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Standard Specification for Prefabricated Reflective Insulation Systems for Equipment and Pipe Operating at Temperatures above Ambient Air[1]

This standard is issued under the fixed designation C 667; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers the requirements for all metal prefabricated, reflective insulation systems for equipment and piping operating in air at temperatures above ~~ambient in air.~~ambient. Typical applications are in nuclear power-generating plants and industrial plants.

1.2 Reflective insulation is thermal insulation that reduces radiant heat transfer across spaces by the use of surfaces of high reflectance and low emittance.

~~1.3The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are provided for information only.~~

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C 168 ~~Terminology Relating to Thermal Insulating Materials~~ Terminology Relating to Thermal Insulation

C 335 Test Method for Steady-State Heat Transfer Properties of ~~Horizontal~~ Pipe Insulation

C 411 Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

C 835 Test Method for Total Hemispherical Emittance of Surfaces ~~from 20 up~~ to ~~1400°C~~[2]1400C

C 854 Test for Resistance to External Loads on Metal Reflective Pipe Insulation[3]

C~~1033Test Method for Steady-State Heat Transfer Properties of Pipe Insulation Installed Vertically~~[2] 1045 Practice for Calculating Thermal Transmission Properties Under Steady-State Conditions

C 1058 Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation

C 1061 ~~Test Method for Thermal Transmission Properties of Non-Homogeneous Insulation Panels Installed Vertically~~ Standard Guide for Prefabricated Panel Insulation Systems for Ducts and Equipment Operating at Temperatures Above Ambient Air[3]

C 1371 Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers

3. Terminology

3.1 *Definitions:*

3.1.1 Terms relating to thermal insulation materials and testing are in accordance with Terminology C 168.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *convection stops*—seals used to reduce convection losses.

3.2.2 *end supports*—structural members placed at the end of a unit of insulation and fastened to both the inner and outer case. ~~Their~~

3.2.2.1 *Discussion*—The primary purpose of the end supports is to increase the structural integrity of the unit.

3.2.3 *inner case*—the innermost sheet of the unit of insulation (closest to the hot surface). ~~It~~

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[1] This specification is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.21 on Reflective Insulation.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* ~~, Vol 04.06.~~volume information, refer to the standard's Document Summary page on the ASTM website.

[3] ~~Discontinued. See 1997 *Annual Book of ASTM Standard*, Vol 04.06.~~

[3] Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

3.2.3.1 *Discussion*— The inner case may perform structural functions in addition to its thermal functions.

3.2.4 *insulation assembly*—an assembly of insulation units arranged and secured together in a prescribed order that comprises the complete insulation for a vessel, pump, pipeline, or other component for a single design objective.

3.2.5 *insulation system*—a collection of insulation assemblies, that when secured together in a prescribed order, comprises the complete insulation for a vessel, pump, pipeline, or other component for a single design objective.

3.2.6 *lap straps*—strips that overlap a longitudinal or circumferential joint in the insulation which aligns adjacent insulation units and may also serve to restrict air infiltration and convection losses and to shed external falling water. ~~They~~

3.2.6.1 *Discussion*—The lap straps may be integral with one piece of the outer case or separate strips secured to it.

3.2.7 *outer case*—the outermost sheet or the unit of insulation (farthest from the hot surface). It usually performs structural functions in addition to its thermal functions.

3.2.8 *penetrations*—openings in a unit of insulation from the cold surface through to the hot surface.

3.2.9 *reflective liners*—those reflective sheets or foil interposed between the inner and outer case to reflect radiant energy, to minimize emission of radiant energy, and to restrict internal convection.

3.2.10 *thickness*—(see Fig. 1).

3.2.11 *unit of insulation*—a single structurally independent assembly of inner case, outer case, reflective liners, and end supports (if required).

4. Ordering Information

4.1 Ordering information ~~should~~shall include the following:

4.1.1 Service requirements including operating hot surface temperature, expected ambient temperatures, and ambient air velocities,

4.1.2 Expected service life and any special environmental exposures,

4.1.3 Permitted average heat loss per unit of cold surface or as otherwise specified,

4.1.4 Personnel exposure surface temperature limitations,

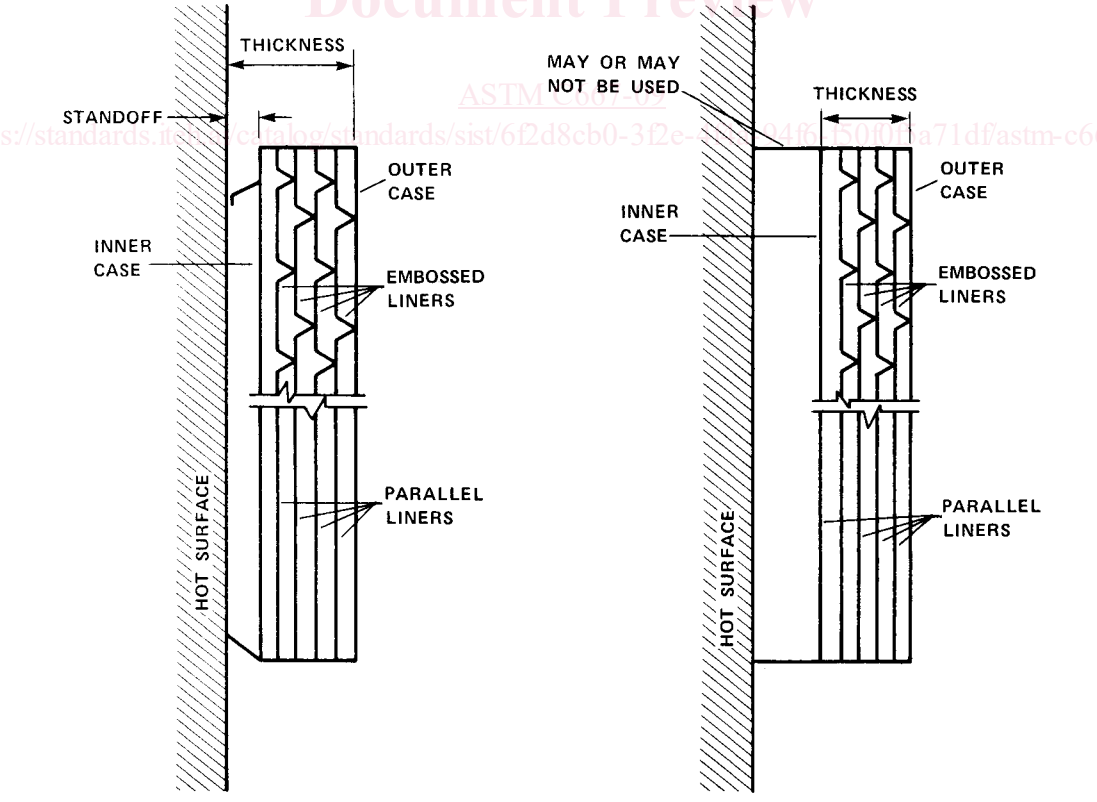
4.1.5 Expected seismic, loading, and vibration exposures,

4.1.6 Purchaser's systems and equipment drawings,

4.1.7 Limits, if any, on size, maximum thickness, weight, or number of insulation units requiring removal for inspection,

4.1.8 Location of components or maintenance, or both, and systems requiring removal of units for inspections,

4.1.9 Any unusual operating or test conditions, and



(*a*) Reflective Insulation Applied to Piping (*b*) Reflective Insulation Applied to Equipment

FIG. 1 Illustration of Terms Relating to Prefabricated Reflective Insulation Systems

4.1.10 Cleanliness level required.

5. Materials and Manufacture

5.1 Each insulation unit is a rigid, self-contained, prefabricated metal construction comprised of an inner casing and an outer casing, and if needed, one or more reflective liners supported and spaced so as to minimize internal convection and conduction. These parts are arranged to form a durable rigid assembly with separated air spaces between the inner and outer casing and the individual reflective liners.

5.2 The reflective insulation described herein is limited to systems of insulating units, designed by the manufacturer to fit the equipment or piping to be insulated, and engineered for the purchaser's service requirements.

~~5.3All parts of reflective insulation units should be made of metals that meet the thermal, physical, and chemical requirements not only of the insulation as a unit, but also as an assembly of units forming the insulation system. The materials shall perform their functions for the service life specified and be compatible with the environment in which they will be used.~~

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5.4 The stainless steel liners/foils shall be a minimum of 0.002 in. (0.05 mm) in thickness. Liners shall have an emittance of 0.25 or less when tested at 75 °F (24 °C) in accordance with Test Method C 1371. There shall be a minimum of three foils per in. of insulation thickness. The options for the foils configuration are flat or patterned.

6. Temperature Limitations

6.1 Each insulation unit must effectively limit the flow of heat through the insulation by radiation, convection, and conduction. The reflective liners (also referred to as radiation shields or foils) are made of metals having low ~~surface~~ emittance and high ~~surface~~ reflectance. The emittance ~~should~~shall be tested ~~according to~~ in accordance with Test Method C 835 or C 1371. The number and spacing of the liners are determined by the required limitation of heat flow.

~~6.2The temperature limits of various materials should be based on the potential increase in radiant heat transfer across spaces due to a reduction in reflectance and a corresponding increase in emittance resulting from surface oxidation. Individual components of the insulation system which will be elevated to a temperature of 750°F (400°C) or higher should not be made of aluminum or aluminum alloys. If components will be elevated to 1200°F (649°C) or higher, Type 300 series austenitic stainless steel should be used. Other materials and alloys are available for use over 1200°F (649°C).~~

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6.3 A representative unit or assembly shall be tested in accordance with Test Method C 411.

7. Thermal Performance

7.1 The purchase specification ~~should~~shall clearly indicate the permissible average rate of heat loss per unit area for each type of surface. The tests ~~should~~shall be in accordance with Test Method C 335 for ~~horizontal~~ pipes, ~~Test Method C1033 for vertical pipes,~~ or Test Method C 1061 for flat surfaces, or a test method ~~as~~ agreed upon between the purchaser and manufacturer. Table 1 and Table 2 contain maximum values for apparent thermal conductivity. Butt joint heat losses shall be accounted for by including at least one butt joint within the metered area in thermal performance test. Practices C 1045 and C 1058 shall be used for determining and reporting thermal transmission properties.

7.2 Due to the limitation of present configurations of reflective insulation, those being flat, cone and cylindrical, there can be a significant difference between the hot equipment surface area and the outer case area. Therefore, the thermal performance for equipment ~~should~~ be referenced to the area of the outer case, unless otherwise specified. To be consistent, the outer case area shall also be used for pipe, unless otherwise specified.

7.3 Thermal performance of pipe insulation per unit of cold surface area ~~may~~shall be obtained by multiplying transference (T) or conductance (C) ~~as reported by Test Methods C335 or C1033~~) as determined by Test Methods C 335, by ratio of the radii of the insulation outer surface (r_2) and the test pipe (r_o). Example:

TABLE 1 Panels
Apparent Thermal Conductivity[A]

Mean Temperature	Btu in./h ft^2(W/mk)
184 (84.4)	0.369 (0.053)
291 (143.8)	0.477 (0.069)
398 (203.3)	0.657 (0.095)

[A]The thermal transmission properties of metal reflective insulation depends on temperature, temperature difference, dimensions, emittance, and heat flow direction. The apparent thermal conductivity requirements specified in the table are based on specimens tested as specified in 7.1.