Designation: D4727/D4727M – 15

StandardSpecification for Corrugated and Solid Fiberboard Sheet Stock (Container Grade) and Cut Shapes[1]

This standard is issued under the fixed designation D4727/D4727M; 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 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.*

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D585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard, and Related Product (Withdrawn 2010)[3]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 Materials[1]

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

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 Atmoshpere

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)

[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] 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.

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

2.3 *Other Standards:*
National Motor Freight Classification[5]
Uniform Freight Classification[6]
ISO 535 Paper and Board—Determination of Water Absorption—Cobb Method[7]

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 55[9]

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 ft^2 [29 g/m^2] 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:

(*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/m^2.

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

[5] National Motor Freight Classification is available from National Motor Freight Traffic Association, Inc. (NMFTA), 1001 N. Fairfax St., Suite 600, Alexandria, VA 22314, 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 810T 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.

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 ft^2 [127 g/m^2], or as specified, when tested in accordance with 9.1.2.

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]		
	Grade		Puncture[B]	
			in.·oz/inches of tear	(J)
TW	700	168 [820]	700	[21]
TW	900	222 [1084]	900	[27]
TW	1100	264 [1289]	1100	[33]
TW	1300	360 [1758]	1300	[39]

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.

7.1.1.3 *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 ft^2 (146 g/m^2), 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 ft^2 (146 g/m^2), 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.

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 −¼ 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 ±⅛ in. [3 mm] for width and −⅛ in. [3 mm] and +½ in. [12 mm] for length.

7.3.1.3 *Pads and Shapes*—The dimensional tolerances for all other materials made from fiberboard shall be ±1⁄16 in. [2 mm] for dimensions under 18 in. [457 mm] and ±⅛ 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 ±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.

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	
		Combined Weight of Facings	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 Immersion)
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.