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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 the standard. The SI values given in parentheses are provided for information only.

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

2. Referenced Documents

2.1 *ASTM Standards:*

A 240 Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels[2]

A 366/A 366M Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality[2]

B 209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate[3]

C 168 Definitions of Terms Relating to Thermal Insulating Materials[4]

C 488 Practice for Conducting Exterior Exposure Tests of Finishes for Thermal Insulation[4]

C 835 Test Method for Total Hemispherical Emittance of Surfaces from 20 to 1400° C[4]

C 921 Practice for Determining the Properties of Jacketing Materials for Thermal Insulation[4]

C 1057 Determination of Skin Contact Temperature from Heated Surfaces Using a Mathematical Model and Thermethesiometer[4]

C 1136 Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation[4]

C 1258 Test Method for Elevated Temperature and Humidity Resistance of Vapor Retarders for Insulation[4]

C 1263 Test Method for Thermal Integrity of Flexible Water Vapor Retarders[4]

C 1338 Test Method for Determining Fungi Resistance of Insulation Materials and Facings[4]

D 828 Test Methods for Tensile Breaking Strength of Paper and Paperboard[5]

D 882 Test Methods for Tensile Properties of Thin Plastic Sheeting[6]

D 1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature[6]

E 84 Test Methods for Surface Burning Characteristics of Building Materials[7]

E 96 Test Methods for Water Vapor Transmission of Materials[4]

E 119 Method for Fire Tests of Building Construction and Materials[7]

E 596 Method for Laboratory Measurement of Noise Reduction of Sound-Isolating Enclosures[4]

F 1249 Test Method for Water Vapor Transmission Rate through Plastic Film and Sheeting Using a Modulated Infrared Sensor[5]

2.2 *Tappi Standards:*[8]

T461 Flame Resistance of Treated Paper and Paperboard

T803 Puncture Test of Containerboard

3. Terminology

3.1 *Definitions*—Definitions C 168 apply to the terms used in this practice. The following terms are also used in this standard.

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[2] *Annual Book of ASTM Standards*, Vol 01.03.

[3] *Annual Book of ASTM Standards*, Vol 02.02.

[4] *Annual Book of ASTM Standards*, Vol 04.06.

[5] *Annual Book of ASTM Standards*, Vol 15.09.

[6] *Annual Book of ASTM Standards*, Vol 08.01.

[7] *Annual Book of ASTM Standards*, Vol 04.07.

[8] Tappi Standards, Atlanta, GA.

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 to be exposed for a defined period of time to a fire with only limited and measurable loss of mechanical properties.

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. C 921 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, 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 materials can be manufactured from Specification B 209, Type 3003, 3004, 3105, 5005, 5010, 5020, or 1100 aluminum, temper ranges from H14 (half hard) through H19 (full hard). Where ambient conditions are severe, the outer surface of the aluminum may be coated when specified. Thicknesses generally available are from 0.006 to 0.040 in. (0.15 to 1.02 mm).

5.2.1.2 Steel jacketing materials can be manufactured from Specification A 366/A 366M, Type 1010, 1015, or 1020 steel. The outer surface is typically protected by aluminizing, galvanizing, or coating with plastic film or enamel to retard exterior corrosion, or a combination thereof. 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 materials can be manufactured from Specification A 240, Type 301, 302, 303, 304, or 316 stainless steel, hardness B85 (soft annealed). Thicknesses generally available are from 0.010 to 0.019 in. (0.25 to 0.46 mm).

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. For flexible low permeance vapor retarders, see Specification C 1136.

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-vital chloride (PVC), CPVS, 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.

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 applicable to the particular application. However, to be certain none are overlooked, the user should consider all 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. 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 prior to selection of the jacketing material. Abuse may include the following factors.

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 Section 9.1.2.

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 Section 9.1.1.

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 Sections 9.1.14.

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 Section 9.1.6.

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 and/or the temperature 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 9.1.11.

6.12 *Surface Burning Characteristics*—Consideration should be given to the jacketing exterior surface burning characteristics presented by Flame Spread/Smoke Developed Indices per ASTM E 84 test method for the selection of the jacketing. The purposes are generally to determine a comparative surface burning behavior of the jacket and to meet building codes that maintain specific, not to exceed, index requirements. See Section 9.1.4.

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 Sections 9.1.9 and 9.1.14.

6.14 *Fire Endurance*—Consideration should be given to the ability of the jacketing materials to be exposed to a fire of a certain time-temperature behavior 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. See Section 9.1.18.

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 Section 9.1.12.

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 Section 9.1.15. 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 Sections 9.1.7 and 9.1.16.

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 E 596.

7. Typical Sizes and Forms

7.1 Jacketing materials are typically available in rolls or sheets for field or factory application and standard dimensions vary with the type, thickness, and shape of the jacketing.

7.2 Nonmetallic materials are typically available in rolls with widths from 24 to 72 in. (0.61 to 1.83 m) and lengths from 150 to 3000 ft (46 to 914 m).

7.3 The vast majority of metallic materials are available in either rolls or sheets. Rolls widths are typically 3 or 4 ft (0.9 or 1.2m) and lengths typically 100 ft (30 m), while sheets will vary depending on type of metal, thickness, shape, and finish.

7.4 Where thickness, length, and width tolerances are required, they should be as agreed upon by the manufacturer and the purchaser.

8. Workmanship and Finish

8.1 Consideration should be given to requiring that the product be free of laminate separations, holes, tears, cuts, or creases, and/or stains and discoloration, and that it show no visual defects that will reduce serviceability.

8.2 Acceptance of visual defects should be agreed upon by the manufacturer and purchaser.

9. Test and Evaluation Methods

9.1 The properties enumerated in this guide should be determined in accordance with the following methods as appropriate for the selected material. Actual performance values can be selected by the user.

9.1.1 *Water Vapor Transmission*—Test Method E 96 and F 1249.

9.1.2 *Puncture Resistance*—Test Methods given in Tappi Test Method T803.

9.1.3 *Tensile Strength*—Test Method D 828 for paper products or D 882 for plastic fiber properties.

9.1.4 *Surface Burning Characteristics*—Test Method E 84. Obtain characteristics for the Jacket and insulation composite system.

9.1.5 *Leachability Resistance of Fire Retardant Additives (applicable to paper-containing products only)*—Test Method given in C 1136.

9.1.6 *Fungal Resistance*—Test Method given in C 1338.

9.1.7 *Dimensional Stability*—Test Method given in C 1136, Section 10.4.

9.1.8 *Low-Temperature Resistance*—Test Method given in C 1263.

9.1.9 *High-Temperature Resistance*—Test Method given in C 1263.

9.1.10 *Flexibility*—Test Method given in C 1136, Section 7.6.

9.1.11 *Total Hemispherical Emittance*—Test Method C 835.

9.1.12 *Cleanability*—Test Method C 488 (for exposure) and then clean using a procedure agreed upon by the buyer and seller. Record any differences between a retained control and the exposed/cleaned samples.

9.1.13 *Flame Resistance of Treated Paper and Paperboard*—Test in accordance with TAPPI Test T461.

9.1.14 *Elevated Temperature and Humidity Resistance of Vapor Retarders for Insulation*—Test in accordance with Test Method C 1258.

9.1.15 *Calculation of Skin contact Temperature*—Evaluate in accordance with Standard Practice C 1057.

9.1.16 *Thermal Expansion/Contraction Characteristics*—for plastic materials, test in accordance with Test Method D 1204.

9.1.17 *Material Compatibility*—There is no ASTM standard for evaluating this property for insulation jacketing materials.

9.1.18 *Fire Endurance*—test in accordance with Method E 119.

10. Keywords

10.1 jacketing materials; metallic jacketing; nonmetallic jacketing; protective jacketing; self-supporting; thermal insulation; vapor retarder