PART 1 GENERAL

1.1 DESCRIPTION

A. The requirements of this section apply to the insulation of mechanical equipment specified elsewhere in these specifications.

B. Related Work: The requirements of Section 23 0500, Common HVAC Materials and Methods, also apply to this section.

1.2 QUALITY ASSURANCE

A. Insulation Thickness and Thermal Performance: Comply with state energy code.

B. Composite (Insulation, Jacket or Facing and Adhesives) Fire and Smoke Hazard Ratings: Not to exceed a flame spread of 25 or smoke development of 50 and containing less than 0.1% by weight deca-PDE fire retardant.

C. Component Ratings of Accessories (Adhesives, Mastics, Cements, Tapes, Finishing Cloth for Fittings): Same as "B" requirements above and permanently treated. No water soluble treatments.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. General: In addition to the requirements specified in Section 23 0500, the following apply:
   1. Deliver insulation, coverings, cements, adhesives and coatings to the site in factory-fabricated containers with the manufacturer's stamp or label affixed showing fire hazard ratings of the products. Store insulation in original wrappings and protect from weather and construction traffic.
   2. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged insulation. Remove such insulation from project site.

1.4 SUBMITTALS

A. Submit catalog data and performance characteristics for each product specified.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Insulating Manufacturers: Johns Manville, Knauf, Armstrong, Owens-Corning, Pittsburgh Corning, Pabco, Imcoa or Certain Teed. Johns Manville products are listed unless indicated otherwise.

B. Adhesive Manufacturers: Foster, 3M, Insul-Coustic, Borden, Kingco or Armstrong.

2.2 PIPING INSULATION

A. Interior and Exterior Piping Systems 50 to 850 Deg. F: Glass fiber preformed pipe insulation with a minimum K-value of 0.23 at 75 Deg. F, a minimum density of 3.5 pounds per cubic foot within all-service vapor barrier jacket containing less than 0.1% by weight deca-PDE fire retardant, vinyl or pre-sized finish and pressure sensitive seal. Johns Manville "Micro-Lok."

B. Exterior Installations: Same as for interior installations except 0.016" stainless steel.

C. Interior Piping Systems 32 to 50 Deg. F: Glass fiber preformed pipe insulation with a minimum K-value of 0.23 at 75 deg. F, a minimum density of 3.5 pounds per cubic foot. Polymer vapor barrier jacket and containing less than 0.1% by weight deca-PDE fire retardant with pressure sensitive seal and wicking system to remove condensation from pipe surface. Owens Corning “VaporWick.”

D. Pipe Temperatures Minus 30 to 180 Deg. F: Flexible, preformed, pre-slit, self-sealing elastomeric pipe insulation up to 2-1/8" ID, thermal conductivity of 0.27 BTU/hr. sq. ft./in. at 75 deg. F and vapor transmission rating of 0.2 perms/inch. Apply in thickness necessary to prevent condensation on the surface at 85 deg. F and 70% RH. Armstrong "Armaflex 2000" or, in concealed locations, Imcoa or Nomaco also approved.

E. Pipe Temperatures up to 1200 Deg. F: High temperature molded calcium silicate insulation with aluminum metal jacket. Furnish with aluminum snap straps. Apply in thickness required for a maximum surface temperature of 120 deg. F at 80 deg. F ambient and for the flow media temperatures. Johns Manville Thermo-12/Gold.

2.3 DUCT INSULATION

A. Interior Above Grade Ductwork: Glass fiber formaldehyde-free blanket with "FSK" facing containing less than 0.1% by weight deca-PDE fire retardant, k value = 0.31 at 75 deg. F, 0.2 perms, and UL 25/50 surface burning rating. Johns Manville "Microlite."

B. Exterior Above Grade Ductwork: Glass fiber board with “FSK” facing containing less than 0.1% by weight deca-PDE fire retardant, 3 pound density, k value of 0.23 at 75 deg. F and 0.2 perms. Install with 0.016" aluminum jacket. Secure with sealed fasteners on the bottom of the duct. Johns Manville 800 Series Spin-Glas.

2.4 EQUIPMENT INSULATION

A. Equipment Temperatures Below 70 Deg. F: Flexible, closed cell, elastomeric sheet insulation of 5.5 #/cubic feet density and 0.27 thermal conductivity at 75 deg. F. Armstrong "Armaflex."

B. Equipment Temperatures From 70 to 450 Deg. F: Glass fiber 3 pound density insulation with a 0.23 thermal conductivity at 75 deg. F. Johns Manville "814 Spin-Glas" with "FSK" jacket containing less than 0.1% by weight deca-PDE fire retardant, or finished as recommended by manufacturer.

C. Equipment Temperatures From 350 to 1200 Deg. F: Molded high temperature calcium silicate minimum 12.5 pound density and 0.4 thermal conductivity at 200 deg. F mean temperature. Glass cloth finish, Claremont Diplag or finished as recommended by insulation manufacturer.

D. Exterior Tanks and Equipment Insulation Covering: Same as interior insulation with weatherproof metal or finished as recommended by insulation manufacturer.

2.5 INSULATION ACCESSORIES

A. Insulation Compounds and Materials: Provide rivets, staples, bands, adhesives, cements, coatings, sealers, welded studs, etc., as recommended by the manufacturers for the insulation and conditions specified except staples not permitted on chilled water lines.

B. Interior Tanks and Equipment Insulation Covering: Finished metal jacket or as recommended by the manufacturer for insulation material specified.

C. PVC Protective Jacketing and Valve and Pipe Fitting Covers: Johns Manville Zeston 2000, Proto LoSmoke, or Ceel-Co Ceel-Tite 100 Series with precut fitting fiberglass insulation or approved.

D. Jacket Lap Sealing Adhesives: Foster Drion 85-75 contact cement or approved substitute.

E. Saddles and Shields: Install to prevent crushing of insulation at support points.
   1. Protection Saddles: MSS Type 39. To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields: MSS Type 40. Of length recommended by manufacturer to prevent crushing insulation.
   3. Preinsulated Pipe Supports: Calcium silicate load bearing metal jacketed inserts. Pipe Shields Inc. or accepted substitute.
      a. Pipe supported on rods - Models A1000, A2000, A3000, A4000.
      b. Pipe supported on flat surfaces - Models A1000, A2000, A3000, A4000.
      c. Pipe supported on pipe rolls - Models A3000, A4000, A5000.
      d. Vertical riser clamp – Models E1000, E1100, E1200.

   4. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi (690-kPa) minimum compressive strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

F. Removable/Reusable Insulation Covers:
   1. 200 to 600 Deg. F Insulation Filler: Install 2-1/4# - 4#/cu. ft. glass fiber, 6# - 8#/ cu. ft. mineral wool or glass fiber/type E felted (9#/cu. ft.) flexible blankets and pads for large, irregular shaped equipment such as pump casings, bolting flanges, etc. For small common shapes such as valves, elbows, flanges, etc., install preformed flexible glass fiber pipe wrap, preformed glass fiber pipe covering or glass fiber/type E felted (9#/cu. ft.) insulation.
   2. 600 - 1000 Deg. F Insulation Filler: Install 4# - 8#/cu. ft. refractory fiber felted, 8# - 10#/ cu. ft. mineral wool or glass fiber/type E felted (9#/cu. ft.) flexible blankets and pads. Install mineral wool pipe wrap, glass fiber/type E felted (9#/cu. ft.), laminated refractory fiber (4# - 6#/cu. ft.) with flexible glass fiber wrap or refractory (ceramic) fiber (6#/cu. ft.) preformed insulation.
   3. Over 1000 Deg. F Insulation Filler: Install refractory (ceramic) fiber (6# - 8#/cu. ft.) blanket or pad insulation or 6#/cu. ft. preformed insulation.
   4. Encasement, 200 to 600 Deg. F: Glass fiber cloth plain or silicon coated on both sides, knitted stainless steel mesh, glass fiber cloth laminate with aluminum, or stainless steel foil or hex wire mesh.
   5. Encasement, 600 to 1000 Deg. F: Glass fiber cloth with stainless or monel wire insertion, knitted stainless steel mesh, ceramic cloth, or glass fiber cloth laminated with stainless steel foil.
   6. Encasement, Over 1000 Deg. F: Refractory cloth with nickel or inconel wire insertion, knitted inconel mesh or ceramic cloth with nickel wire insertion.
   7. Cold Encasement: Glass fiber cloth silicon coated both sides, knitted stainless steel mesh, glass fiber cloth laminate with aluminum or stainless steel foil or glass fiber cloth with nickel wire insertion, silicon coated both sides.
   8. Stitching, 200 to 600 Deg. F: Glass fiber thread/PVC coated, staples - galvanized or stainless steel, galvanized or stainless steel hog rings, 0.010" - 0.15" dia/dead soft stainless steel wire.
   9. Stitching, 600 Deg. F: Same as 200 to 600 Deg. F above except no galvanized staples or rings and PVC coated thread to 850 deg. F.
   10. Attachments and Securements:
      a. Quilting: Stainless 2-hole washers, both sides with twisted 0.035" - 0.051" wire loops, 12 ga. stainless spindle/washer/ speed clip assembly or stainless 0.035" - 0.051" wire loops.

b. Lacing and Hooks: Stainless 2-hole 12 gage bent wire lacing hooks, stainless 2-hole dished washer assembly with twisted 0.035" - 0.051" wire loops, 12 gage stainless spindle washer with built-in hook and speed clip or stainless 1-hole dished and flat washer riveted through the cloth.

PART 3 EXECUTION

3.1 PIPING INSULATION

A. Heating Water Piping: Insulate with glass fiber pipe covering:

Size	Thickness
1/2" to 1-1/2"	1-1/2"
2" to 3"	2"
4" and larger	2-1/2"

B. Refrigerant Piping Insulation: Insulate suction piping with minimum ~~1/2"~~ **1"** thick foamed plastic or of thickness necessary to prevent condensation at 85 deg. F and 70% RH. Where possible, slip insulation over the piping as it is installed. Seal all joint and seams. All exterior installation to be protected with aluminum protective cover.

C. Pipe Fittings:
1. Insulate and finish all fittings including valve bodies, bonnets, unions, flanges and expansion joints with precut fiberglass insulation and preformed PVC covers sealed to adjacent insulation jacket for continuous vapor barrier covering over all fittings.
2. Use 1/2" thick Armaflex or Aerotube foamed plastic at flexible pipe connections on chilled and/or cold water lines. No insulation on other flexible pipe connections.
3. Provide removable/reusable insulation covers on 4" and larger valves, unions, flanges, pump casings, strainers and similar fittings or equipment requiring periodic service.

D. Protective Covering: Install continuous protective PVC or metal covering on all piping and fittings in mechanical rooms, accessible tunnels, attic spaces, accessible ceilings, etc., where insulation may be subject to damage. Install with rivets or cement seams and joints.

E. Insulated Piping: Comply with the following.
1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits according to ASME B31.9.
2. Install MSS SP-58, Type 39 or Type 40 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
3. Shield Dimensions for Pipe: Not less than the following.
   a. NPS 1/4 to NPS 3-1/2 (DN8 to DN90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4 (DN100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN125 and DN150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
   d. NPS 8 and NPS 14 (DN200 and DN350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
   e. NPS 16 and NPS 24 (DN400 and DN600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
4. Pipes NPS 8 (DN200) and Larger: Include wood inserts.

5. Insert Material: Length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

F. Piping Insulation Lap Seams and Butt Joints: Install insulation jacket in accordance with manufacturer's recommendation. Where jacket joint and lap seams have not adhered, remove affected section of insulation and reinstall or apply lap sealing adhesive in accordance with manufacturer's instructions.

3.2 DUCTWORK INSULATION

A. Ductwork: Insulate the following:
1. All supply ductwork.
2. All supply and return ductwork in systems routed in unconditioned spaces or exposed to the outside conditions.
3. All outside air intake ducts.
4. All ductwork required to be insulated by code.

B. Insulation Thickness: Select board and blanket insulation of thickness required to provide the following installed R-value.
1. All heating or cooling system supply and return ducts located on the exterior of the insulated building envelope and all outside air intake ducts.
a. R-8.
2. Ducts located within or below concrete slabs on grade, per code.
3. All heating and cooling system supply and return ducts located inside of building envelope, R-5 per code.

C. Fittings: Wire and duct adhesive as required. To prevent sagging on all rectangular or square ducts over 24" wide, install Gramweld or equal welding pins on the bottom. Maximum spacing 18" on center in both directions.

D. Installation: Applied with butt joints, all seams sealed with vapor seal mastic or taped with 2" wide vapor-proof, pressure-sensitive tape. Seal all penetrations with vapor barrier adhesive.

E. Internally Lined Ductwork: Where internally lined ductwork is indicated on the Drawings and/or specified, no exterior insulation is required. Select duct lining to provide the required R-value. Carefully lap the ends of the exterior insulation a minimum of 6" past the interior insulation unless otherwise shown. Seal the end of vapor barrier jacket to the duct with mastic where the vapor barrier is required. Duct lining is specified in Section 23 30 00.

3.3 EQUIPMENT ROOM ITEMS

A. Items To Be Insulated: All equipment room items except the following:
1. Condensate receivers.
2. Cushion (expansion) tanks.
3. Breechings.

B. Materials:
1. 1-1/2" calcium silicate blocks applied with wire or bands as required. Finish with 1/2" thick smoothing coat of insulating cement and with glass cloth.
2. For equipment and piping systems operating below 350 deg. F., a 3 pound per cubic foot, 1-1/2" thick spun glass fiber blanket with organic binders and aluminum sheet metal exterior jacket may be substituted for the above insulation.
3. Install tank head finish per manufacturer's recommendations.

C. Manholes, Nameplates, Handholes, Cleanouts, Etc.: Do not insulate over manholes, ASME Code stamps, manufacturer's nameplates, handholes, cleanouts, etc. Provide neatly beveled edges at interruptions of the insulation. When surfaces are to operate below ambient saturation temperatures, provide removable sections of insulation to cover the above with vapor sealed edges. Provide appropriate tagging.

3.4 EXPANSION JOINTS

A. Insulation: Insulate expansion joints on heating and/or cooling piping to match thickness of adjacent piping. Build up piping insulation adjacent to the expansion joints sufficiently to allow internal clearance within the insulation for the diameter of the expansion joint. Fasten one end of the expansion joint insulation securely and provide aluminum or sheet metal on the built-up insulation at the other end to permit movement of the insulation without damage.

B. Finish: Finish as specified for adjacent piping with fireproof covering.

END OF SECTION