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. Process and Lab piping.
   c. Cooling coil condensate drainage.
   d. All valves, separators, strainers and fittings for systems listed above.
2. Hot Equipment: - section includes the following Plumbing equipment that is not factory insulated:
   a. Hot water storage tanks.
3. Types of plumbing piping insulation specified in this Section include the following:
   a. Pipe insulation: Fiberglass.
   b. Pipe insulation: Flexible elastomeric closed cell foam.
4. Insulation jackets:
   a. Interior application
   b. Exterior application
   c. Removable covers
5. Types of plumbing equipment insulation specified in this Section include the following :
   a. Equipment insulation: Fiberglass blanket
   b. Equipment insulation: Fiberglass board
   c. Equipment insulation: Cellular glass.
   d. Equipment insulation: Flexible elastomeric closed cell foam.
6. 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. Insulation Group (IG): Definition of Insulation Materials and Operating Temperatures.

C. 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.

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

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

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.
   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. E84 - Test Method for Surface Burning Characteristics of Building Materials.

cc. E119 - Test for Fire Resistance.

dd. G21 – Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

ee. 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. 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 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 ½” 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. Submit samples.

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.

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

A. Type PI-A: Glass Fiber: 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. For all fluid distribution temperatures below 45°F the system shall be of a wicking type.
1. Fiberglass, Non-Wicking:

a. Manufacturers:
   1) Johns Manville Micro-Lok HP meeting ASTM C547; or FSK faced Micro-Flex (pipe sizes larger than 18")
   2) Knauf
   3) einsulation
b. Applications: Insulation of piping up to 18" in diameter and 3" thick insulation.
c. 'K' Value: 0.23 at 75°F.
d. Maximum Service Temperature: 850°F.
e. 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.

B. Type PI-B: Flexible Elastomeric Closed Cell Thermal Insulation: Armacel AP Armaflex, Rubatex K-Flex ECO, Aeroflex Aerocel, closed-cell, halogen free, elastomeric insulation. Comply with ASTM-C177, ASTM E 84 and UL 181.
1. 'K' Value: 0.27 at 75°F.
2. Density: 3.0 to 6.0 lbs./cu.ft.
3. Maximum Service Temperature: 260°F.
4. Seal all seams and joints with contact adhesive.

C. Type PI-C: Cellular Glass- Pittsburgh-Corning Foamglas Meeting ASTM C522: Cellular Glass Thermal Insulation:
1. 'K' Value: 0.35 at 75°F.
2. Density: 8.0 lbs./cu. ft.
3. Maximum Service Temperature: 900°F.
4. Provide with Pittsburg Corning Pittwrap jacketing.

D. Field Applied Jackets (For Interior Applications):
1. All longitudinal seams shall be located on bottom of pipes.
2. PVC Plastic: Johns Manville Zeston 2000. One piece molded type fitting covers and jacketing material, gloss white. Connect with tacks and pressure sensitive color matching vinyl tape.
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/embossed] finish, with longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner.
5. Secure aluminum jackets with 3/8" or ½" stainless steel bands on 12" centers.

E. Field Applied Jackets (For Exterior Applications):
1. All longitudinal seams, on horizontal pipe runs, shall be installed on the bottom of pipes.
2. Aluminum Jacket: 0.016" (minimum) thick sheet, [smooth/embossed] finish, with longitudinal slip joints and 2" laps, die shaped fitting covers with factory attached protective liner.
3. Stainless Steel Jacket: Type 304 stainless steel, 0.010" minimum (smooth/corrugated) finish.
4. Secure stainless steel or aluminum jackets with ⅜" or ½" stainless steel bands on 12" centers.
5. Manufacturers: Pabco, Childers, RPR, or approved equal.

F. 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.
   b. Hot systems: provide PVC covers on elbows and flanges.
   c. Hot Systems: provide removable blanket covers on valves.
3. Removable- type silicon cloth fiberglass filled insulating blankets:
   a. Mfg: Fit Tight Covers, GLT products, or equal custom fabrication by Insulation Contractor, 0-350°F service operating temperature:
      1) Jacket: silicon impregnated fiberglass cloth
      2) Liner: silicon impregnated fiberglass cloth
      3) Liner reinforcement: sstl mesh cloth
      4) Insulation: 1” type E glass matt
      5) Fastening: 2” nomex Velcro
      6) Fastening: 1” straps and stainless steel D-rings
      7) Fastening: 12 gage stainless steel hooks and stainless steel wire
      8) Thread: Kevlar/stainless steel thread

2.3 EQUIPMENT INSULATIONS

A. Type EI-A: Flexible Fiberglass Blanket: Johns Manville Microlite Type 75 Flexible Blanket:
1. 'K' Value: ASTM C518, 0.27 Btu•in./(hr•ft²•ºF) at 75°F installed full thickness.
2. Maximum Service Temperature: 250°F.
3. Density: 0.75 lb/cu ft.
4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

B. Type EI-B: Rigid Fiberglass Board: Johns Manville Spin-Glass 814:
1. 'K' Value: ASTM C518, 0.23 Btu•in./(hr•ft²•ºF) at 75°F.
2. Maximum Service Temperature: 250°F.
3. Density: 3.0 lb/cu ft.
4. Vapor Barrier Jacket: FSK (Foil-Scrim-Kraft) aluminum foil faced reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.
5. Facing: 1” galvanized hexagonal wire mesh stitched on one face of insulation. (Optional.)

C. Type EI-C: Cellular Glass: Pittsburgh-Corning Foamglas Meeting ASTM C552; Cellular Glass Thermal Insulation:
1. 'K' Value: 0.35 at 75°F.
2. Density: 8.0 lb/cu. ft.
3. Maximum Service Temperature: 900°F.

D. Type EI-D: Flexible Elastomeric Closed Cell Thermal Insulation: Armacel AP Armaflex, Rubatex K-Flex ECO, Aeroflex Aerocel, closed-cell, halogen free, elastomeric insulation. Comply with ASTM-C177, ASTM E 84 and UL 181.

1. 'K' Value: 0.27 at 75°F.
2. Density: 3.0 to 6.0 lbs./cu.ft.
3. Maximum Service Temperature: 260°F.
4. Seal all seams and joints with contact adhesive.

E. Type EI-E: Hydrous Calcium Silicate Johns Manville, IIG Thermo-12/Gold Meeting ASTM C533; Rigid Molded Block; Asbestos-Free Coded Throughout Material Thickness and Maintained Throughout Temperature Range:
1. 'K' Value: 0.40 at 300°F.
2. Maximum Service Temperature: 1,200°F.
3. Compressive Strength (block): Minimum of 200 psi to produce 5% compression, based on 1½" thickness.
4. Securement: Insulation shall be securely banded in place, tightly butted, joints staggered and secured with 16 gauge galvanized or stainless steel wire or ½" x .015" galvanized steel bands on 12" maximum centers for large areas.

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. For insulated pipes conveying fluids above ambient temperature, secure jackets with self sealing lap or outward clinched, expanded staples. Seal ends of insulation at equipment, flanges, and unions.
4. For pipe exposed in mechanical equipment rooms or in finished spaces below 7 feet above finished floor, finish with Johns Manville Zeston 2000 PVC jacket and fitting covers.
5. 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.

6. For exterior applications:
   a. Provide weather protection jacket. Insulated pipe lengths, pumps, fittings, joints, and valves shall be covered with aluminum jacket or stainless steel jacket. Jacket seams shall be located on bottom side of horizontal piping. All lateral joints shall be caulked with a minimum 20-year silicone sealant (clear). All longitudinal joints, except those at the bottom of a horizontal pipe run, shall be caulked with a minimum 20-year silicone sealant (clear).
   b. Apply weather-resistant protective finish such as WB Armaflex to flexible elastomeric insulation. Insulation seams shall be located on the bottom side of horizontal piping. All lateral and longitudinal joints to be sealed with low V.O.C., UV inhibitive adhesive, such as Armaflex 520 BLV adhesive.
7. For underground installations, install per manufacturer's written instructions and recommendations.
8. When maintenance or service access for equipment will result in foot traffic over floor mounted insulated piping the general contractor is to fabricate a permanent removable walkway to prevent damage to the piping and insulation.

C. Equipment Insulation:
1. See Piping Insulation above for additional requirements.
2. Apply insulation as close as possible to equipment by grooving, scoring, and beveling insulation, if necessary. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands, per manufacturer’s recommendations.
3. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retardant cement.
4. For insulated equipment containing fluids above ambient temperature, provide jacket with or without vapor barrier.
5. For equipment in mechanical equipment rooms or in finished spaces, finish with Johns Manville Zeston 2000 jacketing and fitting covers or aluminum or stainless steel jacketing.
6. Do not insulate over nameplate or ASME stamps. Bevel and seal insulation around such.
7. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage. Use of lace-on type insulation blankets is acceptable.

3.3 PIPING INSULATION SCHEDULE

A. All insulation thicknesses shall meet or exceed State Energy Code requirements as noted below. Increase thickness 1/2” if 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.

B. Insulation

SERVICE	PIPE SIZE (inches)	THICKNESS (inches)	REMARKS/MATERIAL OPTIONS
Domestic, Industrial, and Lab hot water	Up to 2 2-1/2 and over	1 1-1/2	Type PI-A,B
Domestic, Industrial, and Lab hot water return	All Sizes	1	Type PI-A,B
Safety shower tempered water – Indoors	All Sizes	1	Type PI-A, B
Safety shower tempered water - outdoors	All sizes	1	Type PI-A, B
Misc. drains from ice machines, etc.	All Sizes	1	Type PI-A,B
Cooling coil condensate drain pipes	All Sizes	1/2	Type BI-B

3.4 EQUIPMENT INSULATION SCHEDULE

A. Equipment insulation table: (for equipment not furnished with factory insulation)

EQUIPMENT	THICKNESS (inches)	REMARKS	MATERIAL OPTIONS
Water softeners/brine tanks	1	Provide vinyl or aluminum jacket	Type EI-A, B, C, D
Hot Water Storage Tanks	2	Provide vinyl or aluminum jacket	Type EI-B, C

END OF SECTION