



Designation: ~~D4028~~—~~07~~ D4028/D4028M – 13

Standard Specification for Solar Screening Woven from Vinyl-Coated Fiber Glass Yarn¹

This standard is issued under the fixed designation ~~D4028~~; D4028/D4028M; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope

1.1 This specification covers the requirements for vinyl-coated fiber glass solar screening, and should help users recognize the characteristics of acceptable vinyl-coated fiber glass solar screening. This specification is limited in application to vinyl-coated fiber glass solar screening that is produced with a ribbed pattern woven in the warp direction. The applicability of this specification to vinyl-coated fiber glass type solar screening of a non-rib, a double rib (ribs in both warp and filling direction), or a filling rib construction is not known.

1.2 This specification shows the definitions, general requirements, and physical requirements for commercial standard vinyl-coated fiber glass solar screening designed and woven for installation in any dwelling, building, or structure for the purpose of providing a significant reduction in solar heat gain, while providing outward view and interior light. Solar screening provides a structure that has insect-restraining capabilities equivalent to standard insect screening.

NOTE 1—For information on standard insect screening, see Specification [D3656](#).

1.3 ~~This specification shows the values in both SI units and inch-pound units. “SI” is the technically correct name for the system of metric units known as the International System of Units. “Inch-pound units” is the technically correct name for customary units used in the United States. The values stated in either SI units or in other units shall inch-pound units are to be regarded separately as standard. The values expressed stated in each system may not be exact equivalents; therefore, each system must shall be used independently of the other without combining in any way other. Combining values from the two systems may result in non-conformance with the standard.~~

1.4 The following precautionary caveat pertains only to the test method portion, Sections 8-21 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

[D76 Specification for Tensile Testing Machines for Textiles](#)

[D123 Terminology Relating to Textiles](#)

[D3374 Specification for Vinyl-Coated Glass Yarns](#)

[D3656 Specification for Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns](#)

[D3773 Test Methods for Length of Woven Fabric](#)

[D3774 Test Method for Width of Textile Fabric](#)

[D3775 Test Method for Warp \(End\) and Filling \(Pick\) Count of Woven Fabrics](#)

[D4909 Test Method for Color Stability of Vinyl-Coated Glass Textiles to Accelerated Weathering \(Withdrawn 1996\)](#)³

[D4912 Test Method for Fabric Stability of Vinyl-Coated Glass Yarn Insect Screening and Louver Cloth](#)

[D4963 Test Method for Ignition Loss of Glass Strands and Fabrics](#)

[D5035 Test Method for Breaking Force and Elongation of Textile Fabrics \(Strip Method\)](#)

[D7018 Terminology Relating to Glass Fiber and Its Products](#)

~~E1 Specification for ASTM Liquid-in-Glass Thermometers~~

¹ This specification is under the jurisdiction of ASTM Committee [D13](#) on Textiles and is the direct responsibility of Subcommittee [D13.18](#) on Glass Fiber and its Products. Current edition approved Dec. 1, 2007; Jan. 1, 2013. Published January 2008; February 2013. Originally approved in 1981. Last previous edition approved in 2002 as ~~D4028—96~~ [D4028—07](#) (2002). DOI: 10.1520/D4028-07.10.1520/D4028_D4028M-13.

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.

2.2 AATCC Standard:⁴

Evaluating Procedure 1, Grey Scale for Color Change.

2.3 ANSI ASHRAE Standard:⁵

Standard 74-1988, Method of Measuring Solar-Optical Properties of Materials

2.4 Federal Test Method Standards:⁶

No. 191, Method 5872, Effect of High Temperature on Cloth Blocking, Textile Test Methods

No. 191, Method 5903, Flame Resistance of Cloth, Vertical, Textile Test Methods

CCC D-950 Specification, Dyeing and After Treating Processes for Cotton Cloths

2.5 Military Standard:⁶

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

3. Terminology

3.1 For all terminology relating to D13.18, Glass Fiber and Its Products, refer to Terminology **D7018**.

3.1.1 The following terms are relevant to this standard: acceptable quality level, atmosphere for testing textiles, fabric stability, mesh, shading coefficient, solar screening.

3.2 For all other terms related to textiles, refer to Terminology **D123**

4. General Requirements

4.1 *Material:*

4.1.1 *Workmanship*—All commercial standard vinyl-coated glass yarn solar screening shall be made of high grade material with good workmanship and meet the yarn requirements specified in Specification **D3374**. Products shall be free of any defects that might affect serviceability or appearance, except those permitted in footnote C of **Table 1**. The quality acceptance levels will be determined by agreement between the purchaser and the supplier.

4.1.2 *Plasticizers*—The material used to coat or impregnate the fibrous glass yarn shall be a compound of polymerized or copolymerized vinyl chloride resin, plasticized with phosphate or phthalate ester plasticizers exclusively, pigmented and stabilized to meet the requirements herein.

4.1.2.1 *Optional Plasticizer*—At the supplier's option, plasticizers other than phosphates and phthalates may be used provided the color is not affected and the coating compound is treated with solubilized copper 8 quinolinolate which is listed as inhibitor (e) in Federal Standard CCC-D-950. The amount of fungicide shall be based on the nonvolatile content of the coating. The coating compound shall be chemically analyzed for copper 8 quinolinolate content in accordance with Federal Standard CCC-D-950.

4.1.3 *Color*—For colors listed in **Table 2**, the maximum and minimum shade limits shall be defined by color designations listed in Federal Standard 595A as agreed upon between the purchaser and the supplier.

4.1.4 *Selvage*—Vinyl-coated glass screening may be supplied with or without selvages as agreed between the purchaser and supplier.

⁴ Available from American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709.

⁵ Available from American Society of Heating, Refrigeration, and Air-Conditioning Engineers, 1791 Tullie Circle N.E., Atlanta, GA 30329.

⁶ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

TABLE 1 Defects^A

Bias or bowed filling—distortion at any point 13 mm (½ in.) or more from horizontal	Scalloped selvage
Bias or bowed filling—distortion at any point 13 mm [½ in.] or more from horizontal	Scalloped selvage
Broken or missing end or pick	Slack, or tight selvage
Curled (doubled, rolled, or folded) selvage	Smash
Cut, hole, or tear	Splice—more than one in 929 cm ² (1 ft ²)
Cut, hole, or tear	Splice—more than one in 929 cm ² [1 ft ²]
Damaged selvage extending into body of screening	Splice—more than 25 mm (1 in.) in length
Damaged selvage extending into body of screening	Splice—more than 25 mm [1 in.] in length
Double picks	Splice—not well made or showing loose ends exceeding 25 mm (1 in.) in length
Double picks	Splice—not well made or showing loose ends exceeding 25 mm [1 in.] in length
Floats	Spot, stain, streak, or mottled ^B
Hitch-back, open place, or slippage	Tight end or pick—causing waviness or ridge
Jerked-in filling, slough-off, or kinky filling	Uncoated yarns ^C
Knots	Warp streaks or filling bar
Offshade ^B	Wrong draw

^A For definitions of terms used in this table, refer to Terminology **D123**.

^B At normal inspection distance, approximately 1 m (4 yd) [1 yd].

^C Single ends or picks unevenly coated and giving the appearance of a streak, or light-colored, but coated yarn, shall not be scored as a defect when examined at normal inspection distance of approximately 1 m (4 yd) [1 yd].



TABLE 2 Generally Available Mesh, Widths, and Colors

Product	Nominal Yarn Diameter		Standard Constructions (Mesh)		Standard Minimum Widths		Colors
	µm	in.	Warp	Fill	cm	in.	
			25.4 mm [1 in.]	25.4 mm [1 in.]			
Fiber glass solar screening	292	0.0115	53	16	46, 51, 56, 61, 66, 71,	18, 20, 22, 24, 26, 28,	bronze
	330	0.0130	54	16	76, 81, 86, 91, 96, 102,	30, 32, 34, 36, 38, 40,	charcoal
			54	18	107, 112, 117, 122, 137, 152, 168, 183, 198, 213	42, 44, 46, 48, 54, 60, 66, 72, 78, 84	gray

4.1.5 *Yarn Splices*—Vinyl-coated glass yarn splices shall be permitted provided they show no tails and do not exceed 25 mm (± 1 in.) [1 in.] in length. Yarn splices in the solar screening shall not exceed 15 per standard 30 m (± 100 ft) [100 ft] roll, and no more than one splice shall occur in any 9.30 cm² (± 1 ft²) of product.

4.2 *Put-Up*—Vinyl-coated glass yarn solar screening shall be put-up on rolls and in containers whose dimensions shall be agreed upon between the purchaser and the supplier.

5. Physical Requirements

5.1 *Appearance*—Unless otherwise agreed upon between the purchaser and the supplier, a roll shall be defective if it contains one or more defects from the list in Table 1, and the lot shall be unacceptable if the number of defective sample rolls exceeds the acceptance number in Table 3. Table 3 is based on an acceptable quality level (AQL) of 4% defective rolls. 4 defects per 30.5 m [100 ft] in length.

5.2 *Mesh*—The standard average mesh shall be approximately even-spaced as specified in Table 2, ± 0.5 mesh per 25.4 mm (± 1 in.) [1 in.] in the non-rib direction and ± 2 mesh in the rib direction. There are no tolerance requirements within 13 mm (± 0.5 in.) [0.5 in.] of the selvage.

5.3 *Roll Length*—Each roll of solar screening complying with Specification D4028 shall contain not less than 30 linear m (± 100 [100 linear ft] ft), and shall contain not more than two pieces per roll with no piece less than 3 linear m (± 10 [10 linear ft] ft).

5.3.1 The lot shall be unacceptable if the total of the actual gross lengths of rolls in the sample is less than the total of the gross lengths marked on the roll tickets.

5.4 *Width*—The standard average roll width shall be as specified in Table 2 ± 7 or -0 mm (± 0.25 [± 0.25 or -0 in.] in.).

5.5 *Mass per Unit Area*—The minimum average mass per unit area for each class shall be as specified in Table 34.

5.6 *Ignition Loss*—The average ignition loss shall equal or exceed the value specified in Table 34.

5.7 *Breaking Strength*—The average breaking strength shall equal or exceed the value specified in Table 34.

5.8 *Fabric Stability*—The yarns shall be bonded at the contact or cross-over points to give sufficient fabric stability to the finished product to equal or exceed the applicable average force values specified in Table 34.

5.9 *Shading Coefficient*—The average shading coefficient shall equal or be less than the value specified in Table 34.

5.10 *Flame Resistance*—There shall be no propagation of flame along any specimen for longer than 10 s after removal of flame source, and no single specimen may propagate flame along its entire length in any time increment.

5.11 *Blocking Resistance*—The surfaces of the solar screening shall not adhere or exhibit blocking in excess of Scale No. 1.

TABLE 43 Sample Size and Acceptance Number^A

Lot Size		Rolls	
Length, m	Length, ft	Sample Size	Acceptance Number
Up to 365 inclusive ^B	Up to 1 200 inclusive ^B	3	0
366 up to and including 975	1 201 up to and including 3 200	5	0
976 up to and including 3 048	3 201 up to and including 10 000	8	0
3 049 up to and including 10 668	10 001 up to and including 35 000	13	0
10 669 up to and including 45 720	35 001 up to and including 150 000	20	1
45 721 and over	150 001 and over	32	2

^A Based on MIL-STD-105D, Inspection Level 11, and an AQL of 4.0 defects per 30.5-m (± 100 ft) [100-ft] length.

^B If lot contains fewer than 3 rolls, each roll in the lot shall be examined.



TABLE 34 Properties—Sample Average

Properties	Mesh 53	Mesh 5453	Mesh 5453
	by 16 Mesh/ 25.4 mm [1 in.]	by 16 Mesh/ 25.4 mm [1 in.]	by 18 Mesh/ 25.4 mm [1 in.]
Mass per unit area, min:			
g/m ²	246	246	246
oz/yd ²	7.25	7.25	7.25
Ignition loss, min, %	50	50	50
Breaking strength, min:			
Warp N	400	400	400
lbf	90	90	90
Fill N	155	155	155
lbf	35	35	35
Fabric stability, min:			
Warp N	67	67	89
lbf	15	15	20
Fill N	67	67	89
lbf	15	15	20
Shading coefficient,max	0.36	0.36	0.36

5.12 *Color Stability to Accelerated Weathering*—The change from the original color after 480 h of accelerated weathering exposure shall be no greater than Step 3 of the AATCC Gray Scale for evaluating change in color.

5.12.1 The change from the original color after 960 h of accelerated weathering exposure shall be no greater than Step 2 of the AATCC Gray Scale.

5.12.2 Exposure periods and acceptable changes for colors other than the colors as listed in Table 2 shall be as agreed upon between the purchaser and the supplier.

6. Sampling Inspection and Number of Specimens

6.1 *Lot Size*—A lot shall consist of each shipment of a single solar screening having the same color and mesh, unless otherwise agreed upon between the purchaser and the supplier. The lot size shall be designated in linear units of metres (feet):[feet].

6.2 *Lot Sample*—As a lot sample for acceptance testing, take the number of rolls of solar screening directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider rolls of solar screening to be the primary sampling unit. In the absence of such an agreement, take the number of rolls specified in Table 43.

NOTE 2—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between rolls of solar screening and between test specimens from a swatch or roll of solar screening to produce a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

6.3 *Laboratory Sample*—As a laboratory sample for acceptance testing, proceed as directed in an applicable material specification or other agreement between the purchaser and the supplier. In the absence of such an agreement, proceed as follows:

6.3.1 For solar screening appearance, width, mass per unit area, and length, the rolls in the lot sample serve as the laboratory sample.

6.3.2 For other properties, take at random from the rolls in the lot sample the number of rolls specified in Table 5. From each roll in the laboratory sample, take a 2-m (2-yd)[2-yd] full-width swatch from the end of the roll, but taken no closer than 1 m (1-yd)[1 yd] from the outside end of the roll.

6.4 *Test Specimens*—For solar screening appearance, width, and length, the rolls in the lot sample serve as test specimens. For other properties, take test specimens from the swatches in the laboratory sample as directed in the respective test methods in this specification. Take test specimens from each swatch in the laboratory sample in such a way that no specimen is closer than one tenth the width of the swatch from the selvage with no two specimens cut parallel to the warp containing the same set of warp ends or if cut parallel to the filling, containing the same set of filling picks, and the specimens from different swatches for a specific property are each taken from a different part of the width of the swatches.

TABLE 5 Sample Size for Lot Quantities

Lot Quantity	Sample Size, Number of Rolls	
	Length, m	Length, ft
243 or less	800 or less	2
244 to 6705	801 up to and including 22 000	3
6706 and over	22 001 and over	5



7. Conditioning

7.1 Condition the laboratory samples without preconditioning for a period of at least 5 h in the atmosphere for testing glass textiles, unless otherwise specified.

NOTE 3—In any event, 24 h is considered ample exposure time to bring the samples to moisture equilibrium.

TEST METHODS

8. Material

8.1 Upon prior agreement, the purchaser may accept the supplier's certification that the materials comply with the requirements of Section 4. In the absence of such an agreement, compliance will be tested using Specification D3374 and Federal Standard CCC-D-950.

9. Put-Up

9.1 Verify that the rolls and shipping containers conform to the inspection agreement in the purchaser's plant.

10. Solar Screening Appearance

10.1 Scope:

10.1.1 This test method covers the visual examination of screening material appearance using a major and minor evaluation system. A list of defects is provided designating the degree of the defect and whether minor or major. This test method is applicable to screening fabrics woven from vinyl-coated glass fiber yarns.

10.2 Summary:

10.2.1 The entire roll of screening material is examined on a lighted flat surface as it is rewound under controlled conditions. Minor and major defects are assigned when observed and the number of occurrences are reported.

10.3 Significance and Use:

10.3.1 The visual inspection of screening for defects is performed using an acceptable industry cloth room procedure and equipment before doing any other testing, and is considered satisfactory for acceptance testing of commercial shipments.

10.3.2 In using this test method for acceptance testing, in case of disagreement in values reported by the purchaser and the supplier, inspect the same rolls of screening at each station to determine the statistical bias, if any, between the examination station of the purchaser and the examination station of the supplier.

10.4 Apparatus:

10.4.1 *Fabric-Inspection Machine* that provides a flat viewing area and a controlled fabric-rewinding mechanism.

10.4.2 *Lighting Source* mounted parallel to the viewing surface of the fabric inspection machine so as to illuminate the surface with direct perpendicular impinging light rays that produce an illumination level of approximately 1075 lx (~~100 fc~~); [100 fc].

10.5 *Test Specimen*—Use the entire roll as the test specimen to inspect for appearance. (See 6.2-6.4.)

10.6 *Conditioning*—There are no specific requirements for conditioning.

10.7 Procedure:

10.7.1 Visually examine (inspect) each test specimen in the linear direction, full width, of the finished solar screening. Examine the entire length of each roll.

10.7.2 Traverse the screening longitudinally through the inspection machine at a compatible visual inspection speed.

10.7.3 View and inspect the moving screening from a distance of approximately 1 m (~~1 yd~~); [1 yd]. Stop the traverse to affirm marginal or suspected defects.

10.7.3.1 Count all defects found regardless of their proximity to one another, except where two or more defects represent a single local condition of the solar screening. In this case, count only the more serious defect as one defect for each warp direction 0.3 m (~~1 ft~~); [1 ft] or fraction thereof in which it occurs. Classify the defects as listed in Table 1.

10.7.3.2 Unless agreed otherwise between the purchaser and the supplier, do not count defects on the back of the screening unless the defects are visible on the face of the screening.

10.8 Report:

10.8.1 State that the rolls of screening were visually inspected for defects as directed in Section 10 of Specification D4028.

10.8.2 Report the following information:

10.8.2.1 Description of material sampled,

10.8.2.2 Roll length sampled,

10.8.2.3 For each roll, the number and type of defects per roll length, and

10.8.2.4 For the lot, the average number and type of defects per roll length.

10.9 *Precision and Bias*—No justifiable statement can be made on the precision and bias of Specification D4028 for measuring appearance since the result is based upon a visual examination and of subjective evaluation of what is observed and merely states whether there is conformance to criteria for success specified in the procedure.

11. Roll Length

11.1 Unless agreed otherwise between the purchaser and the supplier, determine the length of a roll by the clock method as directed in Test Methods **D3773**, Option C.

12. Color

12.1 The color shall be as agreed upon between the purchaser and the supplier.

12.2 The color of each sample lot shall be determined by evaluation and comparison to the standard color swatches using the evaluation procedure and light source as described in AATCC Evaluation Procedure 1.

13. Mesh

13.1 Determine the mesh as directed in Test Method **D3775**. Count the number of warp yarns in 25 mm (~~1 in.~~)[1 in.] of fabric width in five randomly designated places across the width of each swatch in the laboratory sample. Count the number of filling picks in 25 mm (~~1 in.~~)[1 in.] of fabric length in five randomly designated places across the length of each swatch in the laboratory sample.

14. Width

14.1 Determine the fabric width as directed in Test Method **D3774**, Option A. Measure the width of the screening at five evenly spaced points along the length of the roll. Make no measurements within 1 m (~~1 yd~~)[1 yd] of the ends of the roll.

15. Mass Per Unit Area

15.1 Determine the solar screening mass per unit area as directed in Test Methods **D4909**, Option C for small swatches.

16. Ignition Loss

16.1 Determine the ignition loss of each swatch in the laboratory sample as directed in Test Method **D4963** using a specimen weighing at least 5 g (~~0.2 oz.~~)[0.2 oz].

17. Breaking Strength

17.1 *Significance and Use:*

17.1.1 This breaking strength method is applicable whenever it is needed to determine the breaking force required to rupture a specific width of screening and can serve as a basis for determining differences between fabrics that may be due to the effect of variables in processing, yarns in the fabric, finishes applied to the yarns or fabric, and the geometric factors of the fabric construction.

17.1.2 Special measures are provided for in the test specimen preparation to prevent the screening from slipping in the clamps or from being damaged as a result of being gripped in the clamps. The testing for breaking strength without the use of the special specimen preparations usually gives breaking force forces that are significantly lower than when testing the specially prepared specimens.

17.2 *Apparatus:*

17.2.1 *Tensile Testing Machine*, constant-rate-of-extension (CRE) type, or constant-rate-of-traverse (CRT) type, as described in Specification **D76**.

17.2.1.1 In cases of dispute, the CRE-type tensile tester shall be preferred, unless agreed otherwise between the purchaser and the supplier.

NOTE 4—Normally it is expected that the use of the CRE-type or the CRT-type tensile testers would give different test results. However, interlaboratory test results on nine commercial vinyl-coated fiber glass solar screening fabrics indicated no significant differences in breaking strengths when the fabrics were tested as directed in Section 16, while using both types of machines.

17.3 *Reagents and Materials:*

17.3.1 *Methacrylate Polymer Solution*, such as *Butyl Methacrylate* or *Poly (Methyl Methacrylate)*. Some solutions are usable in the commercially available premixed form. A butyl methacrylate solution may be prepared by mixing 45 parts by mass of butyl methacrylate with 55 parts by mass of toluene or xylene and adding a small amount of oil-soluble dye. The viscosity of this solution should be about 3000 mPa·s (cP), approximately that of honey at room temperature. It may be necessary to change the consistency for some fabrics for proper protection.

17.3.1.1 **Hazards**—Solution is flammable, keep away from heat, sparks and open flame. Keep containers closed. Use only with adequate ventilation. Avoid prolonged or repeated contact with skin. Spillage and fire instructions will depend on nature of solution.

17.3.2 *Wrapping Paper*, kraft or bleached, minimum 81.35-g/m² (~~50-lb~~)[50-lb] basis.

NOTE 5—It has been found that other commercially available paper will suffice for the mounting of the specimens.

17.3.3 *Paint Brush*, 25 mm (~~1 in.~~)[1 in.] wide.