SECTION 23 0700 - SYSTEM INSULATION

Maintain Section format, including the UH master spec designation and version date in bold in the center columns of the header and footer. Complete the header and footer with Project information.

Edit and finalize this Section, where prompted by Editor's notes, to suit Project specific requirements. Make selections for the Project at text identified **in bold**.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

Delete hidden text after this Section has been edited for the Project.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. The Contractor's attention is specifically directed, but not limited, to the following documents for additional requirements:

1. The current version of the *Uniform General Conditions for Construction Contracts*, State of Texas, available on the web site of the Texas Facilities Commission.
2. The University of Houston's *Supplemental General Conditions and Special Conditions for Construction.*

1.2 DESCRIPTION OF WORK:

A. Work Included: Provide piping, ductwork, and equipment system insulation as specified.

1.3 QUALITY ASSURANCE:

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. Armacell, LLC.
2. Certain-teed Corporation.
3. Rubatex LLC.
4. Resolco Insul-phen.
5. Johns Manville.
6. Owens Corning.

1.4 SUBMITTALS:

A. Ssubmittals shall include, but not be limited to, the following:

1. Cut sheets on all insulation products to be used.
2. Cut sheets on all mastics and other products to be used with insulation products.

3. Cut sheets on PVC and aluminum jacketing materials.
4. Manufacturer's printed installation instructions for all of the above products.
5. Additional information as required in Specification Section 23 0100, “Mechanical Scope of Work”.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Store insulation products in their factory-furnished coverings, and in a clean, dry indoor space which provides protection against the weather.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. Quality: The type of insulation and its installation in accordance with this Section of the Specifications for each service and the application technique shall be as recommended by the manufacturer.

B. Installer Qualifications: Installer shall have successfully completed an apprentice shop program or other craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

C. Surface Burning Characteristics: All insulation and related products, as determined by shall have the maximum ratings defined below as determined by testing identical products according to ASTM E 84 by an independent testing agency. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

2.2 INSULATION THICKNESS:

A. Minimum: Insulation thickness shall not be less than the following:

Equipment Surface (Non-factory Insulated Equipment **[Cold] [or] [Hot]** Surfaces)

Chilled water pumps	2"
Chillers	1"
Water-to-water heat exchangers	1-1/2"
Steam-to-water heat exchangers	1-1/2"
Cooling tower basins & sumps	1"
Steam and steam condensate vessels	2"
Diesel engine silencers and exhaust piping	4"
Heating water **[and auxiliary condenser water]** pumps	1-1/2"
Coils	1-1/2"

Chilled Water Compression/expansion tanks	2"
Heating Water Compression/expansion tanks	1-1/2"
Boiler stack and breeching	2"
Field-installed condensate drain pans	1"

Piping Surface

Chilled water piping 1" and smaller	**[2"] [_____"]**
Chilled water piping, 1-1/4" to 2" and heating hot water	**[2"] [_____"]**
Chilled water piping 2-1/2" and larger	**[2"] [_____"]**
Heating hot water 1" and smaller	**[1-1/2"] [_____"]**
Heating hot water piping, 1-1/4" to 2"	**[2"] [_____"]**
Heating hot water piping 2-1/2" and larger	**[2"] [_____"]**
Condenser water piping (outdoors)	**[1-1/2"] [_____"]**
Medium and high-pressure steam piping 1-1/2" and larger	4-1/2"
Medium and high-pressure steam piping 1" to 1-1/4"	4"
Medium and high-pressure steam piping smaller than 1"	3"
Low Pressure steam piping 3" and smaller **[and all steam relief vent piping]**	2-1/2"
Low Pressure steam piping 4" and larger **[and all steam relief vent piping]**	3"
Steam condensate piping, 2" and smaller	1-1/2"
Steam condensate piping, 2-1/2" and larger	2"
Steam condensate vent piping	1"
Refrigerant piping	1"
Condensate drain piping (except **[above drain pans and]**less than one foot (1') at floor drains)	1"
Cooling tower make-up water lines	1/2"
All otherwise uninsulated pipe exposed to outdoor temperatures	**[1-1/2"] [_____"]**

B. Minimum: R-Value shall not be less than the following

Ductwork Surface

Conditioned air **[and return air***]** ductwork, external duct insulation (where not lined)	R-6
Air devices***	R-6
Kitchen exhaust ductwork (where not in a fire rated insulation)	R-6
Wet exhaust ductwork	R-6

Ductwork, acoustical lining (see Section 23 3113).

Return air ductwork, exterior duct insulation ***	R-6
Exhaust air and relief air ductwork between isolation damper and penetration of building exterior	R-6

* Where exposed to outdoor ambient temperature, insulation R-value shall be **[R-6] [R-8].**
** Unless noted otherwise.
*** Where located in non-return air plenums (e.g. ducted return areas).

2.3 EQUIPMENT:

A. Hot (110° F to 200° F) and Cold (Below 60° F) Surfaces: Provide flexible closed cell elastomeric sheet insulation. Comply with ASTM C 534, Type II.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work:
   a. Aeroflex USA; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. RBX Corporation.

B. High Temperature (200°F and Above) Surfaces: Insulation shall be hydrous calcium silicate in scored block or beveled block form, as best suited for the intended use with consistent thermal performance up to 1200 degrees F. Comply with ASTM C533 Type I. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work:
   a. Johns Manville; Thermo-12-Gold.

2.4 PIPING:

A. Chilled Water Pipe Insulation: Provide Owens Corning Foamglas or an approved equal. Cellular glass insulation shall be Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells with a factory applied jacket.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work:
   a. Pittsburgh Corning Corporation; Foamglas.
2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
6. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

B. Heating Hot Water Pipe Insulation: Insulation shall be pre-formed, rigid, expanded, closed cell insulation complying with ASTM C 1126, Type III, Grade 1 for pipe insulation, ASTM C 1126, Type II, Grade 1 for block insulation. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work:
   a. Kingspan Tare Industrial Insulation NV; Koolphen K.
   b. Resolco International BV; Insul-phen.

C. Calcium Silicate Pipe Insulation (Steam and Steam Condensate Supply Piping): Provide pre-formed calcium silicate insulation. Insulation shall be hydrous calcium silicate in scored block or beveled block form, as best suited for the intended use with consistent thermal performance up to 1200 degrees F. Comply with ASTM C533 Type I. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work:
   a. Johns Manville; Thermo-12-Gold.

D. Condensate Drain Piping: Provide flexible closed cell elastomeric tubular insulation. Comply with ASTM C 534, Type I.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work:
   a. Aeroflex USA; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. RBX Corporation.

E. Fitting Insulation: Provide pre-molded rigid insulation for valves, fittings, flanges, strainers, and unions. Insulation shall be as specified for pipe insulation, except without the all-service jacket, where applicable. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

F. Factory Applied Jackets: White kraft-paper to fiberglass-reinforced scrim with aluminum foil backing with pressure sensitive self-sealing adhesive joints. Comply with ASTM C 1136, Type I.

G. Existing and/or repaired Phenolic Insulation: Provide Venture 1577 W/U, 0 perm and mold resistant jacket material, 5 ply laminate with 6 mil film on with adhesive on one side.

H. Fiberglass Cloth Reinforced Mesh: Provide #10 woven glass-fiber fabric with minimum weight of 2.2 ounces per square yard. Color shall be white unless noted otherwise.

I. Vapor Barrier Mastic: Water based suitable for indoor use on below ambient services. Water vapor permeance shall be 0.013 perm at 43-mil dry film thickness when tested according to ASM E 96, Procedure B.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work:
   a. Foster Brand, 30-80/30-90.
   b. Vimasco Corporation; 749.

J. Joint Sealants for Cellular Glass: Material shall be permanent flexible, elastomeric sealant and shall be compatible with insulation materials, jackets and substrates.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work:
   a. Childers CP-76.
   b. Foster Brand, 30-45.
   c. Marathon Industries; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Owens Corning Corporation; Pittseal 444.
   f. Vimasco Corporation; 750.

K. PVC Jacketing: Provide pre-rolled protective jacketing where required or specified for protection of the insulation all service jacket. PVC jacketing shall be 30 mil thickness. All joints shall be made by lapping the jacket and sealing with an approved PVC welding adhesive. Comply with ASTM D 1784, Class 16354-C.

L. Metal Jacketing: Provide 0.016" thick aluminum jacketing where required or specified. 3/4" x 0.020" aluminum bands and straps shall be provided for banding insulation jacketing.

M. Elastomeric Insulation Sealant: Provide manufacturers recommended adhesive (

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work:
   a. Aeroflex USA, Inc; Aeroseal.
   b. Armacell LLC; Armaflex 520.
   c. Foster Brand Specialty Construction Brands, Inc.; 85-75.
   d. K-Flex USA: R-373 Contact Adhesive.

N. Miscellaneous: Provide all miscellaneous accessories, components and materials required for installation of a complete insulation system.

2.5 DUCTWORK:

A. External Ductwork Blanket Insulation: Provide flexible fiberglass or mineral fiber duct wrap with fiberglass reinforced kraft-scrim-foil vapor barrier jacket. Insulation shall comply with ASTM C 533, Type II and ASTM C 1290, Type III with factory applied jacket.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Owens Corning; SOFTR All-Service Duct Wrap.

B. External Ductwork Board Insulation: Provide rigid fiberglass or mineral fiber bonded with a thermosetting resin and with fiberglass reinforced kraft-scrim-foil vapor barrier jacket. Insulation shall comply with ASTM C 612, Type IA or Type IB.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work:
   a. CertainTeed Corp.; Commercial Board.
   b. Johns Manville; 800 Series Spin-Glas.
   c. Knauf Insulation; Insulation Board.
   d. Owens Corning; Fiberglas 700 Series.

C. Acoustical Duct Lining: Lining provided with ductwork, refer to Specification Section 23 3113, “Ductwork”.

D. Fire Rated Insulation: Where required on drawings, provide a high-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work:
   a. CertainTeed Corp.; FlameChek.
   b. Johns Manville; Firetemp Wrap.
   c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
   d. Thermal Ceramics; FireMaster Duct Wrap.
   e. 3M; Fire Barrier Wrap Products.
   f. Unifrax Corporation; FyreWrap.

Only use where kitchen exhaust ductwork is not required to be wrapped in a fire-rated insulation system.

E. Kitchen Exhaust Ductwork: Provide **[calcium silicate insulation as specified hereinabove for "High Temperature (200° F and Above) Surfaces".] [High temperature fiberglass blanket (1000° F) insulation, 2# density with a K-factor of 0.23 at 75° F.]**

PART 3 - EXECUTION

3.1 INSTALLATION:

A. General: Install insulation products in accordance with the manufacturer's written instructions, the Midwest Insulation Contractors Association (MICA) Commercial and Industrial Insulation Standards, and recognized industry practices to ensure that the insulation serves the intended purpose. Surfaces to be insulated shall be thoroughly cleaned with all testing successfully completed prior to insulation.

3.2 EQUIPMENT APPLICATION:

A. Chilled **[and Heating Hot]** Water Pumps: Apply sheet insulation to the surface to be insulated with adhesive over the entire surface. The entire insulation installation shall be in accordance with

application recommendation described in the latest published manufacturers pamphlets. All lap and butt joints shall be sealed vapor tight. The insulation shall be finished with two coats of manufacturer's finish coating, vinyl-lacquer coating, or approved equal, color to be [manufacturer's standard] [as selected by the Owner]. Application shall be such that removal of the pump casing or a pump casing section will not destroy the installation. Insulation shall be removable and re-usable. For below ambient services, install a vapor barrier at seams, joints and penetrations.

B. Water Chillers and Heat Exchangers: Apply sheet insulation to heating hot water heat exchangers, chilled water heat exchangers and non-factory insulated cold surfaces on water chillers with adhesive over the entire surface being insulated. The entire insulation installation shall be in accordance with application recommendations described in the latest published manufacturers pamphlets. All lap and butt joints shall be sealed, vapor-tight on cold surfaces, using the manufacturers recommended adhesive. The insulation shall be finished using two coats of the manufacturer's finish coating, vinyl-lacquer coating, or approved equal, color to be [manufacturer's standard] [or selected by the Owner]. Insulation installation shall have removable sections to allow maintenance access.

C. Compression/Expansion Tanks and Water Storage Tanks: Apply sheet insulation to the entire surface with recommended adhesive. Apply adhesive over the entire clean dry bare metal surface and all butt and lap joints shall be sealed vapor-tight. The entire insulation installation shall be in accordance with application recommendations described in the latest manufacturers installation instruction. The insulation shall be finished with two coats of manufacturer's finish coating, vinyl-lacquer coating, or approved equal, color to be [manufacturer's standard] [as selected by the Owner]. For below ambient services, install a vapor barrier at seams, joints and penetrations.

D. Diesel Engine Exhaust Pipes and Silencer, Boiler Stack, and Breeching and High Temperature Heat Exchangers and Converters: After all pressure tests have been completed, apply calcium silicate insulation with joints staggered to clean, dry metal surfaces, which have not been factory-insulated and hold in place with one inch (1") galvanized hexagonal wire mesh with edges laced together. Where necessary to achieve snug fit of insulation on large surfaces, install weld clips 18" on center to surfaces before installation of insulation and tie to wire mesh with 20-gauge galvanized wire. **[Cover insulation with two 1/4" thick coats of insulating cement troweled to a smooth finish and reinforced with one-inch (1") hex wire mesh. When cement has cured, apply a layer of 20 x 20 mesh glass fabric adhered with Insul-Coustic IC 102 or approved equal and then give a flooding brush coating of IC 102.] [Cover insulation with 2" fiberglass pipe insulation as specified for heating hot water piping.]**

E. Exterior Installations: Where systems are exposed to ambient temperatures or wet conditions and elsewhere as specified, provide an aluminum jacketing system specifically designed for exterior installation. All longitudinal seams shall be located at the 3 o'clock and 9 o'clock position with a minimum 3" overlap oriented to shed water from entry. Butt joints shall be overlapped a minimum of 3" in a manner to prevent the entry of water. Seal metal jacketing with straps on maximum 12" centers. Locate strap joints so as to prevent personnel contact. A factory-applied metal jacket on calcium silicate systems meeting all aspects of this specification may be used where exposed to ambient temperatures or wet conditions if installed per the manufacturers recommendations.

F. Condensate Drain Pans: Insulate all non-factory-insulated drain pans as specified. Install a vapor barrier at seams, joints and penetrations.

G. Steam and Steam Condensate Vessels: Apply calcium silicate insulation with joints staggered to clean, dry metal surfaces, which have not been factory-insulated and hold in place with one inch (1") galvanized hexagonal wire mesh with edges laced together. Where necessary to achieve snug fit of insulation on large surfaces, install weld clips 18" on center to surfaces before installation of insulation and tie to wire mesh with 20-gauge galvanized wire. **[Cover insulation with two 1/4" thick coats of insulating cement troweled to a smooth finish and reinforced with one inch (1") hex wire mesh. When cement has cured, apply a layer of 20 x 20 mesh glass fabric adhered with Insul-Coustic IC 102 or approved equal and then give a flooding brush coating of IC 102.] [Cover insulation with 2" fiberglass pipe insulation as specified for heating hot water piping.]**Heating and Cooling Coils: Insulate all coil perimeter surfaces that are not factory-insulated with fiberglass insulation as specified for external duct insulation.

3.3 PIPING APPLICATION:

A. General: Apply insulation to clean, dry pipes after all pressure tests have been completed. Firmly butt all joints of insulation and seal all joints per manufacturers recommendations. Install insulation in strict accordance with these specifications and the manufacturer's printed instructions.

B. Flanges, Strainers and Unions: Insulate flanges, strainers, and unions with pre-molded or shop-fabricated rigid insulation of same material and thickness as specified for adjacent piping. Cover insulation with pre-molded PVC covers, held in place with Zeston "Z-tape" or an approved equal. Covers and finish for cellular glass and calcium silicate insulation shall be as specified for the adjacent pipe insulation. Ensure that insulation and covers for flanges, unions, and access plates shall be removable without damage to insulation or jackets.

C. Valves and Fittings: Insulate and cover valves, tees, elbows, test parts, and other fittings the same as flanges and unions.

D. Chilled Water Piping: Install cellular glass insulation to provide a continuous vapor barrier/insulation system. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials. Seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant. Do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant. For pipe flanges, install preformed pipe insulation to outer diameter of pipe flange. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant. Install preformed sections over pipe fittings, elbows, valves and piping specialties. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands. Arrange insulation on valves to permit access to packing and to allow valve operation without disturbing valve.

E. Heating Hot Water Piping, and other Piping which is Insulated where Exposed to Outdoor Temperatures: Install phenolic insulation to provide a continuous external vapor barrier on all

pipe insulation. Seal insulation lap joints using the manufacturer's standard pressure-sensitive self-sealing lap joint system. Seal butt joints using the manufacturer's standard pressure-sensitive closure strip system. Butt strips shall be a minimum of 3" wide. At the Contractor's option, staples (as specified for steam and condensate piping) may be used in lieu of self-sealing closures for hot piping. [Install a protective outer covering using a metal jacket system over [all] [exposed interior and exterior] pipe [and fitting] insulation. [Metal jacket is not required over indoor PVC fitting covers.]

F. **Steam and Steam Condensate Piping: [Install calcium silicate insulation on the entire piping system. Seal insulation lap joints on pre-formed fiberglass using insulation staples on 2" centers. Seal edge of lap joints with Insul-Coustic No. 215 or equal adhesive or a pressure sensitive tape strip to provide a seal to prevent water entry. Seal butt joints using the manufacturer's standard pressure-sensitive closure strip system. Butt strips shall be a minimum of 3" wide.] [Install pre-formed calcium silicate insulation on piping and fittings with butt joints staggered and with insulation firmly wired in place with a minimum of six loops of 16 gauge copper clad iron wire per 3' section.] [Calcium silicate insulation shall be held in place with 20 gauge galvanized wire on 9" centers.] Loop ends shall be twisted together tightly and bent over and hammered into the insulation so as to leave no projection. All cracks and voids in the insulation shall be filled with Manville 301 or approved equal cement such that the resulting surface is smooth and continuous. A layer of 40 pound rosin-sizing paper shall be wrapped around the insulation and an 8 ounce canvas jacket shall be pasted in place. The canvas jacket shall be finish-coated and sized for color-coded finish-painting.] [Install a protective outer covering using a metal jacket system over [all] [exposed interior and exterior] pipe [and fitting] insulation. [Metal jacket is not required over indoor PVC fitting covers.]**

G. Refrigerant Piping: Install elastomeric insulation to refrigerant and hot gas piping. Seal all butt joints using the manufacturers recommended adhesive.

H. Condensate Piping: Install elastomeric insulation to condensate drain piping. Seal all butt joints using the manufacturers recommended adhesive.

I. Hangers and Supports: Blocking (for piping with a vapor barrier) or saddles (for piping without a vapor barrier) shall be provided at all hanger and support locations. Install insulation inside all pipe saddles. Extend vapor barrier across all pipe blocking. Refer to Specification Section 23 0300, "Basic Materials and Methods", for additional requirements.

J. Pipe Anchors: Insulate pipe anchors as specified for piping. Provide an isolating seal at anchors on piping with a vapor barrier for below ambient services.

K. Pipe Accessories: Valve operators, pressure/temperatures plugs, strainer blowdowns, meters and gauge fittings and all other items which extend through required insulation shall be suitably insulated with removable caps to allow use without disturbing the insulation.

L. Heat Tracing: Where pipe is heat-traced, the insulation size shall be increased accordingly.

M. Central Plant **[and] [,] [Mechanical Room] [and Tunnel]** Protective Covering: Protect the insulation jacket on all insulation and accessories in the Central Plant **[and] [,] [mechanical room] [and tunnels] [and within 6'-0" of finished floor in mechanical and air handling unit rooms]** with a field-installed covering using **[vapor barrier mastic and reinforcing mesh installed per the manufacturers recommendations] [except where metal jacket is specified]**. **[The insulation**

surface, covering or jacket on all piping in the Pump Room, Mechanical Rooms, and tunnels shall be sized, coated and prepared as required for finish color-coded painting.]

N. Metal Protective Jacket: Protect outer covering of insulation with a metal jacket system over both pipe and fitting insulation where exposed to weather **[, where _____] [or where exposed indoors]**. Metal jacket shall extend over PVC jacketing or vapor barrier, down to grade at riser locations or building entrance. Longitudinal seals shall provide a 3" overlap installed at the 9 o'clock or 3 o'clock position to shed water. Butt joints shall be overlapped a minimum of 3" in a manner to prevent the entry of water. Seal metal jacketing with 3/4" stainless steel sealing bands shall be installed on 12" centers along the metal jacket. Locate strap joints so as to prevent personnel contact. Metal jacket on valves and flanges shall be removable without disturbing the adjacent jacket.

O. Vapor Barrier: Maintain integrity of vapor barrier on chilled water **[and all other cold]** pipe insulation and protect barrier to prevent puncture and other damage.

P. Penetrations: Extend piping insulation without interruption through walls, floors, and similar penetrations, except where otherwise indicated. Where insulation is interrupted on chilled water piping, an isolating seal shall be provided between the insulation vapor barrier and the pipe and penetration seal as specified under Paragraph 3.03/D. Where insulation is interrupted on steam and condensate piping, the penetration seal shall be insulated as specified for the penetrating piping, such that no high temperature surfaces are exposed.

Q. Ventilation: Provide adequate ventilation during initial start-up of piping systems to remove smoke and odor given off when the organic binders in the insulation are initially heated.

3.4 DUCTWORK APPLICATION:

A. Exterior Duct-Wrap Insulation On **[Supply], [Return] [and General Exhaust]** Ductwork: After ductwork testing has been completed, insulate **[Supply], [Return], [and General Exhaust]** ductwork. On ducts over 18" wide, apply weld clips to bottom of duct, spaced 18" on center each way, maximum. Seal all longitudinal and transverse seams and all punctures caused by weld clips or stick clips with 2" wide SMACNA-labeled duct tape and mastic.

B. Acoustical Duct Lining For Supply, Return and General Exhaust Ductwork: Refer to Specification Section 23 3113 “Ductwork” for additional information.

C. Rigid Ductwork Insulation: Provide rigid external duct insulation where shown on the drawings and for all exposed ductwork in the **[insert location here]**. Insulation shall be secured to the ductwork with mechanical fasteners, "stick clips", Graham Pins or Speed Clips spaced on maximum 12" centers on the bottom of the duct and maximum 24" centers on the top and side of the duct. Additional fasteners shall be provided as recommended by the insulation manufacturer or required to hold insulation securely against the duct. After the insulation is in place, all joints, seams and protrusions through the duct shall be thoroughly sealed with Foster 30-35 or approved equal white vapor barrier emulsion applied over 3" wide Duramesh Glass Fabric or approved equal glass fabric strips. Where ductwork has standing seams or external angle bracing, insulation shall be built up over protrusions and sealed as described hereinabove.

D. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles, cements adhesives, coatings, sealers, protective finishes, and similar compounds as recommended by the insulation manufacturer for the applications indicated.

E. Air Devices: Insulate all air devices not factory-insulated with fiberglass duct-wrap where diffusers are located in ceilings that are not used as return air plenums.

F. Kitchen Grease Exhaust Ductwork:

1. Provide fire-rated insulation for any kitchen grease exhaust duct that penetrates a ceiling, wall, floor or any concealed space. The insulation shall extend from the point of penetration to the outlet terminal. The duct enclosure shall have a fire-resistance rating of not less than that of the assembly penetrated, but not less than one-hour. Comply with latest edition of International Mechanical Code.
   a. Acceptable to provide a rated architectural shaft enclosure in lieu of the fire rated insulation.
2. Install fire rated insulation after pressure testing has been completed.
3. Install per the manufacturer's installation instructions in order to maintain the stated fire rating and UL listing.
4. Secure fire rated insulation to ducts and duct hangers and supports to maintain a continuous fire rating. Install per the manufacturer's installation instructions in order to maintain listed assembly rating.]

G. Surfaces: Install insulation materials with smooth, even surfaces.

H. Butt Joints: Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

I. Vapor Barrier: Maintain integrity of vapor barrier on duct insulation and protect barrier to prevent puncture and other damage.

J. Penetrations: Extend duct insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.

K. Corner Angles: Install corner angles on external corners of insulation on duct in exposed finished spaces before covering with jacketing.

3.5 INSPECTION:

A. General: Visually inspect the completed insulation installation and repair or replace any improperly sealed joints.

B. Wet Insulation: Where there is evidence of vapor barrier failure or "wet" insulation after installation, the damaged insulation shall be removed, the pipe or duct surface shall be cleaned and dried and new insulation shall be installed.

3.6 IDENTIFICATION:

A. Refer to Section 23 0300 "Basic Materials and Methods" for applicable painting and labeling requirements.

END OF SECTION 23 0700