Designation: D 4029 – 97

Standard Specification for Finished Woven Glass Fabrics[1]

This standard is issued under the fixed designation D 4029; 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 finished fabrics woven from "E" electrical glass fiber yarns that are intended as a reinforcing material in laminated plastics for structural use. This specification can also be applied to fabrics made of 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 woven glass fiber finished fabrics. This specification permits the application of sizing materials to the glass fiber yarn during manufacture that helps facilitate weaving. When used as permitted in this specification, such materials are compatible with the resin matrix as specified in the contracting instrument.

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

1.3 This specification shows 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.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 2—This specification is one of a series to provide a substitute for Military Specifications:
MIL-Y-1140H
MIL-C-9084C

NOTE 3—Specification D 2150, for Woven Glass Fabric for Polyester Glass Laminates,[2] is being extensively revised. This method will contain test methods and requirements for laminated plastics made from fabrics referenced in this specification.

2. Referenced Documents

2.1 *ASTM Standards:*

D 123 Terminology Relating to Textiles[3]
D 578 Specification for Glass Fiber Strands[3]
D 579 Specification for Greige Woven Glass Fabrics[3]
D 1059 Test Method for Yarn Number Based on Short-Length Specimens[3]
D 1423 Test Method for Twist in Yarns by the Direct-Counting Method[3]
D 1776 Practice for Conditioning Textiles for Testing[3]
D 1777 Test Method for Measuring Thickness of Textile Materials[3]
D 2150 Specification for Woven Glass Fabric for Polyester Glass Laminates[2]
D 2408 Test Method for Finish Content of Woven Glass Fabric, Cleaned and After-Finished with Amino-Silane Type Finishes, for Plastic Laminates[2]
D 2409 Test Method for Finish Content of Woven Glass Fabric, Cleaned and After-Finished with Vinyl-Silane Type Finishes, for Plastic Laminates[2]
D 2410 Test Method for Finish Content of Woven Glass Fabric, Cleaned and After-Finished with Chrome Complexes, for Plastic Laminates[2]
D 2660 Test Method for Finish Content of Woven Glass Fabric, Cleaned and After-Finished with Acrylic-Silane Type Finishes, for Plastic Laminates[2]
D 3098 Test Method for Finish Content of Woven Glass Fabric, Cleaned and After-Finished with Epoxy—Functional Silane-Type Finishes for Plastic Laminates[2]
D 3773 Test Methods for Length of Woven Fabric[4]
D 3774 Test Methods for Width of Woven Fabric[4]
D 3775 Test Method for Fabric Count of Woven Fabric[4]
D 3776 Test Methods for Mass per Unit Area (Weight) of Woven Fabric[4]
D 4357 Specification for Plastic Laminates Made from Woven-Roving and Woven-Yarn Glass Fabrics[5]

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

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[2] *Annual Book of ASTM Standards,* Vol 08.02.

[3] *Annual Book of ASTM Standards,* Vol 07.01.

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

[5] *Annual Book of ASTM Standards,* Vol 08.03.

D 4963 Test Method for Ignition Loss of Glass Strands and Fabrics[4]
E 171 Specification for Standard Atmospheres for Conditioning and Testing Materials[6]
2.2 *ANSI Standard:*
ANSI/ASQC Z1.4 Sampling Procedures for Inspection by Attributes[7]
2.3 *Military Standard and Specifications:*
MIL-Y-1140H Yarn, Cord, Sleeving, Cloth and Tape-Glass[8]
MIL-C-9084C Cloth, Glass Finished for Resin Laminates[8]
2.4 *Textile Institute Documents:*
Textile Terms and Definitions[9]
Woven Cloth Construction[9]

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) and no greater than 77°F (25°C).

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. 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 4-harness satin or broken crow.

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

3.1.5 *finished, adj—for glass laminates*, a descriptive term for woven fabrics that have passed through a treating procedure which is compatible with a resin matrix or facilitates manufacturing, or both.

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

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.

3.1.8 *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 of the fabric eleven out of twelve adjacent yarns.

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 1.

REQUIREMENTS

5. Material

5.1 The fiber 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 1, the nominal fabric count shall conform to the requirements of Table 1. For fabrics not listed in Table 1, the nominal fabric count shall be agreed upon between the purchaser and the supplier. The average count of warp ends may 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 1, the yarn designations shall conform to the requirements of Table 1. For fabrics not listed in Table 1, the yarn designations may be agreed upon between the purchaser and the supplier. The requirements of the individual elements of the designation are specified in Sections 8-12.

7.1.1 In some cases ECE 225 yarn is specified in Table 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. For fabrics not listed in Table 1, the nominal size-free yarn number may be agreed upon between the purchaser and the supplier.

9. Filament Diameter

9.1 The nominal filament diameter for the yarns in the fabric shall conform to the nominal range for filament diameter average values specified in Table 1 of Specification D 578.

[6] *Annual Book of ASTM Standards*, Vol 15.09.
[7] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.
[8] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, ATTN: NPODS.
[9] Available from the Textile Institute, 10 Blackfriars St., Manchester, M3 5DR England.

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 The primary twist in the singles strands shall be "Z" twist and the final twist in the plied yarns shall be "S" twist unless otherwise agreed upon between the purchaser and the supplier.

12. Twist Level

12.1 The nominal twist in the component strands and the finished yarns shall conform to the requirements of Table 1 unless otherwise agreed upon between the purchaser and the supplier. The tolerances for the primary twist and the final twist shall conform to Table 2.

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 otherwise specified.

16. Breaking Strength

16.1 For fabrics listed in Table 1, 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 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 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 4—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 m or 15 yd, 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[10] may be thermoset unless otherwise agreed upon between the purchaser and the supplier.

19. Ignition Loss

19.1 The ignition loss of finished fabric may be no less than 0.075 % and no more than 0.25 % unless otherwise agreed upon between the purchaser and the supplier.

NOTE 5—In certain cases the limits of the ignition loss may exceed that described in 19.1. When this limit is known, it must be specified in the contractual document.

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

20. Fabric Appearance

20.1 The woven finished 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) shall 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 may be marked by blue direction-indicator yarns running warpwise in the cloth and spaced approximately 6 in. (150 mm) 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 may be as specified in 18.1.

[10] 3M No. 588 splicing medium, available from 3M Co., St. Paul, Minn. 55101, or equivalent, has been found acceptable for this purpose.

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

NOTE 6—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. Packaging

22.1 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. Marking

23.1 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

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

SAMPLING AND CONDITIONING

24. Sampling

24.1 *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.

24.1.1 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.

24.2 *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 between the purchaser and the supplier.

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

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

24.3.2 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 m or 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 11 yd (11 m).

24.4 *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.

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 yards per pound (or tex) 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 upon five test specimens of warp yarn and five test specimens 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 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-.

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 Specification D 4029. 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 Test Method D 1777. For fabrics made with other types of yarns, use Option 3 of Test 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. The CRE-type testing machine shall be operated at 15 ± 11 mm (0.6 ± 0.05 in.)/min unless specified otherwise. A CRT-type testing machine shall be operated at 305 to 300± 10 mm (12 ± ½ in.)/min unless specified otherwise. 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 7—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 100 lbf/in. (17.5 kN/m) or less.

NOTE 8—Fabrics having breaking strength less than 17.5 kN/m (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 3000 cP (mPa·g) 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 9—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 (2.3-kg) basis.

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

36.3.2 Cut two swatches of fabric from the laboratory sample each 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 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 (1⅝ in.) 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 10—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 11—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 12—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 show that cascading breaks across the specimen when using Procedure 2 stated in 36.4, or both.

NOTE 13—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 50-mm (2-in.) 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 14—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 5-lb (2.3-kg) weight 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 15—The decision to discard 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 may be discarded unless it is known to be faulty.

NOTE 16—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 may be accepted as a characteristic of the particular test method.

36.5.12 *Precision and Bias*—The precision and bias of this procedure are as specified in Test Method 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 may 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 and Finish Level

39.1 Determine the ignition loss (organic content) of the finished fabric as directed in Test Method D 4963, unless otherwise agreed to between the purchaser and the supplier.

39.1.1 It is recognized that the determination of degree of resin compatible sizings can be difficult to obtain. Certain procedures applicable to various resin compatible sizings are available and can be found in the specifications listed in 39.1.2. These procedures or any other procedures applicable to finish content may be as specified in the contracting instrument.

39.1.2 If laminate testing is specified in the contracting document, the following ASTM specifications are recommended as the source of a testing procedure to be agreed upon between the purchaser and the supplier:

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

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 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 in which it appears. Classify the defects as listed in Table 1.

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 4029. 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 (yards or metres).

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 tests 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 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 may 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; construction; fabric weave; glass fabrics; laminates; organic content; plastics; twist; yarn number; yarns

TABLE 1 Physical Properties of Typical "E" Glass Finished Woven Glass Fabrics

Commercial Style Designation	Fabric Count, Warp × Fill 25 mm yarns/in.	Yarn Designation[A] inch-pound units tex		Fabric Weave Type[B]	Mass per Unit Area, g/m^2 oz/yd.^{2}	Nominal Thickness,[C] mm in.	Breaking Strength, min,[C] Warp × Fill N/5 cm lbf/in.
		Warp	Filling				
101	147 × 147	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	59 × 51	EC5 5.5 1 × 0	EC5 2.75 1 × 0	plain	19	0.028	131 × 26
	60 × 52	ECD 900 1/0	ECD 1800 1/0		0.56	0.0011	15 × 3
105	59 × 51	EC5 5.5 1 × 0	EC5 5.5 1 × 0	plain	24.4	0.0330	114 × 96
	60 × 52	ECD 900 1/0	ECD 900 1/0		0.72	0.0013	13 × 11
106	55 × 55	EC5 5.5 1 × 0	EC5 5.5 1 × 0	plain	25	0.036	105 × 105
	56 × 56	ECD 900 1/0	ECD 900 1/0		0.73	0.0014	12 × 12
107	59 × 34	EC5 5.5 1 × 2	EC5 5.5 1 × 00	plain	34	0.046	210 × 44
	60 × 35	ECD 900 1/2	ECD 900 1/		1.01	0.0018	24 × 5
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	D 900 1/2		1.40	0.0024	66 × 52
112	39 × 38	EC5 11 1 × 2	EC5 11 1 × 2	plain	71	0.089	350 × 306
	40 × 39	ECD 450 1/2	ECD 450 1/2		2.10	0.0035	40 × 35
113	59 × 63	EC5 11 1 × 2	EC5 5.5 1 × 2	plain	83	0.086	438 × 219
	60 × 64	ECD 450 1/2	ECD 900 1/2		2.45	0.0034	50 × 25
116	59 × 57	EC5 11 1 × 2	EC5 11 1 × 2	plain	105	0.102	525 × 486
	60 × 58	ECD 450 1/2	ECD 450 1/2		3.10	0.0040	60 × 55
118	89 × 59	EC5 11 1 × 2	EC5 11 1 × 2	crowfoot	132	0.132	657 × 525
	90 × 60	ECD 450 1/2	ECD 450 1/2		3.90	0.0052	75 × 60
119	53 × 49	EC5 11 1 × 2	EC5 11 1 × 2	plain	92	0.099	525 × 438
	54 × 50	ECD 450 1/2	ECD 450 1/2		2.71	0.0039	60 × 50
120	59 × 57	EC5 11 1 × 2	EC5 11 1 × 2	crowfoot	106	0.107	525 × 482
	60 × 58	ECD 450 1/2	ECD 450 1/2		3.14	0.0042	60 × 55
125	35 × 33	EC5 11 2 × 2	EC5 11 2 × 2	plain	125	0.145	525 × 482
	36 × 34	ECD 450 2/2	ECD 450 2/2		3.70	0.0057	60 × 55

TABLE 1 *Continued*

Commercial Style Designation	Fabric Count, Warp × Fill 25 mm yarns/in.	Yarn Designation[A] inch-pound units tex		Fabric Weave Type[B]	Mass per Unit Area, g/m² oz/yd.²	Nominal Thickness,[C] mm in.	Breaking Strength, min,[C] Warp × Fill N/5 cm lbf/in.
		Warp	Filling				
126	33 × 31	EC5 11 3 × 2	EC5 11 3 × 2	plain	180	0.193	701 × 482
	34 × 32	ECD 450 3/2	ECD 450 3/2		5.30	0.0076	80 × 55
127	41 × 31	EC5 11 3 × 2	EC5 11 3 × 2	plain	197	0.198	701 × 482
	42 × 32	ECD 450 3/2	ECD 450 3/2		5.80	0.0078	80 × 55
128	41 × 31	EC7 22 1 × 3	EC7 22 1 × 3	plain	197	0.183	701 × 482
	42 × 32	ECE 225 1/3	ECE 225 1/3		5.80	0.0072	80 × 55
141	31 × 21	EC7 22 3 × 2	EC7 22 3 × 2	plain	288	0.292	1095 × 788
	32 × 21	ECE 225 3/2	ECE 225 3/2		8.50	0.0115	125 × 90
143	48 × 30	EC7 22 3 × 2	EC5 11 1 × 2	crowfoot	281	0.241	2189 × 175
	49 × 30	ECE 225 3/2	ECD 450 1/2		8.30	0.0095	250 × 20
162	28 × 16	EC7 22 2 × 5	EC7 22 2 × 5	plain	397	0.419	1664 × 1995
	28 × 16	ECE 225 2/5	ECE 225 2/5		11.7	0.0165	190 × 125
164	20 × 18	EC7 22 4 × 3	EC7 22 4 × 3	plain	420	0.406	1664 × 1401
	20 × 18	ECE 225 4/3	ECE 225 4/3		12.4	0.016	190 × 160
166	59 × 57	EC5 11 1 × 2	EC5 22 1 × 0	plain	105	0.102	420 × 488
	60 × 58	ECD 450 1/2	ECD 225 1/0		3.10	0.0040	48 × 57
182	59 × 55	EC7 22 2 × 2	EC7 22 2 × 2	8-H satin	414	0.343	1576 × 1401
	60 × 56	ECE 225 2/2	ECE 225 2/2		12.2	0.0135	180 × 160
183	53 × 478	EC7 22 3 × 2	EC7 22 3 × 2	8-H satin	542	0.470	2189 × 1970
	54 × 4	ECE 225 3/2	ECE 225 3/2		16.0	0.0185	250 × 225
184	41 × 35	EC7 22 4 × 3	EC7 22 4 × 3	8-H satin	848	0.762	2627 × 2189
	42 × 36	ECE 225 4/3	ECE 225 4/3		25.0	0.0300	300 × 250
325	89 × 43	EC5 5.5 1 × 0	EC5 2.75 1 × 0	plain	24	0.033	149 × 44
	90 × 44	ECD 900 1/0	ECD 1800 1/0		0.70	0.0013	17 × 5
341	30 × 48	EC5 11 1 × 2	EC7 22 3 × 2	crowfoot	294	0.241	263 × 2189
	30 × 49	ECD 450 1/2	ECE 225 3/2		8.68	0.0095	30 × 250
1047	92 × 92	EC6 51 1 × 0	EC6 51 1 × 0	plain	184 4	0.147	1638 × 1638
	47 × 47	DE100 1/0	DE100 1/0		5.44	0.0058	188 × 188
1070	59 × 34	EC5 11 1 × 0	EC5 5.5 1 × 0	plain	35	0.043	210 × 44
	60 × 35	ECD 450 1/0	ECD 900 1/0		1.03	0.0017	24 × 5
1080	59 × 46	EC5 11 1 × 0	EC5 11 1 × 0	plain	47	0.058	210 × 15
	60 × 47	ECD 450 1/0	ECD 450 1/0		1.40	0.023	24 × 18
1116	59 × 57	EC5 22 1 × 0	EC5 22 1 × 0	plain	105	0.0864	394 × 280
	60 × 58	ECD 225 1/0	ECD 225 1/0		3.10	0.0034	45 × 32
1125	39 × 38	EC5 11 1 × 2	EC9 33 1 × 0	plain	88	0.104	350 × 394
	40 × 39	ECD 450 1/2	ECG 150 1/0		2.60	0.0041	40 × 45
1165	59 × 51	EC5 11 1 × 2	EC9 33 1 × 0	plain	122	0.112	482 × 525
	60 × 52	ECD 450 1/2	ECG 150 1/0		3.60	0.0044	55 × 60
1316	60 × 60	EC5 22 1 × 0	EC5 22 1 × 0	plain	105.0	0.102	394 × 298
	61 × 61	ECD 225 1/0	ECD 225 1/0		3.18	0.0040	45 × 34
1510	31 × 29	EC9 33 1 × 2	EC9 33 1 × 2	plain	162	0.127	482 × 394
	32 × 29	ECG 150 1/2	ECG 150 1/2		4.78	0.0050	55 × 45
1523	28 × 20	EC9 33 3 × 2	EC9 33 3 × 2	plain	390	0.356	1401 × 1226
	28 × 20	ECG 150 3/2	ECG 150 3/2		11.5	0.0140	160 × 140
1526	33 × 31	EC9 33 1 × 2	EC9 33 1 × 2	plain	179	0.180	701 × 482
	34 × 32	ECG 150 1/2	ECG 150 1/2		5.27	0.0071	80 × 55
1527	17 × 17	EC9 33 3 × 3	EC9 33 3 × 3	plain	431	0.406	1576 × 1489
	17 × 17	ECG 150 3/3	ECG 150 3/3		12.7	0.0160	180 × 170
1528	43 × 31	EC9 33 1 × 2	EC9 33 1 × 2	plain	202	0.185	701 × 482
	44 × 32	ECG 150 1/2	ECG 150 1/2		5.95	0.0073	80 × 55
1543	48 × 30	EC9 33 2 × 2	EC7 22 1 × 0	crowfoot	281	0.229	2189 × 175
	49 × 30	ECG 150 2/2	ECE 225 1/0		8.30	0.0090	250 × 20
1557	56 × 30	EC9 33 1 × 2	EC7 22 1 × 0	crowfoot	179	0.147	1095 × 219
	57 × 30	ECG 150 1/2	ECE 225 1/0		5.27	0.0058	125 × 25
1564	20 × 18	EC9 33 4 × 2	EC9 33 4 × 2	plain	414	0.381	1664 × 1401
	20 × 18	ECG 150 4/2	ECG 150 4/2		12.2	0.0150	190 × 160
1581	56 × 53	EC9 33 1 × 2	EC9 33 1 × 2	8-H satin	290	0.254	1313 × 1138
	57 × 54	ECG 150 1/2	ECG 150 1/2		8.55	0.010	150 × 130
1582	59 × 55	EC9 33 1 × 3	EC9 33 1 × 3	8-H satin	464	0.394	1401 × 1313
	60 × 56	ECG 150 1/3	ECG 150 1/3		13.7	0.0155	160 × 150
1583	53 × 47	EC9 33 2 × 2	EC9 33 2 × 2	8-H satin	542	0.445	2189 × 1970
	54 × 48	ECG 150 2/2	ECG 150 2/2		16.0	0.0175	250 × 225
1584	43 × 34	EC9 33 4 × 2	EC9 33 4 × 2	8-H satin	834	0.711	2627 × 2189
	44 × 35	ECG 150 4/2	ECG 150 4/2		24.6	0.028	300 × 250
1610	31 × 28	EC9 33 1 × 0	EC9 33 1 × 0	plain	80	0.0914	306 × 263
	32 × 28	ECG 150 1/0	ECG 150 1/0		2.35	0.0036	35 × 30
1643	55 × 47	EC6 33 1 × 0	EC6 33 1 × 0	crowfoot	138	0.0127	613 × 482
	56 × 48	ECDE 150 1 × 0	ECDE 150 1/0		4.06	0.0050	70 × 55
1652	102 × 102	EC6 33 1 × 0	EC6 33 1 × 0	plain	136.9	0.114	1591 × 1591

TABLE 1 *Continued*

Commercial Style Designation	Fabric Count, Warp × Fill 25 mm yarns/in.	Yarn Designation[A] inch-pound units tex		Fabric Weave Type[B]	Mass per Unit Area, g/m² oz/yd.²	Nominal Thickness,[C] mm in.	Breaking Strength, min,[C] Warp × Fill N/5 cm lbf/in.
		Warp	Filling				
	52 × 52	DE150 1/0	DE150 1/0		4.04	0.0045	182 × 182
1659	20 × 10	EC9 33 1 × 0	EC9 68 1 × 0	leno	54	0.0107	131 × 140
	20 × 10	ECG 150 1/0	ECG 75 1/0		1.60	0.0042	15 × 16
1674	39 × 31	EC9 33 1 × 0	EC9 33 1 × 0	plain	95	0.109	438 × 306
	40 × 32	ECG 150 1/0	ECG 150 1/0		2.80	0.0043	50 × 35
1675	39 × 31	EC6 33 1 × 0	EC6 33 1 × 0	plain	96	0.094	438 × 306
	40 × 32	ECDE 150 1/0	ECDE 150 1/0		2.83	0.0037	50 × 35
1676	55 × 47	EC6 33 1 × 0	EC6 33 1 × 0	plain	136	0.122	613 × 525
	56 × 48	ECDE 150 1/0	ECDE 150 1/0		4.00	0.0048	70 × 60
1677	39 × 39	EC6 33 1 × 0	EC6 33 1 × 0	plain	106	0.112	525 × 438
	40 × 40	ECDE 150 1/0	ECDE 150 1/0		3.14	0.0044	60 × 50
1678	79 × 79	EC9 33 1 × 0	EC9 33 1 × 0	plain	105.8	0.091	1051 × 1051
	40 × 40	G150 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	188	0.152	832 × 701
	72 × 70	ECDE 150 1/0	ECDE 150 1/0		5.56	0.0060	95 × 80
1681	55 × 35	EC6 33 1 × 0	EC6 33 1 × 0	plain	122	0.0122	525 × 394
	56 × 36	ECDE 150 1/0	ECDE 150 1/0		3.60	0.0048	60 × 45
1687	39 × 41	EC9 33 1 × 0	EC9 33 1 × 0	plain	108.5	0.1140	578 × 525
	40 × 42	ECG 150 1/0	ECG 150 1/0		3.20	0.0045	66 × 60
1800	16 × 14	EC13 275 1 × 0	EC13 275 1 × 0	plain	327	0.330	1313 × 1051
	16 × 14	ECK 18 1/0	ECK 18 1/0		9.65	0.0130	150 × 120
1874	43 × 34	EC13 275 1 × 0	EC13 275 1 × 0	8-H satin	865	0.0681	3152 × 2758
	44 × 35	ECK 18 1/0	ECG 37 1/2		26.08	0.0245	360 × 315
1884	43 × 34	EC13 275 1 × 0	EC13 275 1 × 0	8-H satin	847	0.7112	2627 × 2189
	44 × 35	ECK 18 1/0	ECK 18 1/0		25.0	0.0280	300 × 250
1887	39 × 20	EC13 275 1 × 0	EC13 275 1 × 0	mock leno	715	0.584	311 × 163
	40 × 21	ECK 18 1/0	ECK 18 1/0		21.10	0.0230	2723 × 1427
2112	39 × 38	EC5 22 1 × 0	EC5 22 1 × 0	plain	71	0.079	263 × 210
	40 × 39	ECD 225 1/0	ECD 225 1/0		2.10	0.0031	30 × 24
2113	59 × 55	EC5 22 1 × 0	EC5 11 1 × 0	plain	81	0.0076	420 × 210
	60 × 56	ECD 225 1/0	ECD 450 1/0		2.38	0.0030	48 × 24
2116	59 × 57	EC5 22 1 × 0	EC5 22 1 × 0	plain	105	0.086	350 × 280
	60 × 58	ECD 225 1/0	ECD 225 1/0		3.10	0.0034	40 × 32
2119	53 × 49	EC7 22 1 × 0	EC7 22 1 × 0	plain	90.2	0.086	315 × 236
	54 × 50	ECE 225 1/0	ECE 225 1/0		2.66	0.0034	36 × 27
2120	59 × 57	EC5 22 1 × 0	EC5 22 1 × 0	crowfoot	106	0.107	525 × 482
	60 × 58	ECD 225 1/0	ECD 225 1/0		3.12	0.0042	60 × 55
2125	39 × 38	EC5 22 1 × 0	EC9 33 1 × 0	plain	88	0.0965	263 × 394
	40 × 39	ECD 225 1/0	ECG 150 1/0		2.60	0.0038	30 × 45
2165	59 × 512	EC5 22 1 × 0	EC9 33 1 × 0	plain	123	0.122	482 × 525
	60 × 5	ECD 225 1/0	ECG 150 1/0		3.62	0.0048	55 × 60
2218	89 × 59	EC7 22 1 × 0	EC7 22 1 × 0	crowfoot	138	0.0127	534 × 394
	90 × 60	ECE 225 1/0	ECE 225 1/0		4.06	0.0050	61 × 45
2225	35 × 33	EC7 22 1 × 2	EC7 22 1 × 2	plain	127	0.323	51 × 48
	36 × 34	ECE 225 1/2	ECE 225 1/2		3.75	0.0127	447 × 420
2238	63 × 59	EC7 22 1 × 2	EC7 22 1 × 2	crowfoot	231	0.0452	102 × 90
	64 × 60	ECE 225 1/2	ECE 225 1/2		6.80	0.0178	893 × 788
2313	59 × 63	EC7 22 1 × 0	EC5 11 1 × 0	plain	80.5	0.838	50 × 24
	60 × 64	ECE 225 1/0	ECD 450 1/0		2.38	0.0033	438 × 210
2316	60 × 60	EC7 22 1 × 0	EC7 22 1 × 0	plain	108	0.0889	359 × 298
	61 × 61	ECE 225 1/0	ECE 225 1/0		3.18	0.0035	41 × 34
2319	59 × 45	EC7 22 1 × 0	EC7 22 1 × 0	plain	93.2	0.0864	350 × 228
	60 × 46	ECE 225 1/0	ECE 225 1/0		2.75	0.0034	40 × 26
2500	16 × 16	EC10 190 1 × 0	EC10 190 1 × 0	leno	272	0.508	876 × 858
	16 × 16	ECH 25 1/0	ECH 25 1/0		8.01	0.0200	100 × 98
2523	28 × 20	EC10 198 1 × 0	EC10 198 1 × 0	plain	390	0.328	1138 × 1138
	28 × 20	ECH 25 1/0	ECH 25 1/0		11.5	0.0129	130 × 130
2532	16 × 14	EC10 198 1 × 0	EC10 198 1 × 0	plain	230	0.246	876 × 832
	16 × 14	ECH 25 1/0	ECH 25 1/0		6.8	0.0097	100 × 95
3070	138 × 138	EC6 17.5 1 × 0	EC6 17.5	plain	93.6	0.078	1104 × 1104
	70 × 70	DE300 1/0	DE300 1/0		2.76	0.0031	133 × 133
3313	118 × 122	EC6 17.5 1 × 0	EC6 17.5	plain	80.5	0.084	944 × 976
	60 × 62	DE300 1/0	DE300 1/0		2.38	0.0033	114 × 118
3700	15 × 14	EC9 134 1 × 2	EC9 134 1 × 2	plain	311	0.312	1033 × 928
	15 × 14	ECG 37 1/2	ECG 37 1/2		9.18	0.0123	118 × 106
3701	12 × 6	EC9 134 1 × 0	EC9 134 1 × 0	leno	134.6	0.244	446 × 438
	12 × 6	ECG 37 1/0	ECG 37 1/0		3.97	0.0096	51 × 50
3732	47 × 31	EC9 134 1 × 0	EC9 134 1 × 0	crowfoot	424	0.318	1532 × 1313
	48 × 32	ECG 37 1/0	ECG 37 1/0		12.5	0.0125	175 × 150

TABLE 1 *Continued*

Commercial Style Designation	Fabric Count, Warp × Fill 25 mm yarns/in.	Yarn Designation[A] inch-pound units tex		Fabric Weave Type[B]	Mass per Unit Area, g/m² oz/yd.²	Nominal Thickness,[C] mm in.	Breaking Strength, min,[C] Warp × Fill N/5 cm lbf/in.
		Warp	Filling				
3733	18 × 18	EC9 134 1 × 0	EC9 134 1 × 0	plain	190	0.198	788 × 744
	18 × 18	ECG 37 1/0	ECG 37 1/0		5.60	0.0078	90 × 85
3734	47 × 31	ECG 134 1 × 0	ECG 134 1 × 0	crowfoot	432	0.366	1681 × 1147
	48 × 32	ECDE 37 1/0	ECDE 37 1/0		12.74	0.0144	192 × 131
3743	48 × 30	EC9 134 1 × 0	EC7 22 1 × 0	crowfoot	281	0.208	2189 × 175
	49 × 30	ECG 37 1/0	ECE 225 1/0		8.30	0.0082	250 × 20
3744	28 × 14	EC9 134 1 × 2	EC9 134 1 × 4	2 end plain	610	0.508	1926 × 1909
	28 × 14	ECG 37 1/2	ECG 37 1/4		18.00	0.0200	220 × 218
3745	27 × 28	EC9 134 1 × 0	EC9 134 1 × 2	2 pk. plain	593	0.470	1751 × 1883
	27 × 28	ECG 37 1/2	ECG 37 1/2		17.50	0.0185	200 × 215
3783	53 × 47	EC9 134 1 × 0	EC9 134 1 × 0	8-H satin	576	0.406	1751 × 1707
	54 × 48	ECG 37 1/2	ECG 37 1/2		16.99	0.0160	200 × 195
3784	43 × 34	EC9 134 1 × 0	EC9 134 1 × 0	8-H satin	901	0.610	2522 × 2242
	44 × 35	ECG 37 1/2	ECG 37 1/2		26.57	0.0240	288 × 256
3787	39 × 21	EC9 134 1 × 2	EC9 134 1 × 2	mock leno	695	0.762	2102 × 1261
	40 × 21	ECG 37 1/2	ECG 37 1/2		20.50	0.0300	240 × 14
3788	41 × 35	EC9 134 1 × 4	EC9 134 1 × 4	12-H satin	1856	1.156	4282 × 3555
	42 × 36	ECG 37 1/4	ECG 37 1/4		54.75	0.0455	489 × 406
5020	18 × 18	EC9 99 1 × 2	EC9 99 1 × 2	plain	294	0.305	928 × 876
	18 × 18	ECG 50 1/2	ECG 50 1/2		8.68	0.0120	106 × 100
5023	48 × 30	EC9 99 1 × 2	EC9 99 1 × 2	crowfoot	288	0.330	1489 × 1226
	49 × 30	ECG 50 1/2	ECG 50 1/2		8.50	0.0130	170 × 140
5027	17 × 17	EC9 99 1 × 3	EC9 99 1 × 3	plain	417	0.419	1489 × 1401
	17 × 17	ECG 50 1/3	ECG 50 1/3		12.30	0.0165	170 × 160
5032	16 × 14	EC9 99 1 × 2	EC9 99 1 × 2	plain	245	0.254	893 × 753
	16 × 14	ECG 50 1/2	ECG 50 1/2		7.23	0.0100	102 × 86
5082	59 × 55	EC9 99 1 × 0	EC9 99 1 × 0	8-H satin	471	0.330	1471 × 1401
	60 × 56	ECG 50 1/0	ECG 50 1/0		13.90	0.0130	168 × 160
6060	118 × 118	EC6 8.75 1 × 0	EC6 8.75 1 × 0	plain	39.0	0.048	472 × 472
	60 × 60	DE600 1/0	DE600 1/0		1.15	0.0019	57 × 57
7500	16 × 14	EC9 68 2 × 2	EC9 68 2 × 2	plain	324	0.368	1313 × 1051
	16 × 14	ECG 75 2/2	ECG 75 2/2		9.55	0.0145	150 × 120
7520	18 × 17	EC9 68 1 × 3	EC9 68 1 × 3	plain	279	0.251	919 × 876
	18 × 17	ECG 75 1/3	ECG 75 1/3		8.22	0.0099	105 × 100
7532	16 × 14	EC9 68 1 × 3	EC9 68 1 × 3	plain	239	0.305	1007 × 876
	16 × 14	ECG 75 1/3	ECG 75 1/3		7.05	0.012	115 × 100
7533	18 × 18	EC9 68 1 × 2	EC9 68 1 × 2	plain	192	0.234	788 × 744
	18 × 18	ECG 75 1/2	ECG 75 1/2		5.65	0.0092	90 × 85
7543	48 × 30	EC9 68 1 × 2	EC7 22 1 × 0	crowfoot	288	0.2032	1681 × 193
	49 × 30	ECG 75 1/2	ECE 225 1/0		8.50	0.0080	192 × 22
7544	28 × 14	EC9 68 2 × 2	EC9 68 2 × 4	2/1 basket	600	0.559	1664 × 1401
	28 × 14	ECG 75 2/2	ECG 75 2/4		17.7	0.0220	190 × 160
7557	56 × 300	EC9 68 1 × 0	EC7 22 1 × 0	crowfoot	184	0.140	981 × 193
	57 × 3	ECG 75 1/0	ECE 225 1/0		5.42	0.0055	112 × 22
7581	56 × 53	EC9 68 1 × 0	EC9 68 1 × 0	8-H satin	302	0.246	718 × 525
	57 × 54	ECG 75 1/0	ECG 75 1/0		8.90	0.0097	82 × 60
7583	53 × 47	EC9 68 1 × 2	EC9 68 1 × 2	8-H satin	546	0.396	1821 × 1646
	54 × 48	ECG 75 1/2	ECG 75 1/2		16.10	0.0156	208 × 188
7587	39 × 21	EC9 68 2 × 2	EC9 68 2 × 2	mock leno	678	0.800	2627 × 1489
	40 × 21	ECG 75 2/2	ECG 75 2/2		20.0	0.0315	300 × 170
7626	33 × 312	EC9 68 1 × 0	EC9 68 1 × 0	plain	176	0.157	701 × 482
	34 × 3	ECG 75 1/0	ECG 75 1/0		5.20	0.0062	80 × 55
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	202	0.173	525 × 420
	44 × 32	ECG 75 1/0	ECG 75 1/0		5.95	0.0068	60 × 48
7629	43 × 33	EC9 68 1 × 0	EC9 68 1 × 0	plain	213.0	0.0180	508 × 403
	44 × 34	ECG 75 1/0	ECG 75 1/0		6.19	0.0071	58 × 46
7635	86 × 57	EC9 68 1 × 0	EC9 100 1 × 0	plain	230.9	0.196	2184 × 2508
	44 × 29	G75 1/0	G50 1/0		6.81	0.0077	251 × 290
7637	43 × 22	EC9 68 1 × 0	EC9 134 1 × 0	plain	227	0.224	683 × 665
	44 × 22	ECG 75 1/0	ECG 37 1/0		6.70	0.0088	78 × 76
7641	31 × 21	EC9 68 1 × 2	EC9 68 1 × 2	plain	288	0.267	1095 × 788
	32 × 21	ECG 75 1/2	ECG 75 1/2		8.50	0.0105	125 × 90
7642	43 × 200	EC9 68 1 × 0	ET9 134 1 × 0	plain	220	0.254	657 × 350
	44 × 2	ECG 75 1/0	ETG 37 1/0		6.50	0.0100	75 × 40
7652	31 × 31	EC9 99 1 × 0	EC9 99 1/0	plain	253	0.221	1876 × 788
	32 × 32	ECG 50 1/0	ECG 50 1/0		7.45	0.0087	100 × 90
7658	43 × 31	EC9 68 1 × 0	EC9 68 1 × 0	crowfoot	202	0.175	701 × 482

TABLE 1 *Continued*

Commercial Style Designation	Fabric Count, Warp × Fill 25 mm yarns/in.	Yarn Designation[A] inch-pound units tex		Fabric Weave Type[B]	Mass per Unit Area, g/m² oz/yd.²	Nominal Thickness,[C] mm in.	Breaking Strength, min,[C] Warp × Fill N/5 cm lbf/in.
		Warp	Filling				
	44 × 32	ECG 75 1/0	ECG 75 1/0		5.95	0.0069	80 × 55
7660	30 × 30	EC9 68 1 × 0	EC9 68 1 × 0	plain	163.0	0.0150	359 × 350
	30 × 30	ECG 75 1/0	ECG 75 1/0		4.80	0.0059	41 × 40
7664	20 × 18	EC9 68 2 × 2	EC9 68 2 × 2	plain	424	0.419	1664 × 1401
	20 × 18	ECG 75 2/2	ECG 75 2/2		12.5	0.0165	190 × 160
7743	118 × 20	EC6 68 1 × 0	EC9 33 1 × 0	8-H satin	339	0.244	2408 × 306
	120 × 20	ECDE 75 1/0	ECG 150 1/0		10.0	0.0096	275 × 35
7781	59 × 53	EC6 68 1 × 0	EC6 68 1 × 0	8-H satin	295	0.234	1313 × 1138
	57 × 54	ECDE 75 1/0	ECDE 75 1/0		8.70	0.0092	150 × 130

[A] Yarn designations are as specified in Specification D 578. For engineering information only, and may be made by substituting other yarn equivalents, providing fiber diameter and other properties are not affected. For example, when EC 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.

[C] Nominal values, the type finish can affect the breaking strength and thickness of fiberglass fabrics.

TABLE 2 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 Tolerances—Mass/Unit Area

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

TABLE 4 Tolerances—Thickness

Nominal Thickness	Permissible Variations
millimetres	
0.0075 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

TABLE 5 Classification of Defects[A]

Defect	Description	Major	Minor
Baggy, ridgy, or wavy cloth	Clearly noticeable	x	
Cut or tear	¼ in. (6.5 mm) or more in any direction (body only)	x	
Hole	½ in. (1.3 cm) or more in diameter	x	
	Less than ½ in. (1.3 cm) in diameter		x
Spots, streaks, stains, foreign inclusions	Clearly noticeable	x	
Tender or weak spot	Clearly noticeable 2 in. (5 cm) or more in combined directions	x	
	Clearly noticeable less than 2 in. (5 cm) but greater than ¼ in. (0.6 cm) in combined directions		x
Smash	3 in. (7.6 cm) or more in combined directions	x	
	Less than 3 in. (7.6 cm) 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	
	Less than 2 in. (5 cm) in combined directions		x
Light marks	Greater than ¼ in. (6.5 mm) 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 ¼ in. (6.5 mm) in length	x	
	Clearly noticeable less than ¼ in. (6.4 mm) in length		x
Weave separation	Clearly noticeable ⅛ in. (3 mm) or more	x	
Brittle or fused area	Any	x	
Selvage defects	Curled or folded under		x
	Cut or torn less than ¼ in. (0.6 cm) in length		x
	Cut or torn ¼ in. (0.6 cm) and over in length	x	
Selvage leno ends out	Greater than 5 yds (500 cm) missing (continuously)	x	
	Less than 5 yds (500 cm) missing		x
Feather edge	Greater than 3/16 in. (5 mm) running more than 5 yds (500 cm)		
	Greater than 3/16 in. (5 mm) but running less than 5 yds (500 cm)		

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

TABLE 6 Sample Size Determination for Construction and Physical Properties

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

TABLE 7 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 *b* |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.

TABLE 8 95 % Confidence Limits for Number of 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:

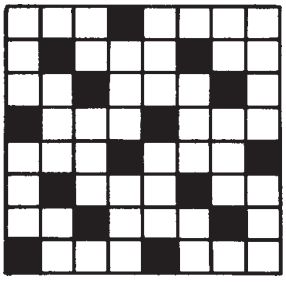
c = observed number of counts,
d = $c + 1$, and
t = 1.960, the value of Student's t for infinite degrees of freedom, two-sided limits, and the 95 % probability level.

ANNEX

(Mandatory Information)

A1. BASIC WEAVE DIAGRAMS

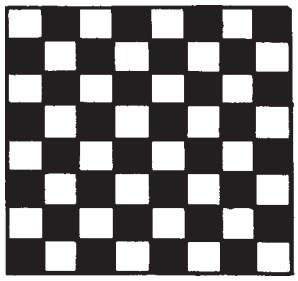
A1.1 The basic weaves illustrated in Figs. A1.1-A1.3 are typical weaves used in conjunction with Table 6 unless otherwise specified. Other weave variations of these basic forms shall be agreed upon between the purchaser and the supplier. An acceptable source for reference is "Textile Terms and Definitions" 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

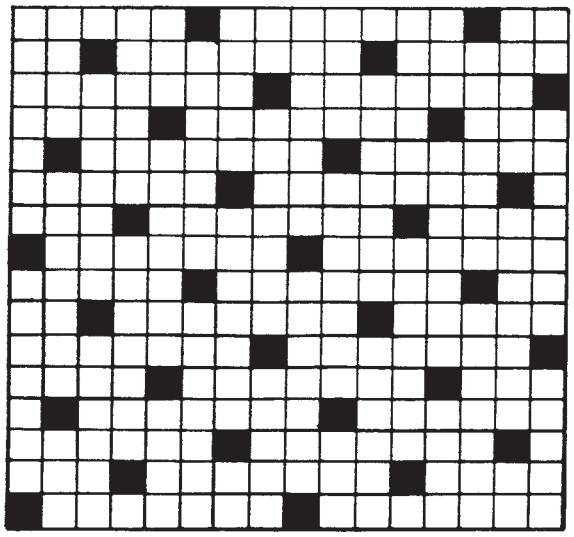
FIG. A1.1 Crowfoot



Standard Form

1 up
1 down
4 repeats high, 4 repeats wide

FIG. A1.2 Plain



Standard Form Filling Flush

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

FIG. A1.3 8-Harness Satin