

**MECHANICAL THERMAL INSULATION**

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**1. GENERAL**

**1.1 References**

.1 The following is a list of standards which may be referenced in this Section:

.1 ASHRAE:

.1 Standard 90.1, Energy-Efficient Design of New Buildings Except Low-Rise Residential Buildings.

.2 ASTM:

.1 B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.2 C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

.3 C195, Standard Specification for Mineral Fiber Thermal Insulating Cement.

.4 C335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.5 C411, Test Method for Hot Surface Performance of High Temperature Thermal Insulation.

.6 C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

.7 C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

.8 C547, Standard Specification for Mineral Fibre Pipe Insulation.

.9 C552, Standard Specification for Cellular Glass Thermal Insulation.

.10 C553, Standard Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.

.11 C592, Standard Specification for Mineral Fibre Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Meshed Covered) (Industrial Type).

.12 C916, Standard Specification for Adhesives for Duct Thermal Insulation.

.13 C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

.14 C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.

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- .15 D1784, Standard Specification for Rigid PVC Compounds and Chlorinated CPVC Compounds.
- .16 D2310, Standard Classification for Machine-Made 'Fibreglass' (Glass-Fibre-Reinforced Thermosetting Resin) Pipe.
- .17 E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .18 E96, Test Methods for Water Vapour Transmission of Materials.
- .19 G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .20 G22, Standard Practice for Determining Resistance of Plastics to Bacteria.
- .3 Association of the Non-Woven Fabrics Industry, INDA.
- .4 MSS:
  - .1 SP 58, Pipe Hangers and Supports - Materials, Design and Manufacture.
  - .2 SP 69, Pipe Hangers and Supports - Selection and Application.
- .5 NFPA:
  - .1 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
  - .2 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
  - .3 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
  - .4 259, Standard Test Method for Potential Heat of Building Materials.
- .6 UL: 723, UL Standard for Safety Test for Surface Burning Characteristics of Building Materials.
- .7 TIAC, Thermal Insulation Association of Canada – Standards Manual for Mechanical Insulation.
- .8 CAN/ULC-S102, Standard Method & Test for Surface Burning Characteristics of Building Materials and Assemblies.

**1.2 Definitions**

- .1 Piping: Includes fittings, flanges, valves, special pipe fittings, drains, vents and similar items, both indoors and outdoors.

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- .2 Ducting: Includes fittings, drains, accessories and similar items.
- .3 Concealed: Insulated mechanical services and equipment above suspended ceilings and non-accessible chases and furred spaces.
- .4 Exposed: Not concealed.

**1.3 Submittals**

- .1 Submittals: product description, list of materials and thickness for each service or equipment scheduled, locations, and Manufacturer's installation instructions.
- .2 Informational Submittals:
  - .1 Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

**1.4 Quality Assurance**

- .1 Materials Supplied and Installed under this Specification shall be standard, catalogued products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.
- .2 Supply and Install materials by firms engaged in the manufacture of insulation products of the types and characteristics specified herein, whose products have been in use for not less than five (5) years.
- .3 UL Listing or satisfactory certified test report from an approved testing laboratory is required to indicate fire hazard ratings for materials proposed for use do not exceed those specified.

**1.5 Coordination**

- .1 Some piping shall be electrically heat traced. Coordinate installation of insulation with installation of heat tracing power.

**1.6 Delivery, Storage, and Handling**

- .1 Manufacturer's Stamp or Label:
  - .1 Every package or standard container of insulation, jackets, cements, adhesives and coatings delivered to Site for use must have Manufacturer's stamp or label attached, giving name of Manufacturer, brand, and description of material.
  - .2 Insulation packages and containers shall be marked "asbestos-free."

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**2. PRODUCTS**

**2.1 General**

- .1 Insulation exterior shall be cleanable, grease-resistant, nonflaking, and nonpeeling.
- .2 Insulation shall conform to referenced publications and specified temperature ranges and densities in  $\text{kg/m}^3$ .
- .3 Insulation for fittings, flanges, and valves shall be premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.
- .4 Fire Resistance:
  - .1 Insulation, adhesives, vapour barrier materials and other accessories, except as specified herein, shall be noncombustible.
  - .2 Use no fugitive or corrosive treatments to impart flame resistance.
  - .3 Flame proofing treatments subject to deterioration due to effects of moisture or high humidity are not acceptable.
  - .4 Materials including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with ASTM E84 (NFPA 255) methods.
- .5 Materials exempt from fire-resistant rating:
  - .1 Nylon anchors.
  - .2 Treated wood inserts.
- .6 Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:
  - .1 Polyurethane insulation.
  - .2 PVC casing.
  - .3 Fibreglass-reinforced plastic casing.

**2.2 Pipe Insulation**

- .1 Type P1—Fibreglass (ASTM C547, Class 1):
  - .1 Fibreglass, UL-rated, preformed, sectional rigid, with factory-applied ASJ composed of reinforced Kraft paper and aluminum foil laminate. Jacket shall have self-sealing lap to facilitate closing longitudinal and end joints.
  - .2 Minimum density:  $64 \text{ kg/m}^3$ .

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- .3 Thermal conductivity K factor 0.039 W/m°C maximum at 24°C mean per ASTM C177 or ASTM C518.
- .4 Temperature Rating: -28 to 260°C.
- .5 Fitting Insulation: wired-in-place premolded insulation or mitred segments, or soft fibreglass insulation inserts, covered with 0.51 mm minimum thickness PVC fitting covers.
- .6 Acceptable Manufacturers:
  - .1 CertainTeed; 500° Snap-On ASJ/SSL
  - .2 Schuller (Manville); Micro-Lok 650 with AP-T jacket.
  - .3 Owens/Corning Fiberglass; 25 ASJ/SSL.
  - .4 Knauf Pipe Insulation; ASJ/SSL.
- .2 Type P3—Elastomeric (ASTM C534):
  - .1 Flexible, closed cell elastomeric, nominal 96 kg/m<sup>3</sup> density,
  - .2 Thermal conductivity K factor 0.039 W/m°C maximum at 24°C mean per ASTM C177 or ASTM C518.
  - .3 Temperature Rating: -40 to 104°C.
  - .4 Flame Spread Rating: Less than 25 per ASTM E84.
  - .5 Fitting Insulation: same as pipe.
  - .6 Acceptable Manufacturers:
    - .1 Armstrong; AP Armaflex.
    - .2 Schuller (Manville); Aerotube II.
    - .3 Nomaco; Therma-Cel.
    - .4 Rubatex; R-180-FS.
- .3 Type P4—Cellular Glass:
  - .1 Temperature Rating: -179 to 482°C.
  - .2 Acceptable Manufacturers:
    - .1 Pittsburg Corning Foamglass.

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**2.3 Duct Insulation**

- .1 Type D1—Blanket (ASTM C553, Type 1, Class B3):
  - .1 Fibreglass, nominal 16 kg/m<sup>3</sup> density blanket, K factor 0.045 W/m°C maximum at 24°C mean, with factory-applied foil-scrim-kraft vapour barrier jacket, for temperatures to 121°C.
  - .2 Acceptable Manufacturers:
    - .1 CertainTeed; Standard Duct Wrap.
    - .2 Schuller (Manville); Microlite.
    - .3 Owens/Corning Fiberglass; RFK-75.
    - .4 Knauf; Ductwrap.
- .2 Type D2—Board:
  - .1 Fibreglass, minimum 44 kg/m<sup>3</sup> density board, K factor 0.033 W/m°C maximum at 24°C mean, with factory-applied FSK vapour barrier jacket, for temperatures from 38°C to 454°C.
  - .2 Acceptable Manufacturers:
    - .1 CertainTeed; IB 850.
    - .2 Knauf; Elevated Temperature Board.
    - .3 Owens/Corning Fiberglass; TIW.
    - .4 Schuller (Manville); 1000 Series Spin-Glass.
- .3 Type D3—Liner (ASTM C1071, Type 1):
  - .1 Fibreglass, nominal 24 kg/m<sup>3</sup> density liner, K factor 0.036 W/m°C maximum at 24°C mean, black composite coated surface exposed to airstream to prevent erosion of glass fibres, for temperatures to 121°C.
  - .2 Liquid water repellency rating not less than 4 when tested in accordance with INDA IST 80.6.
  - .3 Potential heat value not exceeding 8140 kJ/kg when tested in accordance with NFPA 259 and meeting the classification of “Limited Combustible” as defined by NFPA 90A.
  - .4 Maximum rated velocity not less than 30 m/s when tested in accordance with ASTM C1071.

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- .5 Resistant to microbial growth using a “no growth criteria” when tested in accordance with ASTM C1139, G21 and G22.
- .6 Acceptable Manufacturers:
  - .1 CertainTeed; Toughgard.
  - .2 Schuller (Manville); Linacoustic.
  - .3 Knauf; Duct Liner M.

**2.4 Equipment Insulation**

- .1 Type E1—Elastomeric (ASTM C534):
  - .1 Flexible, closed-cell elastomeric, nominal 96 kg/m<sup>3</sup> density, K factor 0.039 W/m°C maximum at 24°C mean.
  - .2 Acceptable Manufacturers:
    - .1 Armstrong; Armaflex II.
    - .2 Schuller (Manville); Aerotube II.
    - .3 Nomaco; Therma-Cel.
    - .4 Rubatex; R-180-FS.

**2.5 Insulation Finish Systems**

- .1 Type F1—PVC:
  - .1 PVC jacketing, white, for straight run piping and fitting locations, temperatures to 70°C.
  - .2 Acceptable Manufacturers:
    - .1 Knauf; Proto.
    - .2 Schuller (Manville); Zeston.
- .2 Type F3—Aluminum:
  - .1 Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100 or 3105 to ASTM B209 with H-14 temper, minimum 0.4 mm thickness, with embossed finish.

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- .2 Moisture Barrier: Supply and Install factory applied moisture barrier, consisting of 18 kg kraft paper with 1 mil thick low density polyethylene film, heat and pressure bonded to inner surface of the aluminum jacketing.
- .3 Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, etc.
- .4 Manufacturer:
  - .1 Permaclad
  - .2 Childers
  - .3 Insul-Coustic
  - .4 RPR Products

**3. EXECUTION**

**3.1 Application of Piping Insulation**

- .1 Install insulation products in accordance with Manufacturer's written instructions, and in accordance with recognized industry practices.
- .2 Apply insulation over clean, finish painted, and dry surfaces.
- .3 Install insulation after piping system has been pressure tested and leaks corrected.
- .4 Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
- .5 Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces of scraps abutting each other.
- .6 Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
- .7 Maintain integrity of vapour-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Seal open ends of insulation with mastic. Sectionally seal all butt ends of chilled water and condensate drain piping insulation at fittings with white vapour barrier coating.
- .8 Cover valves, flanges, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory



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- molded, precut or job-fabricated units. Finish cold pipe fittings with white vapour barrier coating and hot piping with white vinyl acrylic mastic, both reinforced with glass cloth.
- .9 Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.
  - .10 Install protective metal shields and foamglass inserts where pipe hangers bear on outside of insulation. Insulation shall be continuous through pipe supports and hangers.
  - .11 Insulation on piping that is to be heat traced shall be installed after installation of heat tape.
  - .12 Insulate valve bodies, flanges, and pipe couplings.
  - .13 Insulate and vapour seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
  - .14 Do not insulate flexible pipe couplings and expansion joints.
  - .15 Do not allow insulation to cover nameplates or code inspection stamps.
  - .16 Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.
  - .17 Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.
  - .18 Cold Surfaces: Supply and Install continuous vapour seal on insulation on cold surfaces where vapour barrier jackets are used.
  - .19 Placement:
    - .1 Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.
    - .2 Insulate valves and fittings with sleeved or cut pieces of same material.
    - .3 Seal and tape joints.
  - .20 Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.
  - .21 Roof Drains: Insulated entire length of roof drain piping.
  - .22 Vapour Barrier:
    - .1 Supply and Install continuous vapour barrier at joints between rigid insulation and pipe insulation.
    - .2 Install vapour barrier jackets with pipe hangers and supports outside jacket.

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- .3 Do not use staples and screws to secure vapour sealed system components.

**3.2 Installation of Ductwork Insulation**

- .1 General: Install insulation products in accordance with the Manufacturer's written instructions and in accordance with recognized industry practices.
- .2 Install insulation materials with smooth and even surfaces.
- .3 Clean and dry ductwork prior to insulation. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
- .4 Maintain integrity of vapour-barrier on ductwork insulation and protect it to prevent puncture and other damage. Tape all punctures.
- .5 Seal longitudinal and circumferential joints with FSK tape, and finish with fibreglass mesh fabric embedded in vapour barrier mastic.
- .6 Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.
- .7 Except as otherwise indicated, omit external insulation on ductwork where internal insulation or sound absorbing linings have been installed.
- .8 Refer to Section 15810 – Metal Ductwork and Accessories, for installation of internal duct liner.

**3.3 Installation of Equipment Insulation**

- .1 Application Requirements: Insulate where external surface temperature of equipment is below ambient temperature in the space, including surfaces that have a recognized possibility for condensation.
- .2 Install equipment thermal insulation products in accordance with Manufacturer's written instructions and in compliance with recognized industry practices to ensure that insulation serves intended purpose.
- .3 Install insulation materials with smooth and even surfaces and on clear and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.
- .4 Maintain integrity of vapour-barrier on equipment insulation and protect it to prevent puncture and other damage.
- .5 Supply and Install removable insulation sections to cover parts of equipment that must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, and accessories.

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- .6 Replace damaged insulation that cannot be repaired satisfactorily, including units with vapour barrier damage and moisture-saturated units.
- .7 Avoid using scrap pieces of insulation where larger sheets will fit.

### 3.4 Installation of Insulation Finish Systems

- .1 Use a continuous friction type joint to hold jacket in-place, providing positive weatherproof seal over entire length of jacket.
- .2 Secure circumferential joints with preformed snap straps containing weatherproof sealant.
- .3 On exterior piping, apply coating over insulation and vapour barrier to prevent damage when aluminum fitting covers are installed.
- .4 Do not use screws or rivets to fasten the fitting covers.
- .5 Install removable prefabricated aluminum covers on exterior flanges and unions.
- .6 Caulk and seal all exterior joints to make watertight.

### 3.5 Piping Insulation Requirements

- .1 Install insulation over entire length of pipes unless noted otherwise.
- .2 Condensate Drain:
  - .1 Type P3, elastomeric.
  - .2 12 mm thickness for pipe sizes up to 65 mm ID.
  - .3 20 mm thickness for pipe sizes over 65 mm ID.
- .3 Potable Cold Water (DCW, PW), Plant Service Water (PSW):
  - .1 Type P3, elastomeric.
  - .2 12 mm thickness for pipe sizes 32 mm and smaller.
  - .3 25 mm thickness for pipe sizes larger than 32 mm.
- .4 Potable Hot Water (DHW, DHWR, TDW):
  - .1 Type P1, fibreglass.
  - .2 25 mm thickness for all pipe sizes.

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- .5 Hot Water Heating (GHS, GHR):
  - .1 Type P1, fibreglass.
  - .2 40 mm thickness for all pipe sizes.
- .6 Low Pressure Steam and Condensate (LPS, LPC):
  - .1 Type P1, fibreglass.
  - .2 40 mm thickness for all pipe sizes.
- .7 Roof Drain (RD):
  - .1 Type P3, elastomeric.
  - .2 25 mm thickness.
- .8 Caustic (CS)
  - .1 Type P1, fibreglass.
  - .2 Temperature: 25 to 90°C.
  - .3 40 mm thickness.
- .9 Pipe Hangers:
  - .1 Type P1, Fibreglass: UL-rated, preformed rigid pipe insulation inserts of thickness equal to adjoining insulation, 250 mm in length, with factory-applied, vinyl-coated and embossed vapour barrier jacket with self-sealing lap.
  - .2 Type P3, Elastomeric: Rigid insulation section with 225 mm long, 1.6 mm thick (16 gauge) galvanized steel saddle.
- .10 Refrigerant Pipework
  - .1 Type P3, Elastomeric
  - .2 20 mm thickness

**3.6 Ductwork Insulation Requirements**

- .1 Mechanically Cooled supply air and Mechanically Cooled and Heated supply Air:
  - .1 Type D2, board.
  - .2 40 mm thickness.

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- .3 Insulate full length of ductwork, unless otherwise noted.
- .2 Exhaust Air (1200 mm from external wall or roof):
  - .1 Type D2, board.
  - .2 40 mm thickness.
- .3 Unheated Supply Air:
  - .1 Type D2, liner.
  - .2 40 mm thickness.
  - .3 Insulate full length of ductwork, unless otherwise noted.
- .4 Sheet Metal Plenums:
  - .1 Type D3, liner.
  - .2 40 mm thickness.

**3.7 Insulation Finish Requirements**

- .1 Piping, Duct, and Equipment Insulation (Concealed Areas): Factory finish.
- .2 Piping Insulation (Exposed to View, Indoors):
  - .1 Type F1, PVC.
- .3 Ductwork Insulation (Exposed to View, Indoors):
  - .1 Factory finished.
- .4 Equipment Insulation (Exposed to View, Indoors):
  - .1 Type F3, Aluminum.
- .5 Piping Insulation (Outdoors):
  - .1 Type F3, aluminum.
- .6 Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

**3.8 Field Quality Control**

- .1 Test factory-applied materials assembled. Field-applied materials may be tested individually.

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**END OF SECTION**