirements for roof top units shall be the same as specified for ductwork in Specification Section 23 31 00, HVAC DUCTS AND CASINGS except leakage shall not exceed Leakage Class ( $C_L$ ) 12 listed in SMACNA HVAC Air Duct Leakage Test Manual when tested at 1.5 times the design static pressure. Repair casing air leaks that can be heard or felt during normal operation and to meet test requirements.



- E. Perform field mechanical (vibration) balancing in accordance with Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- F. Seal and/or fill all openings between the casing and RTU components and utility connections to prevent air leakage or bypass.

### **3.2 STARTUP SERVICES**

- A. The air handling unit shall not be operated for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings are lubricated and fan has been test run under observation.
- B. After the air handling unit is installed and tested, provide startup and operating instructions to VA personnel.
- C. An authorized factory representative should start up, test and certify the final installation and application specific calibration of control components. Items to be verified include fan performance over entire operating range, noise and vibration testing, verification of proper alignment, overall inspection of the installation, Owner/Operator training, etc.

### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

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**SECTION 23 81 00**  
**DECENTRALIZED UNITARY HVAC EQUIPMENT**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section specifies self-contained, split-systems, rooftop, and room-type air conditioners.
- B. Definitions:
  - 1. Energy Efficiency Ratio (EER): The ratio of net cooling capacity is Btu/h to total rate of electricity input in watts under designated operating conditions (Btu hour/Watt).
  - 2. Seasonal Energy Efficiency Ratio (EER): The ratio of the total cooling output of an air conditioner during its normal annual usage period for cooling in Btu/h divided by total electric energy input in watts during the same period (Btu hour/Watt).
  - 3. Unitary: A Unitary Air Conditioner consists of one or more factory-made assemblies which normally include an evaporator or cooling coil, a compressor and condenser combination, and may include a heating function as well.
  - 4. Where such equipment is provided in more than one assembly the separated assemblies are to be designed to be used together and the requirements of rating are based upon use of matched assemblies.

**1.2 RELATED WORK**

- A. Section 01 00 00, GENERAL REQUIREMENTS: Requirements for pre-test of equipment: Seismic requirements for non-structural equipment.
- 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 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT: Requirements for different types of vibration isolators and noise ratings in the occupied areas.
- D. Section 23 07 11, HVAC and BOILER PLANT INSULATION: Requirements for piping insulation.
- E. Section 23 23 00, REFRIGERANT PIPING: Requirements for refrigerant pipes and fittings.
- F. Section 23 36 00, AIR TERMINAL UNITS and Section 23 82 00, CONVECTION HEATING and COOLING UNITS: Requirements for other similar units.

- G. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS:  
Requirements for air handling units using chilled water and hot water coils.
- H. Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS: Requirements for air handling units using chilled water and hot water coils.
- I. Section 23 40 00, HVAC AIR CLEANING DEVICES: Requirements for air filtration.
- J. Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- L. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC:  
Requirements for testing and adjusting air balance.

### **1.3 QUALITY ASSURANCE**

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Safety Standards: ASHRAE Standard 15, Safety Code for Mechanical Refrigeration.

### **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. Sufficient information, including capacities, pressure drop and piping connections clearly presented, shall be included to determine compliance with drawings and specifications for units noted below:
    - a. Unitary air conditioners:
      - 1) Split systems
  - 2. Unit Dimensions required clearances, operating weights accessories and start-up instructions.
  - 3. Electrical requirements, wiring diagrams, interlocking and control wiring showing factory installed and portions to be field installed.
  - 4. Mounting and flashing of the roof curb to the roofing structure with coordinating requirements for the roof membrane system.
- C. Certification: Submit proof of specified ARI Certification.
- D. Performance Rating: Submit catalog selection data showing equipment ratings and compliance with required sensible-to-heat-ratio, energy efficiency ratio (EER), and coefficient of performance (COP).

- E. Operating and Maintenance Manual: Submit three copies of Operating and Maintenance manual to Resident Engineer three weeks prior to final inspection.
- F. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

**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. Federal Specifications (Fed. Spec.):
  - A-A-50502-90 ..... Air conditioner (Unitary Heat Pump) Air to Air (3000-300,000 Btu)
- C. Military Specifications (Mil. Specs.):
  - MIL-PRF-26915D-06 .....Primer Coating, for Steel Surfaces
- D. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
  - 210/240-08 .....Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment
  - 270-08 .....Sound Rating of Outdoor Unitary Equipment
  - 310/380-04 .....Standard for Packaged Terminal Air-Conditioners and Heat Pumps (CSA-C744-04)
  - 340/360-07 .....Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
  - 520-04 .....Performance Rating of Positive Displacement Condensing Units
- E. Air Movement and Control Association (AMCA):
  - 210-07 .....Laboratory Methods of Testing Fans for Aerodynamic Performance Rating (ANSI)
  - 410-96 .....Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans
- F. American National Standards Institute (ANSI):
  - S12.51-02 (R2007) .....Acoustics - Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Method for Reverberation Rooms (same as ISO 3741:1999)

- G. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
  - 2008 Handbook .....HVAC Systems and Equipment
  - 15-10 .....Safety Standard for Refrigeration Systems  
(ANSI)
- H. American Society of Testing and Materials (ASTM):
  - B117-09 .....Standard Practice for Operating Salt Spray  
(Fog) Apparatus
- I. American Society of Civil Engineers (ASCE)
  - ASCE 7-10 .....Minimum Design Loads for Buildings and Other  
Structures
- J. National Electrical Manufacturer's Association (NEMA):
  - MG 1-09 (R2010) .....Motors and Generators (ANSI)
  - ICS 1-00 (R2005, R2008) Industrial Controls and Systems: General  
Requirements
- K. National Fire Protection Association (NFPA) Publications:
  - 90A-09 .....Standard for the Installation of Air-  
Conditioning and Ventilating Systems

**PART 2 - PRODUCTS**

**2.1 UNITARY AIR CONDITIONERS - GENERAL**

- A. Applicable ARI Standards:
  - 1. Cooling Capacity 39.6 kW (135,000 Btu/h) and More: AHRI 340/ 360.
  - 2. Cooling Capacity Less Than 39.6 kW (135,000 Btu/h): AHRI 210/240.  
Units shall be listed in the ARI Directory of Certified Unitary Air-Conditioners.
- B. Performance Rating: Cooling capacity of units shall meet the sensible heat and total heat requirements shown in the contract documents. In selecting unit size, make true allowance for "sensible to total heat ratio" to satisfy required sensible cooling capacity.
- C. Machinery Guards: 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. Drive guards may be excluded where motors and drives are inside factory fabricated casings.
- D. Corrosion Prevention: Unless specified otherwise, equipment fabricated from ferrous metals that do not have a zinc coating or a duplex coating of zinc and paint shall be treated for prevention of rust with a factory coating or paint system that will withstand 125 hours in a

salt-spray fog test, except that equipment located outdoors shall be tested for 500 hours. The salt-spray fog test shall be in accordance with ASTM B117 using a 20 percent sodium chloride solution. Immediately after completion of the test, the coating shall show no signs of blistering, wrinkling or cracking, no loss of adhesion, and the specimen shall show no signs of rust beyond 3 mm (1/8-inch) on both sides from the scratch mark. For units located in high humidity areas, provide factory-coated coils for protection from corrosion by using multiple stage electro-deposition coating process. Refer to Drawings and Section 23 82 16, AIR COILS, for additional coil requirements.

### **2.3 SPLIT-SYSTEM AIR CONDITIONERS**

- A. Description: Factory assembled and tested, wall-mounted or ceiling mounted unit, with an air-cooled remote condensing unit, and field-installed refrigeration piping.
- B. Concealed Evaporator Components:
  - 1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
  - 2. Insulation: Factory-applied duct liner.
  - 3. Drain Pans: Galvanized steel, with connection for drain; insulated and complying with ASHRAE 62.1-2007.
  - 4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.
  - 5. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.
  - 6. Electric-Resistance Heating Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection. Provide SCR control of electric heating coils as indicated.
  - 7. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
  - 8. Fan Motors: Comply with requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT for multi-tapped, multi-speed motors with internal thermal protection and permanent lubrication.

9. Disposable Filters: 25 mm (1 inch) thick, in fiberboard frames with MERV rating of 7 or higher according to ASHRAE 52.2.

10. Wiring Terminations: Connect motor to chassis wiring with plug connection.

D. Wall-Mounting, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.

3. Drain Pan and Drain Connection: Comply with ASHRAE 62.1-2007.

4. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with thermal-expansion valve.

5. Electric-Resistance Heating Coil: Helical, nickel-chrome, resistance-wire heating elements with refractory ceramic support bushings; automatic-reset thermal cutout; built-in magnetic contactors; manual-reset thermal cutout; airflow proving device; and one-time fuses in terminal box for overcurrent protection.

6. Fan: Direct drive, centrifugal fan.

7. Fan Motors: Comply with requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT for multi-tapped, multi-speed motors with internal thermal protection and permanent lubrication.

8. Filters: Disposable, with MERV rating of 7 or higher according to ASHRAE 52.2.

F. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Service valves, fittings, and gage ports shall be brass and located outside of the casing.

2. Compressor: Hermetically sealed scroll with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

3. Compressor motor with manual-reset, high-pressure switch and automatic-reset, low-pressure switch.



4. Refrigerant: R-410A unless otherwise indicated.
5. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with AHRI 210/240, and with liquid subcooler.
6. Fan: Aluminum, propeller type, directly connected to motor.
7. Motor: Permanently lubricated, with integral thermal-overload protection.
8. Low Ambient Kit: Permit operation down to minus 18 deg C (0 deg F).
9. Mounting Base: Polyethylene.
10. Minimum Energy Efficiency: Comply with ASHRAE/IESNA 90.1-2004, "Energy Standard for Buildings except Low-Rise Residential Buildings."

### **PART 3 EXECUTION**

#### **3.1 INSTALLATION**

- A. Install unit level and plumb maintaining manufacturer's recommended clearances and tolerances.
- B. Install ground-mounting, compressor-condenser components on 100 mm (4-inch) thick, reinforced concrete base; 100 mm (4 inches) larger on each side than unit. Concrete, reinforcement, and formwork are specified in Section 03 30 00, CAST-IN-PLACE CONCRETE. Coordinate anchor installation with concrete base.
- C. Install roof-mounting compressor-condenser components on equipment supports specified in Section 07 72 00, ROOF ACCESSORIES. Anchor units to supports with removable, cadmium-plated fasteners.
- D. Install seismic restraints.
- E. Install compressor-condenser components on restrained, spring isolators with a minimum static deflection of 25 mm (1 inch) unless otherwise indicated. Refer to Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT.
- F. Install and connect refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- G. Install wall sleeves in finished wall assembly and weatherproof. Install and anchor wall sleeves to withstand, without damage seismic forces as required by code.

#### **3.2 CONNECTIONS**

- A. Verify condensate drainage requirements.
- B. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

- C. Install piping adjacent to units to allow service and maintenance.
- D. Gas Piping: Comply with applicable requirements in Section 23 11 23, FACILITY NATURAL-GAS PIPING. Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- E. Install ducts to termination at top of roof curb. Cut roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
- F. Connect supply ducts to units with flexible duct connectors specified in Section 23 31 00, HVAC DUCTS and CASINGS.
- G. Install return-air duct continuously through roof structure.
- H. Install normal-weight, 20.7-MPa (3000-psi), compressive strength (28-day) concrete mix inside roof curb, 100 mm (4 inches) thick.
- I. Ground equipment and install power wiring, switches, and controls for self-contained and split systems.
- J. Connect refrigerant piping to coils with shutoff valves on the suction and liquid lines at the coil and a union or flange at each connection at the coil and condenser.
- K. Install ducts to the units with flexible duct connections.
- L. Connect piping with shutoff duty valves on the supply and return side of the coil and unions at all connections and with a throttling valve on the return piping near the coil.
- M. Connect piping with shutoff duty valves on the supply and return side of the water cooled condenser and unions at all connections and with a throttling valve on the return piping near the condenser
- N. Connect piping with shutoff duty valves and unions on the steam supply and condensate side of the steam coil. On the condensate line near the coil provide a strainer, trap and shutoff valve.

### **3.3 FIELD QUALITY CONTROL**

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections: After installing units and after electrical circuitry has been energized, test units for compliance with requirements. Inspect for and remove shipping bolts, blocks, and tie-down straps. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and

equipment. Remove and replace malfunctioning units and retest as specified above.

**3.4 INSTRUCTIONS**

Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.

**3.5 STARTUP AND TESTING**

The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

**3.6 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

**3.7 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS.

---END---



**SECTION 23 82 00**  
**CONVECTION HEATING AND COOLING UNITS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Fan-coil units.

**1.2 RELATED WORK**

- A. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic restraints for equipment.
- 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 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT: Noise requirements.
- D. Section 23 21 13, HYDRONIC PIPING: Heating hot water and chilled water piping.
- E. Section 23 31 00, HVAC DUCTS and CASINGS: Ducts and flexible connectors.
- F. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Valve operators.
- G. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC: Flow rates adjusting and balancing.
- H. Section 23 82 16, AIR COILS: Additional coil requirements.
- I. Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- J. Section 01 09 00 - GENERAL COMMISSIONING REQUIREMENTS

**1.3 QUALITY ASSURANCE**

Refer to Paragraph, QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
  - 1. Fan-Coil units.
- C. Certificates:
  - 1. Compliance with paragraph, QUALITY ASSURANCE.
  - 2. Compliance with specified standards.

- D. Operation and Maintenance Manuals: Submit in accordance with paragraph, INSTRUCTIONS, in Section 01 00 00, GENERAL REQUIREMENTS.
- E. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

**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 Standards Institute / Air Conditioning, Heating and Refrigeration Institute (ANSI/AHRI):
  - 440-08 .....Performance Rating of Room Fan CoilsNational Fire Protection Association (NFPA):
  - 90A-09 .....Standard for the Installation of Air Conditioning and Ventilating Systems
  - 70-11 .....National Electrical Code
- C. Underwriters Laboratories, Inc. (UL):
  - 181-08 .....Standard for Factory-Made Air Ducts and Air Connectors
  - 1995-05 .....Heating and Cooling Equipment

**1.6 GUARANTY**

In accordance with FAR clause 52.246-21

**PART 2 - PRODUCTS**

**2.1 ROOM FAN-COIL UNITS**

- A. Capacity Certification: AHRI 440.
- B. Safety Compliance: NEC compliant and UL listed.
- C. Noise Levels: Operating at full cooling capacity, sound power level shall not exceed by more than 5 dB the numerical value of sound pressure levels associated with noise criteria specified in Section 23 05 51, NOISE AND VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT. Select units at intermediate speed, for compliance with the noise criteria.
- D. Chassis: Galvanized steel, acoustically and thermally insulated to attenuate noise and prevent condensation.
- E. Cabinet: Minimum 1.3 mm (18 gage) steel reinforced and braced. Arrange components and provide adequate space for installation of piping

package and control valves. Finish shall be factory-baked enamel color as selected by the architect on all exposed surfaces.

2. Horizontal Unit: Provide Concealed type as shown. Provide supports and vibration isolators for horizontal units as recommended by the manufacturer.

a. Concealed Units:

Provide fully enclosed cabinet with inlet and outlet duct collars.

F. Fans: Centrifugal, forward curved, double width type wheels, galvanized steel or polyester resin construction, statically and dynamically balanced, direct driven.

1. Motors: Premium efficiency, 3-speed permanent split capacitor type with integral thermal overload protection, for operation at not more than 1200 RPM.

2. Provide a fan speed selector switch, with off, low, medium, and high positions. Switch shall have a set of auxiliary contacts which are open when the switch is in the "off" position and closed when the switch in any of the other positions. On vertical units, mount switch in a junction box in the cabinet of each unit. On ceiling-suspended horizontal and concealed units, switch shall be wall mounted.

G. Cooling and Heating Coils:

1. Hydronic (two separate coils for cooling and heating): Copper tubes, 10 mm (three-eighths inch) minimum inside diameter, not less than 4.3 mm (0.017 inch) thick with copper or aluminum fins. Coils shall be pressure tested for bursting and strength in accordance with Underwriters Laboratories, Inc., requirements for pressure tested coils, and shall be designed to provide adequate heat transfer capacity. Provide manual air vent at high point of each coil and drain at each low point.

H. Piping Package: Factory furnished with unit by the manufacturer or field-installed by the contractor to fit control valves provided by the controls supplier. Submit manufacturer's detailed drawings of the piping in the end compartments for approval prior to fabrication of the piping packages. Provide ball stop valves on the supply and return pipes and balancing fittings on the return pipes.

- I. Drain pans: Furnish galvanized steel with solderless drain connections and molded polystyrene foam insulating liner:
1. Auxiliary drain pan: Located under control valve and piping within the unit enclosure to prevent dripping.
  2. Secondary Drain Pan: Where the unit is located such that drain pan overflow will damage the building, provide a secondary drain pan located underneath the unit, constructed to extend a minimum of 50 mm (2 inches) beyond the edges of the unit and be a minimum of 38 mm (1-1/2 inches deep) provided with a separate drain line discharging to conspicuous point or water detection device to deactivate the cooling in the unit.
- J. Air Filter: Manufacturer's standard throwaway type, not less than 25 mm (1 inch) thick, MERV 7, supported to be concealed from sight and be tight fitting to prevent air by-pass. Filters shall have slide out frames and be easily replaced without removing enclosure or any part thereof.
- K. Control valves: Provide two-way modulating control valves as scheduled on the drawings and specified under Section 23 21 13, HYDRONIC PIPING.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Work shall be installed as shown and according to the manufacturer's diagrams and recommendations.
- B. Handle and install units in accordance with manufacturer's written instructions.
- C. Support units rigidly so they remain stationary at all times. Cross-bracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and malfunction of units cannot occur.

#### **3.2 OPERATIONAL TEST**

Refer to Section 23 05 11, COMMON WORK RESULTS FOR HVAC.

#### **3.3 STARTUP AND TESTING**

- A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.



**3.4 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection, start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.
- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

**3.5 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS.

- - - E N D - - -



**SECTION 23 82 16**  
**AIR COILS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

Heating and cooling coils for air handling unit and duct applications

**1.2 RELATED WORK**

- A. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT and STEAM GENERATION.
- B. Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- C. Section 23 31 00, HVAC DUCTS AND CASINGS
- D. Section 23 36 00, AIR TERMINAL UNITS: Reheat coils for VAV/CV terminals.
- E. Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS.
- F. Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS
- G. Section 23 82 00, CONVECTION HEATING AND COOLING UNITS
- H. Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- I. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS

**1.3 QUALITY ASSURANCE**

- A. Refer to paragraph, QUALITY ASSURANCE, Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Unless specifically exempted by these specifications, heating and cooling coils shall be tested, rated, and certified in accordance with AHRI Standard 410 and shall bear the AHRI certification label.

**1.4 SUBMITTALS**

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data for Heating and Cooling Coils: Submit type, size, arrangements and performance details. Present application ratings in the form of tables, charts or curves.
- C. Provide installation, operating and maintenance instructions.
- D. Certification Compliance: Evidence of listing in current ARI Directory of Certified Applied Air Conditioning Products.
- E. Coils may be submitted with Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS, Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS, Section 23 36 00, AIR TERMINAL UNITS, or Section 23 82 00, CONVECTION HEATING AND COOLING UNITS.

- F. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

**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 (AHRI):  
Directory of Certified Applied Air Conditioning Products  
AHRI 410-01 .....Forced-Circulation Air-Cooling and Air-Heating  
Coils
- C. American Society for Testing and Materials (ASTM):  
B75/75M-02 .....Standard Specifications for Seamless Copper  
Tube
- D. National Fire Protection Association (NFPA):  
70-11 .....National Electric Code
- E. National Electric Manufacturers Association (NEMA):  
250-11 .....Enclosures for Electrical Equipment (1,000  
Volts Maximum)
- F. Underwriters Laboratories, Inc. (UL):  
1996-09 .....Electric Duct Heaters

**PART 2 - PRODUCTS**

**2.1 HEATING AND COOLING COILS**

- A. Conform to ASTM B75 and AHRI 410.
- B. Surgical Suites - All Locations: All coils installed in the air handling units serving surgical suites, duct-mounted reheat coils, and air terminal unit-mounted reheat coils shall be equipped with copper fins.
- C. High Humidity Locations: For air-handling unit mounted coils provide the following corrosion treatment:
  - 1. Epoxy Immersion Coating - Electrically Deposited: The multi-stage corrosion-resistant coating application comprises of cleaning (heated alkaline immersion bath) and reverse-osmosis immersion rinse prior to the start of the coating process. The coating thickness shall be maintained between 0.6-mil and 1.2-mil. Before the coils are subjected to high-temperature oven cure, they are treated to

permeate immersion rinse and spray. Where the coils are subject to UV exposure, UV protection spray treatment comprising of UV-resistant urethane mastic topcoat shall be applied. Provide complete coating process traceability for each coil and minimum five years of limited warranty.

2. The coating process shall such that uniform coating thickness is maintained at the fin edges. The quality control shall be maintained by ensuring compliance to the applicable ASTM Standards for the following:

- a. Salt Spray Resistance (Minimum 6,000 Hours)
- b. Humidity Resistance (Minimum 1,000 Hours)
- c. Water Immersion (Minimum 260 Hours)
- d. Cross-Hatch Adhesion (Minimum 4B-5B Rating)
- e. Impact Resistance (Up to 160 Inch/Pound)

D. Tubes: Minimum 16 mm (0.625 inch) tube diameter; Seamless copper tubing.

E. Fins: 0.1397 mm (0.0055 inch) aluminum or 0.1143 mm (0.0045 inch) copper mechanically bonded or soldered or helically wound around tubing.

F. Headers: Copper, welded steel or cast iron. Provide seamless copper tubing or resistance welded steel tube for volatile refrigerant coils.

G. "U" Bends, Where Used: Machine die-formed, silver brazed to tube ends.

H. Coil Casing: 1.6 mm (16 gage) galvanized steel with tube supports at 1200 mm (48 inch) maximum spacing. Construct casing to eliminate air bypass and moisture carry-over. Provide duct connection flanges.

I. Pressures kPa (PSIG):

Pressure	Water Coil	Steam Coil	Refrigerant Coil
Test	2070 (300)	1725 (250)	2070 (300)
Working	1380 (200)	520 (75)	1725 (250)

J. Protection: Unless protected by the coil casing, provide cardboard, plywood, or plastic material at the factory to protect tube and finned surfaces during shipping and construction activities.

K. Vents and Drain: Coils that are not vented or drainable by the piping system shall have capped vent/drain connections extended through coil casing.

- L. Cooling Coil Condensate Drain Pan: Section 23 73 00, INDOOR CENTRAL-STATION AIR-HANDLING UNITS or Section 23 74 13, PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS.
- M. Steam Distributing Coils: Conform to ASTM B75 and ARI 410. Minimum 9.5 mm (3/8-inch) steam distributing tubing installed concentrically in 25 mm (one-inch) OD condensing coil tubes.
- N. Integral Face and Bypass Type Steam Coil:
  - 1. Exempt from ARI Test and Certification.
  - 2. Conform to ASTM B75 and ARI 410.
  - 3. Minimum 16 mm (5/8-inch) steam tube installed in concentrically 25 mm (one-inch) OD diameter tube.
  - 4. Casing: 1.9 mm (14 gage) galvanized steel with corrosion resistant paint.
  - 5. Tubes and Bypasses: Vertical or horizontal.
- O. Dampers: Interlocking opposed blades to completely isolate coil from air flow when unit is in bypass position; 1.6 mm (16 gage) steel, coated with factory applied corrosion resistant baked enamel finish. Provide damper linkage and electric operators. Damper operators shall be of same manufacturer as controls furnished under Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.

## **2.2 REHEAT COILS, DUCT MOUNTED**

The coils shall be continuous circuit booster type for steam or hot water as shown on drawings. Use the same coil material as listed in Paragraphs 2.1.

## **2.3 WATER COILS, INCLUDING GLYCOL-WATER**

- A. Use the same coil material as listed in Paragraphs 2.1.
- B. Drainable Type (Self Draining, Self Venting); Manufacturer standard:
  - 1. Cooling, all types.
  - 2. Heating or preheat.
  - 3. Runaround energy recovery. ARI certification of capacity adjustment is waived. See Section 23 72 00, AIR-TO-AIR ENERGY RECOVERY EQUIPMENT.

## **2.5 ELECTRIC HEATING COILS**

- A. Standards: ARI 410 is not applicable. Electric coils shall meet the requirements of the National Electric Code (NEC) and UL 1996.

- B. General: Aluminized steel frame, spot welded. Duct mounted units may be flanged or slip-in design with built-in terminal box completely factory wired to terminals. Control panels for coils in air handling units may be built-in or remote in NEMA 1 enclosure.
- C. Coils: Open type, 80 percent nickel, 20 percent chromium resistance wire, insulated by floating ceramic bushings and supported in aluminized steel brackets spaced on 100 mm (4-inch) maximum centers. Coils shall be mechanically crimped in stainless steel terminals which are insulated from the frame with high temperature molded phenolic bushings.
- D. Over Temperature Protection:
  - 1. Primary system: Automatic reset thermal cutout.
  - 2. Secondary system: Load-carrying manual reset thermal cutout factory wired in series with each heater stage.
- E. Overcurrent Protection: Comply with UL and NEC.
- F. Contactors: Disconnecting magnetic type, (when required), except for duct mounted reheat coils contractors shall be disconnecting mercury type.
- G. Airflow Interlock: Diaphragm operated differential airflow pressure switch.
- H. Leaving air temperature control for electric coils mounted in air handling units shall be as shown on the drawings.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Follow coil manufacturer's instructions for handling, cleaning, installation and piping connections.
- B. Comb fins, if damaged. Eliminate air bypass or leakage at coil sections.

#### **3.2 STARTUP AND TESTING**

- A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

#### **3.3 COMMISSIONING**

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection,

start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

**3.4 DEMONSTRATION AND TRAINING**

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS.

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