SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 220500 - Basic Plumbing Materials and Methods, and other Sections in Division 22 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this Section shall include, but not necessarily be limited to, providing insulation for the following:

1. Piping Services:

   a. Domestic hot water supply and return.
   b. Domestic cold water
   c. Drains from electric water coolers to first connection.
   d. All valves, separators, strainers and fittings for systems listed above.

2. Types of plumbing piping insulation specified in this Section include the following:

   a. Pipe insulation: Fiberglass.
   b. Pipe insulation: Flexible elastomeric closed cell foam.

3. Insulation jackets:

   a. Interior application
   b. Removable covers

4. Insulation accessories.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 220500: Basic Plumbing Materials and Methods.

1.4 DEFINITIONS

A. Ambient: The air temperature to be maintained in a conditioned room, typically between 70°F and 78°F.

B. Insert: Spacer placed between the pipe support system and the piping to allow for the space required for insulation.

C. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.

D. Insulation Shield: Buffer material placed between the pipe support system and the insulation to prevent the insulation material from crushing.

E. Jacket: Protective covering over the pipe insulation; may be factory applied such as “all service jacket” or field applied to provide additional protection; of such materials as canvas, PVC, aluminum or stainless steel.

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F. Piping Insulation: Thermal insulation applied to prevent heat transmission to or from a piping system.

G. Vapor Barrier Jacket: Insulation jacket material that impedes the transmission of water vapor.

H. Freezing Climate: Where outdoor design temperature is less than 34°F (1°C), as stated in ASHRAE Fundamentals under 99% column for winter design conditions.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Provide products conforming to the requirements of the following:

1. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM Standards, including:

a. B209 – Specification for Aluminum and Aluminum-Alloy Sheet and Plat.
b. C165 – Recommended Practice for Measuring Compressive Properties of Thermal Insulation.
c. C167 – Test Methods for Thickness and Density of Blanket or Batt Thermal Insulations.
d. C177 – Test Method for Steady-State Heat Flux Measurements and Thermal Transmission.
e. Properties by Means of the Guarded-Hot-Plate Apparatus.
f. C195 – Specification for Mineral Fiber Thermal Insulating Cement.
g. C196 – Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
h. C302 – Test Method for Density of Preformed Pipe-Covering-Type Thermal Insulation.
i. C303 – Test Method for Density of Preformed Block-Type Thermal Insulation.
j. C305 – Test for Thermal Conductivity of Pipe Insulation.
k. C356 – Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation.
l. C411 – Test for Hot-Surface Performance of High Temperature Thermal Insulation.
m. C423 – Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
n. C449 – Specification of Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
o. C518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
p. C533 – Specification for Calcium Silicate Block and Pipe Thermal Insulation.
q. C534 – Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
r. C547 – Specification for Mineral Fiber Preformed Pipe Insulation.
s. C552 – Specification for Cellular Glass Block and Pipe Thermal Insulation.

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t. C553 – Specification for Mineral Fiber Blanket-Type Pipe Insulation (Industrial Type).
u. C592 – Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered).
v. C612 – Specification for Mineral Fiber Block and Board Thermal Insulation.
w. C916 – Standard Specification for Adhesives for Duct Thermal Insulation.
x. C921 – Practice for Determining Properties of Jacketing Materials for Thermal Insulation.
y. C1104 – Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
z. C1071 – Standard Specification for Thermal and Acoustical Insulation.
aa. C1338 – Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
bb. D1667 – Standard Specification for Flexible Cellular Material-Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).
cc. E84 – Test Method for Surface Burning Characteristics of Building Materials.
dd. E119 – Test for Fire Resistance.
ee. G21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
ff. G22 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Bacteria.

2. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Provide and install pipe and duct insulation in accordance with the following ASHRAE Standard:

a. 90 Energy Conservation in New Building Design.

3. National Fire Protection Association (NFPA): Manufacture insulation in accordance with the following NFPA standards:

a. 255 Test Methods, Surface Burning Characteristics of Building Materials.

B. Do not provide materials with flame proofing treatments subject to deterioration due to the effects of moisture or high humidity.

C. Products Containing Prohibited Chemicals:

1. Products containing the following prohibited chemicals for use as flame retardants or for other purposes will not be acceptable:

a. Pentabrominated diphenyl ether (CAS#32534-81-9)
b. Octabrominated diphenyl ether (CAS#32536-52-0)
c. Decabrominated diphenyl ether (CAS#1163-19-50)

D. Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method and UL 723. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing; or

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satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

E. Corrosiveness: Provide insulation such that when tested in accordance with the following test, the steel plate in contact with the insulation shows no greater corrosion than sterile cotton in contact with a steel plate for comparison.

1. Test Specimen: Two specimens shall be used, each measuring 1” by 4” by approximately 1/2” thick.
2. Apparatus: Provide a humidity test chamber in which two polished-steel test plates, 1” wide, 4” long and 0.020” thick, shall be placed. Plates shall be clear finish, cold-rolled strip steel, American quality, quarter hard, temper No. 3, weighing 0.85 lb/sq. ft.
3. Procedure: The steel test plates shall be rinsed with cp benzol until their surfaces are free from oil and grease and allowed to dry. One piece of cold-rolled steel shall be placed between the two insulation specimens and secured with tape or twine. The test specimen and uncovered plate shall be suspended vertically in an atmosphere having a relative humidity of 95% (plus or minus 3%), and a temperature of 120°F (plus or minus 3°F), for 96 hours, and then be examined for corrosion.

F. Insulation thickness shall be the greater standard of that specified here or the State energy conservation requirements.

1.6 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, K-value, thickness, and furnished accessories for each mechanical system requiring insulation. Also furnish necessary test data certified by an independent testing laboratory.

B. Provide a statement with the submittal indicating that no product submitted contains an amount equal to or greater than 0.10% by mass of the following chemicals:

1. Pentabrominated diphenyl ether (CAS#32534-81-9)
2. Octabrominated diphenyl ether (CAS#32536-52-0)
3. Decabrominated diphenyl ether (CAS#1163-19-50)

C. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product in maintenance manual.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coating to the site in containers with manufacturer's stamp or label affixed showing fire hazard indexes of products.

B. Store and protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged or wet insulation; remove from project site.

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1.8 WARRANTY

A. Provide minimum one-year warranty from date of Substantial Completion, including all parts, material, labor and travel.

B. Refer to Section 220500 for additional warranty and Substantial Completion requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Johns Manville, Owens-Corning, Knauf, Armstrong, Pittsburgh-Corning, Trymer, IIG, Certainteed, Halstead, Rubatex, 3M FireMaster, Pabco, Reflectix, or approved equal. Manufacturer and insulation types listed below indicate a minimum acceptable level of quality required for each classification.

2.2 PIPE INSULATIONS (IDENTIFIED BY KEY CODE PI)

A. **PI-A**, Preformed Mineral Wool or Fiberglass:

1. Molded fibrous glass pipe insulation shall comply with the requirements of ASTM C 547 and meet ASTM C 585 for sizes required in the particular system. UL 723 or ASTM E84 compliant for Flame Spread Index of 25 or less and Smoke Developed Index of 50 or less. For all fluid distribution temperatures below 45°F the system shall be of a wicking type.
2. Non-Wicking.
3. Applications: Insulation of piping up to 18” in diameter and 3” thick insulation.
4. 'K' Value: 0.23 at 75°F.
5. Maximum Service Temperature: 850°F.
6. Flame spread index: ASTM E84 and UL 723, less than 25.
7. Smoke developed index: ASTM E84 and UL 723, less than 50.
8. Vapor Retarder Jacket: AP-T PLUS white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self-sealing longitudinal laps and butt strips or AP jacket with outward clinch expanding staples or vapor barrier mastic as needed.
9. Manufacturers: Johns Manville #Micro-Lok HP, Owens Corning #SSL II, Knauf, or einsulation.

B. **PI-B**, Flexible Closed-Cell Elastomeric or Neoprene:

1. Closed-cell, halogen free, elastomeric insulation.
2. Comply with ASTM-C177, ASTM E 84 and UL 181.
3. ‘K’ Value: 0.27 Btu•in./(hr•ft²•ºF) at 75°F.
4. Density: 3.0 to 6.0 lbs./cu.ft.
5. Maximum Service Temperature: 260°F.
6. Flame spread index: ASTM E84 and UL 723, less than 25.
7. Smoke developed index: ASTM E84 and UL 723, less than 50.
8. Seal all seams and joints with contact adhesive.
9. Manufacturers: Armacel #AP Armaflex, Rubatex #K-Flex ECO, or Aeroflex #Aerocel.

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C. **PI-C**, Rigid Closed-Cell Cellular Glass:

1. Comply with ASTM C522.
2. 'K' Value: 0.34 Btu•in./(hr•ft²•ºF) at 140°F (60°C).
3. Density: 8.0 lbs./cu. ft.
4. Maximum Service Temperature: 900°F.
5. Flame spread index: ASTM E84 and UL 723, less than 25.
6. Smoke developed index: ASTM E84 and UL 723, less than 50.
7. Manufacturers: Pittsburgh-Corning #Foamglas with Pittwrap jacketing.

D. **PI-D**, Flexible High Temperature Aerogel:

1. High performance flexible insulation for specialty insulation applications with reduced available space for traditional insulation materials or higher thermal performance is required.
2. Compliant with ASTM C177, C1728, C165, C1101/1101M, C1104/1104M, C1336, C1617, C1763, and E84.
3. 'K' Value: 0.12 Btu•in./(hr•ft²•ºF) at 212°F (100°C). Thickness as required to meet energy code requirements.
4. Density: 10.7 lbs./cu. ft. (0.16 g/cc)
5. Maximum Service Temperature: 392°F (200°C).
6. Water Absorption, % of volume: <5% (maximum).
7. Surface Burning Characteristics: Flame Spread Index ≤5 and Smoke Developed Index ≤10 ratings as tested per ASTM E84.
8. Manufacturer: Pacor #Pryogel 2250.

2.3 JACKETING MATERIALS

A. Field Applied Jackets (For Interior Applications):

1. All longitudinal seams shall be located on bottom of pipes.
2. PVC Plastic: One piece molded type fitting covers and jacketing material, gloss white. Connect with tacks and pressure sensitive color matching vinyl tape. Not allowed in ceiling return air plenums or other areas requiring flame/smoke spread rating less than 25/50. Manufacturers: Johns Manville Zeston 2000.
3. Canvas Jacket: UL listed fabric, 6 oz/sq. yd. plain weave cotton, treated with dilute fire retardant lagging adhesive.
4. Aluminum Jacket: 0.016” thick sheet, smooth or embossed] finish, with longitudinal slip joints and 2” laps, die shaped fitting covers with factory attached protective liner. Secure aluminum jackets with 3/8” or 1/2” stainless steel bands on 12” centers.

B. Removable Covers:

1. Provide removable covers on pumps, backflow devices, valves greater than 2”, flanges, strainers, etc., where periodic maintenance or removal of insulation may is required.
2. Use of pre-molded fittings with PVC covers is acceptable, unless noted otherwise.
    a. Cold systems: Provide PVC covers on elbows.

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b. Cold systems: Provide Armaflex elastomeric foam for flanges, valves, pumps and strainers.
c. Hot systems: provide PVC covers on elbows and flanges.
d. Hot Systems: provide removable blanket covers on valves, pumps, and strainers.

3. Removable- type silicon cloth fiberglass filled insulating blankets:

a. 0-350°F service operating temperature.
b. Jacket: silicon impregnated fiberglass cloth.
c. Liner: silicon impregnated fiberglass cloth.
d. Liner reinforcement: stainless steel mesh cloth.
e. Insulation: 1” type E glass matt, minimum.
f. Fastening: 2” nomex Velcro, 1” straps and stainless steel D-rings, or 12-gauge stainless steel hooks and stainless steel wire.
g. Thread: Kevlar/stainless steel thread.
h. Manufacturers: Fit Tight Covers, GLT products, or equal custom fabrication by Insulation Contractor.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Verify that piping has been tested for leakage in accordance with specifications before applying insulation materials. All piping shall be inspected by Owner's Representative prior to installation of insulation. Any insulation applied prior to inspection shall be removed and new insulation applied at no additional cost to Owner. Notify Owner's Representative five (5) working days prior to insulation installation.

B. Verify that all surfaces are clean, dry and free of foreign material.

3.2 INSTALLATION

A. General:

1. Install materials in accordance with manufacturer's recommendations, building codes and industry standards.
2. Remove and replace any insulation that has become wet or damaged during the construction process.
3. Continue insulation and vapor barrier at penetrations and supports, except where prohibited by code.

B. Piping Insulation:

1. Locate insulation and cover seams in least visible locations unless otherwise specified.
2. Neatly finish insulation at supports, protrusions, and interruptions.
3. Insulate all hot water and cold water pipes as defined in the following tables.
4. All insulation joints, lateral and longitudinal, shall be sealed to maintain integrity of vapor barrier to maximize thermal performance and minimize condensation potential.

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5. Provide vapor retardant jackets on all insulated domestic cold water pipes, dual temperature pipes, and storm (rainwater) drain pipes, conveying fluids below 60°F with self-sealing laps. Insulate complete system. No staples shall be used.
6. For insulated pipes conveying fluids above 105°F, secure jackets with self-sealing lap or outward clinched, expanded staples. Seal ends of insulation at equipment, flanges, and unions.
7. Provide insert between support shield and piping on piping 1-1/2” diameter or larger. Fabricate of Johns Manville Thermo-12, or other heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:

    a. 1-1/2" to 2-1/2" pipe size 10" long
    b. 3" to 6" pipe size 12" long
    c. 8" to 10" pipe size 16" long
    d. 12" and over 22" long

8. Use of metal saddles is acceptable as specified in Section 220500. Fill interior voids with segments of insulation matching adjoining pipe insulation.
9. Use of pipe hangers designed as an insulation coupling is acceptable in lieu of saddles and other devices. Manufacturer: Klo-Shure coupling.
10. For pipe exposed in mechanical equipment rooms or in finished spaces below 7 feet above finished floor, finish PVC jacket and fitting covers. Manufacturers: Johns Manville #Zeston 2000 PVC.

    a. Where pumps, valves, strainers, etc., with insulation require periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage.
    b. Cold systems: Provide Armaflex elastomeric foam for pumps and strainers.

11. For insulated pipes exposed inside the building in corridors, offices, conference room, lobbies and similar occupied spaces cover the insulation with PVC jacket and fitting covers. Manufacturers: Johns Manville #Zeston 2000 PVC.
12. When maintenance or service access for equipment will result in foot traffic over floor mounted insulated piping the contractor is to fabricate a permanent removable walkway to prevent damage to the piping and insulation.

3.3 ENCAPSULATING NON-RATED PIPES AND CABLES

A. Where combustible non-fire rated pipes (plastic) and cables are installed in an air plenum space provide one layer of **EI-G** fire barrier plenum wrap to fully encapsulate the item to comply with ASTM E84 or UL-723.

3.4 PIPING INSULATION SCHEDULE

A. TABLE 1: PIPING SERVICES, FLUID TEMPERATURE, AND INSULATION TYPE REQUIRED.

1. All insulation thicknesses shall meet or exceed State and Local Energy Code requirements as noted below. All metal and plastic composite materials used for hot water distribution and recirculation shall be insulated including, but not limited to, copper, PEX, and CPVC. Provide additional insulation as required in the

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following sections. Increase all thicknessed by 1/2" where piping is exposed to exterior ambient air. Minimum thermal resistance in range of 4.2 to 4.6 per inch of thickness. Insulation thicknesses are based on fiberglass insulation and may be adjusted for equivalent insulation values for materials with superior "K" factors.

INSULATION INDEX	
INSULATION KEY CODE	INSULATION TYPE
PI-A	Preformed Mineral Wool or Fiberglass
PI-B	Flexible Closed-Cell Elastomeric, Neoprene or Polyethylene
PI-C	Rigid Closed-Cell Cellular Glass
PI-D	Flexible High Temperature Aerogel:

TABLE 1:
PIPING SERVICES, FLUID TEMPERATURE, AND INSULATION TYPE REQUIRED

SERVICE	PIPE SIZE (inches)	THICKNESS (inches)	MATERIAL OPTIONS
Domestic hot water supply and return.	All Sizes	Refer to Applicable Energy Code, one inch minimum.	**PI-A or PI-B**. Refer to Applicable Energy Code and Table 2 below.
Domestic hot water supply and return, and other services, where space is limited and other insulation materials won't fit.	All sizes	1	**PI-D**. Refer to Applicable Energy Code and Table 2 below.
Domestic cold water.	All Sizes	1	**PI-A or PI-B.** See subsections below for required locations.

B. TABLE 2: CODE MINIMUM PIPING INSULATION THICKNESS BASED ON FLUID TEMPERATURE AND PIPING SIZE.

1. Oregon

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TABLE 2 INSULATION BASED ON OREGON OEESC ENERGY CODE MINIMUM PIPE INSULATION THICKNESSES OR GREATER							
FLUID TEMPERATURE RANGE (°F)	CONDUCTIVITY RANGE (in Btu-inch per hour per square foot °F)	INSULATION MEAN RATING TEMPERATURE (°F)	NOMINAL PIPE DIAMETER (in inches)				
			Less than 1	1 and 1-1/4	1-1/2 to 3	4 to 6	8 and larger
			INSULATION THICKNESS REQUIRED (in inches)				
Above 350	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251-350	0.29-0.32	200	3.0	4.0	4.5	4.5	4.5
201-250	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105-140	0.22-0.28	100	1.0	1.0	1.5	1.5	1.5
Above 90	0.24-0.27	100	1.0	1.0	1.0	1.0	1.0
Space cooling systems (chilled water, refrigerant and brine)							
40-60	0.21-0.27	75	0.5	0.5	1.0	1.0	1.0
Below 40	0.20-0.26	50	0.5	1.0	1.0	1.0	1.5

END OF SECTION 220700

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