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An American National Standard

# Standard Specification for Plastic Laminates Made from Woven-Roving and Woven-Yarn Glass Fabrics<sup>1</sup>

This standard is issued under the fixed designation D 4357; 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 (e) indicates an editorial change since the last revision or reapproval.

# 1. Scope

1.1 This specification covers standard plastic laminates. their testing, and minimum property requirements, for the qualification of materials used to manufacture structural, semi-structural, or electrical composites of fiberglass wovenroving and woven-yarn fabrics. It covers, in part, plastic laminates designed for printed-circuit boards, which are specified in MIL-P13949. It does not cover glass-reinforced plastic laminates for armor, which are specified in MIL-A-46166 and the companion MIL-A-46165 on input wovenroving glass fabric.

NOTE 1-Companion ASTM specifications on the input wovenroving glass fabrics and woven-glass fabrics are included in Section 2.

NOTE 2—This specification is one of a series to provide a replacement for ASTM Specification D 2150 and Military Specifications MIL-Y-1140 and MIL-C-19663.

Note 3-This specification may replace Military Specification MIL-C-9084 upon further examination as to the utility of Specification D 4357 in military procurement.

1.2 The following precautionary caveat pertains only to the test method portion, Section 8, of the 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.

NOTE 4-There is no similar or equivalent ISO standard.

# 2. Referenced Documents

- 2.1 ASTM Standards:
- D 123 Terminology Relating to Textiles<sup>2</sup>
- D 150 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials<sup>3</sup>
- D618 Practice for Conditioning Plastics for Testing<sup>4</sup>
- D 638 Test Method for Tensile Properties of Plastics<sup>4</sup>
- D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials4
- D883 Terminology Relating to Plastics<sup>4</sup>

- D 2584 Test Method for Ignition Loss of Cured Reinforced Resins<sup>6</sup>
- D 4029 Specification for Finished Woven Glass Fabrics<sup>7</sup>
- D 4389 Specification for Finished Glass Fabrics Woven from Rovings<sup>7</sup>
- 2.2 Military Specifications.8

MIL-A-46165 Armor: Woven Glass Roving Fabrics

MIL-A-46166 Plastic Laminates, Glass Reinforced (For Use in Armor Composites)

MIL-C-9084 Cloth, Glass, Finished, for Resin Laminates MIL-C-19663 Cloth, Woven Roving, for Plastic Laminates

MIL-C-9084C

MIL-P-13949 Plastic Sheet, Laminated, Metal Clad (for Printed Wiring Boards), General Specification for

MIL-Y-1140 Yarn, Cord, Sleeving, Cloth, and Tape-Glass 2.3 Military Standard:8

MIL-STD-105 Sampling Procedures for Inspection by Attributes

2.4 This plastic laminate specification will provide a substitute for the following military specifications:

MIL-R-7575 Resin, Polyester, Low Pressure Laminating MIL-R-9299 Resin, Phenolic, Laminating

MIL-R-9300 Resin, Epoxy, Low Pressure Laminating

MIL-P-13949 Plastic Sheet, Laminated, Metal Clad (for Printed Writing Boards), General Specification for

MIL-R-21607 Resin, Polyester, Low Pressure Laminating, Fire Retardant

MIL-R-25506 Resin, Silicone, Low Pressure Laminating

# 3. Terminology

- 3.1 Definitions:
- 3.1.1 fabric, woven, n-a planar structure produced by interlacing two or more sets of rovings or yarns where the elements pass each other essentially at right angles and one set is parallel to the fabric axis (warp) and the other set is perpendicular to the axis (filling).
- 3.1.2 roving, n—a multiplicity of continuous fibers or filaments coated with a suitable sizing system and gathered together into an approximate parallel arrangement with little or no twist. The filaments may or may not be grounded into intermediate strands.

D 2150 Specification for Woven Roving Glass Fabric for Polyester-Glass Laminates<sup>5</sup>

<sup>&</sup>lt;sup>1</sup> This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.18 on Reinforced Thermosetting Plastics.

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<sup>&</sup>lt;sup>2</sup> Annual Book of ASTM Standards, Vol 07.01.

<sup>&</sup>lt;sup>3</sup> Annual Book of ASTM Standards, Vol 10.01.

<sup>4</sup> Annual Book of ASTM Standards, Vol 08.01.

<sup>&</sup>lt;sup>5</sup> Discontinued, see 1986 Annual Book of ASTM Standards, Vol 08.02.

<sup>&</sup>lt;sup>6</sup> Annual Book of ASTM Standards, Vol 08.02.
<sup>7</sup> Annual Book of ASTM Standards, Vol 07.02.

<sup>&</sup>lt;sup>8</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

Minimum Average Flexural and Tensile Strengths for 3.17 mm (0.125 in.) Thick Polyester Laminates made with Woven-Roving TABLE 1 Glass Fabrics of Plain Weave

ASTM TYPE	Woven Roving Nominal Average Mass/Weight <sup>A</sup>		Roving Count 25.4 mm (1 in.) min		Number of Plies in Laminate	Flexural Strength, MPa <sup>8</sup> /psi					Tensile Strength, MPa <sup>8</sup> /psi					
						Lengthwise			Crosswise			Lengthwise		Crosswise		
	g/m²	oz/yd²	warp	fill		dry		wet		dry	٧	vet	dry	wet	dry	wet
1	441	13.0	10	4	8	410		280		170		100				
						60 000	40	000	25		15	000				
2	542	16.0	10	4	6	380		210		240		140				
						55 000	30	000	35	000	20	000				
3	831	24.0	5	4	4	340	-	210	33	280	20	210	260		210	
						50 000	40	000	40	000	99	000	38 000		210	
4	831	24.5	5	3	4	340	•••	210	40	240	JE	140	36 000		30 000	
						50 000	30	000	35		20	000				
5		22.0	5	3.5		To be determined		000	00	000	20	000				
6	915	27.0	5 5	2.5	3¢	340		210		280		210				
					_	50 000	30	000	40	000		000				
7	610	18.0	7	6	5	280	-	210	40	210		210				
				-	_	40 000	30	000	30			000				
8		18.0	7	5		To be determined		000	30	•••	20	w				
9	745	22.0	5	4	4	340		210		240		140				
			-	•	•	50 000	30	000	25	000						
10		18.0	5	4		To be determined		000	33	000	30	000				
11	610	18.0	4	4	5	340		210		040						
			•	•	•	50 000	20	000		210 000		140				
12	559	16.5	5	4		55 000	30	000	30	UUU	20	000				
13	711	21.0	4	4	4	60 000	50	000	45	000	40	000				
14	610	18.0		2.5						000		000	40.000			
A Tolom	610	18.0	4	2.5	5	70 000	55	000		000		000	40 000		32 000	

A Tolerance ±10 %

<sup>8</sup> Megapascal (MPa) rounded to the nearest ten (10).

- <sup>c</sup> The laminate thickness shall be  $2.79 \pm 0.254$  mm (0.110  $\pm 0.010$  in.) instead of  $3.17 \pm 0.254$  mm (0.125  $\pm 0.010$  in.) for this style only.
- 3.1.3 strand, n—an ordered, parallel assemblage of textile fibers having a high ratio of length to diameter and normally used as a unit intermediate in size between a single fiber and derived products, consisting of a multiplicity of strands, such as multi-end rovings, plied yarns, cords, braids, ropes, etc.
- 3.1.4 yarn, continuous glass, n—yarn made of filaments that extend substantially throughout the length of the yarns.
- 3.1.5 yarn, glass-fabricated, n-yarn containing two or more strands plied together.
- 3.1.6 yarn, textured-glass, n-yarns processed from continuous yarns in such a manner so as to induce bulk to the yarn by disorientation of the filaments.
  - 3.2 Definitions of Terms Specific to this Standard:
- 3.2.1 roving, woven, n-a heavy, coarse, but drapable fabric woven from roving and having characteristically unequal bi-directional laminate strengths even with equal roving count in plain weave.
- 3.2.2 yarn, woven, n-a light, supple fabric, or cloth, woven from textile yarn, which, when in plain weave with uniform count and equal yarn numbers, has approximately equal laminate strengths in the warp and fill directions.
- 3.3 For definitions of other textile terms used in the specification, refer to Terminology D 123.
- 3.4 For definitions of other terms related to laminate properties, refer to Terminology D 883.

#### 4. Classification

- 4.1 Designation of Glass Woven-Roving Laminates—The ASTM-type numbers assigned to glass woven-roving fabrics, which are characterized by their mass per unit area and fabric counts, are also used to designate the corresponding test laminates (see Table 1).
  - 4.2 Glass woven-yarn fabrics for laminates are cleaned

and after-finished in five basic types of sizing (coupling) systems. The five types of finishes are as follows:

- 4.2.1 Type I—Amino-silane.
- 4.2.2 Type II—Vinyl-silane.
- 4.2.3 Type III—Chrome complex.
- 4.2.4 Type IV—Acrylic-silane.
- 4.2.5 Type V—Epoxy-functional silane.
- 4.3 The grades of woven-glass-yarn fabric laminates shall be designated by fabric style numbers that are standard throughout the industry. Generally used style numbers are listed in numerical order in Tables 2 and 3.
- 4.4 Each type and grade of woven-glass fabric may be used with one or more classes of resin systems to produce plastic laminates. The six classes of resins are as follows:
  - 4.4.1 Class 1—Polyester.
  - 4.4.2 *Class 2*—Epoxy.

  - 4.4.3 Class 3—Silicone. 4.4.4 Class 4—Phenolic.
  - 4.4.5 Class 5—Vinylester.
- 4.4.6 Class 6-All others, including furfural formaldehyde, melamine formaldehyde, and urethanes.

#### 5. Requirements

- 5.1 Material:
- 5.1.1 Glass woven-roving fabric shall meet the requirements of Specification D 4389, unless otherwise specified in an applicable order or contract.
- 5.1.2 Woven-glass-yarn fabric shall meet the requirements of Specification D 4029, unless otherwise specified in an applicable order or contract.
  - 5.2 Finish on Woven-Glass Fabric:
- 5.2.1 For woven-roving glass fabric used in standard plastic laminates, the sizing on the glass rovings to facilitate

TABLE 2 Minimum Average Longitudinal Tensile Strength of Polyester Laminates made with Woven Yarn Glass Fabrics of Plain Weave

	Tensile Strength (Thousands of psi) (Minimum Average)											
Finished Fabric	Class 1 (p	oolyester)	Class 2	(epoxy)	Class 3	(silicone)	Class 4 (phenolic)					
Commercial Style Designation	Standard Conditions	Wet Condition	Standard Conditions	Wet Condition	Standard Conditions	Wet Condition	Standard Conditions	Wet Condition				
112	40	38	47	45	30	27	48	46				
112-150	40	38	47	45	30	27	48	46				
116	40	38	47	45	30	27	48	46				
116-150	40	38	47	45	30	27	48	46				
120	40	38	47	45	30	27	48	46				
128	40	38	47	45	30	27	48	46				
128-150	40	38	47	45	30	27	48	46				
128-75G	40	38	47	45	30	27	48	46				
143	80	75	90	85	60	53	96	90				
143-150	80	75	90	85	60	53	96	90				
162	40	38	47	45	30	27	48	46				
164	33	30	39	35	25	21	40	36				
164-150	33	30	39	35	25	21	40	36				
181	40	38	48	45	30	27	40	38				
181-150	40	38	48	45	30	27	40	38				
181-75DE	40	38	48	45	30	27	40	38				
182	43	40	50	47	32	28	52	48				
182-150	43	40	50	47	32	28	52 52	48				
183	43	40	50	47	32	28	52 52	48				
184	43	40	50	47	32	28	52 52	_				
184-150	43	40	50	47	32	28	52 52	48 48				
1000-150	33	30	39	35	25	21	40					
1000-75	33	30	39	35	25	21	40	36 36				
1044-150	33	30	39	35	25 25	21	40					
1044-75	33	30	39	35	25 25	21	40 40	36 36				

A The longitudinal direction of the laminate is parallel to the warp direction of the base cloth.

weaving and to impart high wet strength to laminates shall be compatible with a wide variety of resins, including those that are fire retardant and those commonly referred to as corrosion-resistant resins. Unless otherwise specified for test purposes, the sizing shall be compatible with a polyester laminating resin selected by the supplier of the woven roving. The test laminate (see Section 7) shall be made with that resin unless another type resin is specified. The laminate must meet the property requirements of Table 1.

- 5.2.2 For woven-yarn fabric, the type of finish after cleaning shall be chosen from the following:
- 5.2.2.1 Class 1—For polyester laminates, Type II, Type III, or Type IV finishes.
- 5.2.2.2 Class 2—For epoxy laminates, Type I, Type III, or Type V finishes.
  - 5.2.2.3 Class 3—For silicone laminates, Type V finish.
- 5.2.2.4 Class 4—For phenolic laminates, Type I or Type III finishes.
- 5.2.2.5 Class 5—For vinyl ester laminates, Type II, Type IV, or Type V finishes.
  - 5.2.2.6 Class 6—For other resin laminates, Type I finish.
- 5.2.3 These laminates have a wide variety of properties for general use, or for use under specific conditions, such as high physical or chemical stress, high moisture, high temperature, or in electrical environments, or combination thereof.
- 5.2.3.1 Within a class, the type and amount of finish for woven-yarn glass fabrics shall be selected to meet the laminate property requirements of Tables 2 and 3, when laminates are prepared in accordance with Section 7. The average laminate properties for each class shall not be less than the requirements of Tables 2 and 3. For fabrics or laminates not listed in Tables 2 and 3, the laminate properties shall be agreed upon between the user and the supplier.

- 5.2.3.2 When required, as in Federal/Military procurement documents, or when agreed upon between the user and the supplier, laminate electrical properties must meet the requirements of Table 4.
  - 5.3 Acceptable Quality Level:
- 5.3.1 The Acceptable Quality Level shall be zero defective sample units, or as otherwise agreed upon between the user and the supplier. (No sample unit shall fail to meet the required average value for any applicable laminate characteristic.)

## 6. Sampling

- 6.1 Lot Size:
- 6.1.1 For woven-roving glass fabric, a lot shall consist of 9070 kg (20 000 lb) of a single woven-roving glass fabric type, unless otherwise agreed upon between the user and the supplier.
- 6.1.2 For woven-yarn glass fabric, a lot shall consist of 10 000 yd (9000 m) of finished woven-yarn glass fabric or portion thereof in a shipment or consignment from one production lot, unless otherwise agreed upon between the user and the supplier.
- 6.2 Lot Sample—Take at random, as the lot sample, the number of rolls of fabric specified in MIL-STD-105D for Inspection Level I and a single sampling plan, unless otherwise agreed upon, as when specified in an applicable order or contract.
- 6.2.1 Laboratory Sample—The sample for laminate tests shall be taken from just under the outer convolution of the selected roll.
- 6.2.2 The sample unit shall be of sufficient size to fabricate laminates for the tests specified in Section 7.
  - 6.2.3 When specified, if small multiple shipments are

TABLE 3 Minimium Average Longitudinal Flexural Strength of Polyester Laminates made with Woven Yarn Glass Fabrics of Plain Weave 4

	Tensile Strength (Thousands of psi) (Minimum Average)											
Finished Fabric Cloth	Class 1 (p	polyester)	Class 2	(epoxy)	Class 3	(silicone)	Class 4 (phenolic)					
Commercial Style Designation	Standard Conditions	Wet Condition	Standard Conditions	Wet Condition	Standard Conditions	Wet Condition	Standard Conditions	Wet Condition				
112	50	45	70	65	35	30	60	54				
112-150	50	45	70	65	35	30	60	54				
116	45	40	63	58	32	27	54	48				
116-150	45	40	63	58	32	27	54	48				
120	50	45	70	65	35	30	60	54				
128	45	39	63	58	32	26	54	47				
128-150	45	39	63	58	32	26	54	47				
128-75G	45	39	63	58	32	26	54	47				
143	90	78	115	110	63	52	108	94				
143-150	90	78	115	110	63	52	108	94				
162	35	30	49	45	25	20	42	36				
164	35	30	49	45	25	20	42	36				
164-150	35	30	49	45	25	20	42	36				
181	50	45	75	65	35	30	50	45				
181-150	50	45	75	65	35	30	50	45				
181-75DE	50	45	75	65	35	30	50	45				
182	50	45	70	65	35	30	60	54				
182-150	50	45	70	65	35	30	60	54				
183	45	40	63	58	32	27	54	48				
184	45	40	63	58	32	27	54	48				
184-150	45	40	63	58	32	27	54	48				
1000-150	40	30	56	43	28	20	48	36				
1000-75	40	30	56	43	28	20	48	36				
1044-150	40	30	56	43	28	20	48	36				
1044-75	40	30	56	43	28	20	48	36				

A The longitudinal direction of the laminate in parallel to the warp direction of the base fabric.

TABLE 4 Minimum Average Electrical Requirements of Laminates made with Woven Roving Glass Fabric and Woven Yarn Glass Fabric<sup>4</sup>

	Class 1 (	polyester)	Class 2	(epoxy)	Class 3 (silicone)	
Characteristic	Standard Conditions	Immersion Conditions	Standard Conditions	Immersion Conditions	Standard Conditions	Immersion Conditions
At 1 MHz (radio frequency)				<u> </u>		
Dielectric constant (max avg)	4.4	4.6	4.4	4.6	4.2	4.2
Loss tangent (max avg)	0.045	0.055	0.045	0.055	0.030	0.030
At 8500 to 10 000 MHz (radar frequency) <sup>8</sup>						
Dielectric constant (max avg)	4.2	4.4	4.6	4.6	4.5	4.5
Loss tangent (max avg)	0.020	0.025	0.020	0.025	0.025	0.025

<sup>&</sup>lt;sup>A</sup> There are no electrical requirements for Class 4 finished woven-glass fabric.

made from an inspected lot, the shipments may be made without additional inspection.

#### 7. Laminate Preparation

- 7.1 Resin laminates for testing shall be made in accordance with the following parallel lay-up procedure and with 7.1.2 through 7.1.6.
- 7.1.1 Prepare the laminates in the form of two or more flat sheets, measuring approximately 360 by 360 by 3.17  $\pm$  0.25 mm (14 by 14 by 0.125  $\pm$  0.010 in.). Cut the woven-glass fabric specimens along the warp and fill strands while pulling the strands to ensure right angle lay-up of all layers. Lay carefully in place with all warp strands parallel. Apply resin to each layer in such a manner as to wet out completely all layers of woven-glass fabric with the minimum inclusion of air. Enclose the laminate in a suitable plastic bag or cover with a transparent sheet of release film and roll with a round steel pipe so as to remove all air bubbles and produce an essentially void-free laminate.
- 7.1.2 Woven-Roving Glass-Fabric Laminates—Unless otherwise specified, the resin used to make the laminates shall be a medium-reactivity styrenated polyester selected by the supplier of the woven-roving glass fabric. The resin content of the laminate by weight, as determined in accordance with 7.2, shall be between 40 to 45 %, and the number of plies shall be in accordance with Table 1.
- 7.1.2.1 Fully cure the laminate in an open mold, with or without shims, under conditions recommended by the resin supplier. A pressure of 69 kPa (10 psi) usually will be found sufficient. If desired, the test laminate may be made by the vacuum-bag technique following the foregoing parallel lay-up procedure.
- 7.1.3 Woven-Yarn Glass-Fabric Laminates, Class 1 Polyester—The polyester resin used to make the laminates shall be a medium-reactivity styrene type. The resin content of the laminate by weight, as determined in accordance with 7.2, shall be  $38 \pm 2 \%$ . This resin content does not necessarily yield the optimum properties in a laminate. The number of

<sup>&</sup>lt;sup>8</sup> "X-band" frequency range. The recommended test frequency for this band is 9375 MHz.

plies required to meet the laminate thickness will vary depending upon the particular fabric thickness. For example, 10 to 12 plies of style 181 fabric (0.008 to 0.012-in. thickness) are required. Cure in accordance with the resin manufacturer's instructions under a laminating pressure not to exceed 207 kPa (30 psi).

- 7.1.4 Woven-Yarn Glass-Fabric Laminates, Class 2 Epoxy—Epoxy resin of the diglycidyl ether of bisphenol-A type with an aromatic amine curing agent has been found satisfactory for these tests. Laminate in a press, with or without stops, at the pressure (207 kPa, 30 psi max) and temperature recommended by the resin manufacturer. The laminate shall be essentially void-free and representative of the best quality workmanship and shall have a resin content of  $28 \pm 2$  % as determined in accordance with Section 7.
- 7.1.5 Woven-Yarn Glass-Fabric Laminates, Class 3 Silicone-Fabric the woven-glass-fabric base plastic laminate to the dimensions previously given following the resin manufacturer's instructions relative to the resin handling and cure. Laminate pressure should not exceed 207 kPa (30 psi). Determine resin/glass content required to meet the laminate property requirements of Tables 2 and 3, and if specified, Table 4.
- 7.1.6 Woven-Yarn Glass-Fabric Laminates, Class 4 Phenolic—The laminate shall be prepared and fully cured to the dimensions previously given in accordance with the resin manufacturer's instructions at a laminating pressure not exceeding 2070 kPa (300 psi).
  - 7.2 Resin Content of Laminate:
- 7.2.1.1 Test Specimens—The test specimens shall have a minimum weight of 3 g and a maximum size of 2.5 by 2.5 cm (1 by 1 in.). The sides shall be square to the faces and the edges shall not be frayed. Two specimens shall be tested in accordance with Test Method D 2584 and the results averaged.

#### 8. Test Methods

- 8.1 Laminate Properties—Determine the laminate properties enumerated in this specification and in accordance with the following methods:
  - 8.1.1 Mechanical Tests:
- 8.1.1.1 Flexural Strength of Laminate—Cut, prepare, and test five specimens each for flexural strength in the warp and fill directions for woven-roving glass-fabric-based laminates, and five test specimens for flexural strength in the warp direction only for woven-yarn glass-fabric-based laminates in accordance with Test Methods D 790. The axis of the specimen shall be parallel with the reinforcement.
- 8.1.1.2 Tensile Strength of Laminate—Cut, prepare, and test five test specimens each for tensile strength in the warp and fill directions for woven-roving glass-fabric-based laminates, and five test specimens for tensile strength in the warp direction only for woven-yarn glass-fabric-based laminates in accordance with Test Method D 638. The axis of the specimen shall be parallel with the reinforcement.
  - 8.1.2 Electrical Tests:
- 8.1.2.1 Relative Permittivity (Dielectric Constant) and Dissipation Factor—Cut and prepare five test specimens for

dielectric constant and dissipation factor in accordance with Test Methods D 150. Test frequency shall be 1 MHz unless otherwise specified.

- 8.3 Conditioning:
- 8.3.1 For Mechanical Tests:
- 8.3.1.1 Dry Condition—Condition five test specimens at  $23 \pm 2$ °C (73.4  $\pm 3.6$ °F) and  $50 \pm 5$  % relative humidity for not less than 48 h prior to test in accordance with Procedure A of Practice D 618, for those tests where conditioning is required. In cases of disagreement, the tolerances shall be  $\pm 1^{\circ}$ C ( $\pm -1.8^{\circ}$ F) and  $\pm 2^{\circ}$  relative humidity.
- 8.3.1.2 Wet Condition—Immerse five test specimens in boiling distilled water for 2 h, after which remove them and place in a beaker containing distilled water at room temperature. Allow to cool for at least 1 h. Conduct the test on the wet specimens immediately after removing from the cooling water and wiping off the surface water. In case of any question as to the validity of the test results, additional specimens shall be soaked for 30 days in distilled water at room temperature and then tested wet immediately after removal from the water. Results determined under the latter condition shall be final. If the cure temperature of the laminate is 100°C (212°F) or less, the 30-day soak at room temperature shall be mandatory for wet conditioning.
  - 8.3.2 For Electrical Tests:
- 8.3.2.1 Dry Conditions—Condition five specimens in accordance with 8.3.1.1
- 8.3.2.2 Wet Conditions—Condition five specimens in accordance with 8.3.1.2.

### 9. Conformance

- 9.1 The test results for the lot must conform to the requirements for all characteristics listed in this specification for the lot to be acceptable.
- 9.2 The user and 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.

## 10. Certification

- 10.1 When agreed upon in writing by the user and the supplier, a certification shall be made of the basis of acceptance of the material. This shall consist of a statement by the supplier, accompanied by a copy of the test results if requested, that the material has been sampled, tested, and inspected in accordance with the provisions of the specification that are of interest to the user. Each certification so furnished shall be signed by an authorized agent of the seller or the manufacturer.
- 10.2 When original identity cannot be established, certifications can only be based on the sampling procedure provided by the applicable specification.
- 10.3 For cleaned and after-finished woven yarn glass fabrics only, the certification shall include the type of finish applied and, if requested, the results obtained on the properties listed in the specification. If the order is less than the lot size, as described in 6.1, the test results of the lot shall apply to the individual rolls.

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**∰** D 4357

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