

Delete the following current section in its entirety (deletions are shown struck through).

23 07 00 HVAC INSULATION

~~.01 Insulation~~

~~A.—Fire Hazard Ratings~~

- ~~1.—All insulation shall have composite (insulation jacket and adhesive used to adhere the jacket to the insulation) Fire and Smoke Hazard ratings as tested under procedure ASTM E 84, NFPA 225 and UL 723 not exceeding:
 - ~~a.—Flame Spread 25~~
 - ~~b.—Smoke Developed 50~~~~
- ~~2.—Accessories such as adhesives, mastics, cements, and cloth for fittings shall have the same component ratings as listed above.~~
- ~~3.—Paper laminate jackets shall be permanently fire and smoke resistant. Chemicals used for treating paper in jacket laminates shall not be water soluble and shall be unaffected by water and humidity. The only exceptions to the above are flexible foamed plastic insulation.~~

~~B.—General~~

- ~~1.—All pipe insulation shall be continuous through walls, partitions, ceiling openings and sleeves where fire and smoke ratings permit such penetration.~~
- ~~2.—Where pipes pass through fire-rated floors, walls, or partitions, the use of a UL approved system for through penetrations is required. The annular space around the pipes shall be packed with mineral wool or other noncombustible material and sealed at each exposed edge to maintain the rating of the system in accordance with the through penetration sealant manufacturer's recommendations.~~
- ~~3.—Insulation on all cold surfaces must be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors, etc., that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.~~
- ~~4.—Edges of vapor barrier insulation at valve stems, instrument wells, unions and other raw edges must be adequately sealed to prevent moisture from penetrating the insulation.~~

~~C.—Insulation Protection Shields:~~

- ~~1.—Insulation protection shields fabricated from galvanized steel shall be installed at all pipe hangers and supports. Shields shall span an arc of 180°.~~
- ~~2.—Provide shield lengths and thicknesses as outlined in the latest version of the International Mechanical Code or MSS-SP69.~~
- ~~3.—Rigid cellular glass insulation, capable of resisting the crushing effect of the hydraulically loaded piping, shall be placed under each shield. Jacketing material shall be wrapped around rigid insulation and adjacent top and butt sections to maintain the jacketing continuity.~~
- ~~4.—An 18 gauge stainless steel shield shall be installed on insulated piping located on the roof. The shield shall be a minimum length of 36 inches and field located to prevent damage to the insulation while walking over the piping.~~

~~D.—Duct Insulation~~

- ~~1.—Insulation systems shall conform to requirements in ASHRAE Standard 90.1-1999.~~
- ~~2.—The use of duct liner is discouraged. Duct liner may be considered for acoustical purposes only with the written approval of the University.~~

3. ~~All duct insulation in mechanical rooms shall be rigid fiberglass board, minimum density 6 lb/ft³. All other duct insulation shall be blanket-type insulation wrapped on the outside of the ductwork.~~

~~E.—Pipe Insulation~~

1. ~~Insulation systems shall conform to requirements in ASHRAE Standard 90.1-1999.~~
2. ~~In general, refrigerant piping systems shall be insulated with elastomeric pipe insulation.~~
3. ~~In general, all other piping systems shall be insulated with fiberglass piping insulation with an all-service jacket. Fittings, flanges, and valves shall be insulated with fiberglass inserts and premolded polyvinyl jackets.~~
4. ~~Special insulation protection shall be considered for areas subject to abuse, moisture, etc. (i.e. outside, wash down areas).~~

~~F.—Equipment Insulation~~

1. ~~In general, equipment shall be insulated with elastomeric or mineral fiber insulation. All equipment handling a medium below ambient temperature shall be additionally provided with a sealed vapor barrier.~~
2. ~~The following equipment must be insulated to the fullest extent possible. Removable “Hot Cap” insulation must be provided for those items that will require insulation removal for periodic maintenance or inspection. This includes many of the items listed below.~~
 - a. ~~Steam~~
 - i. ~~Valves, strainers, pressure-reducing valves, pressure-relief valves, traps, and condensate receivers/pumps, flash tanks, heat exchangers~~
 - b. ~~Hot water~~
 - i. ~~Valves, strainers, pumps, expansion tanks, air eliminators, storage tanks.~~
 - c. ~~Chilled water~~
 - i. ~~Pumps, valves, heat exchangers.~~

Replace with following text.

23 07 00 HVAC INSULATION

.01 General Owner Requirements and Design Intent

A. General

1. Professional shall use industry best practices and professional engineering judgment to design and select HVAC Insulation to be the most appropriate for long service life for its intended application and service temperature. Insulating systems shall be durable and allow ease of maintenance and provide the lowest life cycle cost.
2. Include all necessary insulation to satisfy the following objectives: Energy Conservation, Personnel Protection, Condensation Control, Freeze Protection, Noise Control, Fire Safety, and Process Control (where present).
3. Design and construction of insulation systems shall comply with the following industry standards and guidelines:

- a. ASHRAE Fundamentals Handbook – Insulation for Mechanical Systems.
 - b. [Mechanical Insulation Design Guide](#) by the National Mechanical Insulation Committee (NMIC).
4. Ancillary materials used for weatherproofing (e.g., sealants, caulks, weather stripping, adhesives, mastics) should be appropriate for the application, and be applied following the manufacturer’s recommendations.
 5. Thicknesses greater than the optimum economic thickness may be required for other technical reasons such as condensation control, personnel protection, or noise control.
- B. Energy Conservation:
1. **Minimum** insulation R-value shall comply with the most stringent requirements in current editions of the **International Energy Conservation Code, ASHRAE Standard 90.1** - Energy Standard for Buildings Except Low-Rise Residential Buildings, or as superseded by **ASHRAE Standard 189.1** - Standard for the Design of High-Performance Green Buildings, Chapter 7: Energy Efficiency.
 2. Providing Optimum economic insulation thickness should be evaluated to minimize the total life cycle cost and alternate bids developed where the estimated payback is expected to meet the threshold criteria of the University.
- C. Personnel Protection
1. In general, provide adequate insulation on hot systems to ensure a maximum temperature of 140°F for surfaces that may be contacted by personnel.
 2. In locations where personnel would be routinely expected to be in close proximity to hot surfaces for prolonged periods, the insulation shall be increased appropriately to maintain a safe working environment.
- D. Condensation Control
1. Systems operating below ambient condition shall have adequate insulation to keep the surface temperature above the ambient air dew point temperature.
 2. For outdoor applications, there are times when the ambient air conditions are saturated or very nearly so. Therefore the goal above would not be fully achievable. For outdoor applications and mechanical rooms vented to outdoor conditions, it is suggested to design for a relative humidity of 90% at the project’s design dew-point temperature to cover most hours of the year. Appropriate water-resistant vapor-retarder jacketing or mastics must then be specified to protect the system from the inevitable surface condensation and to prevent condensation from getting trapped behind any outer weather protective coverings.

E. Freeze Protection

1. Review any unusual conditions with Engineering Services in which it would be impractical to maintain freeze protection with anti-freeze, flow or adequate insulation. Electrical heat trace (on normal/standby power) should typically only be used as a last resort.

F. Noise Control

1. Where needed to maintain acceptable noise criteria levels in occupied spaces, apply combinations of absorptive insulation with mass-loaded jacketings or mastics on the pipe or duct exterior to reduce radiating breakout noise.
2. Refer to [23 31 00 HVAC DUCTS AND CASINGS](#) for limitations of use and allowable type of internal acoustic duct lining.

G. Fire Safety

1. All insulation materials and applications must comply with building code requirements for fire and smoke safety ratings.

H. Corrosion Under Insulation Control

1. The design and installation of all insulation systems shall be such to minimize conditions that contribute to Under Insulation Corrosion.
 - a. Designs and installations shall conform to the current edition of **NACE SP0198-Control of Corrosion Under Thermal Insulation and Fireproofing Materials**.
 - b. Comply with recommendations and guidelines in ASHRAE Fundamentals Handbook, Insulation for Mechanical Systems, "Corrosion Under Insulation".
 - c. Steel pipe, fittings and welds shall be primed with an epoxy coating under the insulation.

I. Abuse Resistance

1. Where insulated systems are subject to high risk of damage due to proximity to foot traffic or routine access points for maintenance, select insulating materials with adequate compressive resistance and rigid jacketing to provide adequate protection from mechanical abuse.

J. Weather Protection

1. HVAC insulation in outdoor applications must be protected with weather barriers of superior workmanship, installed by highly experienced, knowledgeable and skilled craftspeople in order to maintain the expected service life of the insulated systems.

K. Coordinate piping layout/installation to ensure adequate clearances to allow for Inspection, Repair and Replacement

1. Even with vapor-retarding insulation, jackets, and vapor sealing of joints and fittings, moisture inevitably accumulates in permeable insulations. Therefore the routing of insulated distribution systems shall be designed and constructed to be adequately accessible for periodic inspection and insulation replacement.
2. Maintenance staff shall be able to monitor for and immediately repair compromises in the protective jacketing system. Because water may infiltrate the insulation system, inspection ports shall be strategically used to facilitate inspection without requiring destructive insulation removal. This is particularly important on subambient systems.
3. Items regularly accessed for inspection, repair, or balancing must be insulated to either allow access to all required components, or insulated with a manufactured, removable insulation system. Examples of these devices are: balance valves, control valves, piping ports, isolation valves, strainers, check valves. These systems must be insulated with a removable access section, preformed insulation system, or insulated jacket. Adjacent insulation should be sealed to maintain the system vapor barrier.

L. Contract Documents:

1. Include construction specifications, plans, elevations, sections, and typical details to properly convey the HVAC insulation scope of work, which shall conform to at least the minimum requirements of this section.
2. Specify the following required Shop Drawings:
 - a. Include summary schedule of application, insulation product, material thickness, R-value, finishes, jacket, and accessories.
 - b. For special coordination to avoid or minimize conflicts in the field on an as-needed basis, include plans, elevations, sections, details, and attachments to other work.
 - c. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - d. Detail attachment and covering of heat tracing inside insulation.
 - e. Detail insulation application at pipe expansion joints for each type of insulation.
 - f. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - g. Detail removable insulation at piping specialties.

- h. Detail application of field-applied jackets.
- i. Detail application at linkages of control devices.
- j. Inspection ports used to facilitate moisture inspection without requiring insulation removal

.02 Product Requirements

A. General

1. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
2. Likewise, any ancillary weatherproofing materials should have low chloride content.
3. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

B. Select materials for low environmental impact during manufacturing and installation and to not negatively impact indoor environmental air quality.

1. Supply fiber glass products that are manufactured using a minimum of 60% “post-consumer” recycled material.
2. Supply fiber glass products that are manufactured using a bio-based binder rather than non-renewable petroleum-based chemicals and with a binder that does not contain phenol, formaldehyde, or acrylics; whenever possible.
3. Products shall not contain asbestos, lead, mercury, or mercury compounds, or formaldehyde-based binders; or will be third-party certified for conformance with GREENGUARD or Indoor Advantage Gold.
4. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

C. Fire Hazard Ratings

1. Insulation materials shall comply with the International Mechanical Code flame spread and smoke-developed index and testing requirements, appropriate for the application (piping, ducts, materials within plenums).
2. Accessories such as adhesives, mastics, cements, and cloth for fittings shall have the same component ratings as listed above.
3. Paper laminate jackets shall be permanently fire and smoke resistant. Chemicals used for treating paper in jacket laminates shall not be water soluble and shall be unaffected

by water and humidity. The only exceptions to the above are flexible foamed plastic insulation.

D. Duct Insulation Products

1. Glass fiber materials shall comply with all basic requirements above.
2. All duct insulation in mechanical rooms shall be rigid fiberglass board, minimum density 6 lb/ft³.
3. For typical concealed ducts, insulation shall be blanket-type insulation wrapped on the outside of the ductwork.
4. Exposed ductwork in occupied, finished spaces shall have insulation that is selected to be the most appropriate for the round or rectangular ductwork to provide a professional, durable, quality fit and finish. Double wall ductwork might be an alternative. But any insulation exposed to the airstream shall not be fibrous. Refer to prohibitions of fibrous duct liner above.

E. Pipe Insulation Products

1. Glass fiber materials shall comply with all basic requirements above.
2. In general, refrigerant piping systems shall be insulated with flexible, closed-cell elastomeric pipe insulation.
3. In general, all other piping systems shall be insulated with mineral wool/glass fiber piping insulation with a high-performance All-Service Jacket (ASJ).
 - a. The high-performance jacket shall have an outer film surface with no exposed paper, be tougher than standard ASJ, puncture resistant, moisture and mold resistant, dimple and wrinkle resistant, easily cleanable with soap and wet cloth, able to accept mastic and painting.
 - b. Manufacturers: Knauf "ASJ+", Owens Corning "Evolution Paper-Free ASJ", or approved similar.
 - c. On chilled water piping, a pipe insulation wicking system (similar to Owens Corning "VaporWick") designed for use on below-ambient temperatures (but only above freezing pipe temperatures) services located in humid climates can be an alternative method to remove condensed water from the surface of the cold piping to the outer surface of the insulation where it can be evaporated by the ambient air. However, dripping is avoided only if ambient conditions allow for adequate evaporation, so proper application depends on location and controlled ambient conditions.

4. Fittings, flanges, and valves shall be insulated with fiberglass inserts and premolded polyvinyl jackets.
5. Special insulation protection shall be selected and specified for areas subject to abuse, moisture, etc. (i.e. outside, wash down areas).
6. Insulation Protection Shields:
 - a. Insulation protection shields fabricated from galvanized steel shall be installed at all pipe hangers and supports. Shields shall span an arc of 180°.
 - b. Provide shield lengths and thicknesses as outlined in the latest version of the International Mechanical Code or MSS-SP69.
 - c. High Density Inserts, capable of resisting the crushing effect of the hydraulically loaded piping, shall be placed under each shield. Insulating material shall be suitable for the planned temperature range. Jacketing material shall be wrapped around rigid insulation and adjacent top and butt sections to maintain the jacketing continuity.
 - i. On copper/non-ferrous piping - Single-piece thermally insulated pipe hanger with self-adhesive closure. Similar to Armafix IPH/NPH series.
 - ii. On steel piping (2-1/2" and up) - rigid cellular glass insulation is recommended.
 - iii. Inserts shall be the same thickness as the adjacent insulation.
 - d. An 18 gauge stainless steel shield shall be installed on insulated piping located on the roof. The shield shall be a minimum length of 36 inches and field located to prevent damage to the insulation while walking over the piping.

F. Equipment Insulation

1. In general, equipment shall be insulated with flexible, closed-cell elastomeric or mineral fiber insulation. All equipment handling a medium below ambient temperature shall be additionally provided with a sealed vapor barrier.
2. For portions of packaged equipment that are factory insulated, insulation thicknesses shall be coordinated to comply with the Energy Conservation, Personnel Protection, Condensation Control, Noise Control requirements above for the associated duct or pipe application and location. If manufacturer's available options for factory installed insulation do not meet requirements, then specify field-installed supplemental insulation as required.

.03 Execution

A. General Installation Requirements

1. All materials shall be installed by skilled labor regularly engaged in this type of work. All materials shall be installed in strict accordance with manufacturer's recommendations, building codes, and industry standards.
2. Keep insulation materials dry during application and finishing.
 - a. Any fiber glass insulation that becomes wet or damaged shall be replaced at no additional cost.
 - b. Air handling insulation used in the air stream must be discarded if exposed to water. No exceptions.
3. Verify that all piping, ductwork, and equipment have been fully inspected, pressure or leak tested and approved prior to applying paint or insulation installation.
4. All surfaces to be insulated shall be thoroughly cleaned as required to remove all oil, grease, loose scale, rust, and foreign matter and verified to be acceptable before applying paint and insulation materials. Piping shall be completely dry at the time of application of primer paint. Painting on piping where condensation is occurring on the pipe surface is strictly prohibited.
5. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout.
6. Insulation on all cold surfaces must be applied with a continuous, unbroken vapor seal.
7. Flexible Elastomeric Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended UV-resistant protective coating.

B. Pipe Insulation Installation

1. Even with vapor-retarding insulation, jackets, and vapor sealing of joints and fittings, moisture inevitably accumulates in permeable insulations. Therefore the piping installation shall be adequately accessible for periodic inspection and insulation replacement.
2. Surface Preparation: Clean and prepare surfaces to be insulated.
3. Corrosion Under Insulation Protection: **Before insulating, apply a corrosion-resistant coating to insulated surfaces as follows:**
 - a. Carbon Steel: Coat carbon steel operating at a service temperature below ambient with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - b. Provide primer coat on all steel piping field welds.

- c. The corrosion resistant coating shall be completed and approved prior to installation of insulation. Coating shall be applied in accordance with the coating manufacturer's instructions, environment, and pipe surface temperatures and shall be the responsibility of the Mechanical Contractor/piping installers, not the insulation installers.
4. On piping systems operating below ambient air conditions, provide dams in insulation to prevent migration of condensation or fluid leaks. At a minimum, **dams shall be formed at every fourth 3' section (intervals not to exceed 12 feet) and at each butt joint of insulation at fittings, flanges, valves, and at insulation support inserts and shield assemblies at hangers.** Include clear visual indicators where the dams are located for maintenance personnel to identify.
5. Edges of vapor barrier insulation at valve stems, instrument wells, unions and other raw edges must be adequately sealed to prevent moisture from penetrating the insulation.
6. All pipe insulation and vapor barriers (when present) shall be continuous through walls, partitions, ceiling openings and sleeves where fire and smoke ratings permit such penetration.
 - a. Where insulated pipes pass through fire-rated floors, walls, or partitions, the use of a UL approved system, specific for each insulation type, is required. Comply with requirements in "Penetration Firestopping" for firestopping and fire-resistive joint sealers to maintain the rating of the system in accordance with the through penetration sealant manufacturer's recommendations.
 - b. The General and Mechanical trades are responsible for coordinating the correct UL approved firestopping of these penetrations. The primary trade that requires the penetration is responsible for the proper firestopping. The insulation trade is not responsible for firestopping/firecaulking.
7. Hangers shall support the load of the insulated pipe section on the outside of the insulation and shall not be in direct contact with the pipe. Supporting the pipe directly on hanger and attempting to insulate around the pipe and hanger is prohibited.
Professional shall include necessary details on construction drawings.
8. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - a. Install insulation continuously through hangers and around anchor attachments.
 - b. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of

attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

- c. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- d. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

9. Piping Coupon Rack Insulation:

- a. The University provided coupon racks are causing a problem in the field in regards to insulation. Some of the projects calling for thicker insulation, or fiberglass insulation make it very tough to perform a clean job based on the clearance between the pipes. Furthermore, the access needed for testing is not conducive to fiberglass insulation. Standardizing the insulation and handling methods will ensure more consistent installations.
- b. Therefore, Flexible Elastomeric Cellular (1" thick) is the preferred insulation method for the coupon racks only. This is recommended based on the following conditions/criteria:
 - i. The coupon rack is constructed of stainless steel.
 - ii. Insulated caps are provided at the coupon access points (plugs).
 - iii. Rigid Armafix IPH series hangers (only available up to 1" thick) are used to secure the rack.
 - iv. Armaflex and adjacent insulation systems are sealed at the junction point to prevent under-insulation condensation.

C. Equipment Insulation Installation

1. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
2. 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.
3. For equipment with surface temperatures below ambient, apply vapor barrier mastic to open ends, joints, seams, breaks, and punctures in insulation. Seal between flanges with replaceable gasket material to form a vapor barrier.

4. All Equipment identification labels must be readily accessible. On equipment where the nameplate data is obscured by the insulation requirements, a stamped steel nameplate shall be permanently affixed to the equipment in a visible location. DO NOT REMOVE THE ORIGINAL NAMEPLATE.
5. The following equipment must be insulated to be covered to fullest extent practical.
 - a. On Steam Systems:
 - i. Valves, strainers, pressure reducing valves, pressure relief valves, traps, and condensate receivers/pumps, flash tanks, heat exchangers
 - ii. Removable “Hot Cap” insulation must be provided for those items or portions that will require insulation removal for periodic maintenance or inspection.
 - b. On Hot water Systems:
 - i. Valves, strainers, pumps, air/dirt eliminators, heat exchangers, storage tanks.
 - ii. Removable “Hot Cap” insulation must be provided for those items or portions that will require insulation removal for periodic maintenance or inspection.
 - c. On Chilled water Systems:
 - i. Pumps, air/dirt eliminators, valves, heat exchangers.
 - ii. Insulation on pumps and other equipment operating below ambient dew point requiring routine service shall be insulated with flexible, closed-cell elastomeric insulation to conform to the shape of the equipment, with all joints and penetrations completely sealed to maintain vapor barrier.
 - iii. Provide removable insulation sections of smallest, most appropriate size to cover parts of equipment and specialties that must be accessed periodically for maintenance (i.e. – strainer ends, to access grease fittings and inspect bearings for proper lubrication, vent/drain plugs or valves, p/t ports) without damaging insulation or compromising vapor barrier. Removable sections shall be constructed to provide a removable or replaceable yet adequate vapor barrier seal at the interface between the permanent and removable sections that still allows the section to be removed and replaced on a regular, continued basis. Note: A room temperature, pressure-sensitive, permanently-

tacky, vapor-barrier adhesive/tape (similar to carpet square adhesive) that would be compatible with the insulation material is a possibility being investigated at time of this writing. Review currently available options with OPP Engineering Services.

- iv. Main joints and splits shall coincide with flange/splits of the equipment to minimize extent of removing and replacing insulation for major, non-periodic access for repairs.
- v. Ensure that the bearing assembly grease fittings remain accessible and visible. Any vent slots on the sides and bottom of the bearing assembly should remain uncovered and completely open.
- vi. Balance valves, control valves, piping ports, isolation valves, strainers, check valves on low-temperature systems must be insulated either with a removable access section as described above; or of valve manufacturer's optional preformed 2-piece insulation kit covers (similar to products offered by [TA Hydronics](#) – verify fire resistance ratings meet application specific requirements); or precision-cut, 2-piece insulation covers pre-formed to custom fit the contour of the valve/fitting shapes, (similar to products as fabricated by [Extol](#)). Adjacent insulation shall be sealed to maintain the system vapor barrier.

END of revision

Update Commentary:

Section was updated primarily for the following reasons:

- 1) *To require use of most stringent minimum insulation R-value requirements in current codes and high-performance building standards in lieu of superseded ASHRAE 90.1 - 1999 reference.*
- 2) *To require Corrosion Under Insulation Protection - coating ferrous piping under insulation*
- 3) *To add cross reference to HVAC duct section to be consistent on fiberglass duct liner policy*
- 4) *To coordinate optional additional insulation thickness on factory insulated packaged equipment to meet associated system insulation thickness.*
- 5) *Other miscellaneous insulation revisions.*
- 6) *To reorganize section into parts for General Owner, Product, and Execution requirements.*