



Designation: **D579/D579M—10 D579/D579M – 15**

Standard Specification for Greige Woven Glass Fabrics¹

This standard is issued under the fixed designation D579/D579M; 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 greige fabrics woven from “E” electrical glass fiber yarns. This specification can also be applied to fabrics made of other glass fiber types as agreed upon between the purchaser and the supplier.

1.2 This specification specifies the terminology, definitions, general requirements and physical requirements for greige glass fiber fabrics. This specification permits the application of organic materials to the glass fiber yarn during manufacture that helps facilitate weaving.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately 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 non-conformance with the standard.

1.4 This specification is one of a series to provide a substitute for Military Specifications: MIL-Y-1140 Yarn, Cord, Sleeving, Cloth, and Tape-Glass; and MIL-C-9084 Cloth, Glass Finished for Resin Laminates.

1.5 Additional ASTM specifications in this series have been drafted and appear in current editions of the Annual Book of ASTM Standards. These include finished glass fabrics, unfinished glass fabrics, glass tapes, glass sleeveings, glass cords, glass sewing threads, and finished laminates made from finished glass fabrics.

1.6 *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 Documents²

2.1 ASTM Standards:

- [D123 Terminology Relating to Textiles](#)
- [D578 Specification for Glass Fiber Strands](#)
- [D1059 Test Method for Yarn Number Based on Short-Length Specimens](#) (Withdrawn 2010)³
- [D1423 Test Method for Twist in Yarns by Direct-Counting](#)
- [D1776 Practice for Conditioning and Testing Textiles](#)
- [D1777 Test Method for Thickness of Textile Materials](#)
- [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](#)
- [D3776 Test Methods for Mass Per Unit Area \(Weight\) of Fabric](#)
- [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](#)

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 Jan. 1, 2010/Jan. 1, 2015. Published January 2010/March 2015. Originally approved in 1940. Last previous edition approved in 2009/2010 as D579 – 09/D579 – 10. DOI: 10.1520/D0579-10.10.1520/D0579-15.

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 *ANSI Standards:*

[ANSI/ASQC Z1.4 Sampling Procedures for Inspection by Attributes⁴](#)

2.3 *Military Standard and Specifications:*

[MIL-Y-1140H Yarn, Cord, Sleeving, Cloth and Tape-Glass⁵](#)

[MIL-C-9084C Cloth, Glass Finished for Resin Laminates⁵](#)

2.4 *Textile Institute Documents:*

[Textile Terms and Definitions⁶](#)

[Woven Cloth Construction⁶](#)

3. Terminology

3.1 For all terminology relating to D13.18, Glass Fibers and Its Products, refer to Terminology [D7018](#).

3.1.1 The following terms are relevant to this specification: atmosphere for testing textiles, continuous filament, crowfoot weave, eight-harness satin, greige goods, leno weave, mock leno weave, twelve-harness satin

3.2 For all other terms related to textiles, see Terminology [D123](#).

CLASSIFICATION

4. Classification

4.1 The designation of a fabric shall be by style numbers that are standard throughout the industry. Generally used style numbers are listed in numerical order in [Table 8](#).

REQUIREMENTS

5. Material

5.1 The yarn shall be continuous filament, unless otherwise specified, free of any free alkali metal salts, such as soda or potash, and foreign particles, dirt, and other impurities.

6. Fabric Count

6.1 For fabrics listed in [Table 8](#), the nominal fabric count shall conform to the requirements of [Table 8](#). For fabrics not listed in [Table 8](#), the nominal fabric count shall be agreed upon between the purchaser and the supplier. The average count of warp ends shall be within two ends of the nominal count, and the average count of the filling picks shall be within two picks of the nominal count.

7. Yarn Designations

7.1 For fabrics listed in [Table 8](#), the yarn designations shall conform to the requirements of [Table 8](#). For fabrics not listed in [Table 8](#), the yarn designations shall be agreed upon between the purchaser and the supplier. The requirements of the individual elements of the designation are specified in Sections [8 – 12](#).

7.1.1 In some cases ECE 225 yarn is specified in [Table 8](#). ECD 225 may be substituted with no significant decrease in property performance.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁵ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁶ Available from the Textile Institute, 10 Blackfriars St., Manchester, M3 5DR England.

TABLE 1 Twist Tolerances

	Tolerances
Turns per Centimetre:	
From zero to 0.4, incl	±0.1 turn per centimetre
Over 0.4 and up to and including 4.0	±0.2 turn per centimetre
Over 4	±5.0 % of the specified average twist
Turns per Metre:	
From zero to 40, incl	±10 turns per metre
Over 40 and up to and including 400	±20 turns per metre
Over 400	±5.0 % of the specified average twist
Turns per Inch:	
From zero to 1, incl	±0.25 turn per inch
Over 1 and up to and including 10	±0.5 turn per inch
Over 10	±5.0 % of the specified average twist



TABLE 2 Tolerances—Mass/Unit Area

Nominal Mass/Unit Area, g/m ² (oz./yd ²)	Permissible Variation, %
136 (4.0) and under	±10
Over 136 (4.0)	±6

TABLE 2 Tolerances—Mass/Unit Area

Nominal Mass/Unit Area, g/m ² [oz./yd ²]	Permissible Variation, %
136 [4.0] and under	±10
Over 136 [4.0]	±6

TABLE 3 Tolerances—Thickness

Nominal Thickness	Permissible Variations
millimetres	
0.075 and under	±0.013
Over 0.075 to 0.250	±0.025
Over 0.250 to 0.380	±0.050
Over 0.380	±0.075
inches	
0.0030 and under	±0.0005
Over 0.0030 to 0.0100	±0.0010
Over 0.0100 to 0.0150	±0.0020
Over 0.0150	±0.0030

8. Yarn Number

8.1 For fabrics listed in Table 8, the nominal size-free yarn numbers of the yarns designated shall conform to Specification D578. For fabrics not listed in Table 8, the nominal size-free yarn number shall be agreed upon between purchaser and supplier.

9. Filament Diameter

9.1 The nominal filament diameter for yarns in the fabric shall conform to the nominal range for filament diameter average values specified in Table 1 of Specification D578.

10. Strand Construction

10.1 The basis for specifying strand construction is given in Specification D578. For fabrics listed in Table 8, the construction of the component strands shall conform to the requirements of Table 8. For fabrics not listed in Table 8, the construction of the component strands shall be agreed upon between the purchaser and the supplier.

11. Direction of Twist

11.1 Unless otherwise agreed upon between the purchaser and the supplier, the primary twist in the singles strands shall be “Z” twist and the final twist in the plied yarns shall be “S” twist.

12. Twist Level

12.1 The nominal twist in the component strands and the finished yarns shall conform to the requirements of Table 8 in Specification D578. The tolerances for the primary twist and the final twist shall conform to Table 1 of this document unless otherwise agreed upon between the purchaser and the supplier.

13. Fabric Weave Type

13.1 For fabrics listed in Table 8, the fabric weave type shall conform to the requirements of Table 8. For fabrics not listed in Table 8, the fabric weave type shall be agreed upon between the purchaser and the supplier.

14. Mass Per Unit Area

14.1 For fabrics listed in Table 8, the nominal mass per unit area shall conform to the requirement of Table 8. For fabrics not listed in Table 8, the nominal mass per unit area shall be agreed upon between the purchaser and the supplier. The average mass per unit area for the lot shall conform to the requirements of Table 2.

15. Thickness

15.1 For fabrics listed in Table 8, the nominal thickness shall conform to the requirements of Table 8. For fabrics not listed in Table 8, the nominal thickness shall be agreed upon between the purchaser and the supplier. The average thickness of the fabric in the lot shall conform to the requirements of Table 3, unless specified otherwise.



TABLE 4 Classification of Defects^A

Defect	Description	Major	Minor
Bias or bowed filling	Pick line distortion from horizontal by more than 2.5 % for entire width	X	
Baggy, ridged, or wavy cloth	Clearly noticeable	X	
Cut or tear	6.5 mm (0.25 in.) or more in any direction (body only)	X	
Cut or tear	6.5 mm [0.25 in.] or more in any direction (body only)	X	
Hole	13 mm (0.5 in.) or more in diameter	X	
Hole	13 mm [0.5 in.] or more in diameter	X	
	Less than 13 mm (0.5 in.) in diameter		X
	Less than 13 mm [0.5 in.] in diameter		X
Spots, streaks, or stains, foreign inclusions	Clearly noticeable	X	
Tender or weak spot	Clearly noticeable 50 mm (2 in.) or more in combined directions	X	
Tender or weak spot	Clearly noticeable 50 mm [2 in.] or more in combined directions	X	
	Clearly noticeable less than 50 mm (2 in.) but greater than 6.5 mm (0.25 in.) in combined directions		X
	Clearly noticeable less than 50 mm [2 in.] but greater than 6.5 mm [0.25 in.] in combined directions		X
Smash	76 mm (3 in.) or more in combined directions	X	
Smash	76 mm [3 in.] or more in combined directions	X	
	Less than 76 mm (3 in.) in combined directions		X
	Less than 76 mm [3 in.] in combined directions		X
Broken, missing ends or picks	2 or more contiguous regardless of length	X	
Floats and skips	50 mm (2 in.) or more in combined directions	X	
Floats and skips	50 mm [2 in.] or more in combined directions	X	
	Less than 50 mm (2 in.) in combined directions		X
	Less than 50 mm [2 in.] in combined directions		X
Light marks	Greater than 6.5 mm (0.25 in.) in width	X	
Light marks	Greater than 6.5 mm [0.25 in.] in width	X	
	2 picks less than nominal pick construction		X
Heavy marks	Puckering clearly noticeable	X	
	2 picks more than nominal pick construction		X
Crease	Hard embedded and folded over on self	X	
Waste	Clearly noticeable over 6.5 mm (0.25 in.) in length	X	
Waste	Clearly noticeable over 6.5 mm [0.25 in.] in length	X	
	Clearly noticeable less than 6.5 mm (0.25 in.) in length		X
	Clearly noticeable less than 6.5 mm [0.25 in.] in length		X
Weave separation	Clearly noticeable 3 mm (0.125 in.) or more	X	
Weave separation	Clearly noticeable 3 mm [0.125 in.] or more	X	
Brittle or fused area	Any	X	
Selvage Defects	Curled or folded under		X
	Cut or torn less than 6.5 mm (0.25 in.) in length		X
	Cut or torn less than 6.5 mm [0.25 in.] in length		X
	Cut or torn 6.5 mm (0.25 in.) and over in length	X	
	Cut or torn 6.5 mm [0.25 in.] and over in length	X	
Selvage leno ends out	Greater than 5 m (5 yd) missing (continuously)	X	
Selvage leno ends out	Greater than 5 m [5 yd] missing (continuously)	X	
	Less than 5 m (5 yd) missing		X
	Less than 5 m [5 yd] missing		X
Feather edge	Greater than 5 mm (0.1875 in.) running more than 5 m (5 yd)	X	
Feather edge	Greater than 5 mm [0.1875 in.] running more than 5 m [5 yd]	X	
	Greater than 5 mm (0.1875 in.) but running less than 5 m (5 yd)		X
	Greater than 5 mm [0.1875 in.] but running less than 5 m [5 yd]		X

^A At a normal viewing distance of 1 m or 3 ft.

TABLE 5 Sample Size Determination for Construction, Mass, Width, and Physical Properties

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

16. Breaking StrengthForce

16.1 For fabrics listed in Table 8, the minimum breaking strengthforce shall conform to the requirements of Table 8. For those fabrics and/or breaking strength in which breaking force is not listed in Table 8, the minimum breaking strengthforce shall be agreed upon between the purchaser and the supplier. The average breaking strengthforce for the lot shall exceed the specified breaking strengthforce, and no individual break shall be less than 80 % of the specified minimum breaking strengthforce.

TABLE 6 Values of b for Critical Differences in Defect Counts, a and b , for Two Test Results

	Probability Level		Probability Level			Probability Level			Probability Level			
	$r = a + b$	90 %	95 %	$r = a + b$	90 %	95 %	$r = a + b$	90 %	95 %	$r = a + b$	90 %	95 %
1				26	8	7	51	19	18	76	30	28
2				27	8	7	52	19	18	77	30	29
3				28	9	8	53	20	18	78	31	29
4				29	9	8	54	20	19	79	31	30
5	0			30	10	9	55	20	19	80	32	30
6	0	0		31	10	9	56	21	20	81	32	31
7	0	0		32	10	9	57	21	20	82	33	31
8	1	0		33	11	10	58	22	21	83	33	32
9	1	1		34	11	10	59	22	21	84	33	32
10	1	1		35	12	11	60	23	21	85	34	32
11	2	1		36	12	11	61	23	22	86	34	33
12	2	2		37	13	12	62	24	22	87	35	33
13	3	2		38	13	12	63	24	23	88	35	34
14	3	2		39	13	12	64	24	23	89	36	34
15	3	3		40	14	13	65	25	24	90	36	35
16	4	3		41	14	13	66	25	24	91	37	35
17	4	4		42	15	14	67	26	25	92	37	36
18	5	4		43	15	14	68	26	25	93	38	36
19	5	4		44	16	15	69	27	25	94	38	37
20	5	5		45	16	15	70	27	26	95	38	37
21	6	5		46	16	15	71	28	26	96	39	37
22	6	5		47	17	16	72	28	27	97	39	38
23	7	6		48	17	16	73	28	27	98	40	38
24	7	6		49	18	17	74	29	28	99	40	39
25	7	7		50	18	17	75	29	28	100	41	39

Probability levels are for two-sided limits. If the observed value of ILm the tabulated value, the two test results should be considered significantly different at the indicated probability level.

a = the larger of two defect counts, each of which is the total count for all specimens in a test result and each of which is based on the same number of specimens,

b = the smaller of the two defect counts taken as specified for a , and

$r = a + b$.

When $r > 100$, use the following approximation:

$$b = c - 1 - k \sqrt{c}$$

where:

b = calculated value of b , rounded to the nearest whole number,

$c = r/2$, and

$k = 1.386$ and 1.163 respectively for the 95 % and 90 % probability levels.

17. Width

17.1 Fabric width shall be agreed upon between the purchaser and the supplier. The fabric width, including both selvages but excluding any feathered edges, shall be no narrower than the specified width and no more than 13 mm (0.5 in.) wider than the specified width.

NOTE 1—During the processing of glass fabrics, the selvages may be slit to minimize tension influences. This slit distance is generally excluded when measuring the fabric width.

18. Length

18.1 The fabric roll length, length between splices, and number of splices per roll shall be agreed upon between purchaser and supplier. All splices must be thermoset unless otherwise agreed upon between the purchaser and supplier.

19. Ignition Loss

19.1 The ignition loss of greige fabric shall be less than 4.0 % unless otherwise agreed upon between the purchaser and the supplier.

20. Fabric Appearance

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



TABLE 7 95 % Confidence Limits for Number of Defect Counts per Test Result

Observed Count	Lower Limit	Upper Limit
0	0.0	3.7
5	1.6	11.7
10	4.8	18.4
15	8.4	24.7
20	12.2	30.9
25	16.2	36.9
30	20.2	42.8
35	24.4	48.7
40	28.6	54.5
45	32.8	60.2
50	37.1	65.9
60	45.8	77.2
70	54.6	88.4
80	63.4	99.6
90	72.4	110.6
100	81.4	121.6
120	99.5	143.5
140	117.8	165.2
160	136.2	186.8
180	154.7	208.3
200	173.2	229.7

$$\text{Lower confidence limit for counts} = c[1 - (1/9c) - t(1/9c)^{1/2}]^3$$

$$\text{Upper confidence limit for count} = d[1 - (1/9d) + t(1/9d)^{1/2}]^3$$

where:

c = observed number of counts,

d = $c + 1$, and

t = 1.960, the value of Student's t for infinite degrees of freedom, two-sided limits, and the 95 % probability level.

20.2 The fabric in the laboratory sample for the fabric appearance shall be examined for the defects listed in Table 4 and the acceptable quality levels (AQLs) are 2.5 major and 6.5 total (major and minor combined) defects per hundred units of fabric unless otherwise agreed upon between the purchaser and the supplier.

20.3 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.) [6 in.] apart.

21. Put-Up

21.1 Fabric shall be furnished in rolls and shall be wound on spiral tubes. The tube dimensions shall be as agreed upon between the purchaser and supplier. The maximum number of pieces contained in any roll shall be as specified in 18.1.

22. Sampling

22.1 *Lot Size*—A lot shall consist of each 9000 m (10 000 yd) [10 000 yd] of a single fabric style unless otherwise agreed upon between the purchaser and the supplier.

22.1.1 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.

22.2 *Lot Sample*—Take at random as a lot sample the number of rolls of fabric specified in ANSI/ASQC Z1.4 and a single sampling plan, unless otherwise agreed upon.

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

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

22.3.2 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 1 m (1 yd) [1 yd] full-width swatch from the end of the roll after first discarding a minimum of 1 m (1 yd) [1 yd] of fabric from the very outside of the roll. Remove only the outer layer of fabric if the circumference of the roll is less than 1 m (1 yd) [1 yd].

22.4 *Test Specimens*—For fabric appearance, fabric width, and fabric 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.



23. Packaging

23.1 Each roll of 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.

23.2 Unless otherwise agreed upon, as when specified in an applicable contract or purchase order, each roll shall be wrapped in polyethylene not less than 0.05 mm (0.002 in.) [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.

24. Marking

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

- 100 % Fiber Glass Cloth
- Style
- Length
- Width
- Purchase Order Number
- Manufacturer's Identification
- Finish Designation

24.1.1 All fabrics will be considered Type "E" electrical unless specified otherwise. If glass type is other than electrical "E," each package shall be marked accordingly.

SAMPLING AND CONDITIONING

25. Conditioning

25.1 Condition the laboratory samples without preconditioning, for a period of at least 5 h in the atmosphere for testing glass textiles as directed in Practice D1776, unless otherwise specified.

TEST METHODS

26. Material

26.1 Accept the supplier's certification that the material is of the correct grade as specified in Specification D578. Unless otherwise specified, during testing for strand construction as directed in Section 30, verify that the yarn is continuous filament. Determine the freedom from objectionable impurities during the inspection for fabric appearances as directed in Section 40.

27. Fabric Count

27.1 Determine the fabric count as directed in Test Method D3775, making one count in each direction on each of the swatches in the laboratory sample.

28. Yarn Number

28.1 Determine the yarn number in tex (yards[yards per pound]pound) for both the warp and filling yarns as directed in Test Method D1059.

29. Filament Diameter

29.1 Determine the filament diameter for both the warp and filling yarns as directed in Specification D578 by using 50 individual filaments from one yarn test specimen from both the warp and filling yarns in each of the swatches in the laboratory sample.

30. Strand Construction

30.1 Verify the number of singles strands and the number of plied or cabled strands on one test specimen of warp yarn and one specimen of filling yarn while determining the twist direction or twist level.

31. Direction of Twist

31.1 Verify the direction of twist in each strand of the yarns as directed in Test Method D1423 in each of five test specimens of warp and filling yarns taken from each of the swatches in the laboratory sample.

32. Twist Level

32.1 Determine the twist level in each of the component strands as directed in Test Method D1423 upon five test specimens of warp yarn and five test specimens of filling yarn from each of the swatches in the laboratory sample.



33. Fabric Weave Type

33.1 *Scope*—This method covers the recognition of the six fabric weave types referred in Table 8. The weaves included are: crowfoot, leno, mock leno, plain, eight-harness satin, and twelve-harness satin.

33.2 *Significance and Use:*

33.2.1 The fabric weave type is important. It can affect the performance of the final product depending on its end use in terms of strength, force, durability and aesthetics. This method specifies a procedure for recognizing specified weaves.

33.2.2 This procedure for recognizing fabric weave type is considered satisfactory for acceptance testing of commercial shipments.

33.3 *Apparatus:*

33.3.1 *Rectangular Coordinate Graph Paper.*

33.3.2 *Linen or Magnifying Glass.*

33.3.3 *Marking Pen or Pencil.*

33.4 *Procedure:*

33.4.1 Place a swatch of the sample on a flat surface, face side up (see Terminology D7018 for definitions relative to Eight and Twelve Harness Satins). Position the swatch with the warp direction extending forward and away from the observer.

33.4.2 Select a starting point on the surface of the fabric where a warp end is raised over a filling pick (raiser yarn).

33.4.3 Denote a filling end raised over a warp end (Sinker yarn) on the face of the fabric by an unmarked block.

33.4.4 Plot the weave construction by first marking a block on the graph paper designating the starting raiser yarn.

33.4.5 Continue plotting from left to right, from the first raiser yarn, showing raiser yarns as marked blocks and sinker yarns as unmarked blocks until a minimum of two repeats of the pattern are observed. In a like manner, plot up from the first raiser yarn until a minimum of two repeats of the pattern are observed corresponding to each designated block in the left-to-right pattern.

33.4.6 Compare the design plot to Figs. A1.1-A1.6.

33.4.6.1 Leno and mock leno have a distinct visual appearance and may be identified without plotting.

33.5 *Report:*

33.5.1 State that the fabric weave type of the rolls of fabric was determined as directed in Section 33 of Specification D579. Describe the material or product sampled and the method of sampling used.

33.5.2 Report the fabric weave type for each roll including the raiser/sinker pattern in terms of the warp ends up and down.

33.6 *Precision and Bias*—No justifiable statement can be made either on the precision or on the bias of this procedure since the procedure merely determines whether the weave in the test specimen conforms to that specified.

34. Mass Per Unit Area

34.1 Determine the mass per unit area of the fabric as directed in Test Method D3776, Option A, using each of the rolls in the laboratory sample.

35. Thickness

35.1 Determine the thickness of the fabric as directed in Test Method D1777, using ten test specimens from each swatch in the laboratory sample.

35.2 For glass fabrics and tapes made with continuous filament yarns, use Table 1 Option 3 of Method D1777. For fabrics made with textured or open-end yarns, use Table 1 Option 1 of Method D1777.

36. Breaking Strength

36.1 Determine the breaking strength in newtons per 25 mm (or pounds-force per inch) of fabric in both the warp and filling directions as directed in Test Method D5035. There may be no overall correlation between the results obtained with the CRE machine and the CRT machine. Consequently, these two testers cannot be used interchangeably. In case of controversy the CRE tensile tester shall prevail.

36.1.1 The use of hydraulic pneumatic clamping systems with 50 by 75-mm (2 by 3-in.) serrated jaw faces is recommended for testing samples prepared as directed in 36.4 and 36.5. The 50-mm (2-in.) dimension of the jaw face shall be in the direction of test. Manual clamping is permitted.

NOTE 2—When using jaw faces other than serrated, minimize crushing and cutting of the glass yarns in the test specimens by lining the inside surface of the jaws with cardboard 0.25 to 0.40 mm (0.010 to 0.015 in.) in thickness or moleskin. Secure the end of the jaws with pressure-sensitive tape.

36.2 Prepare specimens as directed in 36.3, 36.4, or 36.5, as applicable.

36.3 *Procedure 1*—Procedure 1 is for fabrics having breaking strengths of 445 N/25 mm (100 lbf/in.) or less.

NOTE 3—Fabrics having breaking strength less than 445 N/25 mm (100 lbf/in.) can be prepared as outlined in 36.4 with no effect on the obtained value. Preparation Procedure 1 is provided to allow for a lower test specimen preparation cost when extensive preparation is not required.



36.3.1 Reagents and Materials:

36.3.1.1 *Butyl Methacrylate Solution* is prepared by mixing 45 parts by mass of butyl methacrylate with 55 parts by weight of toluene or xylene and adding a small amount of oil-soluble dye. The viscosity of this solution should be about mPa·s (3000 cP), approximately that of honey at room temperature. It may be necessary to change the consistency for some types of fabrics to permit complete penetration of all interstices and to prevent capillary migration of the solution along the yarns into the test area.

NOTE 4—Substitute solutions can be used providing specimen damage does not occur or that specimens break or slip at the jaw faces.

36.3.1.2 **Precaution**—Butyl methacrylate solution ingredients are flammable. Keep away from heat, sparks and open flame. Keep containers closed. Use only with adequate ventilation. Avoid prolonged breathing of vapor or spray mist. Avoid prolonged or repeated contact with skin. Spillage and fire instructions will depend on nature of solution.

36.3.1.3 *Multipurpose Paper*, 20 lb bond or greater (as needed to prevent slippage in the grips).

36.3.1.4 *Paint Brush*, 16 to 25 mm (0.6 [0.6 to 1.0 in.] in.), with bristles 25 mm (1 in.) [1 in.] long.

36.3.2 Cut two swatches of fabric from the laboratory sample each 200 by 250 mm (8 [8 by 10 in.] in.), one with the warp yarns and the other with filling yarns parallel to the 200 mm (8 in.) [8 in.] direction.

36.3.3 Lay each sample cut as directed in 36.3.2 on a piece of wrapping paper of similar size. Lay out five test specimens 38 by 150 mm (1.5 [1.5 by 6 in.] in.) on the fabric by drawing light lines with a soft, black wax pencil so that the yarns to be tested, warp or filling, are parallel to the longer direction. Draw lines across the specimens 40 mm (1.6 in.) [1.6 in.] from each end, using very light pressure on the wax pencil to avoid possible damage to the surface filaments. Thoroughly impregnate the 40 mm (1.625 in.) [1.625 in.] specimen end strips with butyl methacrylate solution (or substitute) which must soak through the fabric in order to secure firm adhesion to the paper. Spread the solution in an even film to secure a uniform pressure from the testing machine jaws against the test specimen. Dry the impregnated sample slowly, 24 h without forcing, until the solvent is completely removed. Be sure to have the impregnant cover the cross lines to reinforce those sections where some of the surface fibers may have been fractured when those lines were drawn. On thick fabrics, paint both sides of the specimens by applying a coat of the impregnant to the back of the fabric or to the top surface of the backing paper.

36.3.4 Cut the 150 by 38 mm (6 [6 by 1.5 in.] in.) test specimen strips from the prepared sample without removing the paper backing. Ravel the central unimpregnated portion of the specimen to 25 mm (1 in.) [1 in.] in width as directed in Test Method D5035. After raveling, load samples in the test clamps, cut the 38 mm (1.5 in.) [1.5 in.] wide paper backing across midway between the ends, taking care not to damage the fabric specimen.

NOTE 5—Raveling of the specimen can be facilitated by slitting each test specimen at its center, perpendicular to the yarn components severing all yarns except those in the central 25 mm (1 in.) [1 in.]

36.4 *Procedure 2*—Procedure 2 is for fabrics having breaking strengths forces greater than 445 N/mm (100 lbf/in.) [100 lbf/in.] or tending to consistently break in, or slip from, the jaws when using Procedure 1 stated in 36.3.

36.4.1 Prepare test specimens as directed in 36.3 except as described in 36.4.2 – 36.4.10.

36.4.2 Substitute Sub 65 grade white cardboard in place of the wrapping paper.

36.4.3 Draw two legible lines 75 ± 1 mm (3.0 [3.0 \pm 0.05 in.] in.) from each other and parallel across the center section of the cardboard.

36.4.4 Uniformly apply a resin solution on the cardboard along the drawn lines and outwards for a distance of 50 ± 1 mm (2.0 [2.0 \pm 0.05 in.] in.). Do not include the center 75 ± 1 mm (3.0 [3.0 \pm 0.05 in.] in.) between the drawn lines.

NOTE 6—A mixture by weight of 60 parts CIBA Giegy 6004 Epoxy resin and 40 parts General Mills Versimid 125 polyamide resin has been found suitable for this purpose.

36.4.5 Lay the cut swatches of fabrics each 200 by 250 mm (8 [8 by 10 in.] in.), one with the warp yarns and the other with the filling yarns parallel to the 200 mm (8 in.) [8 in.] direction, centrally and equally spaced on the resin prepared cardboard. The shorter direction of the sample is perpendicular to the drawn lines.

36.4.6 Uniformly reapply the resin mixture on the specimen directly above the first application.

36.4.7 Place a 50 ± 1 mm (2.0 [2.0 \pm 0.05 in.] in.) by 250 mm (10 in.) [10 in.] strip of cardboard over the resin-impregnated area of the specimen. Allow to dry a minimum of 16 h.

NOTE 7—When substitute solutions are used, drying time may vary.

36.4.8 Cut five specimens, 150 by 38 mm (6 [6 by 1.5 in.] in.) in each of the warp and filling directions, and label accordingly, having the longer direction in the direction of test.

36.4.9 Ravel a sufficient number of yarns from each side of the specimen so that the central portion is a 25 mm (1 in.) [1 in.] width plus two yarns.

36.4.10 After the specimen is loaded in the test clamps, cut and ravel one yarn from each side of the test specimen and cut the cardboard backing across, midway between the ends, taking care not to damage the fabric specimen.

36.4.11 In the case of hydraulic pneumatic clamps, apply a pressure of 6750 to 7650 N (1500 [1500 to 1700 lbf] lbf) to the clamp faces. In the case of manual clamping, tighten sufficiently to prevent slippage of the test specimen.

36.5 *Procedure 3*—Procedure 3 is for fabrics having breaking strengths forces greater than 2224 N/25 mm (500 lbf/in.) [500 lbf/in.] or that show cascading breaks across the specimen when using Procedure 2 stated in 36.4, or both.

NOTE 8—Glass yarns have a tendency to move within some fabrics when cut and handled in the greige state. This procedure is designed to ensure straightness of individual yarn components throughout the test.

36.5.1 Cut five specimens, 300 by 50 mm (~~12~~[12 by 2 in.] in.) from the laboratory sample in each of the warp and filling directions, and label accordingly, having the longer direction in the direction of test.

36.5.2 Draw two legible lines 75 ± 1 mm (~~3.0~~[3.0 \pm 0.05 in.] in.) from each other and parallel to the long directions and across the center section of a 200 by 280 mm (~~8~~[8 by 11 in.] in.) piece of Sub 65 white cardboard. Prepare one for each the warp and filling directions.

36.5.3 Place the cardboard sections at the outer edge of a workbench that is covered with a 0.19 mm (~~75~~[75 in.] in.) thick piece of plywood. The 280 mm (~~11~~[11 in.] in.) length is parallel to the bench edge.

36.5.4 Lay the cut specimens on the lined cardboard so that one end is 25 mm (~~1~~[1 in.] in.) above the cardboard and the other end is hanging over the bench edge. Secure the top edge of the specimen to the plywood base by nailing through a 25 by 50 mm (~~1~~[1 by 2 in.] in.) 19 mm (~~0.75~~[0.75 in.] in.) plywood block placed above the specimen to the base. The 50 mm (~~2~~[2 in.] in.) dimension is placed parallel to the specimen width. Four or five 32 mm (~~1.25~~[1.25 in.] in.) nails equally spaced have been found acceptable for this purpose.

NOTE 9—A permanent fixture can be designed to replace the wooden blocks to facilitate testing.

36.5.5 Place two similar wooden blocks, one on each side of the other end of the specimen so that the fabric is sandwiched between the blocks. Nail the blocks and fabric together.

36.5.6 Fold the specimen upwards and away from the lined cardboard.

36.5.7 Apply a resin solution as directed in 36.4.4.

36.5.8 Secure a 2.3-kg (~~5-lb~~[5-lb]) mass to the free specimen end. With an arc motion, apply the load to the specimen while placing the specimen on the resin prepared cardboard, allowing the weight to hang over the bench edge.

36.5.9 Reapply the resin mixture on the specimen directly above the first application.

36.5.10 Proceed as directed in 36.4.8 – 36.4.10.

36.5.11 If a specimen slips in the jaws, breaks at the edge of, or in, the jaws, or if for any reason attributed to faulty operation the result falls markedly below the average for the set of specimens, discard the result and take another specimen. Continue this procedure until the required number of acceptable breaks have been obtained.

NOTE 10—The decision to reject a break shall be based on observation of the specimen during the test and upon the inherent variability of the fabric. In the absence of other criteria for rejecting a so-called jaw break, any break occurring within 6 mm (~~0.25~~[0.25 in.] in.) of the jaws that results in a value below 50 % of the average of all the other breaks shall be discarded. No other break shall be discarded unless it is known to be faulty.

NOTE 11—It is difficult to determine the precise reason why certain specimens break near the edge of the jaws or specimen tab edges. If this is caused by damage to the specimen by the jaws, then the results should be discarded. If, however, it is merely due to randomly distributed weak places, it is a perfectly legitimate result. In some cases, it may also be caused by a concentration of stress in the area adjacent to the jaws or specimen tab edges because they prevent the specimen from contracting in width as the force is applied. In these cases, a break near the edge of the jaws or specimen tab edges is inevitable and shall be accepted as a characteristic of the particular test method.

36.5.12 *Precision and Bias*—The precision and bias of this procedure are as specified in Test Method D5035.

37. Width

37.1 Determine the width of the fabric as directed in Test Methods D3774, 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.

38. Length

38.1 Measure the length of each roll in the lot sample as directed in Test Methods D3773, using any one of the four optional procedures. Verify that none of the sample rolls contains more than the allowable number of pieces. Total the yardages for each of the rolls measured and compare the total to the total of the yardages specified on the identification labels for those rolls. In case of dispute, use Option A of Test Methods D3773 to resolve the dispute.

39. Ignition Loss

39.1 Determine the ignition loss as directed in Test Method D4963, unless otherwise agreed upon between the purchaser and the supplier.

40. Fabric Appearance

40.1 *Scope*—This method establishes a means of examining defects in glass fiber fabrics by a major and minor evaluation system. A list of defects is provided designating the degree of the defect, whether minor or major.

40.2 *Significance and Use*—This method for determining fabric appearance is considered satisfactory for acceptance testing of commercial shipments because the method has been used extensively in the trade for fabric appearance acceptance determination. In cases of disagreement arising from differences in values reported by the purchaser and the supplier when using this method for