Designation: C 921 – 03a

Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation[1]

This standard is issued under the fixed designation C 921; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This practice covers jackets applied over thermal insulation on piping and equipment, including materials applied solely for physical protection, and materials applied as vapor retarders.

1.2 This practice provides material and physical requirements, or both, for jackets. Guidance in selecting the proper jacket for a given application can be found in Guide C 1423.

1.3 This practice does not cover field applied mastics or barrier coatings and their attendant reinforcements, nor does it cover jackets for buried insulation systems.

1.4 The values stated in inch-pound units are to be regarded as standard. SI units are given in parenthesis.

1.5 *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 167 Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip[2]

A 240 Specification for Heat-Resistant Chromium and chromim-Nickel Stainless Steel Plate, Sheet and Steel[2]

A 366/A366M Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality[3]

A 653/A653M Specification for Steel Sheet, Zinc Coated (Galvanized), or Zinc-Iron Alloy, Coated (Galvanealed) by the Hot-dip Process[4]

A 792/A792M Specification for Steel Sheet, 55% Aluminum-Zinc Alloy, Coated by the Hot-Dip Method[4]

B 209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate[5]

C 168 Terminology Relating to Thermal Insulating Materials[6]

C 390 Practice for Sampling and Acceptance of Preformed Thermal Insulation[6]

C 921 Practice for Sampling and Acceptance of Preformed Thermal Insulation[6]

C 1258 Practice for Sampling and Acceptance of Preformed Thermal Insulation[6]

C 1263 Test Method for Thermal Integrity of Flexible Water Vapor Retarders[6]

C 1338 Test Method for Determining Fungi Resistance of Insulation Materials and Facings[6]

C 1423 Guide for Selecting Jacketing Materials for Thermal Insulation [6]

C 835 Test Method for Total Hemispherical Emittance of Surfaces from 20 to 1400°C[6]

D 828 Test Method for Tensile Properties of Paper and Paperboard Using Constant-Rate-of-Elongation Apparatus[7]

D 882 Test Methods for Tensile Properties of Thin Plastic Sheeting[8]

D 1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature[9]

E 84 Test Method for Surface Burning Characteristics of Building Materials[10]

E 96 Test Methods for Water Vapor Transmission of Materials[6]

2.2 *TAPPI Standards:*

T461 Flame Resistance of Treated Paper and Paperboard[11]

[1] This practice is under the jurisdiction of ASTM Committee C16 on Thermal Insulation and is the direct responsibility of Subcommittee C16.33 on Insulation Finishes and Moisture.

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

[3] *Annual Book of ASTM Standards*, Vol 01.05.

[4] *Annual Book of ASTM Standards*, Vol 01.06.

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

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

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

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

[9] *Annual Book of ASTM Standards*, Vol 08.03.

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

[11] Available from Technical Association of the Pulp and Paper Industry (TAPPI), P.O. Box 105113, Atlanta, GA 30348; 15 Technology Parkway South, Norcross, GA 30092.

T803 Puncture Test of Containerboard[11]

3. Terminology

3.1 *Definitions*—Definitions in Terminology C 168 apply to terms used in this practice, including the word jacket, which is defined as ″a form of facing applied over insulation″. In common use, the terms jacket and jacketing shall be considered interchangeable.

4. Classification

4.1 *Type I*—Semi-rigid, for physical abuse resistance, physical support, and finish.

4.1.1 Grade 1: Aluminum sheet metal,

4.1.2 Grade 2: Stainless steel sheet metal,

4.1.3 Grade 3: Coated steel sheet metal, and,

4.1.4 Grade 4: Plastic sheet.

4.2 *Type II:* Flexible for vapor retardance, or physical support or finish combination thereof.

4.2.1 Grade 1:Laminated multi-layer,

4.2.1.1 Class A: Below ambient application; extremely low permeance,

4.2.1.2 Class B: Below ambient application; very low permeance,

4.2.1.3 Class C: Below ambient application; low permeance, and

4.2.1.4 Class D: Above ambient application; no vapor retarder needed,

4.2.2 Grade 2: Plastic film.

4.2.2.1 Class A: Below ambient application; extremely low permeance,

4.2.2.2 Class B: Below ambient application; very low permeance,

4.2.2.3 Class C: Below ambient application; low permeance, and

4.2.2.4 ClassD: Above ambient application; no vapor retarder needed.

4.3 Grade 3: Fabric

4.3.1 No grades; support only, vapor retarder properties not applicable.

5. Significance and Use

5.1 Jackets provide one or more of three basic functions when applied over thermal insulation:

5.1.1 Physical protection, in the form of abuse resistance and added structural integrity or support for the insulating medium.

5.1.2 Resistance to moisture vapor intrusion into the insulating medium in those applications where ambient and operating temperatures create a vapor driving force toward the cold (insulated) surface.

5.1.3 Exposed finish for the insulation

5.2 Type I semi-rigid jackets, in the form of metallic or heavy gauge plastic sheet, are used over insulation on piping or equipment to provide high abuse resistance. In this case, the material is also referred to as a protective jacket.

5.3 The vapor retarding Type II flexible jacket (Grades 1 and 2, Classes A, B and C) is used by itself in below ambient service applications not requiring high abuse resistance. In those cases where high abuse resistance is required, it is applied to the insulation prior to installation of a protective jacket.

5.4 The non vapor-retarding Type II flexible jacket (Grades 1 and 2, class D) is used by itself in above ambient service applications not requiring high abuse resistance. It may also be used for support of the insulation prior to installation of a protective jacket in above ambient applications requiring high abuse resistance.

5.5 Since semi-rigid protective jackets do not perform a vapor retarder function, and flexible jackets do not provide high abuse resistance, the various materials categorized herein are commonly used in combination, but not interchangeably.

5.6 Vapor-retarding properties are not necessary for systems operating above ambient.

5.7 In applications where there is a need to reduce surface emittance, non-metallic jacket, or painted, or film covered metal jacket may be specified.

5.8 For direct outdoor exposure, certain Type I jackets may be used. UV resistance is an important consideration with the Grade 4 materials. Consult with the manufacturer for recommendations on suitability for these applications.

6. Materials and Manufacture

6.1 Jackets shall be composed of a single material or a lamination of several component The material shall be in the form of rolls or sheets or performed 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.

6.2 *Type I - Semi-rigid Protective:* :

6.2.1 Semi-rigid jackets consist of metal jackets (Grades 1,2, and 3) and heavy gauge plastic jackets (Grade 4).

6.2.2 Metal jackets are those whose primary material (usually the component of greatest thickness) is metal, such as aluminum alloy, stainless steel, or aluminum - zinc alloy coated steel sheet. Depending upon the metal, it may be available in a smooth mill finish, corrugated, embossed, painted or covered with a laminated, protective film. The inner surface (that side in contact with the insulation) is usually coated or covered with corrosion inhibiting film.

6.2.3 Aluminum Alloy jackets are commonly manufactured to Specification B 209, Type 3003, 3004, 3104, 3105, 5005, 5052, or 1100. Aluminum temper ranges from half hard through full hard. Thicknesses generally available are 0.010 to 0.063 in.(0.25 to 1.60 mm) nominal.

6.2.4 Stainless steel jackets are manufactured to Specification A 240, Type 301, 302, 304, or 316 stainless. Thicknesses generally available are from 0.010 to 0.032inches (0.25 to 0.81 mm) nominal.

6.2.5 Coated steel jackets are manufactured to requirements in Specifications A 366/A 366M, A 653/A 653M, or A 792/A 792M as appropriate. Thickness generally available is 0.016 inches (0.41 mm) nominal. Other thicknesses shall be available as agreed upon between purchaser and seller.

6.2.6 Heavy gauge plastic Type I, Grade 4 jackets are manufactured in plastic films or sheet with materials such as Polyvinylchloride (PVC) and Polyvinylidenechloride (PVdC) and are available in various thicknesses.

6.3 *Type II - Flexible*:

6.3.1 Type II, Grade 1 jackets are made of any of a number of different combinations of films, foils, cloths, papers and reinforcements.

6.3.2 Type II, Grade 2 jackets are manufactured from any of a number of different plastic materials, ranging from soft and flexible to hard and rigid. These materials include, but are not limited to: polyvinylchloride, polyvinylfluoride, acrylic, and polyvinylidenechloride. Thicknesses vary with the type of material and must be appropriate to the intended application.

6.3.3 Type II, Grade 3 jackets include, but are not limited to, cotton canvas (typically 4, 6, or 8 oz/sq. yd. (0.14, 0.20, or 0.27 kg/sq. m), woven glass fiber yarns, pre-sized glass cloth, and knit, woven, or non-woven synthetic fibers.

7. Material and Physical Requirements

7.1 *Type I Semi-rigid Protective Jackets:*

7.1.1 7.1.1 Material properties for semi-rigid jackets are shown in Table 1.

7.2 *Type II Flexible Jackets:*

7.2.1 Physical property requirements that vary by Class or Grade are shown in Table 2. Common requirements for Type II jackets are specified in this section.

7.2.2 All jackets shall demonstrate a maximum flame spread of 25 and smoke developed of 50 when tested on the service-exposed side for Surface Burning Characteristics (SBC), when tested in accordance with 10.4.

7.2.3 Jackets which contain paper or other absorbent materials shall not demonstrate an increase in char length of more than 20% when tested for flame retardance permanence in accordance with 10.5.

7.2.4 All jackets shall not corrode, delaminate nor show permeance higher than the maximum for the class, when tested for elevated temperature and humidity resistance in accordance with 10.8.

7.2.5 All jackets shall not exhibit growth of fungus, or mold, when tested for fungi resistance in accordance with Section 10.7.

7.2.6 All jackets shall not crack or delaminate when tested for thermal integrity at the maximum service exposure temperature of the jacket in accordance with 10.9.

TABLE 2 Physical Properties for Type II Jackets

TYPE II JACKETS		GRADE 1 Laminated	GRADE 2 Plastic	GRADE 3 Fabric
CLASS A Permeance	perms, max	0.01	0.01	...
	ng PA sm, max	0.58	0.58	
CLASS B Permeance	perms, max	0.02	0.02	...
	ng PA sm, max	1.15	1.15	
CLASS C Permeance	perms, max	0.05	0.05	...
	ng PA sm, max	2.90	2.90	
CLASS D	no permeance requirement	...	...	...
Tensile Strength	lbs/in width, min.	30	40	30
	N/mm width, min.	5.3	7.0	5.3
Puncture Resistance	Beach units, min	50	25	50
	Joules, min[A]	1.50	0.75	1.50
Dimensional Change	percent max	0.50	4.5	0.50

[A]Metric units previously used were cm·kg. The conversion from Beach units were 1.15 cm·kg/Beach unit

8. Dimensions and Tolerances

8.1 Dimensions for roll or sheeted materials shall be as specified by the purchaser.

8.2 Except for metal jackets, tolerance for roll materials shall be +/-1/8 in. (+/-3 mm) on width and +5,-0 % on length

8.3 Except for metal jackets, tolerance for roll materials shall be +/-1/8 in. (+/- 3mm) on length and width.

8.4 Tolerances for metal jackets shall be as called out in Speicifactions A240 or B209, as applicable to material.

9. Workmanship and Finish

9.1 There shall be no defects in materials or workmanship that will adversely affect the required performance of the jacket.

9.2 There shall be no defects that adversely affect the appearance of the jacket.

9.3 There shall be no defects that would affect the ability of the user to process material.

TABLE 1 Physical Properties for Type I Jackets

TYPE I JACKETS	GRADE 1 Aluminum	GRADE 2 Stainless Steel	GRADE 3 Coated Steel	GRADE 4 Plastic
thickness in. (mm)	0.006–0.050 (0.15–1.27)	0.010–0.032 (0.025–0.81)	0.016 (0.41)	0.010–0.040 (0.25–1.00)
Outside finish				
option 1	smooth	smooth	smooth	
option 2	corrugated	corrugated	corrugated	matte
option 3	embossed	embossed	embossed	gloss
option 4	painted	painted	painted	colored
option 5	laminate	laminate	laminate	
Corrosion Inhibiting Coatings				
option 1	kraft/PE	kraft/PE	kraft/PE	
option 2	ionomer	ionomer	ionomer	n/a
option 3	coating	coating	coating	
Available Metal Alloys of Plastic Polymer Type	3003, 3004, 3105, 3104, 5005, 5052, 1100	301, 302, 304, 316	1010, 1015, 1020	PVC PVdC

10. Test Methods

10.1 Permeance: Test in accordance with Test Method E96, (desiccant method at 73°F (23 °C) and 50% RH)

10.2 *Tensile Strength*:

10.2.1 Test the tensile strength of plastic film jackets (Type II, Grade 2) in accordance with Test Method D 882, with results reported in pounds per inch width of specimen width (Newtons per millimeter width).

10.2.2 Test the tensile strength of all other jackets in accordance with Test Method D 828, with results reported in pounds per inch of specimen width (Newtons per millimeter width).

10.2.2.1 Tested specimens shall be 2 in. (51 mm) width with 1 in. (25 mm) between jaws.

10.3 *10.3 Puncture Resistance:* —Test in accordance with TAPPI T803.

10.4 Surface Burning Characteristics. Test in accordance with Test Method E 84.

10.5 *Flame Retardance Permanence:* —Test in accordance with TAPPI T461.

10.6 *10.6 Dimensional Stability:* —Test in accordance with Test Method D 1204.

10.6.1 10.6.1 Expose the specimens to a temperature of 150 +/- 4 °F(66 +/- 2°C) for 24hrs.

10.7 *Fungi Resistance*:

Test in accordance with Test Method C 1338.

10.7.1 Test both sides of laminated products that use dissimilar materials, except metal foil need not be tested.

10.7.2 Test either side of plastic film materials.

10.7.3 Test three specimens of the selected sample and inspect for growth on any of the three.

10.8 *Elevated Temperature and Humidity Resistance*:

Test in accordance with Test Method C 1258. Low-Temperature Resistance.

10.9 *Thermal Integrity*:

Test in accordance with Test Method C 1263.

11. Sampling

11.1 Inspection and qualification shall be in accordance with Practice C 390. Other provisions for sampling can be agreed upon between the purchaser, seller, and manufacturer.

12. Certification

12.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this practice and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

13. Product Marking

13.1 The packaged jacket shall bear identification including the following information.

13.1.1 Manufacturer,

13.1.2 Product designation,

13.1.3 Roll, sheet, or unit dimensions, and

13.1.4 Lot number or date of manufacture.

13.2 If required by the user, the packaged material shall bear a marking of conformation to this practice, such as: ASTM C 921, Type II, Grade 1, Class A.

13.3 If required by the user, material which has been classified as to surface burning characteristics in accordance with Test Method E 84 by an independent testing laboratory agreed upon by both parties, shall bear the authorized label or marking of that institution.

14. Packaging

14.1 Unless otherwise specified, the material shall be supplied in the manufacturer's standard commercial package.

15. Keywords

15.1 below ambient; flexible; jacket; semi-rigid; thermal insulation