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Standard Guide for Selecting Jacketing Materials for Thermal Insulation[1]

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1. Scope

1.1 This guide covers criteria for selecting thermal insulation jacketing materials and is not intended for use as a performance or product specification.

1.2 This guide applies to jacketing materials applied over thermal insulation for piping, ducts, and equipment.

1.3 This guide includes jacketing materials used over thermal insulation whether the insulation is in the form of pipe, board, or blanket, or field applied materials that are self-supporting, including insulating cements.

1.4 This guide does not include covers or other retaining walls that contain loose fill, other nonsupporting insulation materials, or conduits or containers for buried insulation systems.

1.5 This guide does not include mastics and coatings and their reinforcements.

1.6 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.

1.7 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A240/A240M Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A366/A366M Specification for Commercial Steel (CS) Sheet, Carbon, (0.15 Maximum Percent) Cold-Rolled (Withdrawn 2000)[3]

A1008/A1008M Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable

B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate

C165 Test Method for Measuring Compressive Properties of Thermal Insulations

C168 Terminology Relating to Thermal Insulation

C488 Test Method for Conducting Exterior Exposure Tests of Finishes for Thermal Insulation

C835 Test Method for Total Hemispherical Emittance of Surfaces up to 1400°C

C921 Practice for Determining the Properties of Jacketing Materials for Thermal Insulation

C1057 Practice for Determination of Skin Contact Temperature from Heated Surfaces Using a Mathematical Model and Thermesthesiometer

C1136 Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation

C1258 Test Method for Elevated Temperature and Humidity Resistance of Vapor Retarders for Insulation

C1263 Test Method for Thermal Integrity of Flexible Water Vapor Retarders

C1338 Test Method for Determining Fungi Resistance of Insulation Materials and Facings

[1] This guide is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is direct responsibility of Subcommittee C16.40 on Insulation Systems.

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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* volume information, refer to the standard's Document Summary page on the ASTM website.

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

C1371 Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers
C1729 Specification for Aluminum Jacketing for Insulation
C1767 Specification for Stainless Steel Jacketing for Insulation
C1775 Specification for Laminate Protective Jacket and Tape for Use over Thermal Insulation for Outdoor Applications
C1785 Test Method for Concentration of Pinhole Detections in Moisture Barriers on Metal Jacketing
D774/D774M Test Method for Bursting Strength of Paper (Withdrawn 2010)[3]
D828 Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus
D882 Test Method for Tensile Properties of Thin Plastic Sheeting
D1000 Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications
D1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
D3330/D3330M Test Method for Peel Adhesion of Pressure-Sensitive Tape
D3363 Test Method for Film Hardness by Pencil Test
D3759/D3759M Test Method for Breaking Strength and Elongation of Pressure-Sensitive Tape
E84 Test Method for Surface Burning Characteristics of Building Materials
E96/E96M Test Methods for Water Vapor Transmission of Materials
E119 Test Methods for Fire Tests of Building Construction and Materials
E596 Test Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures
F1249 Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor
G154 Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

2.2 *TAPPI Standards:*[4]
T461 Flame Resistance of Treated Paper and Paperboard

2.3 *ANSI Standards:*
H35.2.H35.2(M) Dimensional Tolerances for Aluminum Mill Products

3. Terminology

3.1 *Definitions*—Terminology C168 apply to the terms used in this practice. The following terms are also used in this standard.

3.1.1 *abuse resistance*—ability of a material to be exposed for prolonged periods of time to normal physical abuse without significant deformation or punctures.

3.1.2 *ambient temperature*—the dry bulb temperature of surrounding air when shielded from any sources of incident radiation.

3.1.3 *cleanability*—ability of a material to be washed or otherwise cleaned to maintain its appearance.

3.1.4 *corrosion resistance*—ability of a material to be exposed for prolonged periods of time to a corrosive environment without significant onset of corrosion and the consequential loss of mechanical properties.

3.1.5 *fire resistance*—ability of a material, product, or assembly to withstand fire or give protection from it for a period of time.

3.1.6 *fungal growth resistance*—ability of a material to be exposed continuously to damp conditions without the growth of mildew or mold.

3.1.7 *temperature resistance*—ability of a material to perform its intended function after being subjected to high and low temperatures which the material might be expected to encounter during normal use.

3.1.8 *weather resistance*—ability of a material to be exposed for prolonged periods of time to the outdoors without significant loss of mechanical properties.

4. Significance and Use

4.1 This standard is intended to be used by engineers and designers as a guide to assist them in selecting appropriate thermal insulation jacketing materials. As a guide, it can be used to identify performance characteristics that might be necessary for a particular insulation jacketing system. This guide is not a specification and therefore should not be used as such. It might, however, be useful in writing a specification. Specification C921 can also be used to determine properties of jacketing materials for thermal insulation.

5. Materials and Manufacture

5.1 Jacketing materials may be composed of a single material or a lamination of several components. The material may be in the form of rolls or sheets or preformed to fit the surface to which they are to be applied. The materials may be applied in the field or may be a factory-applied composite with the insulation.

5.2 *Metallic:*

5.2.1 Metallic jacketing materials are those whose primary material (usually the component of greatest thickness) is metal, such as, aluminum, coated steel, and stainless steel. The metal may be smooth, corrugated, or embossed. The dimensions of corrugations (pitch and depth) may be specified by the purchaser for interchangeability, constant rigidity, and control of sizes. The inner surface of metallic jacketing materials may be coated or covered with a moisture resistant film to retard possible galvanic and/or chemical corrosion of the jacketing.

5.2.1.1 Aluminum jacketing should be manufactured in compliance with Specification C1729 which incorporates by reference the chemical composition and physical properties of Specification B209. Where ambient conditions are particularly

[4] Available from Technical Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Norcross, GA 30092, http://www.tappi.org..

corrosive or when a higher surface emissivity is desired, the outer surface of the aluminum may be coated with paint or plastic film.

5.2.1.2 Coated steel jacketing materials can be manufactured in compliance with several Specifications including A366/A366M and A1008/A1008M using alloys 1010, 1015, or 1020 steel. The outer surface is typically protected by aluminizing, galvanizing, or coating with another type of corrosion resistant metal alloy. Metal thicknesses generally available are from 0.010 to 0.019 in. (0.25 to 0.46 mm).

5.2.1.3 Stainless steel jacketing should be manufactured in compliance with Specification C1767 which incorporates by reference the chemical composition and physical properties of Specification A240/A240M.

5.3 *Nonmetallic and Laminated Jacketing:*

5.3.1 Laminated jacketing materials are typically manufactured from combinations of plastic films, plastic composites, metallic foils, reinforcing fabrics, papers, or felts selected to obtain the required performance characteristics. Laminated jacketing for outdoor applications should be manufactured in compliance with Specification C1775.

5.3.1.1 One common type of laminated jacketing is flexible low permeance vapor retarders, which should be manufactured in compliance with Specification C1136.

5.3.2 Textile or cloth jacketing materials are woven or knitted of textile yarns. Commonly available forms are 4, 6, or 8 oz/yd^2 (0.14, 0.20, or 0.27 kg/m^2) cotton canvas, various weaves of glass fiber yarns, presized glass cloth, knit, or woven plastic fibers.

5.3.3 Plastic jacketing materials are manufactured in various forms and types. Thicknesses generally available are from 0.003 to 0.035 in. (0.08 to 0.89 mm). Various materials can be used such as poly-vinyl chloride (PVC), chlorinated poly-vinyl chloride (CPVC), fiberglass reinforced plastic (FRP), and others.

5.3.4 Saturated felt or cloth jacketing materials are manufactured from various base felts or cloths that have been impregnated with bitumen or resinous materials. Examples: Glass fiber, polyester fiber, polyolefin fiber. This definition does not include tar paper, asphalt paper, or other paperboard materials or other products, such as rag felt, that are made out of waste and they do not represent a continuous and resistant base for a jacketing.

5.3.5 Rubber containing membranes are manufactured from combinations of layers of various rubber containing materials such as butyl rubber or rubberized bitumen with layers of other materials such as plastic films, metallic foils, reinforcing fabrics, or a combination thereof.

5.4 *Classifications used in jacketing specifications*—Each of the various ASTM specifications for jacketing contains a different classification system appropriate for that material. While each individual ASTM specification should be consulted for the details, the general outlines for each of these systems are shown below.

5.4.1 Specification C1136 Flexible Low Permeance Vapor Retarders,

5.4.1.1 Classified into seven Types based on physical properties and structural requirements,

5.4.2 Specification C1729 Aluminum Jacketing for Insulation,

5.4.2.1 Classified into four Types based on outer surface treatment and emittance,

5.4.2.2 Classified into six Grades based on aluminum alloy and temper,

5.4.2.3 Classified into four Classes based on type of moisture retarder,

5.4.3 Specification C1767 Stainless Steel Jacketing for Insulation:

5.4.3.1 Classified into one Type based on outer surface treatment and emittance,

5.4.3.2 Classified into two Grades based on stainless steel alloy and temper, and

5.4.3.3 Classified into three Classes based on type of moisture retarder.

5.4.4 Specification C1775 Laminate Protective Jacket and Tape for Use over Thermal Insulation for Outdoor Applications:

5.4.4.1 Classified into three Types based on several strength properties and peel adhesion, and

5.4.4.2 Classified into three Grades based on emittance.

6. Physical and Chemical Performance Considerations

6.1 This section includes a number of performance issues that should be considered when using this guide to select a jacketing material for thermal insulation. Some may not be applicable to the particular application. However, to be certain none are overlooked, the user should consider all materials initially and then eliminate those that are not applicable.

6.2 *Abuse Resistance*—Consideration should be given to the ability of a jacketing material to withstand a variety of physical conditions in excess of required functional design criteria. Prior to selection, consideration should be given to the expected intensity and types of abuse as well as the length of time the jacketing material is expected to withstand a given level of abuse.

6.2.1 *Abuse May Include the Following Factors:*

6.2.1.1 *Foot traffic*—Will people or equipment be applying loads directly on the jacketing material such as when piping is used like a ladder?

6.2.1.2 *Impact Resistance*—Is the jacketing material located where there is a probability of it being routinely struck by falling tools or other objects or being hit by traffic moving by?

6.2.1.3 *System Maintenance*—Does the system that the jacketing material is on require maintenance at regular intervals that would require the removal and reinstallation of the jacketing material?

6.2.1.4 *Puncture Resistance*—Is the jacketing material easily punctured? See 9.2.2.

6.3 *Weather Resistance*—Consideration should be given to the ability of a jacketing system to be exposed outdoors without a significant loss of properties. Factors to consider in selection of the jacketing materials, that comprise the jacketing system, are the following.

6.3.1 Possible effects of precipitation, including rain, snow, sleet, hail, frost, and dew as appropriate for the use area.

6.3.2 Possible effect of ultra violet radiation from sunlight.

6.3.3 Maximum wind velocity.

6.3.4 Possibility of abrasion caused by blowing sand or salt.

6.3.5 Possible effect of high humidity or fog.

6.4 *Water Vapor Transmission (Vapor Retarding Capability)*—Consideration should be given to the ability of a jacketing material to inhibit transport of water vapor through it. Some factors to consider are the following:

6.4.1 Water vapor tends to travel from areas of high vapor pressure to areas of low vapor pressure. See 9.2.1.

6.4.2 Water in insulation tends to reduce its efficiency. Therefore, if the system constantly runs above ambient it may be appropriate that the jacketing material or system will allow water vapor transmission. If the system constantly runs below ambient then the jacketing material and system should retard the ingress of water vapor.

6.4.3 If a jacketing system is being used as a water vapor transmission retarder, particular care must be paid to the jacketing material's system of attachment so that any screw holes or other penetrations are vapor sealed. Vapor sealing of jacketing and butt joints must be thorough. In general, any penetrations or areas of discontinuity of the jacketing material must be vapor sealed to retard intrusion of ambient moisture vapor.

6.5 *External Corrosion Resistance*—Consideration should be given to whether corrosive chemicals might be present around the insulation jacketing system. Many types of corrosive atmospheres or corrosive chemical spills can corrode certain jacketing materials compromising insulation system performance.

6.6 *Internal Corrosion Resistance*—There are several types of internal corrosion. One is an electrical reaction that results from electrolysis between the metallic surface to be insulated and the inner metallic surface of the jacketing. The second is a chemical reaction between two dissimilar metals. With the insulation otherwise in direct contact with the jacketing and the presence of internal moisture in the insulation, consideration should be given to provide a suitable protective barrier on the jacket's interior surface to retard such corrosion. A third is a chemical reaction, that takes place in the presence of water that has condensed from moisture in the air, between a metal jacket and chemicals leached out of the insulation. See 9.2.13.

6.7 *Fungal Resistance*—Consideration should be given to the ability of a material to be exposed continuously to damp conditions without the growth of mildew or mold. See 9.2.6.

6.8 *Reusability*—Consideration should be given to the ease with which the jacketing material may be removed and reinstalled in its original condition.

6.9 *Aesthetics*—Consideration should be given to the general outward appearance of the jacketing material such that it harmonizes with the other facilities in the area or the environment.

6.10 *Color Identification*—Consideration should be given to the color of the jacketing materials for the purpose of identifying the fluid content, the temperature, or both, of each system being insulated.

6.11 *Surface Emittance*—Consideration should be given to the outer surface emittance, of the system being insulated, for the purpose of lowering surface temperatures for personnel protection. See Section 9.2.10.

6.12 *Surface Burning Characteristics*—For selection of the jacketing, consideration should be given to the surface burning characteristics as determined by Flame Spread/Smoke Developed Indices in accordance with Test Method E84 on the exterior jacket surface or, where required by code, the insulation system including the jacketing material. The purposes are generally to determine a comparative surface burning behavior of the jacket or insulation system or to meet codes or regulatory requirements that maintain specific, not to exceed, index requirements, or a combination thereof. See 9.2.4.

6.13 *Temperature Resistance*—Consideration should be given to the mechanical properties of the jacketing materials after exposure, for extended periods of time, to the expected in-service maximum and minimum temperature. See 9.2.9 and 9.2.13.

6.14 *Fire Resistance*—Consideration should be given to the ability of the jacketing materials or building elements that include the jacketing materials to resist the passage of flame, heat, or smoke when exposed to a time-temperature curve, for example, the standard curve contained in Test Method E119 while maintaining certain mechanical properties. Consideration might also be given to the strength to hold the insulation system in place during and/or after the fire test. See 9.2.17.

6.15 *Mechanical Strength*—Consideration should be given to the mechanical strength of the jacketing materials, in particular to its need to contain the weight of the insulation materials and to withstand seismic acceleration.

6.16 *Cleanability*—Consideration should be given to the ease with which the jacketing materials can be cleaned. See 9.2.11.

6.17 *Thermal Properties*—Consideration should be given to the thermal properties of the jacketing materials and their effect on skin contact temperature for the purpose of personnel protection. See 9.2.14. An example of this is the lower burn potential of cloth jacketing compared to metal jacketing.

6.18 *Thermal Expansion/Contraction Characteristics and Dimensional Stability*—Consideration should be given to the thermal expansion/contraction characteristics of the jacketing materials and their impact on the overall system dimensional stability. See 9.2.7 and 9.2.15.

6.19 *Acoustical Properties*—Consideration should be given to the requirements for sound reduction across the thermal insulation system. The acoustical properties of the insulation jacketing material, such as the Noise Reduction Coefficient, may need to be considered in its selection. See Test Method E596.

6.20 *Insulation Compressive Resistance*—Consideration should be given to the compressive resistance of the insulation (referred to as rigidity in some jacketing standards) under the jacketing and how this might influence the jacket thickness necessary. To prevent physical damage to the jacketing, in