



Designation: D4727/D4727M – 17

Standard Specification for Corrugated and Solid Fiberboard Sheet Stock (Container Grade) and Cut Shapes¹

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

1. Scope*

1.1 This specification covers fiberboard primarily used for the fabrication of boxes and interior details such as pads, sleeves, liners, partitions, die-cut sheets, etc.

1.2 The performance of fiberboard boxes is largely dependent on the paper components from which they are fabricated and, in the case of corrugated boxes, on the flute structure as well. Therefore, a variety of grades reflecting varied performance levels are specified.

1.3 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in non-conformance with the standard. See [IEEE/ASTM-SI-10](#) for conversion of units.

1.4 The following safety hazards caveat pertains only to the test portion, Sections 8 and 9, 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.*

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

¹ This specification is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.27 on Fiberboard Shipping Containers, Containerboard and Related Structures and Materials.

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2. Referenced Documents

2.1 ASTM Standards:²

- D585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, and Related Product (Withdrawn 2010)³
- D996 Terminology of Packaging and Distribution Environments
- D3950 Specification for Strapping, Nonmetallic (and Joining Methods)
- D3951 Practice for Commercial Packaging
- D3953 Specification for Strapping, Flat Steel and Seals
- D4169 Practice for Performance Testing of Shipping Containers and Systems
- D4675 Guide for Selection and Use of Flat Strapping Materials¹
- D5118/D5118M Practice for Fabrication of Fiberboard Shipping Boxes
- D5168 Practice for Fabrication and Closure of Triple-Wall Corrugated Fiberboard Containers
- D5639/D5639M Practice for Selection of Corrugated Fiberboard Materials and Box Construction Based on Performance Requirements
- D6039/D6039M Specification for Open and Covered Wood Crates
- D6199 Practice for Quality of Wood Members of Containers and Pallets
- E162 Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source
- E662 Test Method for Specific Optical Density of Smoke Generated by Solid Materials

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

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

*A Summary of Changes section appears at the end of this standard

IEEE/ASTM-SI-10 Standard for Use of the International System of Units (SI): The Modern Metric System

2.2 **TAPPI Standards:**⁴

T 402 Standard Conditioning and Testing Atmosphere

T 410 Weight per Unit Area (Basis Weight or Substance)

T 411 Thickness (Caliper) of Paper and Paperboard

T 441 Water Absorptiveness of Sized (Non-Bibulous) Paper and Paperboard (Cobb Test)

T 803 Puncture and Stiffness Test of Container Board

T 810 Bursting Strength of Corrugated and Solid Fiberboard

T 811 Edge Crush Test

T 812 Ply Separation of Solid and Corrugated Fiberboard (Wet)

2.3 **Other Standards:**

National Motor Freight Classification⁵

Uniform Freight Classification⁶

ISO 535 Paper and Board—Determination of Water Absorption—Cobb Method⁷

3. Terminology

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

4. Classification

4.1 **Type**—Corrugated fiberboard (CF).

4.1.1 **Classes**—Domestic (D) and domestic/fire retardant (D/FR).

4.1.1.1 **Variety**—Singlewall (SW).

(1) **Burst Grades**—125, 150, 175, 200, 250, 275, and 350.⁸

(2) **ECT Grades**—23, 26, 29, 32, 40, 44, and 55⁹

4.1.1.2 **Variety**—Doublewall (DW).

(1) **Burst Grades**—200, 275, 350, 400, 500 and 600.⁸

(2) **ECT Grades**—42, 48, 51X, 61X, 71X, and 82X.^{9,10}

4.1.1.3 **Variety**—Triplewall (TW).

(1) **Grades**—700, 900, 1100, and 1300.¹¹

4.1.2 **Classes**—Weather-resistant (WR) and weather-resistant/fire retardant (WR/FR).

4.1.2.1 **Variety**—Singlewall (SW).

(1) **Grades**—V3c, and W5c.

4.1.2.2 **Variety**—Doublewall (DW).

(1) **Grades**—V11c, V13c, and V15c

4.1.3 **Classes**—Water and water-vapor resistant (WWVR) and water and water-vapor resistant/fire retardant (WWVR/FR).

4.1.3.1 **Variety**—Singlewall (SW).

(1) **Grades**—V3c WWVR, W5c WWVR.

4.1.3.2 **Variety**—Doublewall (DW).

(1) **Grades**—V11c WWVR and V13c WWVR.

4.2 **Type**—Solid Fiberboard (SF).

4.2.1 **Class**—Domestic (D) and Domestic/Fire Retardant (D/FR).

4.2.1.1 **Grades**—125, 175, 200, 275, 350, 500 and 600.⁸

4.2.2 **Class**—Weather-resistant (WR) and Weather Resistant/Fire Retardant (WR/FR).

4.2.2.1 **Grades**—V2s, V3s, V4s, W5s and W6s.

5. Ordering Information

5.1 Purchasers should select the preferred options permitted herein, and include the following information in procurement documents:

5.1.1 Title, number and date of this specification,

5.1.2 Type, class, variety and grade (see **4.1** and **7.1**),

5.1.3 Size of sheet, pad, etc. (see **7.3.1.4**),

5.1.4 Center line of score to center line of score or sheet edge (see **7.3.1.4**),

5.1.5 Flute design of type corrugated fiberboard; variety SW and DW (see **6.4** and **6.4.1**),

5.1.6 Mill run or trimmed sheets,

5.1.7 Dimensional direction of flutes of type Corrugated Fiberboard (CF),

5.1.8 Packing and marking requirements (see S3 and S4), and

5.1.9 Palletization requirements (see S3.1.1.1).

6. Materials and Manufacture

MATERIALS

6.1 **Paperboard Components:**

6.1.1 **Facings and Outer Plies**—The facings of corrugated fiberboard and the plies of solid fiberboard shall have bending qualities to satisfy the requirements of **7.6**. The paperboard components of weather-resistant class material shall be treated with a suitable wet strength resin to make them water resistant. Similarly, the paperboard components of fire retardant class material shall be treated to make them fire retardant to meet the requirements of **7.7.1** and **7.7.2**.

6.1.1.1 **Outer Facing of Corrugated Fiberboard, Water- and Water Vapor Resistant Class**—One outer facing of this material shall be a composite sheet comprised of one ply of sized, wet strength kraft linerboard laminated to a ply of linerboard conforming to **6.1.1** with a minimum of 6 lb/1000 ft² [29 g/m²] of polyethylene. The sized ply shall be on the exterior side of the facing, with the unsized linerboard next to the corrugated medium. At the supplier's option, both plies of linerboard may be of a sized wet strength material.

6.1.1.2 **Facing and Outer Plies Pertaining to Hazardous Materials Packaging**—The facings of corrugated fiberboard and the plies of solid fiberboard shall have water resistance qualities to satisfy the following requirement from ISO 535:

⁴ Available from Technological Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Suite 115, Peachtree Corners, GA 30092, <http://www.tappi.org>.

⁵ National Motor Freight Classification is available from National Motor Freight Traffic Association, Inc. (NMFTA), 1001 N. Fairfax St., Suite 600, Alexandria, VA 22314-1798, <http://www.nmfta.org>.

⁶ Uniform Freight Classification is available from Rail Publication Service, 151 Ellis St. N.E., Suite 260, Atlanta, GA 30335-6021.

⁷ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁸ Grade numbers for single and double wall corrugated varieties and solid fiber types refer to the bursting strength in lb/in.² as determined by TAPPI T 810.

⁹ Grade numbers for single and double wall corrugated varieties refer to the edge crush in lb/in. as determined by TAPPI T 811.

¹⁰ Grade numbers for double wall corrugated varieties with an "X" indicate that the value should be used as a guide and that the actual required edge crush test value is yet to be determined.

¹¹ Grade number for triplewall refers to the dry puncture resistance in units as determined by TAPPI T 803.

(1) Water resistance of the outer surface shall be such that the increase in mass, as determined in a test carried out over a period of 30 min by the Cobb test method of determining water absorption, is not greater than 155 g/m².

6.1.2 Corrugated Medium—

(1) The corrugating medium of corrugated fiberboard shall be made from any suitable fibers.

(2) The corrugating medium components of Weather Resistant classes and the Water and Water Vapor Resistant classes shall be treated with a suitable wet strength resin to make them water resistant.

6.2 Adhesives:

6.2.1 *Domestic (D) and Domestic/Fire Retardant (D/FR) Classes*—The adhesive used in the construction of the domestic/fire retardant class of fiberboard should be that which is commercially used by the industry, and shall enable the end item to meet the strength requirements specified herein.

6.2.2 *Weather-Resistant (WR) and Weather-Resistant/Fire Retardant (WR/FR) Classes*—The adhesive used in the construction of Weather-Resistant classes of fiberboard shall be water-resistant to the extent that the end item will meet the requirements of this specification (see 7.4).

6.2.3 *Water and Water Vapor-Resistant (WWVR) and Water and Water Vapor-Resistant/Fire Retardant (WWVR/FR) Classes*—The adhesive used in the construction of Water and Water Vapor-Resistant classes of fiberboard shall be water-resistant to the extent that the end item will meet the requirements of this specification (see 7.4). Paragraph 7.4 also applies to the polyethylene linerboard bonds in the laminated facings.

6.3 *Triplewall and Triplewall/Fire Retardant Corrugated Fiberboard Classes*—Triplewall corrugated fiberboard, domestic and domestic/fire retardant classes, non-weather-resistant and weather-resistant in both regular and fire-retardant classes shall conform to the requirements of Practice D5168.

CONSTRUCTION

6.4 *Corrugated Fiberboard*—Corrugated fiberboard shall be made with two, three, or four facings for single, doublewall or triplewall, respectively. Each facing shall be separated by and securely adhered to the corrugated medium.

6.4.1 *Flutes*—The number of flutes per unit length of fiberboard shall be as follows or as specified:

	Flutes/ft	Flutes/m	Flute Height (in.)	Flute Height (mm)
A-Flute	30 to 39	98 to 128	0.1575 to 0.2210	4.00 to 5.61
B-Flute	45 to 53	147 to 174	0.0787 to 0.1102	2.00 to 2.80
C-Flute	35 to 45	115 to 148	0.1300 to 0.1575	3.30 to 4.00
E-Flute	70 to 98	229 to 321	0.0445 to 0.0550	1.13 to 1.40

6.5 *Solid Fiberboard*—Solid fiberboard shall be constructed by laminating plies securely and continuously together.

6.5.1 Domestic:

6.5.1.1 *Grades 125 and 175*—The fiberboard shall consist of not less than two plies of components.

6.5.2 *Grades 200 through 600*—The fiberboard shall consist of not less than three plies of components.

6.6 *Scored Sheets*—The scorelines on scored sheets shall show no visual continuous surface break greater than specified in 7.6 when tested as specified in 9.3.

6.7 *Pads and Cut Shapes*—Pads and cut shapes shall be made in accordance with specified dimensions or drawings.

6.7.1 Pads and cut shapes may be single sheets, or may be made by laminating two or more sheets of specified types and classes of material to the specified thickness.

7. Physical Requirements

7.1 Corrugated Fiberboard:

7.1.1 *Domestic and Domestic/Fire Retardant Classes, All Varieties:*

7.1.1.1 *Facings*—The facings shall conform to the requirements in Table 1 when tested as specified in 9.1.2.

7.1.1.2 *Corrugating Medium*—The corrugating medium for the domestic/fire retardant classes of corrugated fiberboard shall weigh not less than 26 lb/1000 ft² [127 g/m²], or as specified, when tested in accordance with 9.1.2.

7.1.1.3 *End Item*—Domestic and domestic/fire retardant classes of corrugated fiberboard, constructed as specified in 6.4, shall conform to the requirements in Table 1 for bursting strength or puncture resistance or edge crush (as specified) when tested as specified in 9.1.3, 9.1.5, or 9.1.8. (See compliance statement following Table 1 for Burst and Edge Crush.)

7.1.2 *Weather-Resistant and Weather-Resistant/Fire Retardant Classes*—The components and end items conform to the applicable basis weight and bursting strengths specified in Table 2 when tested as specified in 9.1.2, 9.1.5 and 9.2. The corrugating medium for the Weather-Resistant classes and Weather-Resistant/Fire Retardant classes of corrugated fiberboard shall weigh not less than 30 lb/1000 ft² (146 g/m²), or as specified, when tested in accordance with 9.1.2.

7.1.3 *Water and Water Vapor-Resistant, and Water and Water Vapor-Resistant/Fire Retardant Classes:*

7.1.3.1 *Components*—The components shall conform to the applicable requirements as specified in Table 2 and 6.1.1.1, when tested as specified in 9.1.2. The corrugating medium for the Water and Water Vapor-Resistant, and Water and Water Vapor-Resistant/Fire Retardant classes of corrugated fiberboard shall weigh not less than 30 lb/1000 ft² (146 g/m²), or as specified, when tested in accordance with 9.1.2.

7.2 Type SF (Solid Fiberboard):

7.2.1 Class Domestic and Domestic/Fire Retardant:

7.2.1.1 *Facings and Filler Plies*—The combined weights of the facings and filler plies shall conform to the requirements in Table 3 when tested as specified in 9.1.2.

7.2.1.2 *End Item*—Domestic and domestic/fire retardant classes of solid fiberboard constructed as specified in 6.5.1 shall conform to the bursting strength requirements in Table 3, when tested as specified in 9.1.5.

7.2.1.3 *Weather-Resistant and Weather Resistant/Fire Retardant Class, All Grades*—The weather-resistant solid fiberboard shall conform to the requirements in Table 4, when tested as specified in 9.1.1, 9.1.5 and 9.2.

7.3 *Dimensions*—Sheet and pad sizes, and shape dimensions shall be as specified in 7.3.1.4.

**TABLE 1 Type CF (Corrugated Fiberboard), Domestic (D) and Domestic/Fire Retardant Classes (D/FR)**

NOTE 1—Select either burst strength or edge crush strength requirement. (While a choice of either burst or edge crush fiberboard is acceptable, their performance may not be equivalent. Refer to 4.1 and 7.1.1.3.)

Part A Burst or Puncture Strength Related Requirements			
Variety	Combined Weight Facings Only, min		Bursting Strength, Dry, min ^A
	lb/1000 ft ²	[g/m ²]	psi [kPa]
SW	52	[254]	125 [862]
SW	66	[322]	150 [1034]
SW	75	[366]	175 [1207]
SW	84	[410]	200 [1379]
SW	111	[542]	250 [1724]
SW	138	[674]	275 [1896]
SW	180	[879]	350 [2413]
DW	92	[449]	200 [1379]
DW	110	[537]	275 [1896]
DW	126	[615]	350 [2413]
DW	180	[879]	400 [2758]
DW	222	[1084]	500 [3447]
DW	270	[1318]	600 [4137]
Part B Edge Crush Strength Requirements			
Variety	Edge Crush Strength min ^C lb/in. [kN/m]		
SW	23 [4.0]		
SW	26 [4.6]		
SW	29 [5.1]		
SW	32 [5.6]		
SW	40 [7.0]		
SW	44 [7.7]		
SW	55 [9.6]		
DW	42 [7.4]		
DW	48 ^D [8.4]		
DW	51 ^D [8.9]		
DW	61 ^D [10.7]		
DW	71 ^D [12.4]		
DW	82 ^D [14.4]		

^A Only one burst of the initial six may fall beneath the minimum required. Domestic board and domestic fire/retardant failing to pass this test will be accepted if, in a retest consisting of 24 bursts (12 from each side of the board), not more than 4 bursts fall below the minimum value required.

^B A minimum of four puncture tests, conducted in accordance with TAPPI T 803 must be made and only one puncture test will be permitted to fall below the specified minimum value.

^C Only one edge crush test of the initial six may fall below the minimum required, and that one test cannot fall below the specified minimum value by more than 10 %. Domestic board and domestic fire/retardant failing to pass this test will be accepted if, in a retest consisting of 24 edge crush tests, not more than 4 crush test results fall below the minimum value, and none of those tests fall below the specified minimum value by more than 10 %.

^D Values subject to confirmation.

7.3.1 Dimension Tolerance:

7.3.1.1 *Mill Run (Untrimmed) Sheets*—The dimensional tolerance in the machine direction of untrimmed fiberboard sheets shall be $-\frac{1}{4}$ in. [6 mm] and $+2$ in. [50 mm]. The cross machine dimensions shall be not less than specified in 5.1.3.

7.3.1.2 *Trimmed Sheets*—The dimensional tolerances for trimmed fiberboard sheets shall be $\pm \frac{1}{8}$ in. [3 mm] for width and $-\frac{1}{8}$ in. [3 mm] and $+\frac{1}{2}$ in. [12 mm] for length.

TABLE 2 Type CF (Corrugated Fiberboard), Weather-Resistant (WR) and Weather Resistant/Fire Retardant (WR/FR), and Water and Water Vapor Resistant Classes (WWVR)

Variety	Grade ^{A,B}	Basis Weight, lb/1000 ft ² [g/m ²], min	Bursting Strength, psi [kPa], min avg	
			Dry	Wet ^C
SW	V3c	180 [878]	350 [2413]	150 [1034]
SW	W5c	124 [605]	275 [1896]	100 [689]
DW	V11c	270 [1318]	600 [4137]	300 [2068]
DW	V13c	180 [878]	400 [2758]	200 [1379]
DW	V15c	114 [557]	300 [2068]	100 [689]

^A Includes WWVR grades.

^B For doublewall fiberboard, the inner facing shall be the same thickness as the outer facing.

^C After 24 h immersion (see 9.2).

TABLE 3 Type SF (Solid Fiberboard): Class Domestic (D) and Domestic/Fire Retardant (D/FR), All Grades

Grade	Combined Weight Of Plies Before Lamination, lb/1000ft ² [g/m ²], min	Bursting Strength, psi [kPa], min ^A
125	114 [557]	125 [862]
175	149 [727]	175 [1207]
200	190 [928]	200 [1379]
275	237 [1157]	275 [1896]
350	283 [1382]	350 [2413]
500	330 [1611]	500 [3447]
600	360 [1758]	600 [4137]

^A Only one burst of the initial six may fall beneath the minimum required. Domestic board and domestic fire retardant failing to pass this test will be accepted if, in a retest consisting of 24 bursts (12 from each side of the board), not more than 4 bursts fall below the minimum value required.

TABLE 4 Type SF (Solid Fiberboard), Class Weather-Resistant (WR) and Weather Resistant/Fire Retardant (WR/FR), All Grades

Grade	Thickness, in. [mm] ^A	Bursting Strength, psi [kPa], min	
		Dry	Wet (After 24-h Im- mersion)
V2s	0.090 [2.29]	550 [3792]	500 [3447]
V3s	0.090 [2.29]	400 [2758]	150 [1034]
V4s	0.080 [2.03]	400 [2758]	150 [1034]
W5s	0.075 [1.91]	275 [1896]	100 [689]
W6s	0.060 [1.52]	175 [1207]	50 [345]

^A A ± 10 % tolerance shall be permitted.

7.3.1.3 *Pads and Shapes*—The dimensional tolerances for all other materials made from fiberboard shall be $\pm \frac{1}{16}$ in. [2 mm] for dimensions under 18 in. [457 mm] and $\pm \frac{1}{8}$ in. [3 mm] for dimensions 18 in. [457 mm] and above, unless otherwise specified.

7.3.1.4 *Scored Sheets*—The center line of score to center line of score dimension, and the center line of score to sheet edge dimension shall be as specified $\pm \frac{1}{16}$ in. [2 mm], unless otherwise specified.

7.4 *Glue Bond Separation of Weather-Resistant, Weather-Resistant/Fire Retardant, Water, and Water-Vapor Resistant Classes*—The facings and corrugating mediums of corrugated fiberboard and the plies of solid fiberboard shall remain

securely and continuously adhered to their contacting surfaces when tested as specified in 9.1.4. Edge separation shall not exceed ¼ in. [6 mm] in depth.

7.4.1 *Lamination of Pads and Cut Shapes*—The bonding agent used in the lamination process for fabricating pads and cut shapes shall be equal to or greater than the requirements of 7.4 and shall pass the tests specified therein.

7.5 *Warp*—The amount of warp when received shall not exceed ½ in. when measured over a 2 ft span [12 mm/610 mm] when tested in accordance with 9.6.

7.6 *Bending Requirements:*

7.6.1 Numerous factors have significant impact on boxes' score fracturing/checking tendency, including fabrication, handling, and storage environment. A reasonable time frame for assessment of score fracture/checking should be agreed upon between the supplier and purchaser.

7.6.2 Unless otherwise specified, fiberboard shall show no continuous visual surface breaks of the plies, or split completely through, when folded as specified in 9.3 and applicable subparagraphs.

7.7 *Fire Retardant Class*—When fire retardant class is specified, the requirements of 7.7.1 and 7.7.2 as tested by 9.1.6 and 9.1.7, respectively, shall be met.

7.7.1 *Flame Spread Index*—Tests shall be conducted in accordance with Test Method E162. Test samples shall be exposed continuously to 95°F and 95 % relative humidity in a weathering test for seven days and subsequently conditioned in accordance with 8.2 to a constant weight prior to testing. A flame spread index of 20 or less is acceptable.

7.7.2 *Specific Optical Density*—Tests shall be conducted in accordance with Test Method E662. Test samples shall be exposed continuously to 95°F and 95 % relative humidity in a weathering test for seven days and subsequently conditioned in accordance with 8.2 to a constant weight prior to testing. A specific optical density of 100 or less is acceptable.

8. Sampling

8.1 The fiberboard shall be sampled for all tests in accordance with Practice D585, using Plan II for all properties.

8.2 Samples shall be preconditioned and tested in an atmosphere maintained at 50 % relative humidity ± 2 %, and 73.4°F ± 2 °F [23.0°C] in accordance with TAPPI T 402.

9. Test Methods

9.1 *ASTM Standards*—Conduct the tests in accordance with the following ASTM and TAPPI Standards:

- 9.1.1 *Thickness*—TAPPI T 411.
- 9.1.2 *Basis Weight*—TAPPI T 410.
- 9.1.3 *Puncture Resistance*—TAPPI T 803.
- 9.1.4 *Ply Separation*—TAPPI T 812.
- 9.1.5 *Bursting Strength*—TAPPI T 810.
- 9.1.6 *Flame Spread*—Test Method E162.
- 9.1.7 *Specific Optical Density*—Test Method E662.
- 9.1.8 *Edge Crush*—TAPPI T 811.

9.2 *Wet Burst Test*—For the wet burst test, the specimen shall be immersed in water as specified in the applicable

paragraphs of TAPPI T 812 prior to performing the bursting strength test in accordance with TAPPI T 810.

9.3 *Bending:*

9.3.1 *Apparatus:*

9.3.1.1 *Scoring Devices*, on commercial production equipment having the proper profiles for the type, class, variety, and grade of fiberboard to be tested.

9.3.2 *Test Specimen*—The specimen shall be 12 in. [300 mm] by 12 in. [300 mm].

9.3.3 *Test Procedure:*

9.3.3.1 Score the specimen using the proper scoring device both along and across the machine direction of the fiberboard. Cracks and ruptures occurring at the intersection of the scorelines shall be disregarded.

9.3.3.2 *Degree of Bending:*

(1) Singlewall corrugated fiberboard shall be folded 180° toward the inner facing along scorelines.

(2) Doublewall corrugated fiberboard shall be folded 180° toward the inner facing on scores parallel to the corrugations. For scores perpendicular to the corrugations, the fiberboard shall be folded first 90° toward the outer facing, returned to the flat position, and then folded 90° toward the inner facing.

(3) Solid fiberboard shall be folded 180° inward (male score) on scores parallel to the machine direction. Scores parallel to the cross direction shall be folded 90° outward (female), returned to the unfolded position, and then folded 90° inward.

9.4 *Determination of the Amount of Polyethylene:*

9.4.1 *Test Specimen*—The specimen shall be 6 in. [150 mm] by 4 in. [100 mm] with each dimension having a $\pm 1/32$ in. [1 mm] tolerance.

9.4.2 *Test Procedure*—Soak the sample in a 2 % water solution of a wetting agent (Triton X-114 or equivalent). Peel the fibers away from the film with a firm rubbing action until only those fibers remain which are strongly adhered to the polyethylene film. To remove the remaining fiber, place the film in a shallow pan of Cupriethylenediamine, or hot (160 to 180°F [57 to 68°C]) zinc chloride solution (three parts zinc chloride to one part water). When the remaining fibers soften, they can be removed from the film by scraping it with a wooden spatula. When the film becomes clear, it shall be thoroughly washed in cold water and subsequently dried to constant weight. The weight of the film shall be determined accurately to the nearest 0.01 g. The weight of the film in lb/1000 ft² is determined by multiplying the weight of the film in grams by 13.2. The weight of the film in g/m² is determined by multiplying the weight of the film in grams by 64.6

9.5 *Warp*—Measure warp by placing the blank fiberboard on a flat surface so that the bow rises between the ends of the blank. The maximum distance from the bottom of the sample to the flat surface shall then be measured.

9.6 *Precision and Bias*—The precision and bias of the ASTM and TAPPI test methods are as stated by the individual methods. No justifiable statement can be made on the precision and bias of 9.3, 9.4, and 9.6.

10. Preparation for Delivery

10.1 Unless otherwise specified in the contract or purchase order, packing and marking shall be in accordance with Practice **D3951**.

10.2 Unless otherwise specified in the contract or purchase order, fiberboard sheet stock may be strapped in accordance with Guide **D4675**.

10.3 For shipment to the Department of Defense, when specified, packing and marking shall be in accordance with Supplementary Requirements.

11. Keywords

11.1 corrugated; cut shapes; domestic; fire retardant; sheets; solid fiberboard; weather resistant

SUPPLEMENTARY REQUIREMENTS

S1. Scope

S1.1 The following supplementary requirements shall apply only when specified by the purchaser in solicitation, contract, or order for agencies of the U.S. Government.

S2. Applicable Documents

S2.1 The following documents form, in the parts referenced, a part of this document in the issue in effect at the time of placement of the order or contract:

S2.1.1 *ASTM Standard*:¹²

D5118/D5118M Practice for Fabrication of Fiberboard Shipping Boxes

D6039/D6039M Crates, Wood, Open and Covered

D6199 Quality of Wood Members for Containers and Pallets

S2.1.2 *Federal Standard*:¹²

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

S2.1.3 *Military Standards*:¹²

MIL-STD-129 Marking for Shipment and Storage

S3. Preparation for Delivery

S3.1 *Unitization*:

S3.1.1 *Mill Run Sheets*—Unless otherwise specified, a quantity of fiberboard sheets of one type, class, variety, grade, and size, not exceeding a net weight of 800 lb [365 kg] nor a height of 24 in. [610 mm] shall be packed in a wood crate conforming to Specification **D6039/D6039M**, Style A, Type II. A top and bottom waster sheet, of the same board packed, shall be provided. When specified, uncrated fiberboard sheets shall be palletized. A load, including a pallet (constructed as described in S3.1.1.1 and shown in Fig. S3.1) shall not exceed an overall height of 54 in. [1350 mm] and a gross weight of 2000 lb [910 kg]. A top waster sheet of the same board packed shall be used. The stack of fiberboard sheets shall be positioned on the pallet so that they do not protrude beyond any pallet edge. Each stack of sheets shall be secured to its pallet with flat steel strapping conforming to Specification **D3953**, Type 1 or

¹² Available from DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil/>.

- A – DECKBOARD 1 × 6 × PALLET WIDTH
- B – WOOD POST 3 × 4 × 6
- C – STRINGER BOARD 1 × 4 × PALLET LENGTH
- D – TOP DECK 1/2 × SHEET WIDTH × SHEET LENGTH

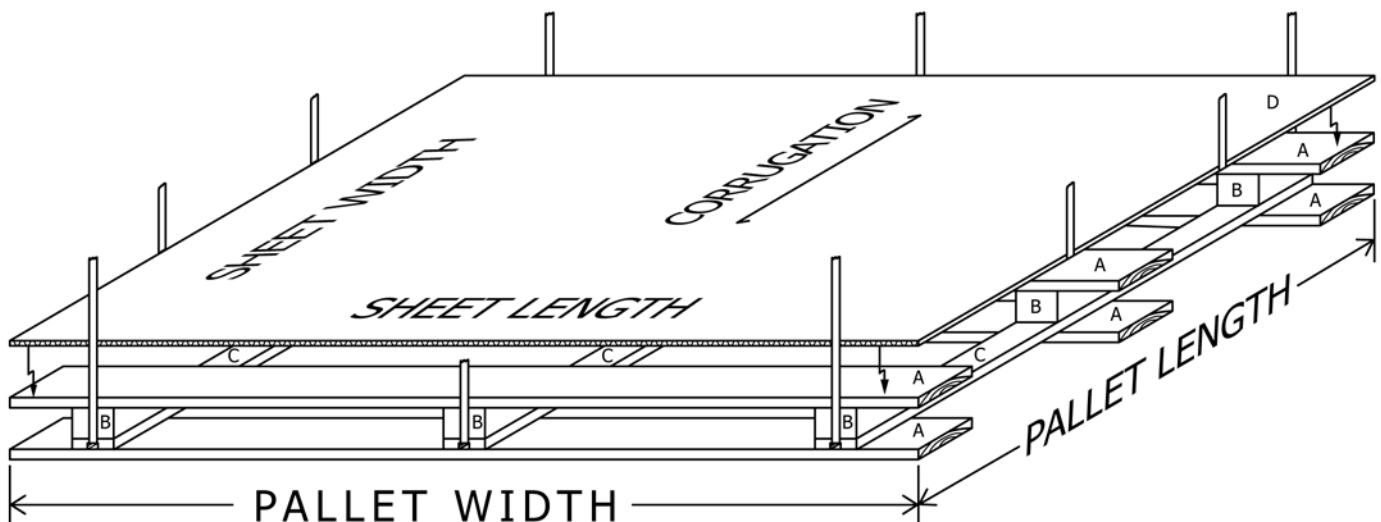


FIG. S3.1 Shipping Pallet Construction



2, or plastic strapping conforming to Specification **D3950**, Type I or III. The size strapping used is dependent upon the gross weight of the pallet load and number of straps used; **Table S1.1** shows the minimum allowable strapping sizes. One strap per stringer shall encircle the load in the direction of the pallet length with each strap being inserted through the stringer strap slot. The load shall also be strapped parallel with the pallet width with each strap passing under the top deck but under the stringers. The number of widthwise straps shall be one less than the number of top deck boards, with one being positioned midway between each adjacent pair of deck boards. All straps shall be tensioned and sealed tightly. Suitable edge protectors shall be used under the strapping at the top of the load to prevent the straps from cutting or creasing the fiberboard sheets.

S3.1.1.1 Construction of Pallet:

(a) The pallet shall have overall length and width dimensions not less than the dimensions of the fiberboard sheets being packed, but not greater than $\frac{1}{2}$ in. [13 mm] more than the fiberboard dimensions. The wood used shall be softwood conforming to Practice **D6199**, Group 1, Class 2. All boards and posts shall be finished top and bottom to a uniform thickness. The pallet shall consist of the following members: (a) nominal 1 by 6 in. [25 by 150 mm] upper and lower deck boards; (b) nominal 1 by 4 in. [25 by 100 mm] lower wood stringers; (c) nominal 3 by 4 by 6 in. [75 by 100 by 150 mm] wood posts; and (d) a top deck of corrugated fiberboard conforming to Grade 1100 TW or two full-sized sheets of V11c laminated together with a water-resistant adhesive.

(b) The outside deck boards shall be flush with the ends of the stringers and all deck boards shall be evenly spaced across the length of the pallet. The number of deck boards used is dependent upon the length of the pallet; spacing between adjacent deck boards shall not exceed 17 in. [430 mm]. The outside stringers shall be set 6 in. [150 mm] $\pm$ $\frac{1}{4}$ in. [6 mm] from the ends of the deck boards; the inside stringers shall be evenly spaced over the distance between the outside stringers. Not less than three stringers shall be used in pallets up to 88 in. [2235 mm] wide, and not less than four stringers in wider pallets. Each stringer shall be slotted so that the strapping required (see **Table S1.1**) can be threaded between the stringer and bottom deck boards. The stringers, deck boards, and posts shall be nailed together, at the joint, with six (three through the top deck boards and three through the bottom deck boards) cement-coated or chemically-etched, box or T-head 8d nails, $2\frac{1}{2}$ in. [64 mm] long with a 0.97 in. [2 mm] shank. The nails shall not protrude into the strap slots of the stringers. The corrugated fiberboard top deck shall be secured to top deck

boards with water-resistant adhesive. **Fig. S3.1** illustrates a typical example of the pallet described in this paragraph.

S3.2 Pads, Scored Sheets, and Cut Shapes—Pads, scored sheets, and cut shapes of one class, type, variety, grade, and size shall be packed in a snug fitting fiberboard shipping container conforming to Practice **D5118/D5118M**, Type CF or SF, Class weather-resistant. Each shipping container shall be closed in accordance with the appendix of Practice **D5118/D5118M**. The weight of contents of each shipping container shall not exceed 65 lb [30 kg]. When specified, pads, scored sheets, and cut shapes too large to box, may be unitized in accordance with S3.1.

S4. Marking

S4.1 Compliance Marking, when Specified—Each sheet, pad, or cut shape shall be marked with identification of the ASTM specification, class, grade, and date of manufacture along one edge, with characters not less than $\frac{3}{16}$ in. [4 mm] in height.

S4.2 Civil Agencies—In addition to any special marking required by the contract or order, shipments shall be marked in accordance with Fed. Std. No. 123.

S4.3 Military Agencies—In addition to any special marking required by the contract or order, shipments shall be marked in accordance with MIL-STD-129.

S5. Ordering Data

S5.1 Purchasers should select the preferred options permitted herein, and include the following information in procurement documents:

S5.1.1 Number, title, and date of the specification,

S5.1.2 Type, class, variety, and grade (see Section 4),

S5.1.3 Flute design (see 6.4.1),

S5.1.4 Mill run or trim sheets,

S5.1.5 Dimensional direction of flute of type CF, when applicable,

S5.1.6 When compliance symbol is not required, (see Section 4),

S5.1.7 Size of sheet, pad, shape, etc., and

S5.1.8 Unitization required (see 3.1).

S6. EXCERPT FROM UNIFORM FREIGHT CLASSIFICATION AND NATIONAL MOTOR FREIGHT CLASSIFICATION RULE 41/ITEM 222

S6.2 Following industry participatory studies for the use of TAPPI T811 as a predictor of box stacking performance, the Edge Crush Test (ECT) has been adopted by both the truck and rail classifications as listed in **Table S6.1**.

TABLE S1.1 Minimum Allowable Strapping Size

Steel Strap		Plastic Type II		Plastic Type III		Maximum Gross Load Per Strap	
in.	[mm]	in.	[mm]	in.	[mm]	lb	[kg]
$\frac{5}{16}$ by 0.020	[16 by 0.5]	$\frac{5}{16}$ by 0.020	[16 by 0.5]	$\frac{7}{16}$ by 0.023	[11 by 0.6]	300	[136]
...	...	$\frac{1}{2}$ by 0.025	[13 by 0.6]	$\frac{1}{2}$ by 0.020	[13 by 0.5]	300	[136]
$\frac{5}{16}$ by 0.023	[16 by 0.6]	$\frac{1}{2}$ by 0.030	[13 by 0.8]	$\frac{7}{16}$ by 0.029	[11 by 0.7]	400	[182]
$\frac{3}{4}$ by 0.020	[19 by 0.5]	$\frac{5}{16}$ by 0.025	[16 by 0.6]	$\frac{1}{2}$ by 0.025	[13 by 0.6]	400	[182]
$\frac{3}{4}$ by 0.023	[19 by 0.6]	$\frac{5}{16}$ by 0.030	[16 by 0.8]	$\frac{1}{2}$ by 0.030	[13 by 0.8]	500	[227]

**TABLE S6.1 Maximum Size and Weight; Minimum Fiberboard Requirements**

NOTE 1—Select either burst test or edge crush test requirement. (While a choice of either burst or edge crush fiberboard is acceptable, their performance may not be equivalent.)

Part A			
Burst Test-Related Requirements			
Weight of Box and Contents, max, lb	Outside Dimensions, Length, Width and Depth, Depth Added, max, in.	Bursting Test, Singlewall, Doublewall or Solid Fiberboard ^A , min, lb/in. ² <i>or</i> Puncture Test, Triplewall Board ^B , min, oz/in. of tear	Combined Weight of Facings Including Center Facing(s) of Doublewall and Triplewall Board, min <i>or</i> Combined Weight of Plies, Solid Fiberboard, Excluding Adhesives, min, lb/100 ft ²
Singlewall Corrugated Fiberboard Boxes			
20	40	125	52
35	50	150	66
50	60	175	75
65	75	200	84
80	85	250	111
95	95	275	138
120	105	350	180
Doublewall Corrugated Fiberboard Boxes			
80	85	200	92
100	95	275	110
120	105	350	126
140	110	400	180
160	115	500	222
180	120	600	270
Triplewall Corrugated Fiberboard Boxes			
240	110	700	168
260	115	900	222
280	120	1100	264
300	125	1300	360
Solid Fiberboard Boxes			
20	40	125	114
40	60	175	149
65	75	200	190
90	90	275	237
120	100	350	283
Part B			
Edge-Crush Related Requirements			
Weight of Box and Contents, max, lb	Outside Dimensions, Length, Width and Depth, Depth Added, max, in.	Edge Crush Test (ECT) min, lb/n.	
Singlewall Corrugated Fiberboard Boxes			
20	40	23	
35	50	26	
50	60	29	
65	75	32	
80	85	40	
95	95	44	
120	105	55	
Doublewall Corrugated Fiberboard Boxes			
80	85	42	
100	95	48	
120	105	51	
140	110	61	
160	115	71	
180	120	82	
Triplewall Corrugated Fiberboard Boxes			
240	110	67	
260	115	80	
280	120	90	
300	125	112	

^A A minimum of six bursts must be made, conducted in accordance with TAPPI T810, three from each side of the board, and only one burst test will be permitted to fall below the specified minimum value. Board failing to pass the test will be accepted if in a retest consisting of 24 bursts, 12 from each side of the board, not more than four burst tests fall below the specified minimum value.

^B A minimum of four puncture tests, conducted in accordance with TAPPI T803 must be made and only one puncture test will be permitted to fall below the specified minimum value.

S6.3 Both ECT and Mullen/Basis Weight board grades are shown in Table S6.1 as they apply to both Rule-41 (rail shipments) and Item-222 (truck shipments).

S6.4 Board grades specified in Table S6.1 are minimum values based on less than truckload (LTL) carrier environments. For distribution environments more or less severe than

described, appropriate board grade adjustments and the use of Practices D4169 and D5639/D5639M are recommended.



SUMMARY OF CHANGES

Committee D10 has identified the location of selected changes to this standard since the last issue (D4727/D4727M-15^{e1}) that may impact the use of the standard. (Approved April 1, 2017.)

(1) Revised S3.1.1.

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