Designation: D 579 – 9704

Standard Specification for
Greige Woven Glass Fabrics[1]

This standard is issued under the fixed designation D 579; 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 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. When used as permitted in this specification, such materials will not interfere with the intended end use requirements. weaving.

1.3 This specification shows the values in both SI units and in inch-pound units. "SI units" 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 the customary units used in the United States. The values in SI units are provided as information only; the values stated in inch-pound units are to be regarded as standard. NOTE 1—This

1.4 This specification is one of a series to provide a substitute for the following Military Specifications:— MIL-Y-1140H — 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 are currently being have been drafted and will appear in current editions of the Annual Book of ASTM Standards, as available. Standards. These are to include finished glass fabrics, unfinished glass fabrics, glass tapes, glass sleevings, glass yarns, glass cords, glass sewing threads, and finished laminates made from finished glass fabrics.

1.46 *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.*

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2. Referenced Documents [2]

2.1 *ASTM Standards:*

D 123 Terminology Relating to Textiles

D 578 Specification for Glass Fiber Strands

D 1059 Test Method for Yarn Number Based on Short-Length Specimens

D 1423 Test Method for Twist in Yarns by the Direct-Counting Method

D 1776 Practice for Conditioning Textiles for Testing

D 1777 Method for Measuring Thickness of Textile Materials

D 3773 Test Methods for Length of Woven Fabric

D 3774 Test Methods for Width of ~~Woven Fabric~~[4] Textile Fabric

D 3775 Test Method for ~~Fabric~~ Warp End Count and Filling Pick Count of Woven Fabric

D 3776 Test Methods for Mass Per Unit Area (Weight) of ~~Woven Fabric~~[4] Fabric

D 4029 Specification for Finished Woven Glass Fabrics

D 4963 Test Method for Ignition Loss of Glass Strands and ~~Fabrics~~[4]

~~E 171 Specification~~ Fabrics

D 5035 Test Method for ~~Standard Atmospheres for Conditioning~~ Breaking Force and ~~Testing Materials~~ Elongation of Textile Fabrics (Strip Method)

2.2 *ANSI Standards:*

ANSI/ASQC Z1.4 Sampling Procedures for Inspection by Attributes[3]

2.3 *Military Standard and Specifications:*

MIL-Y-1140H Yarn, Cord, Sleeving, Cloth and Tape-Glass[4]

MIL-C-9084C Cloth, Glass Finished for Resin Laminates[4]

2.4 *Textile Institute Documents:*

Textile Terms and Definitions[5]

Woven Cloth Construction~~8~~ [5]

2.4 *Institute for Interconnecting and Packaging Circuits Standard:*

IPC-4412 Specification for Finished Fabric Woven from E Glass for Printed Boards[6]

3. Terminology

3.1 *Definitions:*

3.1.1 *atmosphere for testing textiles*, *n—for glass*, air maintained at a relative humidity of at least 48 % and no greater than 67 %, and at a temperature of at least ~~68°F (20°C)~~ 20°C (68°F) and no greater than ~~77°F (25°C).~~ 25°C (77°F).

3.1.1.1 *Discussion*—Glass textiles are used in various products such as reinforced plastics, mat-like material, tire cords, electrical insulation, etc. Each of these materials require different testing atmospheres. It is the intent of this wide spread in testing atmosphere to allow testing of glass textiles in respective laboratories where end product test atmosphere requirements differ. The test atmospheres for respective products should be controlled as specified in ~~Specification E 171.~~ Practice D 1776. It is the opinion of Subcommittee D13.18 that the physical properties cited in respective specifications would not be affected by the range selected. In any event, the test atmosphere should be stated in the report.

3.1.2 *continuous filament yarn*, *n*—a yarn made of filaments that extend substantially throughout the length of the yarn.

3.1.3 *crowfoot weave*, *n*—a broken-twill weave one-up and three-down or three-up and one-down with two ends to the right and two ends to the left, commonly referred to as four-harness satin or broken crow.

3.1.3.1 *Discussion*—See Fig. A1.1 in Annex for the basic weave diagram.

3.1.4 *eight-harness satin*, *n*—a warp-faced or filling-faced weave illustrating that the entire face of the fabric surface is covered with warp or filling yarn, respectively.

3.1.4.1 *Discussion*—There are no distinguishable diagonal lines. In warp-faced fabrics warp yarns show on the face of the fabric seven out of eight adjacent yarns, and in filling-faced fabrics filling yarns show on the face of the fabric seven out of eight adjacent yarns. See Fig. A1.5 in Annex for the basic weave diagram.

3.1.5 *greige goods*, *n*—textile fabrics that have received no bleaching, dyeing, or finishing treatment after being produced by any textile process.

3.1.6 *leno weave*, *n*—a weave in which two adjacent warp yarns cross each other between the picks.

3.1.6.1 *Discussion*—See Fig. A1.3 in Annex for the basic weave diagram.

3.1.7 *mock leno weave*, *n*—a weave in which the warp yarns remain parallel but form open warp stripes by programmed interlacing of warp and filling yarns simulating a leno appearance.

3.1.7.1 *Discussion*—See Fig. A1.4 in Annex for the basic weave diagram.

3.1.8 *twelve-harness satin*, *n*—a weave similar to eight-harness satin except in warp-faced fabrics warp yarns show on the face of the fabric eleven out of twelve adjacent yarns and in filling-faced fabrics filling yarns show on the face eleven out of twelve adjacent yarns.

3.1.8.1 *Discussion*—See Fig. A1.6 in Annex for the basic weave diagram.

3.2 For definitions of other textile terms used in this specification, refer to Terminology D 123.

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 seller. 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.

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 D 578. 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 D 578.

10. Strand Construction

10.1 The basis for specifying strand construction is given in Specification D 578. For fabrics listed in Table 8, the construction

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 3 2 Tolerances—Mass/Unit Area

Nominal Mass/Unit Area, g/m² (oz/yd²)	Permissible Variation, %
4.0 (136) and under	±10
Over 4.0 (136)	±6

TABLE 4 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

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 D 578. 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.

16. Breaking Strength

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

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.

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TABLE ~~5~~ 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, ridgy, or wavy~~	~~Clearly noticeable~~	~~X~~	
Baggy, ridged, or wavy cloth ~~cloth~~	Clearly noticeable	X	
Cut or tear	in. (6.5 mm) 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~~	~~in. (1.3 c m) or more in diameter~~	~~X~~	
Hole	13 mm (0.5 in.) or more in diameter	X	
	~~Less than in. (1.3 c m) 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 2 in. (5 cm) 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 2 in. (5 cm) but greater than in. (0.6 cm) 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~~	~~3 in. (7.6 cm) or more in combined directions~~	~~X~~	
Smash	76 mm (3 in.) or more in combined directions	X	
	~~Less than 3 in. (7.6 cm) 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~~	~~2 in. (5 cm) or more in combined directions~~	~~X~~	
Floats and skips	50 mm (2 in.) or more in combined directions	X	
	~~Less than 2 in. (5 cm) in combined directions~~		~~X~~
	Less than 50 mm (2 in.) in combined directions		X
~~Light marks~~	~~Greater than in. (6.5 mm) 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 in. (6.5 mm) in length~~	~~X~~	
Waste	Clearly noticeable over 6.5 mm (0.25 in) in length	X	
	~~Clearly noticeable less than in. (6.4 mm) in length~~		~~X~~
	Clearly noticeable less than 6.5 mm (0.25 in.) in length		X
~~Weave separation~~	~~Clearly noticeable in. (3 mm) 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 in. (0.6 cm) in length~~		~~X~~
	Cut or torn less than 6.5 mm (0.25 in.) in length		X
	~~Cut or torn in. (0.6 cm) 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 yds (500 cm) missing (continuously)~~	~~X~~	
Selvage leno ends out	Greater than 5 m (5 yd) missing (continuously)	X	
	~~Less than 5 yds (500 cm) missing~~		~~X~~
	Less than 5 m (5 yd) missing		X
~~Feather edge~~	~~Greater than in. (5 mm) running more than 5 yds (500 cm)~~		
Feather edge	Greater than 5 mm (0.1875 in.) running more than 5 m (5 yd)	X	
	~~Greater than in. (5 mm) but running less than 5 yds (500 cm)~~		
	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 ~~6~~ 5 Sample Size Determination for Construction~~,~~ Mass, Width, and Physical Properties

Lot Size in Units, yd or m	Sample Size, Num~~-ber~~ber of Units (Rolls)
800 or less	2
801 up to and including 22 000	3
22 001 and over	5

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.

TABLE ~~7~~ 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 |Lm 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.

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. Current industry practice for fabrics utilized in electronics applications is described in IPC-4412 in Section 4.4.1 Fabric Appearance.

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.) apart.

20.4 Preservation and packaging for fabrics utilized in electronics applications are described in IPC-4412, Section 5.1.

21. Put-Up

21.1 Fabric shall be furnished in rolls and shall be wound on spiral tubes. The tube dimensions shall be 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.

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

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

22. Sampling

22.1 *Lot Size*—A lot shall consist of each 9000 m (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) full-width swatch from the end of the roll after first discarding a minimum of 1 m (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).

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.) 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:

<u>100 % Fiber Glass Cloth</u>
<u>Style</u>
<u>Length</u>
<u>Width</u>
<u>Purchase Order Number</u>
<u>Manufacturer's Identification</u>
<u>Finish Designation</u>

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 D 1776, 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 D 578. 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 D 3775, 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 per pound) for both the warp and filling yarns as directed in Test Method D 1059.

29. Filament Diameter

29.1 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 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 D 1423 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 D 1423 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. A similar technique is also sited in IPC-4412 Specification for Finished Fabric Woven from E Glass for Printed Boards.

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, 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 Section 3, Terminolgy, definitions for 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 D 579. 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 D 3776, 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 D 1777, 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 D 1777. For fabrics made with textured or open-end yarns, use Table 1 Option 1 of Method D 1777.

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 D 5035. 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 to 1.0 in.) ,with bristles 25 mm (1 in.) long.

36.3.2 Cut two swatches of fabric from the laboratory sample each 200 by 250 mm (8 by 10 in), one with the warp yarns and the other with filling yarns parallel to the 200 mm (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 by 6 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) 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.) 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 by 1.5 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.) in width as directed in Test Method D 5035. After raveling, load samples in the test clamps, cut the 38 mm (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.).

36.4 *Procedure 2*—Procedure 2 is for fabrics having breaking strengths greater than 445 N/mm (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 ± 0.05 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 ± 0.05 in.) . Do not include the center 75 ± 1 mm (3.0 ± 0.05 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 by 10 in.), one with the warp yarns and the other with the filling yarns parallel to the 200 mm (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 ± 0.05 in.) by 250 mm (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 (8.0 by 1.5 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 (1.0 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 to 1700 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 greater than 2224 N/25 mm (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 by 2 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 ± 0.05 in.) from each other and parallel to the long directions and across the center section of a 200 by 280 mm (8 by 11 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 in.) thick piece of plywood. The 280 mm (11 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 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 by 2 in.) 19 mm (0.75 in.) plywood block placed above the specimen to the base. The 50 mm (2 in.) dimension is placed parallel to the specimen width. Four or five 32 mm (1.25 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) 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 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 Methods D 5035.

37. Width

37.1 Determine the width of the 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.

38. Length

38.1 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. 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 D 3773 to resolve the dispute.

39. Ignition Loss

39.1 Determine the ignition loss as directed in Test Method D 4963, 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 acceptance testing, the statistical bias, if any, between the examination station of the purchaser and the examination station of the supplier should be determined with each comparison being based on the examination results of inspection of the same rolls of fabric.

40.3 *Apparatus*:

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

40.3.2 *Lighting Source* mounted parallel to the viewing surface of the fabric-inspection machine so as to illuminate the surface with overhead direct perpendicular impinging light rays that produce a minimum illumination level of 1075 lx (100 fc).

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

40.5 *Procedure*:

40.5.1 Visually examine (inspect) each roll in the lot sample in the linear direction, full width, on the face side of the fabric. Examine the entire length of each roll.

40.5.2 Traverse the fabric longitudinally through the inspection machine at a compatible visual inspection speed.

40.5.3 View and inspect the moving fabric from a distance of approximately 1 m (1 yd). Stop and traverse to affirm marginal or suspected defects.

40.5.3.1 Count all defects found, regardless of their proximity to one another, except where two or more defects represent a single local condition (one linear metre or yard) of the fabric. In this case, count only the more serious defect as one defect. A continuous defect is counted as one defect for each lengthwise metre or yard, or fraction thereof, in the sample which it appears. Classify the defects as listed in Table 4.

40.6 *Report*:

40.6.1 State that the rolls of fabric were visually inspected for defects as directed in Section 40 of Specification D 579. Describe the fabric sampled, method of sampling, and the roll widths and lengths sampled.

40.6.2 Report, for each roll, the number and type of defects per roll length.

40.6.3 Report, for the lot average, the number and type of defects for each roll visually inspected.

40.6.4 Report the Quality Level (QL) of the major and the total (major and minor combined) defects per 100 units (metres or yards).

40.7 *Precision and Bias*:

40.7.1 *Introduction*— Test results are reported as the average defect count per roll of fabric for a specific material. The precision of test results is evaluated in terms of the total defect count for all rolls of fabric included in each test result since such total counts have a Poisson distribution while the average defect counts do not have such a distribution. If the total counts for actual test results include bias due to systematic sampling or testing errors, the critical differences in Table 6 will be overly optimistic and the confidence limits in Table 7 will be widened by the existence of such bias.

40.7.2 *Critical Differences*—Table 6 contains criteria for determining if the total defect counts for two test results, each based on the same number of rolls of fabric of a stated size, should be considered significantly different at the indicated probability levels. No justifiable statement can be made about the between-laboratory precision of this procedure until the amount of bias, if any, between the two specific laboratories has been established by comparisons based on recent data obtained on rolls of fabric randomly drawn from one sample of material of the type to be tested.

40.7.3 *Confidence Limits*—Table 7 shows the 95 % confidence limits for the total defect count in a single test result obtained as directed in the specification.

40.7.4 *Bias*—The true value of visual inspection for defects to determine the appearance of the fabric can be defined only in terms of a specific test method. Within this limitation, this procedure has no known bias.

41. Put-Up, Packaging, and Marking

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

CONFORMANCE

42. Conformance

42.1 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.

42.2 The purchaser and the supplier shall agree on other procedures to establish conformance, including control charts furnished by the supplier, and other sampling plans such as sequential or double-sampling.

42.3 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.

42.4 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.

43. Keywords

43.1 appearance; classification; construction; fabric weave; glass fabrics; organic content; twist; yarn number

TABLE 18 Physical Properties of Typical "E" Glass Greige Woven Glass Fabrics

Commercial Style Designation	Fabric Count, Warp × Fill yarns/25 mm (yarns/in.)	Yarn Designation, tex[A] (inch-pound units tex)		Fabric Weave Type[B]	Mass per Unit Area, g/m² (oz/yd²)	Thickness, mm (in.)	Breaking Strength, min,[C] Warp × Fill N/5 cm (lbf/in.)
		Warp	Filling				
100	79 × 69	EC5 5.5 1 × 0	EC5 2.75 1 × 0	plain	27	0.038	438 × 175
	80 × 70	ECD 900 1/0	ECD 1800 1/0		0.80	0.0015	50 × 20
~~101~~	~~147 × 147~~	~~EC5 2.75 1 × 0~~	~~EC5 2.75 1 × 0~~	~~plain~~	~~16.9~~	~~0.020~~	~~162 × 162~~
101	74 × 74	EC5 2.75 1 × 0	EC5 2.75 1 × 0	plain	16.9	0.020	162 × 162
	75 × 75	ECD 1800 1/0	ECD 1800 1/0		0.50	0.0008	19 × 19
~~104~~	~~118 × 102~~	~~EC5 5.5 1 × 0~~	~~EC5 2.75 1 × 0~~	~~plain~~	~~18.6~~	~~0.028~~	~~260 × 112~~
	~~60 × 52~~	~~ECD 900 1/0~~	~~ECD 1800 1/0~~		~~0.55~~	~~0.0011~~	~~30 × 13~~
104	59 × 51	EC5 5.5 1 × 0	EC5 2.75 1 × 0	plain	18.6	0.028	260 × 112
	60 × 52	ECD 900 1/0	ECD 1800 1/0		0.55	0.0011	30 × 13
105	59 × 51	EC5 5.5 1 × 0	EC5 5.5 1 × 0	plain	25	0.038	420 × 192
	60 × 52	ECD 900 1/0	ECD 900 1/0		0.73	0.015	48 × 42
~~106~~	~~110 × 110~~	~~EC5 5.5 1 × 0~~	~~EC5 5.5 1 × 0~~	~~plain~~	~~24.4~~	~~0.033~~	~~242 × 242~~
	~~56 × 56~~	~~D 900 1/0~~	~~D 900 1/0~~		~~0.72~~	~~0.0013~~	~~28 × 28~~
106	55 × 55	EC5 5.5 1 × 0	EC5 5.5 1 × 0	plain	24.4	0.033	242 × 242
	56 × 56	D 900 1/0	D 900 1/0		0.72	0.0013	28 × 28

TABLE 18 *Continued*

Commercial Style Designation	Fabric Count, Warp × Fill yarns/25 mm (yarns/in.)	Yarn Designation, tex[A] (inch-pound units tex)		Fabric Weave Type[B]	Mass per Unit Area, g/m² (oz/yd²)	Thickness, mm (in.)	Breaking Strength, min,[C] Warp × Fill N/5 cm (lbf/in.)
		Warp	Filling				
107	59 × 34	EC5 5.5 1 × 2	EC5 5.5 1 × 0	plain	35	0.043	613 × 175
	60 × 35	ECD 900 1/2	ECD 900 1/0		1.06	0.0017	70 × 20
~~108~~	~~118 × 93~~	~~EC5 5.5 1 × 2~~	~~EC5 5.5 1 × 2~~	~~plain~~	~~47.5~~	~~0.061~~	~~578 × 456~~
	~~60 × 47~~	~~D 900 1/2~~	~~D900 1/2~~		~~1.40~~	~~0.0024~~	~~66 × 52~~
<u>108</u>	<u>59 × 46</u>	EC5 5.5 1 × 2	EC5 5.5 1 × 2	plain	<u>47.5</u>	<u>0.061</u>	<u>578 × 456</u>
	<u>60 × 47</u>	D 900 1/2	D900 1/2		<u>1.40</u>	<u>0.0024</u>	<u>66 × 52</u>
112	39 × 38	EC5 11 1 × 2	EC5 11 1 × 2	plain	71	0.082	718 × 701
	40 × 39	ECD 450 1/2	ECD 450 1/2		2.10	0.0032	82 × 80
113	59 × 63	EC5 11 1 × 2	EC5 5.5 1 × 2	plain	83	0.076	1077 × 525
	60 × 64	ECD 450 1/2	ECD 900 1/2		2.46	0.0030	123 × 60
116	59 × 57	EC5 11 1 × 2	EC5 11 1 × 2	plain	107	0.089	1095 × 1051
	60 × 58	ECD 450 1/2	ECD 450 1/2		3.16	0.0035	125 × 120
117	53 × 38	EC5 11 1 × 2	EC5 11 1 × 2	plain	84	0.089	1007 × 727
	54 × 39	ECD 450 1/2	ECD 450 1/2		2.49	0.0035	115 × 83
118	89 × 59	EC5 11 1 × 2	EC5 11 1 × 2	crowfoot	136	0.127	1664 × 1226
	90 × 60	ECD 450 1/2	ECD 450 1/2		4.00	0.0050	190 × 140
119	53 × 49	EC5 11 1 × 2	EC5 11 1 × 2	plain	95	0.086	963 × 876
	54 × 50	ECD 450 1/2	ECD 450 1/2		2.80	0.0034	110 × 100
120	59 × 57	EC5 11 1 × 2	EC5 11 1 × 2	crowfoot	107	0.089	1095 × 1051
	60 × 58	ECD 450 1/2	ECD 450 1/2		3.16	0.0035	125 × 120
125	35 × 33	EC5 11 2 × 2	EC5 11 2 × 2	plain	127	0.127	1313 × 1226
	36 × 34	ECD 450 2/2	ECD 450 2/2		3.75	0.0050	150 × 140
126	33 × 31	EC5 11 3 × 2	EC5 11 3 × 2	plain	180	0.178	1970 × 1751
	34 × 32	ECD 450 3/2	ECD 450 3/2		5.30	0.0070	225 × 200
127	41 × 31	EC5 11 3 × 2	EC5 11 3 × 2	plain	203	0.191	2189 × 1751
	42 × 32	ECD 450 3/2	ECD 450 3/2		6.00	0.0075	250 × 200
128	41 × 31	EC7 22 1 × 3	EC7 22 1 × 3	plain	201	0.165	2189 × 1751
	42 × 32	ECE 225 1/3	ECE 225 1/3		5.94	0.0065	250 × 200
132	47 × 31	EC9 33 2 × 2	EC9 33 2 × 2	crowfoot	441	0.406	5254 × 3503
	48 × 32	ECG 150 2/2	ECG 150 2/2		13.00	0.0160	600 × 400
138	63 × 59	EC5 11 2 × 2	EC5 11 2 × 2	crowfoot	227	0.178	2277 × 2145
	64 × 60	ECD 450 2/2	ECD 450 2/2		6.70	0.0070	260 × 245
139	63 × 55	EC7 22 1 × 2	EC7 22 1 × 2	crowfoot	217	0.178	2277 × 2014
	64 × 56	ECE 225 1/2	ECE 225 1/2		6.41	0.0070	260 × 230
141	31 × 21	EC7 22 3 × 2	EC7 22 3 × 2	plain	297	0.279	3503 × 2539
	32 × 21	ECE 225 3/2	ECE 225 3/2		8.75	0.0110	400 × 290
143	48 × 30	EC7 22 3 × 2	EC5 11 1 × 2	crowfoot	297	0.229	5254 × 5254
	49 × 30	ECE 225 3/2	ECD 450 1/2		8.75	0.0090	600 × 600
162	28 × 16	EC7 22 2 × 5	EC7 22 2 × 5	plain	400	0.381	3940 × 3065
	28 × 16	ECE 225 2/5	ECE 225 2/5		11.80	0.0150	450 × 350
164	20 × 18	EC7 22 4 × 3	EC7 22 4 × 3	plain	429	0.406	4378 × 3940
	20 × 18	ECE 225 4/3	ECE 225 4/3		12.65	0.0160	500 × 450
166	59 × 57	EC5 11 1 × 2	EC5 22 1 × 0	plain	105	0.0889	1313 × 1576
	60 × 58	ECD 450 1/2	ECD 225 1/0		3.10	0.0035	150 × 180
181	56 × 53	EC7 22 1 × 3	EC7 22 1 × 3	8-H satin	302	0.203	3065 × 2890
	57 × 54	ECE 225 1/3	ECE 225 1/3		8.90	0.0080	350 × 330
182	59 × 55	EC7 22 2 × 2	EC7 22 2 × 2	8-H satin	424	0.343	3853 × 3503
	60 × 56	ECE 225 2/2	ECE 225 2/2		12.50	0.0135	440 × 400
183	53 × 47	EC7 22 3 × 2	EC7 22 3 × 2	8-H satin	559	0.425	5692 × 5166
	54 × 48	ECE 225 3/2	ECE 225 3/2		16.50	0.0170	650 × 590
184	41 × 35	EC7 22 4 × 3	EC7 22 4 × 3	8-H satin	881	0.686	8318 × 7005
	42 × 36	ECE 225 4/3	ECE 225 4/3		26.00	0.0270	950 × 800
190	20 × 10	EC7 22 1 × 3	EC7 22 1 × 3	leno	83	0.152	806 × 508
	20 × 10	ECE 225 1/3	ECE 225 1/3		2.45	0.0060	92 × 58
191	20 × 10	EC7 22 1 × 2	EC7 22 1 × 2	leno	54	0.127	543 × 350
	20 × 10	ECE 225 1/2	ECE 225 1/2		1.60	0.0050	62 × 40
<u>220</u>	<u>59 × 57</u>	EC7 22 1 × 0	EC7 22 1 × 0	4-H Satin	<u>109</u>	<u>0.089</u>	<u>1094 × 1051</u>
	<u>60 × 58</u>	ECE 225 1/0	ECE 225 1/0		<u>3.22</u>	<u>0.0035</u>	<u>125 × 120</u>
248	26 × 20	CD7 71R 1 × 2	CD7 71R 1 × 2	plain	264	0.305	999 × 981
	26 × 20	CSE 70/2R	CSE 70/2R		7.81	0.012	114 × 112
261	20 × 14	CD7 124R 1 × 2	CD7 124R 1 × 2	plain	348	0.381	1480 × 1051
	20 × 14	CSE 40/2R	CSE 40/2R		10.3	0.015	169 × 120
294	16 × 16	CD7 198R 1 × 2	CD7 198R 1 × 2	plain	496	0.584	1542 × 1770
	16 × 16	CSE 25/2	CSE 25/2		14.7	0.023	176 × 202
325	89 × 43	EC5 5.5 1 × 0	EC5 2.75 1 × 0	plain	23.8	0.030	525 × 88
	90 × 44	ECD 900 1/0	ECD 1800 1/0		0.70	0.0012	60 × 10
~~341~~	~~47 × 34~~	~~EC9 134 1 × 0~~	~~EC9 134 1 × 0~~	~~4-H Satin~~	~~427~~	~~0.343~~	~~3502 × 3065~~
	~~48 × 35~~	~~ECG 37 1/0~~	~~ECG 37 1/0~~		~~12.6~~	~~0.0135~~	~~400 × 350~~
<u>332</u>	<u>47 × 34</u>	EC9 134 1 × 0	EC9 134 1 × 0	4-H Satin	<u>427</u>	0.343	<u>3502 × 3065</u>
	<u>48 × 35</u>	ECG 37 1/0	ECG 37 1/0		<u>12.6</u>	<u>0.0135</u>	<u>400 × 350</u>

TABLE 18 *Continued*

Commercial Style Designation	Fabric Count, Warp × Fill yarns/25 mm (yarns/in.)	Yarn Designation, tex[A] (inch-pound units-tex)		Fabric Weave Type[B]	Mass per Unit Area, g/m² (oz/yd²)	Thickness, mm (in.)	Breaking Strength, min,[C] Warp × Fill N/5 cm (lbf/in.)
		Warp	Filling				
341	30 × 48	EC5 11 1 × 2	EC7 22 3 × 2	crowfoot	298	0.228	525 × 5254
	30 × 49	ECD 450 1/2	ECE 225 3/2		8.78	0.0090	60 × 600
401	53 × 51	EC6 33 1 × 2	EC6 33 1 × 2	crowfoot	281	0.203	3065 × 2846
	54 × 52	ECDE 150 1/2	ECDE 150 1/2		8.30	0.0080	350 × 325
1042	87 × 43	EC5 5.5 1 × 0	EC5 2.75 1 × 0	plain	25	0.033	525 × 88
	88 × 44	ECD 900 1/0	ECD 1800 1/0		0.74	0.0013	60 × 10
1047	92 × 92	EC6 51 1 × 0	EC6 51 1 × 0	plain	184.4	0.147	1638 × 1638
	47 × 47	DE 100 1/0	DE 100 1/0		5.44	0.0058	188 × 188
1064	17 × 20	EC9 68 1 × 2	EC9 34 1 × 2	plain	159	0.160	1926 × 1313
	18 × 21	ECG 75 1/2	ECG 150 1/2		4.68	0.0063	220 × 150
1070	59 × 34	EC5 11 1 × 0	EC5 5.5 1 × 0	plain	35.9	0.048	613 × 175
	60 × 35	ECD 450 1/0	ECD 900 1/0		1.06	0.0019	70 × 20
1071	59 × 29	EC5 5.5 1 × 0	EC5 5.5 1 × 0	plain	21	0.030	438 × 175
	60 × 30	ECD 900 1/0	ECD 900 1/0		0.61	0.0012	50 × 20
1076	59 × 24	EC5 11 1 × 0	EC5 5.5 1 × 0	plain	33	0.046	876 × 131
	60 × 25	ECD 450 1/0	ECD 900 1/0		0.98	0.0018	100 × 15
1080	59 × 46	EC5 11 1 × 0	ECD 450 1/0	plain	48.5	0.051	613 × 350
	60 × 47	ECD 450 1/0	EC5 11 1 × 0		1.43	0.0020	70 × 40
1116	59 × 57	EC5 22 1 × 0	EC5 22 1 × 0	plain	104.0	0.089	1226 × 1182
	60 × 58	ECD 225 1/0	ECD 225 1/0		1.38	0.0035	140 × 135
1125	39 × 38	EC5 11 1 × 2	EC9 33 1 × 0	plain	89	0.089	788 × 1138
	40 × 39	ECD 450 1/2	ECG 150 1/0		2.62	0.0035	90 × 130
~~1165~~	~~119 × 51~~	~~EC5 11 1 × 0~~	~~EC9 34 1 × 0~~	~~plain~~	~~124~~	~~0.127~~	~~1226 × 1313~~
	~~120 × 52~~	~~ECD 450 1/0~~	~~ECG 150 1/0~~		~~3.65~~	~~0.005~~	~~140 × 150~~
1131	119 × 51	EC5 11 1 × 0	EC9 34 1 × 0	plain	124	0.127	1226 × 1313
	120 × 52	ECD 450 1/0	ECG 150 1/0		3.65	0.005	140 × 150
1142	30 × 20	EC9 134 1 × 0	EC9 134 1 × 0	plain	285	0.282	2627 × 1926
	31 × 21	ECG 37 1/0	ECG 37 1/0		8.42	0.011	300 × 220
1161	99 × 41	EC5 11 1 × 0	EC6 51 1 × 0	plain	131	0.122	1051 × 1532
	100 × 42	ECD 450 1/0	ECDE 100 1/0		3.87	0.0048	120 × 175
~~1165~~	~~59 × 51~~	~~EC5 11 1 × 2~~	~~EC9 33 1 × 0~~	~~plain~~	~~125~~	~~0.107~~	~~1095 × 1226~~
	~~60 × 52~~	~~ECD 450 1/2~~	~~ECG 150 1/0~~		~~3.70~~	~~0.0042~~	~~125 × 140~~
~~1167~~							
1165	59 × 51	EC5 11 1 × 2	EC9 33 1 × 0	plain	125	0.107	1095 × 1226
	60 × 52	ECD 450 1/2	ECG 150 1/0		3.70	0.0042	125 × 140
1167	59 × 54	EC5 11 1 × 2	EC9 33 1 × 0	plain	130	0.109	1313 × 1751
	60 × 55	ECD 450 1/2	ECG 150 1/0		3.82	0.0043	150 × 200
1185	89 × 45	EC5 11 1 × 2	EC9 33 1 × 0	crowfoot	143	0.132	1664 × 1226
	90 × 45	ECD 450 1/2	ECG 150 1/0		4.23	0.0052	190 × 140
1188	46 × 29	EC10 198 1 × 0	EC9 34 1 × 0	4-H satin	428	0.300	5691 × 788
	47 × 30	ECH 25 1/0	ECG 150 1/0		12.63	0.0118	650 × 90
1257	59 × 45	EC5 11 1 × 2	EC5 11 1 × 2	plain	97	0.089	1138 × 876
	60 × 46	ECD 450 1/2	ECD 450 1/2		2.85	0.0035	130 × 100
1280	59 × 59	EC5 11 1 × 0	EC5 11 1 × 0	plain	54.25	0.0635	482 × 482
	60 × 60	ECD 450 1/0	ECD 450 1/0		1.60	0.0025	55 × 55
1297	49 × 19	EC5 11 1 × 0	EC5 5.5 1 × 0	plain	28	0.058	613 × 88
	50 × 20	ECD 450 1/0	ECD 900 1/0		0.82	0.0023	70 × 10
1299	49 × 19	EC5 11 1 × 0	EC5 11 1 × 0	plain	31	0.056	744 × 219
	50 × 20	ECD 450 1/0	ECD 450 1/0		0.92	0.0022	85 × 25
1316	60 × 60	EC5 22 1 × 0	EC5 22 1 × 0	plain	108	0.1016	1226 × 1226
	61 × 61	ECD 225 1/0	ECD 225 1/0		3.18	0.0040	140 × 135
~~1500~~	~~16 × 14~~	~~EC9 33 4 × 2~~	~~EC9 33 4 × 2~~	~~plain~~	~~327~~	~~0.356~~	~~3503 × 3065~~
	~~16 × 14~~	~~ECG 150 4/2~~	~~ECG 150 4/2~~		~~9.66~~	~~0.014~~	~~400 × 350~~
1500	48 × 41	EC7 51 1 × 0	EC7 45 1 × 0	plain	166	.1372	1051 × 1051
	49 × 42	ECE 100 1/0	ECE 110 1/0		4.90	0.0054	120 × 120
1505	10 × 10	EC9 33 4 × 3	EC9 33 4 × 3	plain	327	0.457	3240 × 3240
	10 × 10	ECG 150 4/3	ECG 150 4/3		9.65	0.018	370 × 370
1510	31 × 29	EC9 33 1 × 2	EC9 33 1 × 2	plain	166	0.114	1707 × 1576
	32 × 29	ECG 150 1/2	ECG 150 1/2		4.90	0.0045	195 × 180
1520	18 × 17	EC9 33 3 × 2	EC9 33 3 × 2	plain	292	0.305	2890 × 2890
	18 × 17	ECG 150 3/2	ECG 150 3/2		8.60	0.012	330 × 330
1522	23 × 21	EC9 34 1 × 2	EC9 34 1 × 2	plain	124	0.122	1094 × 963
	24 × 22	ECG 150 1/2	ECG 150 1/2		3.67	0.0048	125 × 110
1523	27 × 19	EC9 33 3 × 2	EC9 33 3 × 2	plain	390	0.356	4597 × 3284
	28 × 20	ECG 150 3/2	ECG 150 3/2		11.50	0.014	525 × 375
1526	33 × 31	EC9 33 1 × 2	EC9 33 1 × 2	plain	180	0.152	1970 × 1751
	34 × 32	ECG 150 1/2	ECG 150 1/2		5.30	0.0060	225 × 200
1527	17 × 17	EC9 33 3 × 3	EC9 33 3 × 3	plain	417	0.381	4115 × 4115
	17 × 17	ECG 150 3/3	ECG 150 3/3		12.30	0.0150	470 × 470

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TABLE 18 *Continued*

Commercial Style Designation	Fabric Count, Warp × Fill yarns/25 mm (yarns/in.)	Yarn Designation, tex^A (inch-pound units -tex-)		Fabric Weave Type^B	Mass per Unit Area, g/m² (oz/yd²)	Thick-ness, mm (in.)	Breaking Strength, min,^C Warp × Fill N/5 cm (lbf/in.)
		Warp	Filling				
1528	41 × 31	EC9 33 1 × 2	EC9 33 1 × 2	plain	201	0.165	2189 × 1751
	42 × 32	ECG 150 1/2	ECG 150 1/2		5.94	0.0065	250 × 200
1532	16 × 14	EC9 33 3 × 2	EC9 33 3 × 2	plain	247	0.279	2627 × 2277
	16 × 14	ECG 150 3/2	ECG 150 3/2		7.30	0.0110	300 × 260
1533	18 × 18	EC9 33 2 × 2	EC9 33 2 × 2	plain	197	0.216	1926 × 1926
	18 × 18	ECG 150 2/2	ECG 150 2/2		5.80	0.0085	220 × 220
1534	16 × 14	EC9 33 4 × 2	EC9 33 4 × 3	plain	407	0.406	3503 × 4553
	16 × 14	ECG 150 4/2	ECG 150 4/3		12.00	0.0160	400 × 520
1539	38 × 28	EC9 33 1 × 2	EC9 33 1 × 2	plain	185	0.165	2102 × 1489
	39 × 28	ECG 150 1/2	ECG 150 1/2		5.45	0.0065	240 × 170
1543	48 × 30	EC9 33 2 × 2	EC5 22 1 × 0	crowfoot	288	0.203	5254 × 525
	49 × 30	ECG 150 2/2	ECD 225 1/0		8.50	0.0080	600 × 60
1557	56 × 30	EC9 33 1 × 2	EC7 22 1 × 0	crowfoot	184	0.140	3065 × 525
	57 × 30	ECG 150 1/2	ECE 225 1/0		5.42	0.0055	350 × 60
1561	16 × 14	EC9 33 3 × 3	EC9 33 3 × 3	plain	373	0.406	3852 × 3371
	16 × 14	ECG 150 3/3	ECG 150 3/3		11.00	0.0160	440 × 385
1562	30 × 16	EC9 33 1 × 0	EC9 33 1 × 0	leno	62	0.114	657 × 438
	30 × 16	ECG 150 1/0	ECG 150 1/0		1.82	0.0045	75 × 50
1564	20 × 18	EC9 33 4 × 2	EC9 33 4 × 2	plain	424	0.356	4378 × 3940
	20 × 18	ECG 150 4/2	ECG 150 4/2		12.50	0.0140	500 × 450
1579	29 × 15	EC9 34 1 × 2	EC9 68 1 × 0	plain	125	0.114	1226 × 1226
	30 × 16	ECG 150 1/2	ECG 75 1/0		3.68	0.0045	140 × 140
1581	56 × 53	EC9 33 1 × 2	EC9 33 1 × 2	8-H satin	302	0.203	3065 × 2890
	57 × 54	ECG 150 1/2	ECG 150 1/2		8.90	0.0080	350 × 330
1582	59 × 55	EC9 33 1 × 3	EC9 33 1 × 3	8-H satin	471	0.340	4597 × 4378
	60 × 56	ECG 150 1/3	ECG 150 1/3		13.90	0.0134	525 × 500
1583	53 × 47	EC9 33 2 × 2	EC9 33 2 × 2	8-H satin	546	0.406	5692 × 5166
	54 × 48	ECG 150 2/2	ECG 150 2/2		16.10	0.0160	650 × 590
1584	43 × 35	EC9 33 4 × 2	EC9 33 4 × 2	8-H satin	864	0.648	8318 × 7005
	44 × 35	ECG 150 4/2	ECG 150 4/2		25.50	0.0255	950 × 800
1585	63 × 20	EC9 33 4 × 2	EC9 33 3 × 2	8-H satin	864	0.610	13134 × 3284
	64 × 20	ECG 150 4/2	ECG 150 3/2		25.50	0.0240	1500 × 375
1587	39 × 21	EC9 33 4 × 2	EC9 33 4 × 2	mock leno	678	0.749	8318 × 4553
	40 × 21	ECG 150 4/2	ECG 150 4/2		20.00	0.0295	950 × 520
1588	41 × 35	EC9 33 4 × 4	EC9 33 4 × 4	12-H satin	1798	1.143	14010 × 11033
	42 × 36	ECG 150 4/4	ECG 150 4/4		53.00	0.0450	1600 × 1260
1589	13 × 12	EC9 33 4 × 3	EC9 33 4 × 3	plain	414	0.406	4378 × 3984
	13 × 12	ECG 150 4/3	ECG 150 4/3		12.20	0.0160	500 × 455
1590	10 × 5	EC9 33 4 × 3	EC9 33 4 × 5	leno	302	0.508	2890 × 2714
	10 × 5	ECG 150 4/3	ECG 150 4/5		8.90	0.0200	330 × 310
1609	31 × 9	EC9 34 1 × 0	EC5 11 1 × 0	plain	61	0.066	1138 × 131
	32 × 10	G-150 1/0	ECD 450 1/0		1.80	0.0026	130 × 15
1610	31 × 28	EC9 33 1 × 0	EC9 33 1 × 0	plain	83	0.097	1007 × 876
	32 × 28	ECG 150 1/0	ECG 150 1/0		2.45	0.0038	115 × 100
1614	29 × 13	EC9 34 1 × 0	EC9 68 1 × 0	leno	79	0.127	613 × 700
	30 × 14	ECG 150 1/0	ECG 75 1/0		2.33	0.005	70 × 80
1620	20 × 20	EC9 33 1 × 0	EC9 33 1 × 0	plain	54	0.076	701 × 613
	20 × 20	ECG 150 1/0	ECG 150 1/0		1.60	0.0030	80 × 70
1621	30 × 14	EC9 33 1 × 0	EC9 33 1 × 2	leno	79	0.127	657 × 744
	30 × 14	ECG 150 1/0	ECG 150 1/2		2.33	0.0050	75 × 85
1628	39 × 27	EC6 34 1 × 0	EC6 34 1 × 0	plain	91	0.086	1313 × 963
	40 × 28	ECDE 150 1/0	ECDE 150 1/0		2.69	0.0034	150 × 110
1634	50 × 29	EC9 34 1 × 0	EC9 34 1 × 0	plain	107	0.094	1226 × 1051
	51 × 30	ECG 150 1/0	ECG 150 1/0		3.16	0.0037	140 × 120
1636	39 × 23	EC6 34 1 × 0	EC6 34 1 × 0	plain	88	0.094	1313 × 876
	40 × 24	ECDE 150 1/0	ECDE 150 1/0		2.61	0.0037	150 × 100
1643	55 × 47	EC6 33 1 × 0	EC6 33 1/0	crowfoot	141	0.1194	1926 × 1489
	56 × 48	ECDE 150 1 × 0	ECDE 150 1/0		4.16	0.0047	220 × 170
1647	50 × 29	EC9 34 1 × 0	EC9 34 1 × 0	plain	123	0.104	876 × 613
	51 × 30	ECG 150 1/0	ECG 150 1/0		3.62	0.0041	100 × 70
1651	50 × 26	EC9 34 1 × 0	EC9 74 1 × 0	plain	149	0.135	788 × 876
	51 × 27	ECG 150 1/0	ECG 67 1/0		4.39	0.0053	90 × 100
~~1652~~	~~102 × 102~~	~~EC6 33 1 × 0~~	~~EC6 33 1 × 0~~	~~plain~~	~~136.9~~	~~0.114~~	~~1591 × 1591~~
	~~52 × 52~~	~~DE 150 1/0~~	~~DE 150 1/0~~		~~4.04~~	~~0.0045~~	~~182 × 182~~
1652	51 × 51	EC6 33 1 × 0	EC6 33 1 × 0	plain	136.9	0.114	1591 × 1591
	52 × 52	DE 150 1/0	DE 150 1/0		4.04	0.0045	182 × 182
1658	20 × 10	EC9 33 1 × 0	EC9 66 1 × 0	plain	54	0.102	701 × 613
	20 × 10	ECG 150 1/0	ECG 75 1/0		1.60	0.0040	80 × 70
1659	20 × 10	EC9 33 1 × 0	EC9 68 1 × 0	leno	54	0.0107	569 × 744
	20 × 10	ECG 150 1/0	ECG 75 1/0		1.60	0.0042	65 × 70

TABLE 18 *Continued*

Commercial Style Designation	Fabric Count, Warp × Fill yarns/25 mm (yarns/in.)	Yarn Designation, tex[A] (inch-pound units-tex)		Fabric Weave Type[B]	Mass per Unit Area, g/m² (oz/yd²)	Thickness, mm (in.)	Breaking Strength, min,[C] Warp × Fill N/5 cm (lbf/in.)
		Warp	Filling				
1660	59 × 12	EC9 33 1 × 0	EC9 33 1 × 0	plain	96	0.127	1620 × 219
	60 × 12	ECG 150 1/0	ECG 150 1/0		2.84	0.0050	185 × 25
1667	59 × 12	EC9 33 1 × 0	EC5 5.5 1 × 0	plain	85	0.076	1620 × 61
	60 × 12	ECG 150 1/0	ECD 900 1/0		2.50	0.0030	185 × 7
1667	59 × 12	EC9 33 1 × 0	EC5 5.5 1 × 0	plain	85	0.076	1620 × 61
1669	60 × 12	ECG 150 1/0	ECD 900 1/0	plain	2.50	0.0030	185 × 7
	58 × 11	EC9 34 1 × 0	EC5 11 1 × 0		84.76	0.0889	1751 × 131
	59 × 12	ECG 150 1/0	ECD 450 1/0		2.50	0.0035	200 × 15
1674	39 × 31	EC9 33 1 × 0	EC9 33 1 × 0	plain	96.5	0.109	1226 × 832
	40 × 32	ECG 150 1/0	ECG 150 1/0		2.85	0.0043	140 × 95
1675	39 × 31	EC6 33 1 × 0	EC6 33 1 × 0	plain	96.5	0.109	1226 × 832
	40 × 32	ECDE 150 1/0	ECDE 150 1/0		2.85	0.0043	140 × 95
1676	55 × 47	EC6 33 1 × 0	EC6 33 1 × 0	plain	139	0.122	1707 × 1313
	56 × 48	ECDE 150 1/0	ECDE 150 1/0		4.10	0.0048	195 × 150
1677	39 × 39	EC6 33 1 × 0	EC6 33 1 × 0	plain	109	0.114	1226 × 1138
	40 × 40	ECDE 150 1/0	ECDE 150 1/0		3.21	0.0045	140 × 130
1678	79 × 79	EC9 33 1 × 0	EC9 33 1 × 0	plain	105.8	0.091	1051 × 1051
	40 × 40	G 150 1/0	G150 1/0		3.12	0.0036	120 × 120
1680	71 × 69	EC6 33 1 × 0	EC6 33 1 × 0	8-H satin	189	0.158	2207 × 2146
	72 × 70	ECDE 150 1/0	ECDE 150 1/0		5.61	0.0062	252 × 245
1681	55 × 35	EC6 33 1 × 0	EC6 33 1 × 0	plain	122	0.119	1707 × 963
	56 × 36	ECDE 150 1/0	ECDE 150 1/0		3.60	0.0047	195 × 110
1687	39 × 41	EC9 33 1 × 0	EC9 33 1 × 0	plain	111.5	0.1067	1664 × 1532
	40 × 42	ECG 150 1/0	ECG 150 1/0		3.29	0.0042	190 × 175
1692	39 × 21	EC9 34 1 × 0	EC9 68 1 × 0	plain	115	0.117	1313 × 1401
	40 × 22	ECG 150 1/0	ECG 75 1/0		3.39	0.0046	150 × 160
1694	39 × 23	EC9 34 1 × 0	EC9 68 1 × 0	plain	120	0.124	1313 × 1401
	40 × 24	ECG 150 1/0	ECG 68 1/0		3.54	0.0049	150 × 160
1800	16 × 14	EC13 275 1 × 0	EC13 275 1 × 0	plain	326	0.330	3940 × 3065
	16 × 14	ECK 18 1/0	ECK 18 1/0		9.60	0.0130	450 × 350
1874	43 × 34	EC13 275 1 × 0	EC13 275 1 × 0	8-H satin	884	0.8307	9369 × 8625
	44 × 35	ECK 18 1/0	ECG 37 1/2		26.08	0.0245	1070 × 985
1884	43 × 34	EC13 275 1 × 0	EC13 275 1 × 0	8-H satin	860	0.670	8318 × 7005
	44 × 35	ECK 18 1/0	ECK 18 1/0		24.50	0.0260	950 × 800
1887	39 × 20	EC13 275 1 × 0	EC13 275 1 × 0	mock leno	715	0.0749	8318 × 4553
	40 × 21	ECK 18 1/0	ECK18 1/0		21.10	0.0295	960 × 520
2112	39 × 38	EC7 22 1 × 0	EC5 22 1 × 0	plain	71.2	0.086	788 × 701
	40 × 39	ECE 225 1/0	ECD 225 1/0		2.10	0.0034	90 × 80
2113	59 × 55	EC7 22 1 × 0	EC5 11 1 × 0	plain	80.7	0.081	1226 × 525
	60 × 56	ECE 225 1/0	ECD 450 1/0		2.38	0.0032	140 × 60
2116	59 × 57	EC7 22 1 × 0	EC5 22 1 × 0	plain	109	0.102	1095 × 1051
	60 × 58	ECE 225 1/0	ECD 225 1/0		3.20	0.0040	125 × 120
2119	53 × 49	EC7 22 1 × 0	EC6 22 1 × 0	plain	90.2	0.086	1489 × 1357
	54 × 50	ECE 225 1/0	ECE 225 1/0		2.66	0.0034	170 × 155
2120	59 × 57	EC7 22 1 × 0	EC6 22 1 × 0	crowfoot	107	0.102	1095 × 1051
	60 × 58	ECE 225 1/0	ECE 225 1/0		3.16	0.0040	125 × 120
2125	39 × 38	EC7 22 1 × 0	EC9 33 1 × 0	plain	88.8	0.094	788 × 1138
	40 × 39	ECE 225 1/0	ECG 150 1/0		2.62	0.0037	90 × 130
2129	19 × 9	EC6 22 1 × 0	EC5 11 1 × 0	plain	22	0.053	438 × 88
	20 × 10	ECDE 225 1/0	ECD 450 1/0		0.66	0.0021	50 × 10
2165	59 × 51	EC7 22 1 × 0	EC9 33 1 × 0	plain	125	0.114	1095 × 1226
	60 × 52	ECE 225 1/0	ECG 150 1/0		3.70	0.0045	125 × 140
2218	89 × 59	EC7 22 1 × 0	EC6 22 1 × 0	crowfoot	138	0.0127	1664 × 1776
	90 × 60	ECE 225 1/0	ECE 225 1/0		4.06	0.005	190 × 140
2225	35 × 33	EC7 22 1 × 2	EC6 22 1 × 2	plain	127	0.0127	1402 × 1313
	36 × 34	ECE 225 1/2	ECE 225 1/2		3.75	0.005	160 × 150
2238	63 × 59	EC7 22 1 × 2	EC6 221 × 2	crowfoot	231	0.0178	2802 × 2452
	64 × 60	ECE 225 1/2	ECE 225 1/2		6.80	0.007	320 × 280
2313	59 × 63	EC7 22 1 × 0	EC511 1 × 0	plain	80.5	0.084	1182 × 701
	60 × 64	ECE 225 1/0	ECD 450 1/0		2.38	0.0033	135 × 80
2316	60 × 60	EC7 22 1 × 0	EC6 22 1 × 0	plain	108	0.1016	1226 × 1226
	61 × 61	ECE 225 1/0	ECE 225 1/0		3.18	0.0040	140 × 140
2319	59 × 45	EC7 22 1 × 0	EC6 22 1 × 0	plain	93.2	0.089	1226 × 940
	60 × 46	ECE 225 1/0	ECE 225 1/0		2.75	0.0035	140 × 140
2500	16 × 16	EC10 190 1 × 0	EC10 190 1 × 0	leno	255	0.4572	3502 × 3459
	16 × 16	ECH 25 1/0	ECH 25 1/0		7.52	0.0180	400 × 395
2523	28 × 20	EC10 198 1 × 0	EC10 198 1 × 0	plain	390	0.3277	5079 × 3371
	28 × 20	ECH 25 1/0	ECH 25 1/0		11.50	0.0129	580 × 385
2532	16 × 14	EC10 198 1 × 0	EC10 198 1 × 0	plain	246	0.254	2627 × 2452
	16 × 14	ECH 25 1/0	ECH 25 1/0		7.25	0.0100	300 × 280

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TABLE 18 *Continued*

Commercial Style Designation	Fabric Count, Warp × Fill yarns/25 mm (yarns/in.)	Yarn Designation, tex[A] (inch-pound units tex)		Fabric Weave Type[B]	Mass per Unit Area, g/m² (oz/yd²)	Thickness, mm (in.)	Breaking Strength, min,[C] Warp × Fill N/5 cm (lbf/in.)
		Warp	Filling				
~~3070~~	~~138 × 138~~	~~EC6 17.5 1 × 0~~	~~EC6 17.5~~	~~plain~~	~~93.6~~	~~0.078~~	~~1104 × 1104~~
	~~70 × 70~~	~~DE 300 1/0~~	~~DE 300 1/0~~		~~2.76~~	~~0.0031~~	~~133 × 133~~
3070	69 × 69	EC6 17.5 1 × 0	EC6 17.5	plain	93.6	0.078	1104 × 1104
	70 × 70	DE 300 1/0	DE 300 1/0		2.76	0.0031	133 × 133
3080	50 × 29	EC6 17.5 1 × 0	EC6 17.5 1 × 0	plain	54	0.061	-
	51 × 30	ECDE 300 1/0	ECDE 300 1 /0		1.59	0.0024	-
3113	50 × 29	EC7 22 1 × 0	EC9 34 1 × 0	plain	86	0.084	-
	51 × 30	ECE 225 1/0	ECG 150 1/0		2.54	0.0033	-
~~3313~~	~~118 × 122~~	~~EC6 17.5 1 × 0~~	~~EC6 17.5~~	~~plain~~	~~80.5~~	~~0.084~~	~~944 × 976~~
	~~60 × 62~~	~~DE 300 1/0~~	~~DE 300 1/0~~		~~2.38~~	~~0.0033~~	~~114 × 118~~
3313	59 × 61	EC6 17.5 1 × 0	EC6 17.5	plain	80.5	0.084	944 × 976
	60 × 62	DE 300 1/0	DE 300 1/0		2.38	0.0033	114 × 118
3700	15 × 14	EC9 134 1 × 2	EC9 134 1 × 2	plain	311	0.3124	3240 × 2890
	15 × 14	ECG 37 1/2	ECG 37 1/2		9.18	0.0123	370 × 330
3701	12 × 6	EC9 134 1 × 0	EC9 134 1 × 0	leno	134.6	0.2438	1401 × 1357
	12 × 6	ECG 37 1/0	ECG 37 1/0		3.97	0.0096	160 × 155
3731	16 × 14	EC9 134 1 × 0	EC9 134 1 × 0	plain	177	0.140	1751 × 1489
	17 × 15	ECG 37 1/0	ECG 37 1/0		5.21	0.0055	200 × 170
3732	47 × 31	EC9 134 1 × 0	EC9 134 1 × 0	crowfoot	427	0.345	4816 × 3503
	48 × 32	ECG 37 1/0	ECG 37 1/0		12.60	0.0135	550 × 400
3733	18 × 18	EC9 134 1 × 0	EC9 134 1 × 0	plain	197	0.203	2189 × 1751
	18 × 18	ECG 37 1/0	ECG 37 1/0		5.8	0.0080	250 × 200
3734	47 × 31	EC 6134 1 × 0	EC 6134 1 × 0	crowfoot	432	0.3658	5254 × 3590
	48 × 32	ECDE 37 1/0	ECDE 37 1/0		12.74	0.0144	600 × 410
3743	48 × 30	EC9 134 1 × 0	EC7 22 1 × 0	crowfoot	286	0.203	5254 × 525
	49 × 30	ECG 37 1/0	ECE 225 1/0		8.45	0.0080	600 × 60
3744	28 × 14	EC9 134 1 × 2	EC9 134 1 × 4	2 end plain	610	0.508	5998 × 5998
	28 × 14	ECG 37 1/2	ECG 37 1/4		18.00	0.0200	688 × 688
3745	27 × 28	EC9 134 1 × 0	EC9 134 1 × 2	2 pk. plain	593	0.4699	5692 × 5911
	27 × 28	ECG 37 1/2	ECG 37 1/2		17.50	0.185	650 × 675
3783	53 × 47	EC9 134 1 × 0	EC9 134 1 × 0	8-H satin	576	0.3937	5692 × 5512
	54 × 48	ECG 37 1/2	ECG 37 1/2		16.99	0.0155	650 × 630
3784	43 × 34	EC9 134 1 × 0	EC9 134 1 × 0	8-H satin	901	0.6096	7881 × 7005
	44 × 35	ECG 37 1/2	ECG 37 1/2		26.57	0.0240	900 × 800
3787	39 × 21	EC9 134 1 × 2	EC9 134 1 × 2	mock leno	695	0.761	6567 × 3940
	40 × 21	ECG 37 1/2	ECG 37 1/2		20.50	0.0300	750 × 450
3788	41 × 35	EC9 134 1 × 4	EC9 134 1 × 4	12-H satin	1856	1.1557	13397 × 11121
	42 × 36	ECG 37 1/4	ECG 37 1/4		54.75	0.0455	1530 × 1270
5020	18 × 18	EC9 99 1 × 2	EC9 99 1 × 2	plain	294	0.305	2890 × 2890
	18 × 18	ECG 50 1/2	ECG 50 1/2		8.68	0.0120	330 × 330
5023	48 × 30	EC9 99 1 × 2	EC9 99 1 × 2	crowfoot	288	0.203	5254 × 525
	49 × 30	ECG 50 1/2	ECG 50 1/2		8.50	0.0080	600 × 60
5027	17 × 17	EC9 99 1 × 3	EC9 99 1 × 3	plain	417	0.318	4115 × 4115
	17 × 17	ECG 50 1/3	ECG 50 1/3		12.30	0.0150	470 × 470
5032	16 × 14	EC9 99 1 × 2	EC9 99 1 × 2	plain	2.45	0.254	2677 × 2277
	16 × 14	ECG 50 1/2	ECG 50 1/2		7.23	0.0100	300 × 260
5082	59 × 55	EC9 99 1 × 0	EC9 99 1/0	8-H satin	471	0.340	4597 × 4378
	60 × 56	ECG 50 1/0	ECG 50 1/0		13.90	0.0134	525 × 500
~~6060~~	~~118 × 118~~	~~EC6 8.75 1 × 0~~	~~EC6 8.75 1 × 0~~	~~plain~~	~~39.0~~	~~0.048~~	~~472 × 472~~
	~~60 × 60~~	~~DE 600 1/0~~	~~G75 1/0~~		~~1.15~~	~~0.0019~~	~~57 × 57~~
6060	59 × 59	EC6 8.75 1 × 0	EC6 8.75 1 × 0	plain	39.0	0.048	472 × 472
	60 × 60	DE 600 1/0	G75 1/0		1.15	0.0019	57 × 57
7500	16 × 14	EC9 68 2 × 2	EC9 68 2 × 2	plain	325	0.356	3503 × 3065
	16 × 14	ECG 75 2/2	ECG 75 2/2		9.60	0.0140	400 × 350
7520	18 × 18	EC9 68 1 × 3	EC9 68 1 × 3	plain	294	0.305	2890 × 2890
	18 × 18	ECG 75 1/3	ECG 75 1/3		8.68	0.0120	330 × 330
7532	16 × 14	EC9 68 1 × 3	EC9 68 1 × 3	plain	245	0.254	2627 × 2277
	16 × 14	ECG 75 1/3	ECG 75 1/3		7.23	0.0100	300 × 260
7533	18 × 18	EC9 68 1 × 2	EC9 68 1 × 2	plain	196	0.203	1926 × 1926
	18 × 18	ECG 75 1/2	ECG 75 1/2		5.79	0.0080	220 × 220
7539	38 × 28	EC9 68 1 × 0	EC9 68 1 × 0	plain	1.80	0.178	2102 × 1489
	39 × 28	ECG 75 1/0	ECG 75 1/0		5.30	0.0070	240 × 170
7543	48 × 30	EC9 68 1 × 2	EC7 22 1 × 0	crowfoot	288	0.203	5254 × 525
	49 × 30	ECG 75 1/2	ECE 225 1/0		8.50	0.0080	600 × 60
7544	28 × 14	EC9 68 2 × 2	EC9 68 2 × 4	2-end plain	610	0.508	5998 × 5998
	28 × 14	ECG 75 2/2	ECG 75 2/4		18.00	0.0200	685 × 685
7557	56 × 30	EC9 68 1 × 0	EC7 22 1 × 0	crowfoot	184	0.140	3065 × 525
	57 × 30	ECG 75 1/0	ECE 225 1/0		5.42	0.0055	350 × 60
7581	56 × 63	EC9 68 1 × 0	EC9 68 1 × 0	8-H satin	302	0.203	3055 × 2890
	57 × 54	ECG 75 1/0	ECG 75 1/0		8.90	0.0080	350 × 330

TABLE 18 *Continued*

Commercial Style Designation	Fabric Count, Warp × Fill yarns/25 mm (yarns/in.)	Yarn Designation, tex[A] (inch-pound units tex)		Fabric Weave Type[B]	Mass per Unit Area, g/m² (oz/yd²)	Thickness, mm (in.)	Breaking Strength, min,[C] Warp × Fill N/5 cm (lbf/in.)
		Warp	Filling				
7583	53 × 47	EC9 68 1 × 0	EC9 68 1 × 2	8-H satin	546	0.406	5692 × 5166
	54 × 48	ECG 75 1/2	ECG 75 1/2		16.10	0.0146	650 × 590
7585	63 × 20	EC9 68 2 × 2	EC9 68 1 × 3	8-H satin	864	0.610	13134 × 3284
	64 × 20	ECG 75 2/2	ECG 75 1/3		25.50	0.0240	1500 × 375
7587	39 × 21	EC9 68 2 × 2	EC9 68 2 × 2	mock leno	695	0.761	6567 × 3940
	40 × 21	ECG 75 2/2	ECG 75 2/2		20.50	0.0300	750 × 450
7624	43 × 23	EC9 68 1 × 0	EC9 68 1 × 0	plain	188	0.163	1839 × 1576
	44 × 24	ECG 75 1/0	ECG 75 1/0		5.53	0.0064	210 × 180
7626	33 × 31	EC9 68 1 × 0	EC9 68 1 × 0	plain	183	0.168	1970 × 1751
	34 × 32	ECG 75 1/0	ECG 75 1/0		5.40	0.0066	225 × 200
7627	87 × 59	EC9 68 1 × 0	EC9 68 1 × 0	plain	199.0	0.165	2210 × 1499
	44 × 30	G75 1/0	G75 1/0		5.87	0.0065	251 × 171
7628	43 × 31	EC9 68 1 × 0	EC9 68 1 × 0	plain	201	0.178	2189 × 1751
	44 × 32	ECG 75 1/0	ECG 75 1/0		5.94	0.0070	250 × 200
7629	43 × 33	EC9 68 1 × 0	EC9 68 1 × 0	plain	213.0	0.0180	2189 × 1989
	44 × 34	ECG 75 1/0	ECG 75 1/0		6.19	0.0071	250 × 2105
7635	86 × 57	EC9 68 1 × 0	EC9 100 1 × 0	plain	230.9	0.196	2184 × 2508
	44 × 29	G75 1/0	G 50 1/0		6.81	0.0077	251 × 290
7641	31 × 21	EC9 68 1 × 2	EC9 68 1 × 2	plain	297	0.254	3503 × 2539
	32 × 21	ECG 75 1/2	ECG 75 1/2		8.70	0.0100	400 × 290
7642	43 × 20	ET9 68 1 × 0	ET9 133 1 × 0	plain	227	0.234	2846 × 963
	44 × 20	ETG 75 1/0	ETG 37 1/0		6.70	0.0092	325 × 110
7652	31 × 31	EC9 99 1 × 0	EC9 99 1 × 0	plain	259	0.216	3284 × 2627
	32 × 32	ECG 50 1/0	ECG 50 1/0		7.65	0.0085	375 × 300
7658	43 × 31	EC9 68 1 × 0	EC9 68 1 × 0	crowfoot	203	0.173	2189 × 1751
	44 × 32	ECG 75 1/0	ECG 75 1/0		6.00	0.0068	250 × 200
7660	30 × 30	EC9 68 1 × 0	EC9 68 1/0	plain	163.0	0.01372	1620 × 1532
	30 × 30	EC9G 75 × 1/0	ECG 75 × 1/0		4.80	0.0054	185 × 175
7660	30 × 30	EC9 68 1 × 0	EC9 68 1/0	plain	163.0	0.0137	1620 × 1532
	30 × 30	EC9G 75 × 1/0	ECG 75 × 1/0		4.80	0.0054	185 × 175
7664	20 × 18	EC9 68 2 × 2	EC9 68 2 × 2	plain	427	0.381	4378 × 3940
	20 × 18	ECG 75 2/2	ECG 75 2/2		12.60	0.0150	500 × 450
7743	119 × 19	EC6 68 1 × 0	EC9 33 1× 0	8-H satin	346	0.280	7005 × 525
	120 × 22	ECDE 75 1/0	ECG 150 1/0		10.22	0.0110	800 × 60
7781	56 × 53	EC6 68 1 × 0	EC6 68 1 × 0	8-H satin	304	0.228	3065 × 2977
	57 × 54	ECDE 75 1/0	ECDE 75 1/0		8.95	0.0090	350 × 340

[A] Yarn designations are as specified in Specification D 578.

For engineering information only. May be made by substituting other yarn equivalents, providing fiber diameter and other properties are not affected. For example, when EC9 68 2 × 2 (ECG 75 2/2) is substituted with EC9 134 1 × 2 (ECG 37 1/2), the final yarn number remains the same.

[B] See Annex A1.

7. Yarn Designations

7.1 For fabrics listed in Table 1, the yarn designations shall conform to the requirements of Table 1. For fabrics not listed in Table 1, the yarn designations shall be agreed upon between the purchaser and the seller. 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 1. Due to the frequent unavailability of ECE 225 yarn, ECD 225 may be substituted with no significant decrease in property performance.

8. Yarn Number

8.1 For fabrics listed in Table 1, the nominal size-free yarn numbers of the yarns designated shall conform to Specification D 578.

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 D 578.

10. Strand Construction

10.1 The basis for specifying strand construction is given in Specification D 578. For fabrics listed in Table 1, the construction of the component strands shall conform to the requirements of Table 1. For fabrics not listed in Table 1, the construction of the component strands may be agreed upon between the purchaser and the supplier.

11. Direction of Twist

11.1 Unless otherwise agreed upon between the purchaser and the seller, the primary twist in the singles strands shall be "Z"

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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 1. The tolerances for the primary twist and the final twist shall conform to Table 2 unless otherwise agreed upon between the purchaser and the supplier.

13. Fabric Weave Type

13.1 For fabrics listed in Table 1, the fabric weave type shall conform to the requirements of Table 1. For fabrics not listed in Table 1, the fabric weave type may be agreed upon between the purchaser and the supplier.

14. Mass Per Unit Area

14.1 For fabrics listed in Table 1, the nominal mass per unit area shall conform to the requirement of Table 1. For fabrics not listed in Table 1, the nominal mass per unit area may 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 3.

15. Thickness

15.1 For fabrics listed in Table 1, the nominal thickness shall conform to the requirements of Table 1. For fabrics not listed in Table 1, the nominal thickness may 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 4, unless specified otherwise.

16. Breaking Strength

16.1 For fabrics listed in Table 1, the A1.

[C] The minimum breaking strength shall conform to the requirements of Table 1. For fabrics not listed in Table 1, the minimum breaking strength may be agreed upon between the purchaser and the supplier. The average breaking strength force for the lot shall exceed the specified breaking strength, Fabric styles 3080 and no individual break shall be less than 80 % of the specified minimum breaking strength.

17. Width

17.1 Fabric width may 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 0.5 in. (13 mm) wider than the specified width.

NOTE 2—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 length on each roll shall be 100 ± 25 yd (90 ± 23 m) unless otherwise agreed upon between the purchaser and the supplier. The fabric on each roll shall consist of no more than three pieces and the minimum length of any piece shall be 15 yd (15 m) unless otherwise agreed upon between the purchaser and the supplier. 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 length of those rolls on the identification labels. All splices may be thermoset unless otherwise agreed upon between the purchaser and supplier.

19. Ignition Loss

19.1 The ignition loss of greige fabric may 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.

20.2 The fabric in the laboratory sample for the fabric appearance shall be examined for the defects listed in Table 5 and the acceptable quality levels (AQLs) may be 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.) apart.

21. Put-Up

21.1 Fabric shall be furnished in rolls and shall be wound on spiral tubes measuring 3 in. (75 mm) minimum inside diameter and 1 in. (25 mm) 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.

21.2 Unless otherwise agreed upon, as when specified in an applicable contract or purchase order, each roll may be packed in a sealed, vapor-tight bag of polyethylene not less than 0.002 in. (0.05 mm) 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 3—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.

22. Sampling

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

22.1.1 When small multiple shipments 3113 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 6. From each roll in the laboratory sample, take a 1-yd (1-m) full-width swatch from the end of the roll after first discarding a minimum of 1 yd (1 m) 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 yd (1 m).

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.

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 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 D 578. Verify that the fiber is continuous filament, unless otherwise specified, during testing for strand construction as directed in Section 30. 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 D 3775, 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 per pound) for both the warp and filling yarns as directed in Test Method D 1059.

29. Filament Diameter

29.1 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 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. See Section 26.

31. Direction of Twist

31.1 Verify the direction of twist in each strand of the yarns as directed in Test Method D 1423 for one test specimen of warp yarn and one test specimen of filling yarn 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 D 1423 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 1. 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, 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. 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 D 579. 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 turns 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 D 3776, 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 D 1777, using ten test specimens from each swatch in the laboratory sample.

35.2 For fabrics made with textured or open-end yarns, use Option 1 of Method D 1777. For fabrics made with other types of yarns, use Option 3 of Method D 1777.

36. Breaking Strength

36.1 Determine the breaking strength in kilonewtons per metre (or pounds-force per inch) of fabric in both the warp and filling directions as directed in Test Method D 5035, 1 in. (25.4 mm) ravel strip method excluding preconditioning, using five specimens in both the warp and filling directions. A CRE-type testing machine shall be operated at 0.6 ± 0.05 in. (15 ± 1 mm)/min unless

specified otherwise. A CRT-type testing machine shall be operated at 12 ± ½ in. (305 ± 10 mm)/min. The distance between clamps shall be 3 ± 0.05 in. (75 ± 1 mm). 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 2 by 3-in. (50 by 75-mm) serrated jaw faces is recommended for testing samples prepared as directed in 36.4 and 36.5. The 2-in. (50-mm) dimension of the jaw face shall be in the direction of test. Manual clamping is permitted.

Note 4—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 0.010 to 0.015 in. (0.25 to 0.40 mm) 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 100 lbf/in. (17.5 kN/m) or less.

Note 5—Fabrics having breaking strength less than 100 lbf/in. (17.5 kN/m) 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 6—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 *Wrapping Paper*, kraft or bleached, minimum 81.35 g/m 50-lb (23-kg) basis.

36.3.1.4 *Paint Brush*, ⅝ to 1.0 in. (16 to 25 mm), with bristles 1 in. (25 mm) long.

36.3.2 Cut two swatches of fabric from the laboratory sample each Table 8 by 10 in. (200 by 250 mm), one with the warp yarns and the other with filling yarns parallel to the 8-in. (200-mm) 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 1.5 by 6 in. (38 by 150 mm) 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 1⅝ in. (40 mm) from each end, using very light pressure on the wax pencil to avoid possible damage to the surface filaments. Thoroughly impregnate the 1⅝-in. (40-mm) 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 6 by 1.5-in. (150 by 38-mm) test specimen strips from the prepared sample without removing the paper backing. Ravel the central unimpregnated portion of the specimen to 1 in. (25 mm) in width as directed in Test Method D 5035. After raveling, load samples in the test clamps, cut the 1.5-in. (38-mm) wide paper backing across midway between the ends, taking care not to damage the fabric specimen.

Note 7—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 1 in. (25 mm).

36.4 *Procedure 2*—Procedure 2 is for fabrics having breaking strengths greater than 100 lbf/in. (17.5 kN/m) 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 3.0 ± 0.05 in. (75 ± 1 mm) 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 2.0 ± 0.05 in. (50 ± 1 mm). Do not include the center 3.0 ± 0.05-in. (75 ± 1-mm) between the drawn lines.

Note 8—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 8 by 10 in. (200 by 250 mm), one with the warp yarns and the other with the filling yarns parallel to the 8-in. (200-mm) 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 2.0 ± 0.05-in. (50 ± 1-mm) by 10-in. (250-mm) strip of cardboard over the resin-impregnated area of the specimen. Allow to dry a minimum of 16 h.

Note 9—When substitute solutions are used, drying time may vary.

36.4.8 Cut five specimens, 8.0 by 1.5 in. (150 by 38 mm) 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 1.0-in. (25-mm) 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 1500 to 1700 lbf (6750 to 7650 N) 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 greater than 500 lbf/in. (87.5 kN/m) or that show cascading breaks across the specimen when using Procedure 2 stated in 36.4, or both.

Note 10—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, 12 by 2 in. (300 by 50 mm) 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 3.0 ± 0.05 in. (75± 1 mm) from each other and parallel to the long directions and across the center section of a 8 by 11-in. (200 by 280-mm) 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 0.75-in. (19-mm) thick piece of plywood. The 11-in. (280-mm) length is parallel to the bench edge.

36.5.4 Lay the cut specimens on the lined cardboard so that one end is 1 in. (25 mm) 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 1 by 2-in. (25 by 50-mm) 0.75-in. (19-mm) plywood block placed above the specimen to the base. The 2-in. (50-mm) dimension is placed parallel to the specimen width. Four or five 1.25-in. (32-mm) nails equally spaced have been found acceptable for this purpose.

Note 11—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) 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 12—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 ¼ in. (6 mm) 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 13—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 Methods D 5035.

37. Width

37.1 Determine the width of the 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.

38. Length

38.1 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. 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 D 3773 to resolve the dispute.

39. Ignition Loss

39.1 Determine the ignition loss as directed in Test Method D 4963, 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 time. These values reported by the purchaser and the supplier when using this method for acceptance testing, the statistical bias, if any, between the examination station of the purchaser and the examination station of the supplier should be determined with each comparison being based on the examination results of inspection of the same rolls of fabric.

40.3 *Apparatus*:

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

40.3.2 *Lighting Source*—mounted parallel to the viewing surface of the fabric-inspection machine so as to illuminate the surface with overhead direct perpendicular impinging light rays that produce a minimum illumination level of 100 fc (1075 lx).

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

40.5 *Procedure*:

40.5.1 Visually examine (inspect) each roll in the lot sample in the linear direction, full width, on the face side of the fabric. Examine the entire length of each roll.

40.5.2 Traverse the fabric longitudinally through the inspection machine at a compatible visual inspection speed.

40.5.3 View and inspect the moving fabric from a distance of approximately 1 yd (1 m). Stop and traverse to affirm marginal or suspected defects.

40.5.3.1 Count all defects found, regardless of their proximity to one another, except where two or more defects represent a single local condition (one linear metre or yard) of the fabric. In this case, count only the more serious defect as one defect. A continuous defect is counted as one defect for each lengthwise metre or yard, or fraction thereof, in the sample which it appears. Classify the defects as listed in Table 5.

40.6 *Report*:

40.6.1 State that the rolls of fabric were visually inspected for defects as directed in Section 40 of Specification D 579. Describe the fabric sampled, method of sampling, and the roll widths and lengths of the rolls sampled.

40.6.2 Report, for each roll, the number and type of defects per roll length.

40.6.3 Report, for the lot average, the number and type of defects for each roll visually inspected.

40.6.4 Report the Quality Level (QL) of the major and the total (major and minor combined) defects per 100 units (metres or yards).

40.7 *Precision and Bias*:

40.7.1 *Introduction*— Test results are reported as the average defect count per roll of fabric for a specific material. The precision of test results is evaluated in terms of the total defect count for all rolls of fabric included in each test result since such total counts have a Poisson distribution while the average defect counts do not have such a distribution. If the total counts for actual test results include bias due to systematic sampling or testing errors, the critical differences in Table 7 will be overly optimistic and the confidence limits in Table 8 will be widened by the existence of such bias.

40.7.2 *Critical Differences*—Table 7 contains criteria for determining if the total defect counts for two test results, each based on the same number of rolls of fabric of a stated size, should be considered significantly different at the indicated probability levels. No justifiable statement can be made about the between-laboratory precision of this procedure until the amount of bias, if any, between the two specific laboratories has been established by comparisons based on recent data obtained on rolls of fabric randomly drawn published upon their availability from one sample of material of the type to be tested.

40.7.3 *Confidence Limits*—Table 8 shows the 95 % confidence limits for the total defect count in a single test result obtained as directed in the specification.

40.7.4 *Bias*—The true value of visual inspection for defects to determine the appearance of the fabric can be defined only in terms of a specific test method. Within this limitation, this procedure has no known bias.

41. Put-Up, Packaging, and Marking

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

CONFORMANCE

42. Conformance

42.1 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.

42.2 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.

42.3 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.

42.4 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.

43. Keywords

43.1 appearance; classification; construction; fabric weave; glass fabrics; organic content; twist; yarn number

▌ — industry.

ANNEX

(Mandatory Information)

A1. BASIC WEAVE DIAGRAMS

▌ A1.1   The basic weaves illustrated in Figs. A1.1-A1.6 are typical weaves used in conjunction with Table 6 5 unless otherwise specified. Other weave variations of these basic forms shall be agreed upon between the purchaser and the seller. An acceptable source for reference is "Textile Terms and Definitions" by the Textile Institute, Manchester, England.
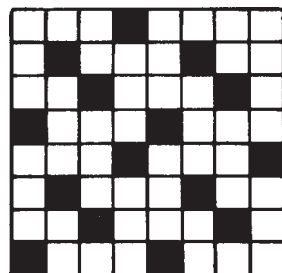
Standard Form Filling Flush

1 up
3 down
2 adjacent ends left
2 adjacent ends right
2 repeats high, 2 repeats wide

FIG. A1.1 Crowfoot
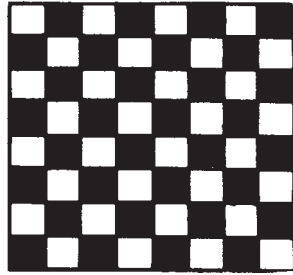
Standard Form

1 up
1 down
4 repeats high, 4 repeats wide

FIG. A1.2 Plain
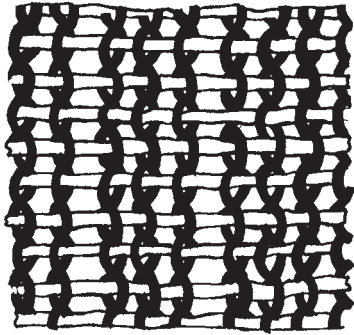
Standard Form
Two adjacent warp yarns cross each other between picks.

FIG. A1.3 Leno
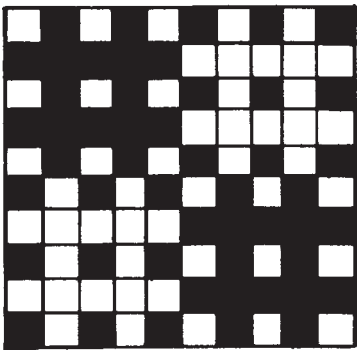
Standard Form
 This weave begins with 1 end of plain weave 1 up, 1 down, 5 repeats high fol-
lowed by 1 end of 5 down, 5 up, 2 repeats high, 2 repeats wide. This is followed by
1 end plain weave 1 up, 1 down, 5 repeats high.
 The pattern is completed by reversing a comparable number of ends, that is, sub-
stituting warp lifts for filling lifts and filling lifts for warp lifts.
 The total pattern is 1 repeat high, 1 repeat wide.

FIG. A1.4 Mock Leno

27
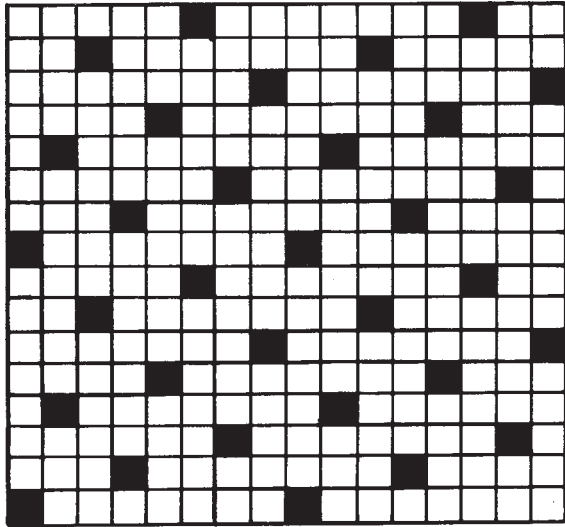
Standard Form Filling Flush

8 ends base of 3
2 repeats high, 2 repeats wide

FIG. A1.5 8-Harness Satin
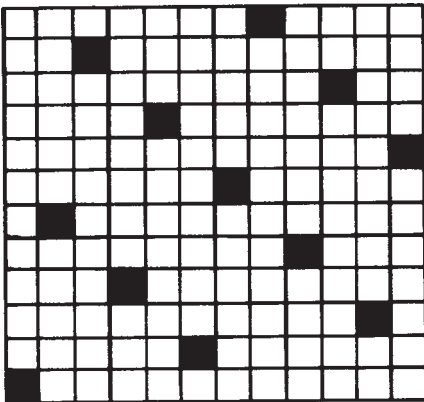
Standard Form Filling Flush

12 ends base of 5
1 repeat high, 1 repeat wide

FIG. A1.6 12-Harness Satin