



Standard Specification for Finished Glass Fabrics Woven From Rovings¹

This standard is issued under the fixed designation D 4389; 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.

1. Scope

1.1 This specification primarily covers glass fabrics woven from “E” electrical continuous glass fiber rovings that are intended primarily as a reinforcing material in laminated plastics for structural use.

1.2 This specification specifies the terminology, definitions, general requirements, and physical requirements for woven roving glass fiber fabrics. This specification permits the application of sizing materials to the glass fiber roving during manufacture that helps facilitate weaving. When used as permitted in this specification, such materials are compatible with the resin matrix as specified in the contracting instrument.

NOTE 1—Sizing materials on glass fiber yarns, in most cases, are removed by various cleaning procedures as a first stage in preparing a finished fabric. When these yarn sizing materials are removed during a cleaning procedure, they need not be compatible with the subsequent resin matrix.

1.3 The values stated in either SI units or inch-pound units are to be regarded as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

NOTE 2—This specification is one of a series to provide a substitute for the following Military Specifications:

- MIL-Y-1140H Yarn, Cord, Sleaving, Cloth, and Tape-Glass
- MIL-C-9084C Cloth, Glass Finished for Resin Laminates
- MIL-C-19663C Cloth, Glass, Woven Roving for Plastic Laminates

2. Referenced Documents

2.1 ASTM Standards:

- D 123 Terminology Relating to Textiles²
- D 578 Specification for Glass Fiber Strands²
- D 1776 Practice for Conditioning Textiles for Testing²
- D 2408 Test Method for Finish Content of Woven Glass Fabric, Cleaned and After-Finished with Amino-Silane Type Finishes for Plastic Laminates³
- D 2409 Test Method for Finish Content of Woven Glass Fabric, Cleaned and After-Finished with Vinyl-Silane Type

Finishes for Plastic Laminates³

- D 2410 Test Method for Finish Content of Woven Glass Fabric, Cleaned and After-Finished with Chrome Complexes, for Plastic Laminates³
- D 2660 Test Method for Finish Content of Woven Glass Fabric, Cleaned and After-Finished with Acrylic-Silane Type Finishes, for Plastic Laminates³
- D 3098 Test Method for Finish Content of Woven Glass Fabric, Cleaned and After-Finished with Epoxy-Functional Silane-Type Finishes for Plastic Laminates³
- D 3773 Test Methods for Length of Woven Fabric⁴
- D 3774 Test Methods for Width of Woven Fabric⁴
- D 3775 Test Method for Fabric Count of Woven Fabric⁴
- D 3776 Test Methods for Mass per Unit Area (Weight) of Woven Fabric⁴
- D 4029 Specification for Finished Woven Glass Fabrics⁴
- D 4963 Test Method for Ignition Loss of Glass Strands and Fabrics⁴

2.2 ANSI Standard:

- ANSI/ASQC Z1.4 Sampling Procedures for Inspection by Attributes⁵

3. Terminology

3.1 Definitions:

- 3.1.1 *continuous filament yarn, n*—a yarn made of filaments that extend substantially throughout the length of the yarn.
- 3.1.2 *roving, n—in glass textiles*, a multiplicity of filaments or yarns gathered together into an approximately parallel arrangement without twist.
- 3.1.3 For definitions of other textile terms used in this specification, refer to Terminology D 123.

CLASSIFICATION

4. Classification

4.1 *Designation of Woven Roving Fabric*—The basic designations for glass woven roving fabric is by mass per unit area and is given in grams per square metre (ounces per square yard). Historically, an ASTM type number has been used by the industry. These numbers have been sequentially assigned as new woven roving constructions as they were added to this specification. Numbers, 1 through 10, are shown in Table 1

¹ This specification is under the jurisdiction of ASTM Committee D-13 on Textiles and is the direct responsibility of Subcommittee D13.18 on Glass Fiber and Its Products.

Current edition approved March 10, 1999. Published June 1999. Originally published as D 4389 – 84. Last previous edition D 4389 – 94.

² *Annual Book of ASTM Standards*, Vol 07.01.

³ Discontinued 1990; see *Annual Book of ASTM Standards*, Vol 08.02.

⁴ *Annual Book of ASTM Standards*, Vol 07.02.

⁵ Available from American National Standards Institute 11 W. 42nd St., 13th Floor, New York, NY 10036.

TABLE 1 Physical Properties of Generally Available “E” Glass Finished Woven Roving Fabrics

ASTM Type	Weave	Nominal Mass Per Unit Area		Roving Count 25.4 mm (1 in.) min		Construction ^A				Standard Roll Length	
						Nominal Roving Length Per Unit Mass					
		g/m ²	oz/yd ²	Warp	Fill	Tex		yd/lb		m	yd
1	Plain	441	13.0	10	4	840 to 755	1065 to 925	590 to 655	465 to 535	91.5	100
2	Plain	542	16.0	10	4	840 to 755	1680 to 1505	590 to 655	295 to 330	91.5	100
3	Plain	831	24.5	5	4	2360 to 2065	2680 to 2255	210 to 240	185 to 220	68.5	75
4	Plain	831	24.5	5	3	2360 to 2065	3545 to 3105	210 to 240	140 to 160	68.5	75
5	Plain	915	27.0	5	2.5	2360 to 2065	4960 to 4725	210 to 240	100 to 105	59.5	65
6	Plain	610	18.0	7	6	1210 to 1835	1340 to 1155	410 to 270	370 to 430	68.5	75
7	Plain	745	22.0	5	4	2360 to 2065	2155 to 1910	210 to 240	230 to 260	68.5	75
8	Plain	610	18.0	4	4	2360 to 2065	1655 to 1505	210 to 240	300 to 330	68.5	75
9	Plain	559	16.5	5	4	1710 to 1525	1710 to 1525	290 to 325	290 to 325	91.5	100
10	Plain	711	21.0	4	4	2420 to 2155	2420 to 2155	205 to 230	205 to 230	82.5	90

^A In some cases, the fill yarn may be woven as 2 picks per shed and as 1 fill yarn. The basic roving length per unit area used to produce the above fill yarns should be doubled.

with the relationship to mass per unit area and fabric count.

REQUIREMENTS

5. Material

5.1 The roving shall be continuous filament fiber, free of any free alkali, such as sodium or potassium metal salts and foreign particles, dirt, and other impurities. It shall be “E” electrical grade.

5.1.1 The fabric shall be uniformly woven, have uniform color, overall cleanness, and no objectionable odor.

6. Fabric Count

6.1 For woven roving fabrics listed in Table 1, the average fabric count shall conform to the requirements of Table 1. For woven roving fabrics not listed in Table 1, the average fabric count shall be agreed upon between the purchaser and the supplier.

7. Yarn Designations

7.1 For woven roving fabrics, the roving designations shall be as agreed upon between the purchaser and the supplier. The requirements of the individual elements of the designation are specified in Sections 8-10.

8. Yarn Number

8.1 For woven roving fabrics listed in Table 1, the average size-free yarn numbers of the yarns designated shall conform to the requirements of Table 1. For woven roving fabrics not listed in Table 1, the average size-free yarn numbers shall be agreed upon between the purchaser and the supplier.

9. Filament Diameter

9.1 The range of values for the filament diameters are listed in Table 2. The average filament diameter for the rovings in the woven roving fabric shall be within the interval listed in Table 2.

10. Strand Construction

10.1 The construction of the component strands shall be agreed upon between the purchaser and the supplier.

11. Weave Type

11.1 For woven roving fabrics listed in Table 1, the weave

TABLE 2 Letter Designation for Average Fiber Diameter Range of Glass Roving Used in Woven Roving Fabrics

Letter Designation	SI Units Diameter in Micrometres		US Customary Units Diameter in Inches	
	At Least	Below	At Least	Below
G	8.9	10.2	0.00035	0.00040
H	10.2	11.4	0.00040	0.00045
J	11.4	12.7	0.00045	0.00050
K	12.7	14.0	0.00050	0.00055
L	14.0	15.2	0.00055	0.00060
M	15.2	16.5	0.00060	0.00065
N	16.5	17.8	0.00065	0.00070
P	17.8	19.0	0.00070	0.00075

type shall be plain weave. For woven roving fabrics not listed in Table 1, the weave type shall be agreed upon between the purchaser and the supplier.

12. Mass per Unit Area

12.1 For woven roving fabrics listed in Table 1, the average mass per unit area shall conform to the requirements of Table 1. For woven roving fabrics not listed in Table 1, the average mass per unit area shall be agreed upon between the purchaser and the supplier. The average mass per unit area for the lot shall be within the interval: specified mass per unit area \pm 10 % of the specified mass per unit area.

13. Width

13.1 Fabric width shall be agreed upon between the purchaser and the supplier. The fabric width, including both selvages but excluding any feathered edges, shall not be less than the specified width and no more than 13 mm (0.5 in.) wider than the specified width.

NOTE 3—During the processing of glass fabrics, the selvages may be slit to minimize tension influences. This slit distance is excluded when measuring the fabric width unless otherwise agreed upon between the purchaser and the supplier.

14. Length

14.1 For woven roving fabrics listed in Table 1, the fabric length on each roll shall not be less than 2 m (2 yd) below the requirements listed in Table 1 unless otherwise agreed upon between the purchaser and the supplier. For woven roving fabrics not listed in Table 1, the fabric length on each roll shall be agreed upon between the purchaser and the supplier.

14.2 No piece of woven roving fabric shall be less than 14 m (15 yd) long and there shall be no more than two pieces in a roll, unless otherwise agreed upon between the purchaser and the supplier.

14.3 None of the sample rolls shall contain more than the allowable pieces, and the combined length of all of the sample rolls shall not be less than the combined lengths given on the identification labels of the sample rolls.

15. Ignition Loss

15.1 The organic content of woven roving fabric shall be no less than 0.075 % and no more than 0.25 % unless otherwise agreed upon between the purchaser and the supplier.

15.2 The type of, level of, and tolerances for roving finish shall be agreed upon between the purchaser and the supplier. The roving finish should be compatible with, and produce the required performance characteristics for the resin system specified in the applicable laminate specification or other procurement document. If the purchaser and the supplier agree that laminate testing (wet and dry) is to be used to determine acceptability of the finish content, this fact and the test method shall be specified in the contracting document.

16. Fabric Appearance

16.1 The woven roving fabric shall be generally uniform in quality and condition, clean, smooth, and free of foreign particles and defects detrimental to fabrication, appearance, or performance.

16.2 The fabric in the laboratory sample for the fabric appearance shall be examined for the defects listed in Table 3 and the acceptable quality levels (AQLs) shall be 6.5 total defects per hundred units of fabric unless otherwise agreed upon between the purchaser and the supplier.

16.3 When specified, the warp direction of the fabric shall be marked by blue direction-indicator yarns running warpwise in the cloth and spaced approximately 150 mm (6 in.) apart.

17. Put-Up

17.1 Woven roving fabric shall be furnished in rolls and shall be wound on spiral tubes measuring 76.2-mm (3-in.) minimum inside diameter and 25 mm (1 in.) longer than the overall width of the fabric, unless otherwise specified. The maximum number of pieces contained in any roll shall be as specified in 18.1.

17.2 Unless otherwise agreed upon, as when specified in an applicable material specification, each roll shall be packed in a sealed, vapor-tight bag of polyethylene not less than 0.05 mm

(0.002 in.) thick in such a manner as to ensure that the fabric, during shipment and storage, will be protected against damage from exposure to moisture, weather, or any other normal hazard.

NOTE 4—Once opened by the user, if the roll is not totally consumed, it is good practice to rebag the roll, add desiccant, and seal the bag.

18. Packaging

18.1 Each roll of woven roving fabric, put up as specified, shall be packaged to afford adequate protection against physical damage during shipment from the supply source to the receiving activity. The supplier may use his standard practice when it meets this requirement.

19. Marking

19.1 Each package shall be marked to show the following information unless specified otherwise between the purchaser and the supplier. Characters shall be of such size as to be clearly legible and shall not be obliterated by normal handling:

- 100 % Fiber Glass Woven Roving Cloth
- Glass Type E
- Fabric Type
- Length
- Width
- Purchase Order Number
- Manufacturers Identification
- Finish Designation

SAMPLING AND CONDITIONING

20. Sampling

20.1 *Lot Size*—A lot shall consist of each 9070 kg (20 000 lb) of a single woven roving fabric type unless otherwise agreed upon between the purchaser and the supplier.

20.1.1 When small multiple shipments are made from an inspected lot, the shipments may be made without additional inspection as agreed upon between the purchaser and the supplier.

20.2 *Lot Sample*—Unless otherwise agreed upon, as when specified in an applicable order or contract, take at random as a lot sample the number of rolls of woven roving fabric specified in ANSI/ASQC Z1.4 and a single sampling plan.

20.3 *Laboratory Sample*—As a laboratory sample, take the following samples:

20.3.1 For visual appearance, width, mass per unit area, and length, the rolls in the lot sample serve as the laboratory sample.

20.3.2 For other properties, take at random from the rolls in the lot sample the number of rolls specified in Table 4.

20.4 *Test Specimens*—For visual appearance, width, mass per unit area, and length, the rolls in the lot sample serve as test

TABLE 3 Woven Roving Fabric Defects

Crease or wrinkle, embedded; cannot be removed by hand rubbing
Any knots
Any brittle or fused area
Any smash
Any broken or missing end or pick
Any hole, cut, or tear
Any spot, stain, or streak clearly visible
Any pulled together or torn filament
Any torn, broken, or otherwise damaged selvage
Any thick or thin place, clearly visible
Foreign matter adhering to surface, clearly visible
Any jerked-in filling or slough-off

TABLE 4 Sample Size Determination for Physical Properties Other Than Visual Appearance, Width, Length, and Mass Per Unit Area

Lot Size in Units, m or yd	Sample Size, Number of Units
800 or less	2
801 up to and including 22 000	3
22 001 and over	5

specimens. For other properties, take material from the outside of each roll in the laboratory sample as a source of the test specimens required in the respective test methods in this specification after first discarding a minimum of 1 m (1 yd) from the very outside of the roll.

21. Condition

21.1 Condition the laboratory samples without preconditioning for a period of at least 5 h in the atmosphere for testing glass textiles in accordance with Practice D 1776, unless otherwise specified.

TEST METHODS

22. Material

22.1 Accept the supplier's certification that the material is of the correct grade as specified in Section 4 of Specification D 578. Verify that the fiber is continuous filament as specified, during testing for filament diameter as directed in Section 25. Determine the freedom from detrimental impurities during the inspection for fabric appearance as directed in Section 32.

23. Fabric Count

23.1 Determine the fabric count as directed in Test Method D 3775, making one count in the warp direction across the full width and three counts in the fill direction spaced 1 m (1 yd) apart, on each of the selected rolls in the laboratory sample.

24. Yarn Number

24.1 Determine the size-free yarn number in tex or yards per pound for both the warp and filling yarns as directed in Specification D 578, using a skein length of 1 m or 1 yd for each specimen and three specimens from each of the rolls in the laboratory sample. Several shorter lengths of yarn can be used to make up the 1-m (1-yd) specimen length.

25. Filament Diameter

25.1 Determine the filament diameter for both the warp and filling yarns as directed in Specification D 578 by using 50 individual filaments from one yarn test specimen from both the warp and filling yarns in each of the rolls in the laboratory sample.

26. Strand Construction

26.1 Verify the number of single strands and the number of plied or cabled strands on one test specimen of warp yarn and one specimen of filling yarn in each of the rolls in the laboratory sample.

27. Fabric Weave Type

27.1 Determine the woven roving fabric weave type as directed in Specification D 4029 using one test specimen from each of the rolls in the laboratory sample.

28. Mass per Unit Area

28.1 Determine the mass per unit area in grams per square metre (ounces per square yard) of the woven roving fabric as directed in Test Method D 3776, Option A, using each roll in the laboratory sample.

29. Width

29.1 Determine the width of the woven roving fabric as directed in Test Methods D 3774, Option A, and the free-of-tension procedure, except that five measurements per roll shall be made on each of the rolls in the lot sample.

30. Length

30.1 Measure the length of each roll in the lot sample as directed in Test Methods D 3773 using any one of the four optional procedures. Verify that none of the sample rolls contains more than the allowable number of pieces. Sum the lengths for each of the rolls measured, and compare to the total of the lengths specified on the identification labels for those rolls. In case of dispute, use Option A of Test Methods D 3773 to resolve the dispute.

31. Finish and Ignition Loss

31.1 Determine the organic content of the woven roving fabric as directed in Test Method D 4963, unless otherwise agreed upon between the purchaser and the supplier.

31.1.1 It is recognized that the determination of degree of resin compatible sizings can be difficult to obtain. Certain procedures applicable to various resin compatible sizings are available and can be found in the specifications listed as follows. These procedures or any other procedure applicable to finish content shall be as specified in the contracting instrument.

Specification	Type of Finish
D 2408	Amino-Silane
D 2409	Vinyl Complex
D 2410	Chrome Complex
D 2660	Acrylic-Silane
D 3098	Epoxy-Functional Silane

31.1.2 If laminate testing is specified in the contracting document, the ASTM specifications listed in 31.1.1 are recommended as the source for testing procedures unless otherwise agreed upon between the purchaser and the supplier.

32. Fabric Appearance

32.1 Determine the fabric appearance as directed in Specification D 4029 on each of the rolls in the lot sample except classify the defects as listed in Table 3. Each defect listed in Table 3 is considered major.

33. Put-Up, Packaging, and Marking

33.1 During the sampling and testing of the shipment, verify the correctness of put-up, packaging, and marking.

CONFORMANCE

34. Conformance

34.1 The test results for the lot must conform to the requirements for all characteristics listed in this specification for the lot to be considered acceptable.

34.2 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification together with a report of the test results shall be furnished at the time of shipment.

34.3 Upon the request of the purchaser in the contract or order, the certification of an independent third party indicating conformance to the requirements of this specification may be accepted instead of the manufacturer's certification.

34.4 The purchaser and the supplier may agree on other procedures to establish conformance, including control charts

furnished by the supplier, and other sampling plans such as sequential or double-sampling.

35. Keywords

35.1 appearance; construction; fabric count; glass woven roving; ignition loss; length; mass per unit area; width

SUMMARY OF CHANGES

The following are changes since the last revision:

- (1) Updated instructions for use of SI units.
- (2) Changed conditioning reference to Practice D 1776.

- (3) Deleted reference to MIL-STD 105D. Added reference to ANSI/ASQC Z1.4.

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