Designation: D 4727/D4727M – 98

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

This standard is issued under the fixed designation D 4727/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 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 Practice E 380 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:*

D 585 Practice for Sampling and Accepting a Single Lot of Paper, Paperboard, Fiberboard and Related Product[2]

D 685 Practice for Conditioning Paper and Paper Products for Testing[2]

D 996 Terminology of Packaging and Distribution Environments[2]

D 3950 Specification for Strapping, Nonmetallic (and Joining Methods)[2]

D 3951 Practice for Commercial Packaging[2]

D 3953 Specification for Strapping, Flat Steel and Seals[2]

D 4169 Practice for Performance Testing of Shipping Containers and Systems[2]

D 4675 Guide for Selection and Use of Flat Strapping Materials[2]

D 5118/D 5118M Practice for Fabrication of Fiberboard Shipping Boxes[2]

D 5168 Practice for Fabrication and Closure of Triple Wall Corrugated Fiberboard Containers[2]

D 5639/D5639M Practice for Selection of Corrugated Fiberboard Materials and Box Construction Based on Performance Requirements[2]

E 162 Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source[3]

E 380 Practice for the Use of the International System of Units (SI) (The Modernized Metric System)[4]

E 662 Test Method for Specific Optical Density of Smoke Generated by Solid Materials[3]

2.2 *TAPPI Standards:*

T 410 Weight per Unit Area (Basis Weight or Substance)[5]

T 411 Thickness (Caliper) of Paper and Paperboard[5]

T 441 Water Absorptiveness of Sized (Non-Bibulous) Paper and Paperboard (Cobb Test)[5]

T 803 Puncture and Stiffness Test of Container Board[5]

T 810 Bursting Strength of Corrugated and Solid Fiberboard[5]

T 811 Edge Crush Test[5]

T 812 Ply Separation of Solid and Corrugated Fiberboard (Wet)[5]

2.3 *Other Standards:*

National Motor Freight Classification[6]

[1] This specification is under the jurisdiction of ASTM Committee D-10 on Packaging and is the direct responsibility of Subcommittee D10.27 on Paper and Paperboard.

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

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

[4] *Annual Book of ASTM Standards*, Vol 14.02.

[5] Available from the Technical Association of the Pulp and Paper Industry (TAPPI), P.O. Box 105113, Atlanta, GA 30348.

[6] National Motor Freight Classification is available from National Motor Freight Traffic Assoc., Inc., 2200 Mill Road, Alexandria, VA 22314.

Uniform Freight Classification[7]
ISO 535 Paper and Board—Determination of Water Absorbtion—Cobb Method[8]

3. Terminology

3.1 General definitions for packaging and distribution environments are found in Terminology D 996.

4. Classification

4.1 *Type*—Corrugated fiberboard (CF).
4.1.1 *Classes*—Domestic and domestic/fire retardant (D/FR).
4.1.1.1 *Variety*—Singlewall (SW).
(a) (*a*) *Grades*—125, 150, 175, 200, 275, and 350.[9]
4.1.1.2 *Variety*—Doublewall (DW).
(a) (*a*) *Grades*—200, 275, 350, 500 and 600.[9]
4.1.1.3 *Variety*—Triplewall (TW).
(a) (*a*) *Grade*—1100.[10]
4.1.2 *Classes*—Weather-resistant and weather-resistant/fire retardant (WR/FR).
4.1.2.1 *Variety*—Singlewall (SW).
(a) (*a*) *Grades*—V3c, W5c and W6c.
4.1.2.2 *Variety*—Doublewall (DW).
(a) (*a*) *Grade*—V11c, V13c and V15c.
4.1.2.3 *Variety*—Triplewall.
(a) (*a*) *Grade*—1100.[11]
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).
(a) (*a*) *Grades*—V3c WWVR, W5c WWVR.
4.1.3.2 *Variety*—Doublewall (DW).
(a) (*a*) *Grades*—V11c WWVR and V13c WWVR.
4.2 *Type*—Solid Fiberboard (SF).
4.2.1 *Class*—Domestic (D).
4.2.1.1 *Grades*—125, 175, 200, 275, 350, 500 and 600.[10]
4.2.2 *Class*—Weather-resistant.
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 6.2.1 and section 6.2.1.1),
5.1.6 Mill run or trimmed sheets,
5.1.7 Dimensional direction of flutes of type CF, fiberboard,
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 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:

(*a*) 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 absorbtion, is not greater than 155 g/m^2.

6.1.2 *Corrugated Medium*—The corrugating medium of corrugated fiberboard shall be made from any suitable fibers.

6.2 *Adhesives*:

6.2.1 *Domestic and Domestic/Fire Retardant 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 and Weather-Resistant/Fire Retardant Classes*—The adhesive used in the construction of weather-resistant 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 and Water and Water Vapor-Resistant/Fire Retardant Classes*—The adhesives used shall enable the combined board to meet the requirements of 7.4. Paragraph 7.4 also applies to the polyethylene linerboard bonds in the laminated facings.

[7] Uniform Freight Classification is available from Rail Publication Service, 151 Ellis St. N.E., Suite 260, Atlanta, GA 30335–6021.
[8] Available from the American National Standards Institute (ANSI), 105–111 South State Street, Hackensack, NJ 07601.
[9] 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.
[10] Grade number for triplewall refers to the dry puncture resistance in units as determined by TAPPI T803.
[11] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111–5094, Attn: NPODS.

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 D 5168.

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
A-Flute	33 to 39	108 to 128
B-Flute	47 to 53	154 to 174
C-Flute	39 to 45	128 to 148
E-Flute	90 to 98	295 to 321

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 (D/FR)*:

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 lbs/1000 ft^2[127 g/m^2] 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 when tested as specified in 9.1.3 and 9.1.5, except that tests shall consist of an initial six bursts or punctures (three from each side of the board) and, if required, a supplementary 24 bursts (twelve from each side of the board).

7.1.2 *Weather-Resistant and Weather-Resistant/Fire Retardant Classes*—The components and end items conform to the applicable thickness and bursting strengths specified in Table 2 when tested as specified in 9.1.1 and 9.1.5.

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

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

Variety	Grade	Combined Weight Facings Only, min	Bursting Strength, Dry, min[A]	
		lb/1000 ft^2 [g/m^2]	psi [kPa]	
SW	125	52 [254]	125 [862]	
SW	150	66 [322]	150 [1034]	
SW	175	75 [366]	175 [1207]	
SW	200	84 [410]	200 [1379]	
SW	250	111 [542]	250 [1724]	
SW	275	138 [674]	275 [1896]	
SW	350	180 [879]	350 [2413]	
DW	200	92 [449]	200 [1379]	
DW	275	110 [537]	275 [1896]	
DW	350	126 [615]	350 [2413]	
DW	500	222 [1084]	500 [3447]	
DW	600	270 [1318]	600 [4137]	
			Puncture	
			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]

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

Variety	Grade[AB]	Thickness, in. [mm][C]		Bursting Strength, psi [kPa], min avg	
		Corrugating Medium	Outer Facings	Dry	Wet[D]
SW	V3c	0.010 [0.254]	0.023 [0.584]	400 [2758]	150 [1034]
SW	W5c	0.010 [0.254]	0.016 [0.406]	275 [1896]	100 [689]
SW	W6c	0.010 [0.254]	0.010 [0.254]	175 [1207]	50 [345]
DW	V11c	0.010 [0.254]	0.023 [0.584]	600 [4137]	300 [2068]
DW	V13c	0.010 [0.254]	0.016 [0.406]	400 [2758]	200 [1379]
DW	V15c	0.010 [0.254]	0.010 [0.254]	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]A − 5 %, or unlimited plus tolerance shall be permitted.
[D]After 24 h immersion (see 9.2.1).

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 9.1.1.

7.1.3.2 The end items shall conform to the applicable requirements of Table 2 when tested as specified in 9.1.5 and 9.2. In addition, the end item shall not absorb more than 1.1 g of water with wetting agent when tested as specified in 9.5.

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.

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

Grade	Combined Weight Of Plies Before Lamination, lb/1000 ft²[g/m²], 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.

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 ±⅛in. [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 ¼in. [6 mm] in depth.

TABLE 4 Type SF, Class Weather-Resistant and Weather Resistant/Fire Retardant, 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.

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*—Unless otherwise specified, fiberboard shall show no continuous visual surface break 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 E 162. 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 E 662. 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 D 585, 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 Practice D 685.

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 E 162.

9.1.7 *Specific Optical Density*—Test Method E 662.

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*: