Designation: D3953 – 15

Standard Specification for Strapping, Flat Steel and Seals[1]

This standard is issued under the fixed designation D3953; 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 U.S. Department of Defense.

1. Scope

1.1 This specification covers flat steel strapping and seals intended for use in closing, reinforcing, bundling articles for shipment, unitizing, palletizing, and bracing for carloading, truckloading, lifting, and lashing.

1.2 This specification includes strapping and seals made from carbon steel and applies only to the types and sizes as cataloged by strapping suppliers to be a standard, commercially available product. It does not include "specialty"-type strapping as developed for special applications or strapping produced from alloy metals.

1.3 The values stated in inch-pound units are to be regarded as standard.

1.4 Performance characteristics may be negatively affected by extremes of temperatures, such as occur during the annealing of steel.

1.5 The following safety hazards caveat applies only to the test method portion, Sections 11, 12, and 13, of this specification: *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]

A90/A90M Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings

A109/A109M Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled

A239 Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles

B504 Test Method for Measurement of Thickness of Metallic Coatings by the Coulometric Method

D996 Terminology of Packaging and Distribution Environments

D3951 Practice for Commercial Packaging

D4332 Practice for Conditioning Containers, Packages, or Packaging Components for Testing

D4675 Guide for Selection and Use of Flat Strapping Materials[1]

D6039/D6039M Specification for Open and Covered Wood Crates

D6880 Specification for Wood Boxes

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *Military Standard:*[3]

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes

2.3 *AAR Rules:*[4]

AAR Open Top Loading Rules Manual, Section No. 1, General Rules for Loading All Commodities, Part 2, Rule 17 and Section No. 7, Rules for Loading All Commodities on Open Top Trailers and Containers for Rail Transport, Part 2, Rule 117

3. Terminology

3.1 General definitions for packaging and distribution environments are found in Terminology D996.

4. Strapping Classifications

4.1 Strapping shall be of the following types, finish and sizes:

Type 1, Flat Strapping: Power Machine and Hand Application:

Regular-duty

Regular-duty high-strength

[1] This specification is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.25 on Palletizing and Unitizing of Loads.

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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] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

[4] Available from the Association of American Railroads (AAR), Safety and Operations, 50 F St., NW, Washington, DC 20001–1564.

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Heavy-duty
USLM (Unit Strap Lifting Method) (See Note 1.)

NOTE 1—For USLM applications, refer to manufacturer's standard practice.

Type 2: Nail-On

4.1.1 *Strapping Finish, Lubricated or Dry* (see 8.3):

4.1.1.1 *Finish A—Organic (Pigmented or Unpigmented Paint)*

4.1.1.2 *Finish B—Galvanized (Hot Dipped or Electro-Deposit Galvanized*) (see 8.10):

Grade 1—Heavy Coating
Grade 2—Moderate Coating
Grade 3—Commercial Coating

4.1.1.3 *Finish C—Organic Painted Metallic Filled (Aluminum or Zinc)*

4.1.1.4 *Finish D—Uncoated*

4.1.2 *Strapping Sizes*— Strapping shall have the widths and thicknesses in accordance with sizes shown in Table 1, Table 2, Table 3, and Table 4.

5. Seal Classifications

5.1 Seals shall be of the following classes, finishes, types, and styles:

5.1.1 *Seal Classes:*
R—Regular duty
H—Heavy duty

5.1.2 *Seal Finishes:*
Finish A—Organic (painted)
Finish B—Galvanized (hot dipped or electro-deposit galvanized)
Grade 1—Heavy coating
Grade 2—Moderate coating
Grade 3—Manufacturer's standard commercial practice
Finish C—Organic Painted Metallic Filled (Aluminum or Zinc)
Finish D—Uncoated

5.1.3 *Seal Styles:*
I—Snap-on or open
II—Thread-on or closed
III—Push-type or overlap
IV—Magazine-feed
V—Intersectional or cross-tie

5.2 *Seal Sizes*—Seals shall have widths in accordance with strapping width shown in Table 1, Table 2, Table 3, and Table 4.

6. Ordering Information

6.1 The inquiry and order shall indicate the following:

6.1.1 Strapping type, duty, finish, grade, lubrication (when applicable), dimension required, and quantity of each size (see Section 4).

6.1.2 Coil of strapping dimensions, weight and feet per pound, oscillated, ribbon wound, or cut-to-length (see Section 9, Table 5 and Table 6, and Fig. 1 and Fig. 2).

6.1.3 Seals (see Section 5) class, finish, grade (when applicable), type, style, and quantity by width (or nomenclature).

6.1.4 Make or model of strapping equipment that the strapping and seals must work in, if applicable.

6.1.5 Title, designation, and date of this specification.

6.1.6 For Department of Defense, indicate selection of preservation, packing, marking, and palletization, if applicable (see Section 16).

6.2 Sizes or physical properties, or both, other than those covered by this specification shall be as specified in the contract or order.

7. Materials and Manufacture

7.1 Materials shall be cold-rolled carbon steel of the quality normally used for this purpose in commercial practice, and the physical mechanical property requirements, as determined by tests, shall be within the allowable limits.

7.1.1 *Type 1 Regular-Duty Strapping* —Regular-duty strapping in Table 1 shall be low-carbon cold-rolled steel (see 6.1.1).

7.1.2 *Type 1 Regular-Duty High-Strength Strapping*—Regular-duty high strength strapping in Table 2 shall be low to medium carbon cold-rolled steel.

7.1.3 *Type 1 Heavy-Duty Strapping* —Heavy-duty strapping in Table 3 shall be cold-rolled, high carbon, or medium carbon high-manganese steel which has been fully heat-treated; for example, austenitized and quenched.

TABLE 1 Type 1 Regular-Duty Strapping Widths, Thickness, and Breaking Strengths

Width, in. (mm)	0.015 (0.38)	0.018 (0.46)	0.020 (0.51)	0.023 (0.58)	0.028 (0.71)	0.035 (0.89)
⅜ (9.52)	450 (2000)	540 (2400)	600 (2670)	690 (3070)		
½ (12.70)	600 (2670)	720 (3200)	800 (3560)	920 (4090)		
⅝ (15.87)	750 (3335)	900 (4000)	1000 (4450)	1150 (5115)		
¾ (19.05)	900 (4000)		1200 (5340)	1380 (6140)	1680 (7470)	2100 (9340)

TABLE 2 Type 1 Regular Duty High-Strength Strapping Widths, Thickness and Break Strengths

Width, in. (mm)	Thickness, in. (mm)							
	0.016 (0.41)	0.017 (0.43)	0.018 (0.46)	0.020 (0.51)	0.023 (0.58)	0.025 (0.64)	0.031 (0.79)	0.035 (0.89)
	Breaking Strength, min, lbf (N)							
⅜ (9.52)		640 (2849)		750 (3366)				
½ (12.70)	800 (3559)	850 (3781)	900 (4003)	1000 (4448)	1150 (5115)			
⅝ (15.87)	1000 (4448)	1050 (4671)	1125 (5004)	1250 (5560)	1440 (6405)			
¾ (19.05)	1200 (5339)	1275 (5671)	1350 (6005)	1500 (6672)	1725 (7673)	1875 (8340)	2325 (10342)	
1¼ (31.75)						3125 (13901)	3875 (17237)	4375 (19461)

TABLE 3 Type 1 Heavy-Duty Strapping Widths, Thickness, and Breaking Strengths

Width, in. (mm)	Thickness, in. (mm)										
	0.020 (0.51)	0.022 (0.56)	0.023 (0.58)	0.025 (0.64)	0.028 (0.71)	0.029 (0.75)	0.031 (0.79)	0.035 (0.89)	0.040 (1.02)	0.044 (1.12)	0.050 (1.27)
	Breaking Strength, min, lbf (N)										
½ (12.70)	1 280 (5 690)		1 470 (6 540)				1 950 (8 675)				
⅝ (15.87)	1 600 (7 120)		1 840 (8 185)								
¾ (19.05)	2 000 (8 896)	2 280 (10 140)	2 280 (10140)	2 280 (10 140)	2 280 (10 140)	2 850 (12 675)	2 850 (12 675)	2 850 (12 675)		4 050 (18 015)	
1 (25.4)						3 700 (16 455)	3 700 (16 455)				
1¼ (31.75)	3 200 (14 240)			3 680 (16 370)		4 750 (21 130)	4 750 (21 130)	4 750[A] (21 130)	6 135 (27.295)	6 750 (30 025)	6 750 (30 025)
2 (50.80)										10 600 (47 150)	10 600 (47 150)

[A] Heavy-duty, or heavy-duty/high elongation.

TABLE 4 Type 1 Extra-Heavy-Duty (USLM) Strapping Widths, Thickness, Breaking Strengths, and Minimum Seal Joint Strengths

Width, in. (mm)	Thickness, in. (mm)	Min. Break Strength, lb (N)	Min. Seal Joint Strength, lb (N)
1¼ (31.75)	0.044 (1.12)	8500 (37 800)	7650 (34 000)
1¼ (31.75)	0.050 (1.27)	9700 (43 150)	8730 (38 800)
1¼ (31.75)	0.057 (1.45)	11 000 (48 430)	9900 (44 000)

7.1.4 *Type I USLM Strapping*—USLM strapping in Table 4 shall be cold-rolled, high-carbon steel that has been fully heat-treated, austenized, and quenched.

7.1.5 *Type 2 Nail-On Strapping*—Unless otherwise specified, Type 2 nail-on strapping shall be strapping made from Type 1 regular-duty, regular-duty high-strength or Type 1 heavy-duty strapping, available in sizes ⅝ in. (15.87 mm) in width or greater with punched nail holes. Hole diameters and hole spacing can vary depending upon strap size and duty, which shall be in accordance with manufacturer's standard practice. However, nail holes shall be spaced at intervals no more than 3 in. (76 mm) apart.

7.1.6 *Seals for Type 1 Strapping* —Unless otherwise specified, seals for Type 1 strapping shall be made of steel in accordance with the manufacturer's commercial practice.

8. Physical and Mechanical Properties

8.1 *Breaking Strength and Elongation, Type 1 Regular-Duty, Regular-Duty High-Strength, Heavy-Duty, and USLM Strapping :*

8.1.1 *Breaking Strength*—The breaking strength of the strapping shall be as shown in Table 1, Table 2, Table 3, and Table 4 when tested as specified in 13.3.

8.1.2 *Elongation*—The elongation in 6 in. (152 mm) for Type 1 strapping, when tested as specified in 13.4, shall be as follows:

TABLE 5 Number of Feet Per Pound (Metres per Kilogram) of Type 1 Strapping[A]

NOTE 1—Number of feet per pound (metres per kilogram) is based on nominal dimensions and will vary slightly with the width and thickness of the strapping within the tolerances as described in 8.2.

Width, in. (mm)	Thickness, in. (mm)														
	0.010 (0.25)	0.012 (0.311)	0.015 (0.38)	0.018 (0.46)	0.020 (0.51)	0.022 (0.56)	0.023 (0.58)	0.025 (0.64)	0.028 (0.71)	0.029 (0.75)	0.031 (0.79)	0.035 (0.89)	0.040 (1.02)	0.044 (1.12)	0.050 (1.27)
	Length per Unit Mass, ft/lb (m/kg), approximate														
⅜ (9.52)	78.5 (52.7)	65.4 (43.9)	52.4 (35.2)	43.6 (29.3)	39.3 (26.4)		34.1 (22.9)								
½ (12.70)	58.9 (39.6)	49.1 (33.0)	39.3 (26.4)	32.7 (22.0)	29.4 (19.7)		25.6 (17.2)				19.0 (12.7)				
⅝ (15.87)	47.1 (31.6)	39.3 (26.4)	31.4 (21.1)	26.2 (17.6)	23.6 (15.8)		20.5 (13.7)								
¾ (19.05)			26.2 (17.6)		19.6 (13.1)	17.8 (11.9)	17.1 (11.5)	15.7 (10.5)	14.0 (9.4)	13.5 (8.95)	12.7 (8.5)	11.2 (7.5)			
1 (25.4)										10.1 (6.7)	9.5 (6.3)				
1¼ (31.75)					11.8 (7.9)			9.4 (6.3)		8.1 (5.5)	7.6 (5.1)	6.6 (4.4)	5.9 (4.0)	5.3 (3.5)	4.7 (3.1)
2 (50.80)														3.3 (2.2)	2.9 (1.9)

[A] Commercial tolerances apply.

TABLE 6 Size of Coils and Package

Type Coils	Size of Strapping, in. (mm)	Inside Diameter, in (mm) (Commercial Tolerance)	Outside Diameter, max, in. (mm)	Coils Per Package, max	Coil Face Width	Coil Weight
Oscillated	⅜ by 0.015 (9.52 by 0.38) through ¾ by 0.035 (19.05 by 0.89)	16 (406)	23½ (597)	1		
Ribbon	¾ by 0.022 (19.05 by 0.56) through ¾ by 0.035 (19.05 by 0.89)	16 (406)	27 (686)	1		
Ribbon	1 by 0.029 (25.4 by 0.75) through 1 by 0.031 (25.4 by 0.79)	16 (406)	27 (686)	1		
	1¼ by 0.020 (31.75 by 0.51) through 1¼ by 0.057 (31.75 by 1.45)	16 (406)	27 (686)	1		
	2 by 0.044 (50.80 by 1.12) through 2 by 0.050 (50.80 by 1.27)	16 (406)	25⅞ (657)	1		
Jumbos	⅜ by 0.015 (9.52 by 0.38) through 1 ¼ by 0.044 (31.75 by 1.12)	16 (406)	in accordance with manufacturers commercial practice	1	3 in. to 16 in.	350 lb. to 4000 lb.

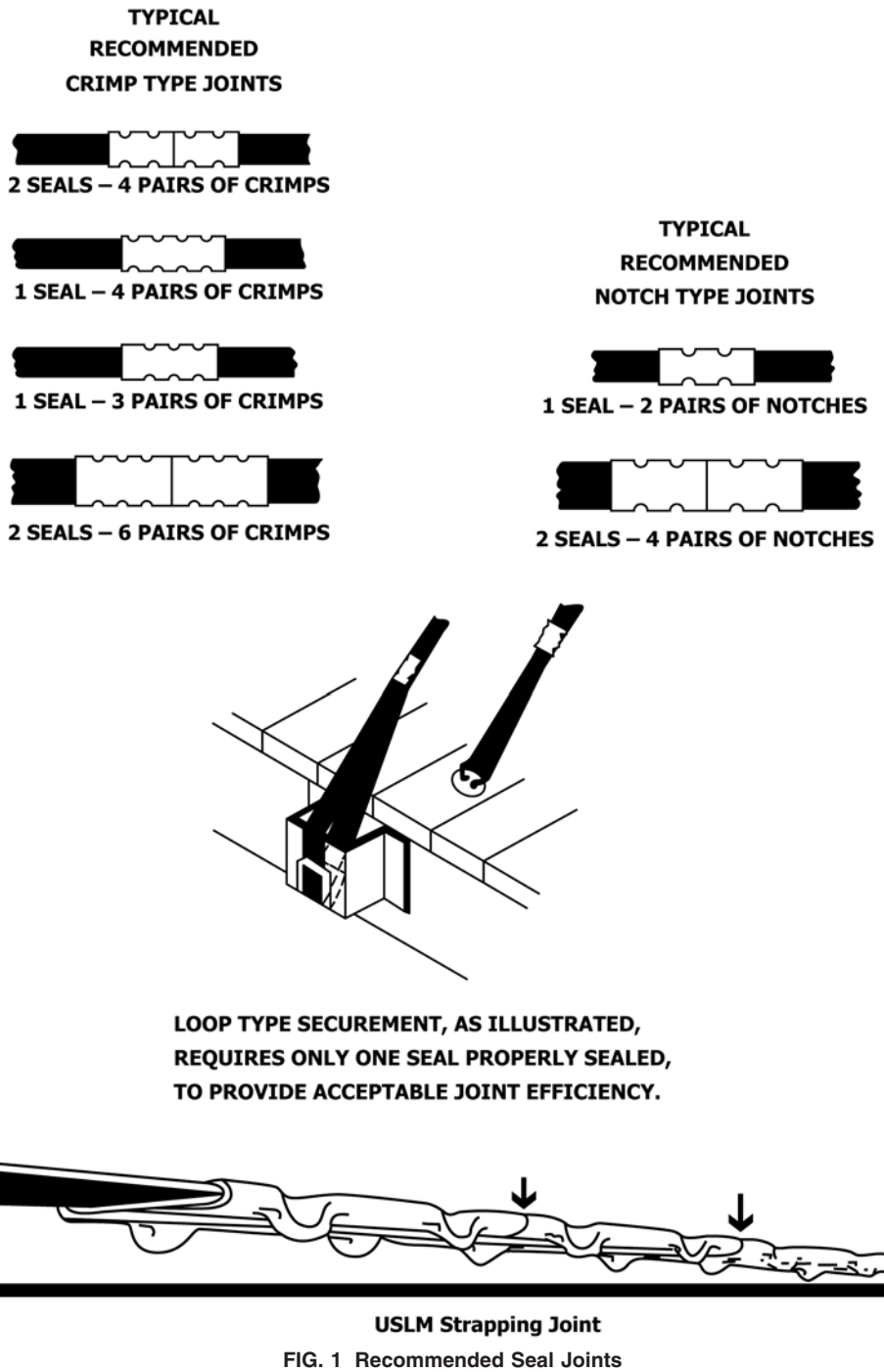

FIG. 1 Recommended Seal Joints

Regular-duty (see 7.1.1)	0.5 to 4.0 %
Regular-duty high-strength (see 7.1.2)	0.5 to 8.0 %
Heavy-duty (see 7.1.3)	
Thickness less than 0.031 in. (0.79 mm)	5.0 to 12 %
Thickness 0.031 in. (0.79 mm) and greater	6.5 to 12 %
USLM Strapping (see 7.1.4)	6.0 to 12 %

8.2 *Tolerances, Type 1 Strapping, Widths*—The widths of the strapping shall not vary from that shown in Table 1, Table 2, and Table 3 by more than ±0.005 in. (0.13 mm) for all cold-rolled strapping.

8.2.1 *Type 1 Strapping, Thickness* —The thickness of strapping sizes listed in Table 1, Table 2, and Table 3 shall not vary from nominal thickness by more than +0.002 in. (0.05 mm), –0.002 (0.05 mm) thickness, thickness of strapping sizes listed in Table 4 (USLM strapping) shall not vary by more than +0.004 in. (0.10 mm) and –0.000 in. (0.00 mm).

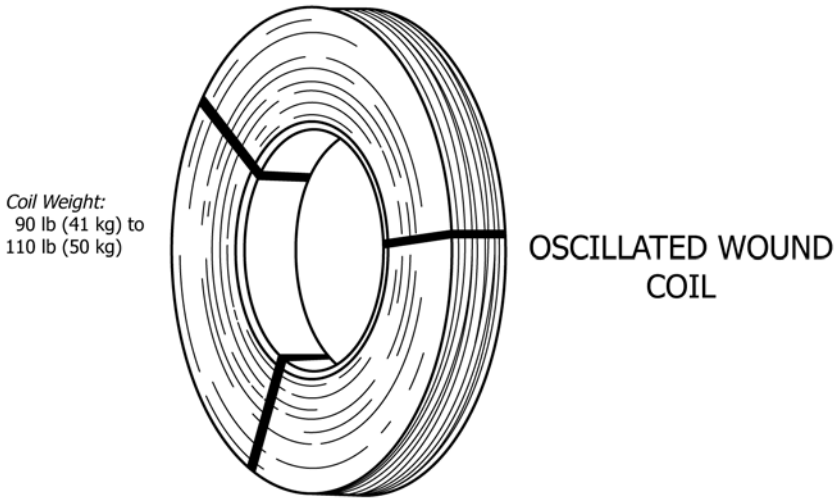

FIG. 2 Oscillated Wound Coil

8.3 *Lubrication*— Unless otherwise specified, Type 1 strapping shall have a coating of wax or wax-like lubricant applied to the surfaces that will render the strapping suitable for application with tension tools of the feed wheel (friction) type (see 4.1.2 and 6.1.4). The lubrication of the strapping is intended to facilitate the use of strapping tools in which the two bands of the strapping are held in contact with each other under pressure by frictional grips, and sliding of the faces of the strapping is necessary during the tensioning operation. Test in accordance with 13.10.

8.4 *Type 1 Strapping, Coils*—Each coil shall consist of one continuous piece of strapping. Coils with lengths of strapping welded together shall be considered as one-piece coil.

8.4.1 *Dimensional Requirements at the Weld*—The thickness at the weld shall be no more than one and one half the thickness of the strap. The width of strapping at the weld shall be subject to the same dimensional requirements as the remainder of the strapping and must be straight with no offsets or angular alignment.. Metal splattering or extruded points causing increased thickness are not permissible. Only machine welds shall be acceptable.

8.4.2 *Weld Efficiency*— Strength of manufacturer's process welded joints in coils of strapping shall have a joint efficiency of not less than 75 % based on the breaking strength shown in Table 1, Table 2, and Table 3 when tested as specified in 13.6. USLM strapping must not contain production welds.

8.5 *Identification Marking*—Each coil of AAR approved Type 1 heavy-duty, ½-in. (12.7-mm) wide by 0.020 in. (0.51 mm) in thickness and greater strapping shall be marked in accordance with the Association of American Railroads General Rule 17 and Rule 117. Each coil of USLM strapping shall be marked in repeating intervals of 18 in. (457 mm) to 40 in. (1016 mm) with identifying circles as follows:

Width	Thickness	Identification Marking
1¼ (31.75)	0.044 (1.12)	00
1¼ (31.75)	0.050 (1.27)	000
1¼ (31.75)	0.057 (1.45)	000M

8.5.1 The thickness and minimum breaking strength and name of the manufacturer of the strap shall be marked by circles or circles plus the letter "M".

8.5.2 The circle diameter shall be a minimum of 0.80 in. (20 mm) to a maximum of 1.0 in. (25.4 mm) diameter.

8.5.3 Seal identification mark must be visible when seal is applied and while seal is in use.

8.6 *Type 2 Strapping:*

8.6.1 *Breaking Strength*—The breaking strength for Type 2 strapping shall be the same as shown in Table 1, Table 2 or Table 3 for the applicable strapping size and type, but shall be based on the cross-sectional metal area of the strapping taken across the hole. Breaking strength will be reduced proportionally in accordance with nail hole diameter.

8.6.2 *Tolerances*—The tolerances on width and thickness for Type 2 strapping shall be the same as for Type 1 strapping (see 8.2).

8.7 *Seals, Type 1 Strapping*—Seals intended for Type 1 strapping shall be made of steel to manufacturer's commercial practice. Seal lengths shall be adequate for a single-notch joint (one pair of cut notches), a double-notch joint (two pairs of cut notches), a double-crimp joint (two pairs of crimps), a triple-crimp joint (three pairs of crimps), or a quadruple-crimp joint (four pairs of crimps). Unless otherwise specified, seals shall be suitable in size or design to satisfy the requirements of 8.9.2 and 8.9.3.

8.7.1 *Seal Width*—Seal width shall be adequate to allow the seal to slip on the applicable strapping and shall be compatible with the sealing tool used to provide the required joint strength.

8.7.2 *Seals, Regular-Duty High Strength, Heavy-Duty and USLM,* Seals shall be in thickness and hardness suitable for use with the type of strapping to which they are applied. USLM strapping seals are to be marked in accordance with 8.5.

8.8 *Application of Seals:*

8.8.1 *Style I*—Style I seals shall have one or both sides open so that the seal shall slip in the overlapping bands of strapping either during or after tensioning the strapping.

8.8.2 *Style II*—Style II seals shall have sides partially closed at the bottom of the seal so that this seal shall be pre-threaded with the overlapping bands of strapping before the tensioning tool is applied.

8.8.3 *Style III*—Style III seals shall have the sides completely closed by overlapping at the bottom of the seal so that pre-threading with the overlapping bands of strapping and bending of the bottom strap under the seal can be accomplished. The seal shall permit the tensioning tool to tension the strapping as the tool butts against the seal.

8.8.4 *Style IV*—Style IV seals shall have sides opened to allow nesting and stacking of the seals for hand or power tools with magazine feed. Seals shall fit and form joints with the seal manufacturer's tool model as specified (see 6.1.4). Means provided on Style IV seals to facilitate stacking are acceptable.

NOTE 2—Style IV seals are commonly designed for use with the seal manufacturer's tool and are not adaptable for other manufacturer's tools.

8.8.5 *Style V*—Style V seals shall have one or both sides open so that the seal shall slip on the crossing bands of strapping either during or after tensioning of the straps.

8.9 *Sealed Joints:*

8.9.1 *Fastening Flat Steel Strapping* —The various methods of fastening flat steel strapping in use commercially are notched seal joints, crimped seal joints, and sealless joints made by die cutting or spot welding the overlapping ends of the strapping. These methods are acceptable provided that the joint made meets the efficiency requirements, as follows:

8.9.2 *Notch Joints,* Notch-type seal joints made with hand tools, power hand tools, or power strapping machines recommended by the supplier, shall be made on applicable strapping, without cracking and tearing of the seal metal. Notched seal joints are usually intended for use with lubricated (waxed) strapping. Notched seal joints when used with Type 1 regular-duty strapping and regular-duty high-strength, or Type 1 heavy-duty strapping must have a minimum joint strength of 75 % for double-notch joints and 45 % for single-notch joints. Joint strength is based on the minimum breaking strength of the applicable strapping size as shown in Table 1, Table 2 and Table 3 when tested as specified in 13.5. Examples of notch-type seal joints are shown in Fig. 3.

8.9.3 *Crimp Joints*— Crimp-type seal joints, made with hand tools or power hand tools, shall be made on applicable strapping without cracking and tearing of the seal metal. Crimped seal joints are usually intended for use with dry Type 1 heavy-duty or USLM strapping, primarily where severe impact or heavy stresses on the strap and joint may be encountered. Crimp joints may also be used with lubricated (waxed) strapping, provided the loss in friction is compensated for by adding sufficient additional seals and crimps, or by using "Grit"-type friction seals. Crimp seal joints when used with Type 1 heavy-duty (high-tension) strapping in sizes 1¼ (31.75 mm) wide by 0.025 in. (0.64 mm) or greater must have a minimum joint efficiency of 75 % based on the minimum breaking strength of the applicable strapping size as shown in Table 3 when tested as specified in 13.5. Crimp seal joints must always be used with Type 1 USLM strapping and must have a minimum joint efficiency of 90 % based on the minimum breaking strength of the applicable strapping size as shown in Table 4. USLM strapping lifting capacity is determined by many factors. Achieving the specified minimum joint strength is, by itself, not sufficient to ensure a safe lifting method. Refer to manufacturer's guidelines for designing lifting. Examples of crimp-type seal joints are shown in Fig. 1.

8.9.4 Test seal joint efficiency periodically on both notch- and crimp-type joints to ensure that the seal and sealer combination provides the desired joint strength.

8.9.5 Die-cut sealless joints shall have a minimum joint efficiency of 75 % based on the minimum breaking strength of the applicable strapping size as shown in Table 1, Table 2 or Table 3, when tested as specified in 13.5. For exceptions, see AAR General Rules 17.

8.9.6 Spot-welded sealless joints shall have a minimum joint efficiency of 75 % based on the breaking strength of the applicable strapping size as shown in Table 1, Table 2 or Table 3, when tested as specified in 13.5.

8.9.7 *Loop Joints* shall be tested as specified in 13.7.

8.10 *Galvanized Strapping*—Finish B galvanized strapping shall have the following minimum coating weights or thicknesses, or both, when tested as specified in 13.8 (see 10.2.3 and Table 7).

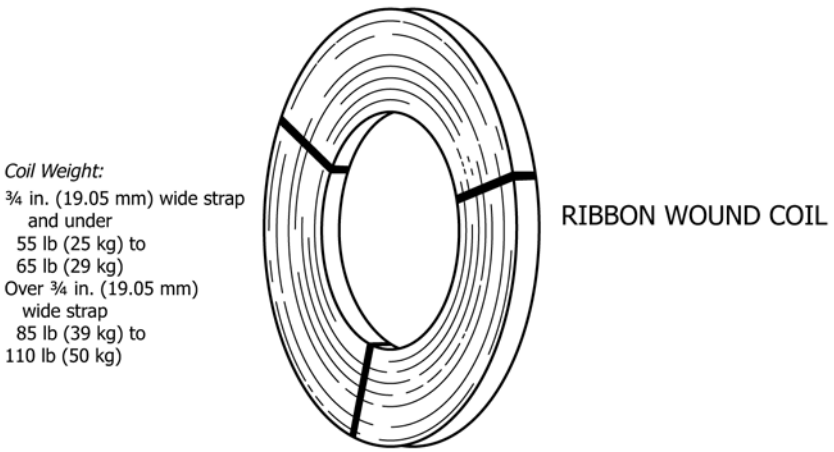

FIG. 3 Ribbon-wound Coil

TABLE 7 Mass Loss of Zinc Coating

Strapping Width		Minimum Mass Loss, mg/6-in. (152-mm) Specimen		
in.	(mm)	Grade 1	Grade 2	Grade 3
⅜	(9.52)	263	158	53
½	(12.70)	350	210	70
⅝	(15.87)	438	262	87
¾	(19.05)	525	315	105
1	(25.40)	700	420	140
1¼	(31.75)	875	525	175
2	(50.8)	1400	840	280

Grade 1—0.30 oz/ft^2 (92 g/m ^{2}) of surface or 0.0005 in. (0.013 mm) thick.

Grade 2—0.18 oz/ft^2 (55 g/m ^{2}) of surface or 0.0003 in. (0.008 mm) thick.

Grade 3—In accordance with manufacturer's commercial practice but no less than 0.06 oz/ft^2 (18 g/m^2) of surface or 0.0001 in. (0.003 mm) thick.

8.10.1 Edges of Grades 1, 2, and 3 shall not show signs of copper sulfate when tested in accordance with 13.11.

8.11 *Ductility of Strapping Coating* —Finish A, painted finish, Finish B, galvanized, Finish C, metallic-filled strapping shall not crack or flake on the outside of the bent portion, except that cracks on the strapping shall be disregarded within a distance from the edge of the strapping equal to one fourth of the width when tested as specified in 13.9.

8.12 *Base Metal Ductility (Bend Test)*—Strapping of various thicknesses shall withstand the minimum number of bends in one area as shown in Table 8. The test procedure is described under 13.2, and shall be conducted on the final finished product. This requirement does not apply to USLM strapping.

8.13 *Straightness—Type 1 Strapping :*

8.13.1 *Camber*—Camber in the strapping shall not be more than ½ in. (12 mm) in any 8-ft (2.4-m) length, when measured in accordance with Specification A109/A109M, Table 10.

8.13.2 *Coil Set (Bundle Curve)*—Strap ends shall not rise from horizontal flat plain more than 2 in. (50.8 mm) in any 8-ft (2.4-m) long section of strap.

TABLE 8 Metal Bend Test Requirements for Strapping

Thickness		Number of Bends
in.	(mm)	
0.010	(0.25)	15
0.012	(0.31)	12
0.015	(0.38)	12
0.016	(0.41)	10
0.017	(0.43)	10
0.018	(0.46)	10
0.020	(0.51)	8
0.022	(0.56)	6
0.023	(0.58)	6
0.025	(0.64)	6
0.028	(0.71)	5
0.029	(0.75)	5
0.031	(0.79)	5
0.035	(0.89)	5
0.040	(1.02)	3
0.044	(1.12)	3
0.050	(1.27)	3
0.057	(1.45)	3

8.13.3 *Spiral Twist (Cork Screw Effect)* —Twist must not exceed 20° in any 8 ft (2.4 m) long section of strap, when laid on horizontal flat surface.

9. Coil Configuration and Permissible Weight Variations

9.1 *Type 1 Coils*— Type 1 and Type 2 strapping shall be oscillated (mill)-wound coils weighing not less than 90 lb (41 kg) or more than 110 lb (50 kg) (see Fig. 2) or jumbo oscillated coils (see Fig. 4) weighing not less than 350 or more than 4000 lbs and ribbon-wound coils (see Fig. 3) weighing not less than 55 lb (25 kg) nor more than 110 lb (50 kg) when put up as specified in Table 6. Oscillated- and ribbon-wound coils of strapping are used in different types of dispensers.

9.2 *Type 1 Core Liners*—Type 1 strapping in oscillated-wound coils shall be wound on core liners. Strapping in ribbon-wound coils shall not require core liners.

9.3 *Type 2 Coils*— Type 2 strapping shall be in small or large coils. Small coils shall be in one piece, not less than 200 ft (61 m) or more than 400 ft (122 m) in length and supplied in individual dispensing cartons. Large coils, oscillated (mill) wound, shall weigh no less than 90 lb (41 kg) nor more than 110 lb (50 kg), and large coils, ribbon wound, shall weigh not less than 50 lb (23 kg) nor more than 125 lb (57 kg) when put up as specified in Table 6.

10. Workmanship, Finish, and Appearance

10.1 *Type 1 Strapping and Seals* —Strapping shall be straight, smooth, and clean and shall be free of kinks, grooves, waves, edge curvature, indentations, excessive oil, and cracks. Seals shall be free of dents, burrs, and slivers, and not be deformed.

10.1.1 *Style of Edges*— Edges of Type 1 strapping shall be as cut, milled, or formed in accordance with current commercial practice and shall be free of sharp edges, burrs, and slivers prior to the finish application.

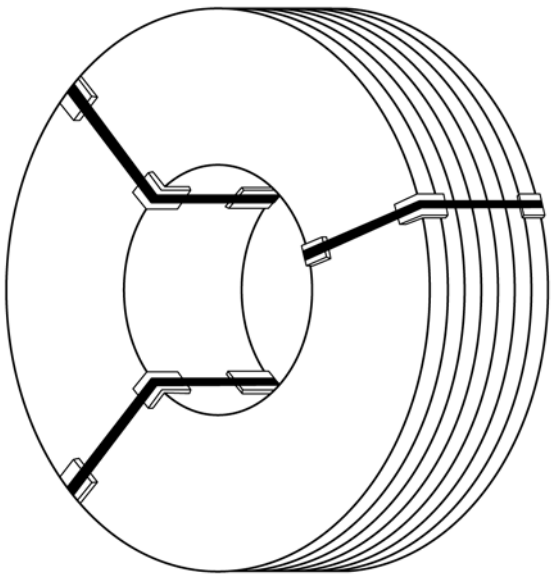

FIG. 4 Jumbo Oscillated Coil

10.2 *Strapping Finish*— The finished coat of the strapping shall be adherent, free of scratches, runs, embedded foreign matter, uncoated areas, rust areas, or loose oxide scale.

10.2.1 *Finish A or C*— Finish A strapping shall have surfaces and edges coated with an organic coating that shall yield a film as specified in 10.2. On Types 1 and 2, cut-to-length strapping, cuts or nail holes or slots, or combination thereof, may be made after the application of the finish coating.

10.2.2 *Finish B*—Finish B strapping shall have surfaces and edges coated with zinc by either the hot-dipped or electro-deposit process (see 8.10 and 10.2.3).

10.2.3 *Finish B Galvanized Strapping* —The choice between Grades 1, 2, or 3 Finish B, galvanized strapping should be guided by the service expected, considering that the protection afforded by the coating is proportional to the weight of the coating. Grades 1 and 2 Finish B zinc-coated strappings are commonly referred to as government-grade galvanized coating, and Grade 3 having a lighter zinc coating is referred to as commercial-grade galvanized strapping (see 8.10).

10.2.4 *Finish D (Uncoated Strapping)* —Finish D strapping shall be finished a natural black or blued, browned, or bright, as resulting from the manufacturing process. Surfaces shall be lubricated as indicated in 8.3 unless otherwise specified.

10.3 *Seal Finish*— The finished coat of the seal shall be adherent, free of scratches, runs, embedded foreign matter, uncoated areas, rust areas, or loose oxide scale. Edges on the seals are bright unfinished metal as a result of the manufacturing process.

10.3.1 *Finish A*—Unless otherwise specified (see 5.1.2), seals shall be finished in accordance with the manufacturer's commercial practice. The outer surface of the seal shall be coated with an organic coating that shall yield a film as specified in 10.2.

10.3.2 *Finish B*—Galvanized seals, Grades 1 and 2, shall be coated as specified in 8.10. Grade 3 galvanized seals shall be coated in accordance with manufacturer's standard commercial practice.

10.3.3 *Finish C*—Seals shall be finished a natural black or blued, browned or bright, as resulting from the manufacturing process.

10.3.4 *Finish D*—Uncoated (bright).

11. Sampling Plan

11.1 Unless otherwise specified in contract or order, sampling for acceptance inspection and testing by attributes shall be performed in accordance with applicable provisions set forth in MIL-STD-105, Tables I and II-A. Inspection levels and acceptable quality level (AQL) as listed in Table 9 of this document apply.

TABLE 9 Single Sampling Plan for Normal Inspection

Properties & Attributes[A]	Rate of Sampling	Acceptable Quality Level
8.1 through 8.13.3	S-2	6.5 %
9.1 through 9.3	Level I	4.0 %
10.1 through 10.3.3	Level I	4.0 %

[A] References are made to paragraphs in this specification.

11.2 *Lot Size*—The lot size shall consist of all product from a specific production run, or that amount offered for acceptance at one time as applicable. In the case of strapping, it shall be of one class, type, finish, grade, duty, and size. In the case of seals it shall be of one type, style, class, finish, and width.

11.3 *Unit Sample*— One coil or one seal shall be considered a unit. Examination of a coil for imperfections, as applicable, shall be made on eight consecutive feet (2.5 m) of the coil, provided that the condition of the remainder of the coil is representative of the length of strap inspected. The test specimen of strapping can be taken from either end of the coil. When the rest of the coil is not representative, examination for permissible number and strength of welds, as applicable, shall be made on the entire length of the coil regardless of the condition of the coil.

11.4 *Rate of Sampling*— The rate of sampling shall be in accordance with Table 9, excerpted from applicable portions of MIL-STD-105. Similarly, the acceptable quality level (AQL) shall be as indicated in Table 9.

11.5 *Product Quality*— A supplier shall be responsible for providing product at a quality level that shall meet the requirements of this specification, or an equivalent as agreed upon between purchaser and seller as part of the order of contract. The purchaser does reserve the right to perform any inspections as deemed necessary to assure supplies and services conform to preestablished requirements.

12. Number of Tests and Retests

12.1 *Acceptance Tests*— For the determination of break strength, elongation, ductility, joint efficiency, and coating tests, a single specimen shall be considered a complete test of a unit sample.

12.2 *End-Use Testing*— Where field activities require testing to ensure compliance with Tables 1-4, the average of test values from three strap (or sealed-joint) specimens of sufficient size are required.

12.3 *Retests*—When determining break strength, elongation, or joint efficiency, a retest shall be permitted if the location of strap failure is outside the 6-in. (152-mm) gage length, or within 1 in. of the holding jaws, or both.

13. Test Methods

13.1 *Dimensions and Weight*—Examine the end item to determine compliance with dimensional, weight, and tolerance requirements. Determine dimensions on flat strapping on base metal after the paint, wax, zinc, or oxide scale has been removed. Any nonconforming dimensions or weight shall be so classified.

13.2 *Metal Bend Test for Strapping* —Fasten a test specimen from a sample unit of strapping in the jaws of a vise and bend by hand over a radius of ⅛ ± 1/64 in. (3.18 ± 0.40 mm). Formed edges may be removed before testing. One bend shall consist of a 90° bend in one direction and return to the original position. Make successive bends in opposite directions. Disregard cracking or flaking of the coating during testing. Strapping of the various thicknesses shall withstand the minimum

number of bends in one area, as shown in Table 8. The inability of the strapping to make the minimum bends before breaking into two pieces shall constitute failure of this test. Test with the final finished product.

13.3 *Breaking Strength of Strapping*— Measure breaking strength on a tension tester capable of load accuracies to within ±1 %. Select the load range in which the point of maximum force will fall between 10 and 95 % of full scale. The test specimen should be approximately 12 in. (305 mm) in overall length, but not less than 8 in. (203 mm) and shall not contain a manufacturer's process weld (see 8.4.1). If elongation is also to be measured, a series of transverse scribe marks shall be placed along the length of specimen at 1-in. intervals in sufficient number to ensure breakage of specimen occurs within a scribed 6-in. (152-mm) length. Place the test specimen in the tension machine so that there is at least a 6-in. (152-mm) gage length centered between the jaws of the clamping device. Use suitable clamping arrangements to minimize slippage or breakage within the clamps. Make manual adjustments to remove slack before the tester is activated. Conduct the test using a maximum crosshead separation speed of 2½ in./min (64 mm). Read the maximum force required to break the strap. Discard all data when the break occurs within 1 in. (25 mm) of the clamp and retest in accordance with 12.3.

13.4 *Elongation of Strapping*—Measure percent elongation at break at the time as the breaking strength and using the same procedure (see 13.3). Elongation is the *permanent* increase in length which results from the breaking strength test. Place the test specimen in the tension machine so that a 6-in (152-mm) section between gage marks is centered between the clamps. After the break, the two parts of the specimen are removed from the clamps, placed on a flat surface, and carefully joined together at the break point. The distance between the gage marks is measured using an accurate scale or vernier. The distance between gage marks is measured using a scale marked in 0.01-in. (0.25-mm) increments, and read to the nearest 0.01 in. Percent elongation is defined as the length between gage marks after the test minus the original length (6 in.) divided by the length before the test, multiplied by 100. Discard all test results where the break occurs within 1 in. (25 mm) of a gage mark, and retest in accordance with 12.3.

13.5 *Joint Strength as Percent of Breaking Strength:*

13.5.1 *Method of Joining by Seals* —Make a seal joint with a sample seal with a single or double notch, or double or more crimps as applicable, joining the two pieces of Type 1 strapping. Check the joint to determine compliance with the joint-making requirements (see 8.9).

13.5.2 *Determination of Joint Strength* —Determine seal joint strength by the same procedure used for determining breaking strength (see 13.3). The sealed joint is to be positioned midway between the holding jaws. The maximum force can be read directly from the indicating device to the nearest scale division.

13.5.3 *Determination of Percent of Breaking Strength*— Determine percent of breaking strength by dividing the seal joint strength value by the minimum breaking strength in accordance with strapping type and size tested and multiplying by 100 (see Table 1, Table 2, Table 3 and Table 4).

13.6 *Determination of Welded Joint Strength*—Determine welded joint strength for manufactured process welds with Type 1 strapping by the same procedure used for determining breaking strength (13.3), except that joint efficiency shall be equal to the ratio of minimum breaking strength of the strapping multiplied by 100.

13.7 *Determination of Loop Joint Strength*—Cut the loop to form an overlap joint before testing. Test in accordance with 13.5.

13.8 *Galvanized Coating:*

13.8.1 *Weight Loss Test*— Test a 6-in. (152-mm) test specimen from a sample unit of Finish B strapping in accordance with Test Methods A90/A90M for loss of coating weight. Loss of weight less than that shown in Table 7 applicable to strapping width shall constitute failure of the specimen to meet the zinc coating requirements of 8.10.

13.8.2 *Thickness Test*— Test a 6-in. (152-mm) test specimen from a sample unit of Finish B strapping for thickness of zinc coating in accordance with Test Method B504, or the magnetic gage or eddy-current method shall be permitted with proper calibration.

13.9 *Ductility Test, Coating*—Test a 12-in. (304-mm) test specimen from a sample unit of strapping for ductility of coating to determine compliance with 8.11. Determination of cracking or flaking of coating shall be by visual examination without magnification. Perform the tests in accordance with Practice D4332. Take care during the tests to avoid scratching or abrading the coating in the area of the bend. Perform the tests as follows:

13.9.1 Bend strapping 0.025 in. (0.64 mm) thick or less cold conditioned, once through 180°, over two thicknesses of the strapping material. Use vise with smooth jaws for this test.

13.9.2 Bend strapping 0.028 through 0.057 in. (0.71 through 1.45 mm) thick, once through 180°, over the rounded end of a steel plate of convenient size and a thickness within ±1/64 in. (0.40 mm) of that shown in Table 10. Bend by clamping the specimen against the plate in a vise, bending the specimen slowly by hand over the rounded end of the plate as far as possible, then completing the bend by inverting the plate and specimen and tightening the vise until the specimen is tight against the plate.

13.10 *Lubrication Test*— To determine an acceptable level of lubrication, apply the straps to a rigid work bench or fixture using the manufacturer's recommended strapping and feed

TABLE 10 Thickness of Steel Plate for Bend Test Fixture

Strapping Thickness		Plate Thickness			
		Finish A Strapping		Finish B Strapping	
in.	(mm)	in.	(mm)	in.	(mm)
0.028	(0.71)	3/8	(10)	3/16	(5)
0.029	(0.75)	3/8	(10)	3/16	(5)
0.031	(0.79)	3/8	(10)	3/16	(5)
0.035	(0.89)	3/8	(10)	3/16	(5)
0.040	(1.02)	½	(12)	3/16	(5)
0.044	(1.12)	½	(12)	3/16	(5)
0.050	(1.27)	½	(12)	3/16	(5)
0.057	(1.45)	½	(12)	3/16	(5)

wheel tensioner (see Guide 4675D4675, Paragraph 15.3, Fig 6) capable of measuring tension, such as a tensiometer spring loaded scale, load cell, etc. The straps shall have a capability of being tensioned to the percent of rated breaking strength of the strapping as shown below, and should tension smoothly without binding (see 8.3):

50 %—All sizes of Type 1 regular-duty and regular-duty high-strength strapping (see Table 1 and Table 2).

40 %—Type 1 heavy-duty strapping up to and including ¾ by 0.028 in. (19.05 by 0.71 mm) (see Table 3).

30 %—Type 1 heavy-duty strapping ¾ by 0.029 in. (19.05 by 0.75 mm) (see Table 3). Larger sizes, for which feed wheel type tensioning tools may be unavailable, and strap finishes are ordered and supplied without lubrication coating, are exempt from the lubricity test.

30 %—Type 1 USLM strapping 1¼ (31.75 mm) by 0.0044 in. (1.12 mm) to 1¼ (31.75 mm) by 0.057 in. (1.45 mm).

13.11 *Edge Test*—Test a sample unit of Finish B galvanized-coated strapping in accordance with Test Method A239 for the presence of zinc coating and absence of copper sulfate on the edge; use two Preece test dips for Grade 1 and one Preece test dip for Grades 2 and 3 (see 8.10). Nonconformance to the requirements shall constitute failure of the test.

14. Precision and Bias

14.1 *Interlaboratory Test Program* —An interlaboratory study (ILS) of dimensional readings, break strength and elongation for flat steel strapping was run in 1994. Each of ten laboratories provided 27 test results each from measuring steel strapping dimensions, nine test results each from strapping break strength and elongation tests, of three different test materials. One regular duty strap size and two heavy duty strap sizes were used to conduct the ILS. The design of the experiment-similar to that of Practice E691, and within-between analysis of the data are given in an ASTM research report.[5]

14.2 *Test Result*— The information given in Appendix X1 has been calculated for the comparison of three test materials, each of which is the average of 27 test determinations for gage and width and 9 test determinations for break strength and elongation.

14.3 *Precision*—See Appendix X1.

14.4 *Bias*—No information can be presented in the bias of the procedure in Section 13, measuring break strength, elongation, gage and width, because no material having an accepted reference value is available.

15. Rejection and Retesting

15.1 Any coil of strapping (or specimen of seals) that fails to meet the test requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may request retesting (see 12.3).

[5] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D10-1009.

16. Certification

16.1 At the time of shipment when specified in the contract or order, the manufacturer shall certify that the end product complies with the requirements of this specification.

17. Overseas/Waterproof Packaging

17.1 *Strapping*—Type 1 and Type 2 strapping, oscillated- or ribbon-wound as specified (see 9.1) shall be wrapped or unit packed in sizes and quantities shown in Table 6.

17.1.1 *Wrapping*—Each coil or multiple of coils of Types 1 and 2 strapping, as specified in Table 5, shall be spiral-wrapped with paper by means of a coil-wrapping machine using tensioning and edge-folding device. Wrapping paper shall be either crepe or hard-sized noncreped paper at the discretion of the supplier (see Fig. 4). Alternatively, for protection instead of wrapping, Types 1 and 2 heavy-duty strapping, in ribbon-wound coils only (when stacked on a skid or platform), shall be capped with a waterproof reinforced paper as shown in Fig. 5.

17.1.1.1 *Creped Material*— Each coil that is wrapped in accordance with 17.1 shall be spiral-wrapped with 45/40/30 duplex reinforced waterproof kraft paper. The paper shall consist of two sheets of kraft paper, 45 lb (20.4 kg) and 30 lb (13.6 kg) basis weight per ream of 500 sheets 24 by 36 in. (6 ft ^{2} or 0.557 m^2 per sheet), respectively, laminated together with asphalt in which are embedded reinforcing cords or strands of fiber running in the machine direction of the paper, not more than ⅜ in. (9.52 mm) apart, having the 45-lb (20.4-kg) sheet saturated, coated, or infused with asphalt. Creping shall be in the machine direction. The minimum construction before creping shall be 45/40/30 when applying the paper. The tension shall be adjusted so that not over 8 % stretch will be left in the paper. The edge-folding device shall fold either one or both edges of the web of paper to give a rolled edge with a minimum of two thicknesses. Each wrap shall overlap each preceding layer of wrap at least 50 %. The saturated, coated, or infused 45-lb (20.4-kg) kraft shall be on the outside of the wrapped coil or coils. Wrapping shall be accomplished in such a manner as to provide a neat and compact unit pack (see Fig. 4).

17.1.1.2 *Hard-Sized Noncreped Materials* —Alternatively, each coil that is wrapped in accordance with 17.1 shall be spiral-wrapped using a hard-sized noncreped paper 2½ in.

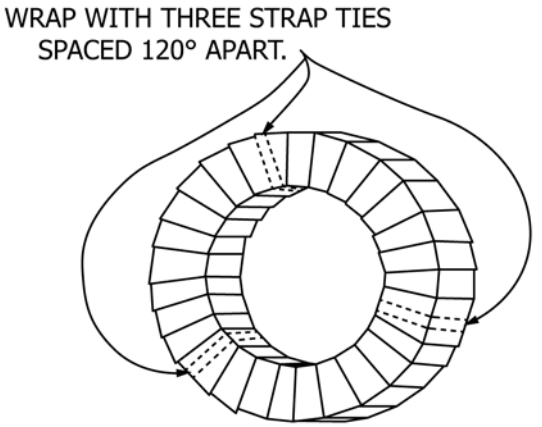

FIG. 5 Wrapping and Tie Straps

(63.5 mm) wide, having a basis weight per ream of 500 sheets 24 by 36 in. (6 ft^2 or 0.557 m^2) of 105 lb (47 kg) ±5 lb (2.3 kg). The paper may be of natural kraft color. The dry tensile strength shall be 105 lbf (467 N)/1 in. (25.4 mm) of width in the machine direction with a tolerance of ±5 lbf (22 N). The wet tensile strength shall be not less than 25 lbf (111 N)/1 in. of width in the machine direction when measured under standard laboratory conditions after 20-min immersion. In applying this material, the individual turns of the spiral wrapping shall be held under tension by spot gluing at intervals along the length of the spiral wrapping in such a way that each individual turn is firmly adhered to the preceding turn in several places along the circumference of each turn. Wrapping material shall be fed into the coil-wrapping machine in continuous strips 2½ in. (63.5 mm) wide. The strips, when glued in cross sections, shall resemble a modified letter *S*, with ¼ in. (6.3 mm) of material folded back on itself 180° along the entire length of each edge. The exposed edge of the wrap shall be folded under. The edges of the wrapping material shall be a maximum of ¾ in. (19.05 mm) apart on the outer circumference of the coil. The use of three equally spaced steel straps on the outside of the strapping as specified in 17.2 does not apply.

17.2 *Coil-Tie Strapping*—Each individual coil of Types 1 and 2 regular duty, regular duty high strength, heavy duty, and USLM, either oscillated- or ribbon-wound, shall be strapped with a minimum of three equally spaced Type 1 regular-duty or regular-duty high-strength steel tie straps not less than ½ by 0.020 in. (12.7 by 0.51 mm). The straps may be applied either under or over the outer spiral wrap when used. When straps are applied under the spiral wrap, the end of the wrap shall be secured by either tucking the end under adjacent wrap or by adhesive, tape, or by the application of one Type 1 regular-duty, regular-duty high-strength, or heavy duty strap not less than ½ by 0.020 in. (12.7 by 0.51 mm). See Fig. 4. Type IV nonmetallic strapping of equivalent or greater minimum break strength and joint efficiency may be substituted for the specified steel strapping.

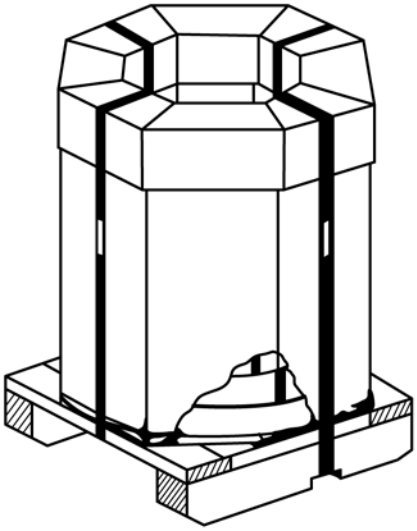

FIG. 6 Single Pile Capped with Corrugated Shroud

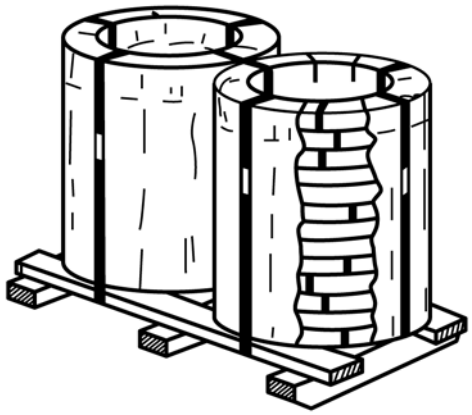

FIG. 7 Double Pile Capped

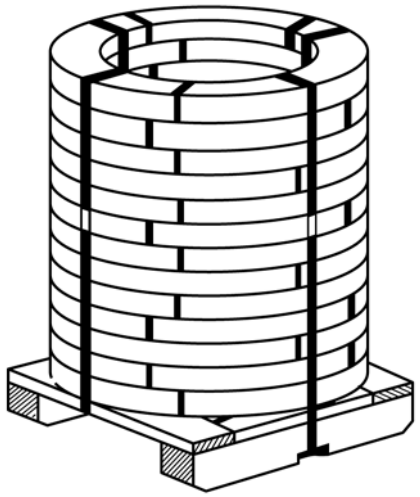

FIG. 8 Single Pile Bare

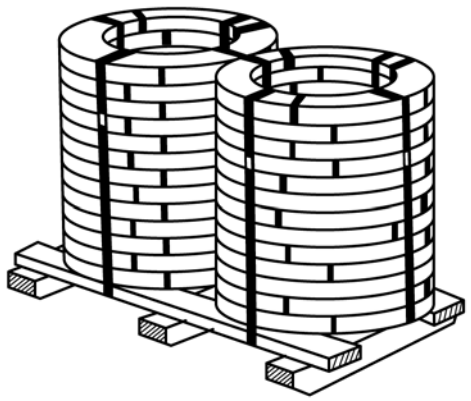

FIG. 9 Double Pile Bare

17.2.1 Alternatively, coils of Types 1 and 2 strapping, when ordered and unit packed in quantities as specified in Table 6, shall be packed in an end loading, full overlap slotted container constructed from V3C fiberboard or equivalent. When practical, containers shall be uniform shape and size, be of minimum cube, and tare consistent with protection required. Containers shall be closed, sealed, and reinforced in accordance with applicable container specifications or supplier's commercial practice.

17.3 *Seals*—Seals of one size, class, finish, type, and style (or nomenclature) unit packed in fiberboard boxes in accordance with supplier's commercial practice, shall be over-packed in a snug-fitting full overlap slotted container constructed from V3C fiberboard or equivalent. The box shall be reinforced with a liner constructed from V3C fiberboard or equivalent. The liner shall be scored to cover the end and side panel of the box. Flutes of the liner shall be perpendicular to the top of the box. Unless otherwise specified, the height of the liner shall be the full inside depth of the box. The liner shall fit snugly inside the intermediate box. This over-pack box shall be closed with not less than two ⅜ by 0.015 in. (9.52 by 0.38 mm) Type 1 regular-duty straps. An alternative method is to use eight overlapped corner sections forming an over-pack ("Adjusta-Pack" Method) constructed from V3C fiberboard or equivalent. A liner is not required with the "Adjusta-Pack". The "Adjusta-Pack" shall be closed with not less than four (2 by 2 pattern) ⅜ by 0.015 in. (9.52 by 0.38 mm) Type 1 regular-duty straps. Dimensions of the over-pack containers shall be determined by the supplier's commercial package and number of commercial packages to be fitted into the over-pack. The dimensions shall be as when specified in the order or as mutually agreed upon between supplier and purchaser. However, the maximum inside dimensions of the over-pack container shall not exceed 100 in. (2540 mm), and the gross weight of the over-pack shipping container shall not exceed 120 lb (54.4 kg).

17.4 *Packing:*

17.4.1 *Strapping*—Coils of flat steel strapping unit packed as specified in 17.1 and 17.2 shall be packed as single or double pile.

17.4.1.1 *Single Pile*— Coils of strapping shall be evenly stacked in a single pile on a platform or skid (see Fig. 6, Fig. 7, Fig. 8, and Fig. 9) and secured to the platform or skid and packaged according to the manufacturer's commercial practice.

17.4.1.2 *Exterior Container*—Coils of strapping unit packed as specified shall be packed in a close-fitting wood box. For shipments to DOD, containers shall conform to overseas type of PPP-B-601 (Specification D6039/D6039M) or Class 2 of PPP-B-621 (Specification D6880). Closure and strapping (as applicable) shall be in accordance with container specifications.

17.4.2 *Seals*—Unit packs will be over-packed in a close-fitting wood box. For DOD shipments, containers shall conform to overseas type of PPP-B-601 or Class 2 of PPP-B-621. Closure and strapping (as applicable) shall be in accordance with container specifications.

18. Preparation for Delivery

18.1 Preparation for delivery shall be either overseas/waterproof packaging or commercial packaging when specified in contract or order.

19. Commercial Packaging

19.1 Commercial packaging shall be in accordance with Practice D3951.

20. Keywords

20.1 baling; bundling; carloading; closing; lashing; lifting; palletizing; steel; strapping; unitizing

APPENDIX

(Nonmandatory Information)

X1. RESEARCH REPORT SUMMARY

X1.1 Based on the test results from ten participating laboratories of the ILS for D3953–91, Section 13, Test Methods, the following conclusions were reached:

X1.1.1 *Within Laboratory Repeatability Standard Deviation—s_r*

X1.1.1.1 *Measurements of Steel Flat Strapping Dimensions:* Gage (in.)

Type 1 Regular-Duty Strapping = 0.000202

Type 1 Heavy-Duty Strapping up to and including ¾ in. × 0.050 in. = 0.000300

Type 1 Heavy-Duty Strapping 1 in. × 0.029 in. and higher = 0.000147

X1.1.1.2 *Measurements of Steel Flat Strapping Dimensions:* Width (in.)

Type 1 Regular-Duty Strapping = 0.000416

Type 1 Heavy-Duty Strapping up to and including ¾ in. × 0.050 in. = 0.000451

Type 1 Heavy-Duty Strapping 1 in. × 0.029 in. and higher = 0.000713

X1.1.1.3 *Breaking Strength of Strapping :* Break Strength (lb)

Type 1 Regular-Duty Strapping = 15.85

Type 1 Heavy-Duty Strapping up to and including ¾ in. × 0.050 in. = 34.46

Type 1 Heavy-Duty Strapping 1 in. × 0.029 in. and higher = 74.32

X1.1.1.4 *Elongation of Strapping:* Elongation (in.)

Type 1 Regular-Duty Strapping = 0.19120

Type 1 Heavy-Duty Strapping up to and including ¾ in. × 0.050 in. = 0.31227

Type 1 Heavy-Duty Strapping 1 in. × 0.029 in. and higher = 1.45982

X1.1.2 *Between Laboratories Reproducibility Standard Deviation—s_r*

X1.1.2.1 *Measurement of Steel Strapping Dimensions:* Gage (in.)
Type 1 Regular-Duty Strapping = 0.000254
Type 1 Heavy-Duty Strapping up to and including ¾ in. × 0.050 in. = 0.000318
Type 1 Heavy-Duty Strapping 1 in. × 0.029 in. and higher = 0.000169

X1.1.2.2 *Measurements of Steel Flat Strapping Dimensions:* Width (in.)
Type 1 Regular-Duty Strapping = 0.000489
Type 1 Heavy-Duty Strapping up to and including ¾ in. × 0.050 in. = 0.000536
Type 1 Heavy-Duty Strapping 1 in. × 0.029 in. and higher = 0.000868

X1.1.2.3 *Breaking Strength of Strapping :* Break Strength (lb)
Type 1 Regular-Duty Strapping = 18.77
Type 1 Heavy-Duty Strapping up to and including ¾ in. × 0.050 in. = 51.01
Type 1 Heavy-Duty Strapping 1 in. × 0.029 in. and higher = 81.80

X1.1.2.4 *Elongation of Strapping:* Elongation (in.)
Type 1 Regular-Duty Strapping = 0.18368
Type 1 Heavy-Duty Strapping up to and including ¾ in. × 0.050 in. = 0.29356
Type 1 Heavy-Duty Strapping 1 in. × 0.029 in. and higher = 1.20007

X1.2 The above terms (repeatability and reproducibility standard deviations) are used as specified in Practice E177. The respective 95 % repeatability and reproducibility limits may be obtained by multiplying the above standard deviation values by 2.8.

X1.3 The following precision information has been calculated for the comparison of three test materials, each of which is the average of 27 test determinations for gage and width and nine (9) test determinations for break strength and elongation.

X1.3.1 *95 % Repeatability Limit (Within Laboratory) of Test Results*

X1.3.1.1 *Break Strength:* Regular Duty—3.7 %
Heavy Duty: Up to and including ¾ in. × 0.025 in. – 3.3 %
Over ¾ × 0.025 in. – 3.9 %

X1.3.1.2 *Elongation:* Regular Duty—18.6 %
Heavy Duty: Up to and including ¾ in. × 0.025 in. – 12.7 %
Over ¾ × 0.025 in. – 47.1 %

X1.3.1.3 *Dimensions: Gage:*
Regular Duty—2.9 %
Heavy-Duty:
Up to and including ¾ in. × 0.025 in. – 3.5 %
Over ¾ in. × 0.025 in. – 1.3 %
Width:
Regular Duty—0.2 %
Heavy Duty—0.2 %

X1.3.2 *95 % Reproducibility Limit (Between Laboratories) of Test Results:*

X1.3.2.1 *Break Strength:* Regular Duty—4.4 %
Heavy Duty: Up to and including ¾ in. × 0.025 in. – 4.9 %
Over ¾ in. × 0.025 in. – 4.3%

X1.3.2.2 *Elongation:* Regular Duty—17.9 %
Heavy Duty: Up to and including ¾ in. × 0.025 in. – 12.0 %
Over ¾ in. × 0.025 in. – 38.7 %

X1.3.2.3 *Dimensions: Gage:*
Regular Duty—3.4 %
Heavy Duty:
Up to and including ¾ in. × 0.025 in. – 3.5 %
Over ¾ in.× 0.025 in. – 1.6 %
Width:
Regular Duty—0.3 %
Heavy Duty—0.2 %

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