

SCOPE

- I 1.1 This practice covers the design, material selection, and application for thermal insulation systems to be used on external surfaces of equipment (including piping, tankage) under the following operating conditions:
- Hot Thermal Insulation:
- A temperature above the atmospheric dewpoint, **and**
 - Not more than 10% of the time below the atmospheric dewpoint.
- Cold Thermal Insulation:** Operates for more than 10% of the time below the atmospheric dew point.
- I 1.2 The requirements of this practice also apply to acoustic insulation systems.
- S 1.3 Asbestos containing materials shall not be used.
- I 1.4 **An asterisk (*)** indicates that additional information is required. If a job is contracted, this additional information is furnished in the Job Specification.

SUMMARY OF ADDITIONAL REQUIREMENTS

- I * 2.1 **Table 1** lists the practices and standards which shall be used with this practice as specified by the purchaser.
- I 2.2 **Table 2** lists the standards which shall be used for insulation materials purchased in the USA for use in the USA, or in countries with no comparable standards. If local codes or standards exist for materials of equivalent properties (to those listed in **Table 2**) they shall apply.

TABLE 1

PRACTICES	
IP 14-3-1	Fireproofing
IP 19-1-1	Paint and Protective Coatings
STANDARDS	
ASTM Standards	
E 84	Surface Burning Characteristics of Building Materials
E 96	Water Vapor Transmission of Materials
F 1249	Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor

TABLE 2

STANDARDS	
ASTM Standards	
A 167	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
A 463	Steel Sheet, Cold-Rolled, Aluminum-Coated (Type 2)
A 526 / A526M	Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality
B 209 / B209M	Aluminum and Aluminum-Alloy Sheet and Plate
C 533	Calcium Silicate Block and Pipe Thermal Insulation (Type I or II)
C 547	Mineral Fiber Preformed Pipe Insulation (Class 5)
C 552	Cellular Glass Block and Pipe Thermal Insulation
C 591	Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation
C 592	Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type)
C 610	Molded Expanded Perlite Block and Pipe Thermal Insulation
C 612	Mineral Fiber Block and Board Thermal Insulation (Class 5)
C 871	Test Method for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride Fluoride, Silicate, and Sodium Ions

- I * 2.3 The recommendations of the paint, insulation, and vapor barrier manufacturers shall be followed in addition to the requirements of this practice. All conflicts with this practice shall be submitted to purchaser for approval by Owner's Engineer. Where such manufacturer's instructions are given in permissive terms, e.g., "should", "may", and "recommended", these instructions shall be considered required.

DOCUMENTATION

- I *3.1 **Proposal information.** The following data, as applicable, shall be submitted to purchaser for approval by Owner's Engineer.
- Product specifications including manufacturer's data sheets and Material Safety Data Sheets where applicable.
 - Material storage requirements, including shelf life and temperature.
 - Design and application details of insulation systems shall include (but not be limited to):
 - Insulation expansion joints
 - Typical designs of weather jackets and/or vapor barrier to prevent water intrusion.
 - For storage tanks: floating roofs; junction of tank shell to roof; junction of insulation system to fireproof coating on sphere supports; tank appurtenances, walkway areas to tank roof appurtenances, termination of insulation system on the first shell course of cylindrical tanks on grade or on low foundations.
 - Design of thermal and/or acoustical insulation systems.
 - Design of pipe and vessel insulation supports.
 - Repair procedures for damaged areas.
 - Inspection and testing procedures.
 - Recommended safety precautions.
 - Installer's quality control methods and inspection criteria.

DESIGN

- O 4.1 **Hot service insulation** shall be installed to conserve heat and for personnel protection. **Cold service insulation** shall be installed to limit surface condensation or icing and conserve refrigeration.
- O 4.2 Where insulation material type and thickness is specified, **alternative materials** may be used, provided that the thermal conductivity at the mean temperature (T_m) falls within 10% of the design thermal conductivity (K_{des}) given below:

MATERIAL TYPE	K_{des} AT MEAN TEMPERATURE T_m	
	Btu in./hr sq ft °F	W/m·°C
Mineral Fiber	$K_{des} = 0.00050 T_m + 0.360$	$K_{des} = 0.00013 T_m + 0.0542$
Calcium Silicate	$K_{des} = 0.00043 T_m + 0.315$	$K_{des} = 0.00011 T_m + 0.0474$
Fibrous glass:to 450°F (230°C) to 850°F (454°C)	$K_{des} = 0.00050 T_m + 0.210$ $K_{des} = 0.00077 T_m + 0.225$	$K_{des} = 0.00013 T_m + 0.0326$ $K_{des} = 0.00020 T_m + 0.0360$
Cellular Glass	Supplied by manufacturer	
Polyurethane Foam:		
T_m , °F °C		
100 38	0.175	0.0252
75 24	0.170	0.0245
50 10	0.165	0.0238
0 -18	0.180	0.0260
-25 -32	0.190	0.0275
-50 -45	0.180	0.0260
-100 -73	0.150	0.0216

- M * 4.3 **Fibrous type insulation** shall not be used on tanks, equipment, or piping systems which handle oil with a gravity equal to or higher than 0.9042 at 60°F (15.5°C) where spillage or leakage onto the insulation is probable, for example manways, nozzles or sample points.
- R 4.4 **Insulation for piping and equipment subject to stress corrosion cracking**, such as austenitic stainless steels, shall meet the requirements of ASTM C 871.

	External Insulation (This practice is appropriate for attachment to Inquiry or Purchase Document)	IP 14-1-1	
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- R 4.5 **Insulation containing sodium silicate** shall not be used for insulating molybdenum containing austenitic stainless steels (such as Type 316) operating at 1500°F (815°C) or greater.
- S 4.6 Thermal insulation systems used for **fireproofing steel vessels** are specified in [IP 14-3-1](#).
- I,O * 4.7 **For hot service**, the normal operating (fluid) temperature shall be used to establish insulation requirements for equipment. For piping, the fluid operating temperature shall be determined from the upstream equipment to which the piping is connected.

Anticipated startup and shutdown conditions, including steamout, process upsets, regeneration, etc., need not be considered in establishing insulation requirements, except for plastic insulation.

For cold service, limitation of condensation shall be based on zero wind velocity, and humidity at the location. If not otherwise specified, the insulation thickness shall be sufficient to limit condensation on the outer surface of the insulation to 10% of the annual hours.

ACOUSTIC INSULATION SYSTEMS

- O 4.8 When **dual layer insulation systems** employing different insulation materials, are used for combined thermal and noise control, the insulation for noise control shall be installed as the inside layer. No credit for noise reduction may be taken for any insulation material in the system other than the fibrous glass or mineral fiber, unless approved by the Owner's Engineer.
- O 4.9 **Acoustic insulation system** thickness shall be based on the actual noise reduction required. Insulation noise reduction shall be considered on an octave band basis.

EQUIPMENT CONSTRUCTED OF LOW MELTING POINT ALLOYS

- S,R 4.10 Vessels, heat exchangers, and other **equipment constructed from low melting point alloys**, such as aluminum, **require fireproofing** if they contain flammable material and are located in potential fire areas - such as within process unit area limits. The insulation (fireproofing) system shall be designed per the following:
- a. Finished insulation shall be covered with a steel jacket: zinc coated or alloyed, aluminum coated or alloyed, or stainless.
 - b. The insulation system shall be capable of withstanding the force of fire hose stream impingement.
 - c. The insulation system shall prevent the shell of the equipment from reaching a temperature where the material will be stressed beyond its yield strength when exposed to a hydrocarbon fire for two hours.
 - * d. For aluminum equipment, this shell temperature shall be considered to be 350°F (177°C). The temperature to be used for other low melting point materials will be specified.

HOT SURFACES NOT REQUIRING INSULATION

- I 4.11 Insulation **systems designed for heat conservation** shall have the insulation omitted from the following surfaces:
- a. Piping or vessel components designed on the basis of reduced metal temperature resulting from heat loss to atmosphere.
 - b. Piping or vessel components which are insulated internally.
 - c. Water side surfaces of coolers and condensers.
 - d. Cooling water piping.
 - e. Steam traps, expansion joints, rotating joints.
 - * f. Pumps, turbines, and compressors at operating temperatures below 250°F (120°C) unless specified to be fireproofed; insulated to afford process protection against the effects of ambient temperature (viscosity change, condensation, etc.); for steam service; or for noise control.
- I * 4.12 The need for **insulation on valve bodies, flanges, flanged fittings**, and unions, will be specified.

R,S * 4.13 When specified, **hot thermal insulation of flanges** is permitted where all of the following conditions are met:

Max. Fluid Operating Temp.	550°F (290°C) ⁽¹⁾
Max. Design Pressure	600 psig (4140 kPa) ⁽¹⁾
Flange Material	Carbon Steel, or Low Alloy Steel (to 5% Cr)
Bolting Material	Grade B7 or B16
Insulation Details	(2) (3) (4) (5)
Service Restrictions	Not for hydrogen service, highly corrosive fluids such as concentrated acids, or toxic materials such as phenol or hydrogen sulfide

Notes:

- (1) Steam service flanges may be insulated for temperatures up to a maximum fluid operating temperature of 750°F (400°C) and a maximum design pressure of 650 psig (4480 kPa).
- (2) Insulation systems around flanged joints shall be provided with a 1/2 in. NPS (15 mm) drain tube or vent ("tell tale"). For hydrocarbon services, the flange periphery shall, in addition, be fitted with a leak band.
- (3) Metal jacket weatherproofing is required.
- (4) The design shall permit removal of the insulation system without destruction of the insulation of the connective piping.
- * (5) Drains and vents shall be piped to a safe location, as specified, for the following services: highly corrosive, flammable and combustible fluids with operating temperatures above their flash points, light hydrocarbons [lighter than 68° API (0.709 relative density)].

INSULATING FOR PERSONNEL PROTECTION

- S 4.14 **Personnel protection** shall comply with the following:
- a. Equipment located within 1 ft (300 mm) horizontally or 7 ft (2100 mm) vertically of a normal access, walkway, or work area shall be insulated to provide a surface temperature no greater than 150°F (65°C).
 - b. As a preferred alternative to insulation, protection can be afforded by open guards, shields, or railing.

INSULATION SUPPORTS

- M,O 4.15 **Support rings** shall be used **on vertical piping** to support insulation. One shall be located at the start of the vertical rise. They shall be spaced so that the compressive strength of the insulation is not exceeded, but not more than 12 ft (3600 mm) apart.
- M,O 4.16 **Support rings on vertical vessels** shall be spaced at approximately 12 ft (3600 mm) centers. One shall be located at or below the bottom tangent line. A support ring shall be located at the top tangent line if the distance to the next ring down exceeds 8 ft (2400 mm).
- M,O 4.17 If **support rings** are used **on storage tank shells**, they shall be spaced on approximately 12 ft (3600 mm) centers, and not closer than 8 in. (200 mm) to horizontal weld seams.
- M,O 4.18 The **minimum thickness of support rings** shall be 3/16 in. (5 mm). Width of support ring for single layer insulation shall be 1/2 the thickness of the insulation. For double layer, it shall be equal to the thickness of the inner layer plus 1/2 the thickness of the outer layer. The support rings shall be offset 1/4 in. for vessels and tankage.
- M,O 4.19 **Materials for pins, clips, and studs**, welded to pressure containing components, shall be of the same nominal chemistry as the component to which they are attached, and shall be installed prior to any required postweld heat treatment of the item being insulated.
- M,O * 4.20 **Piping which needs to be continuously insulated at support points**, to afford protection against the effects of ambient temperature (viscosity change, congealing, condensation, etc.), shall be supported by rigid bands, saddles, or similar devices matching the OD of the insulation. Insulation at supports shall be of the load bearing type.