Designation: D578/D578M – 23

Standard Specification for Glass Fiber Strands[1]

This standard is issued under the fixed designation D578/D578M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This specification covers the requirements for continuous fiber and staple fiber glass strands, including single, plied and multiple wound. It also covers textured glass fiber yarns. This specification is intended to assist ultimate users by designating the general nomenclature for the strand products that are generally manufactured in the glass fiber industry.

1.2 Glass fibers are produced having various compositions. General applications are identified by means of a letter designation. The letter designation represents a family of glasses that have provided acceptable performance to the end-user in the intended application. For example, the composition limits stated for E-Glass in this specification representing the glass fiber family for general and most electrical applications is designated by the letter *E*. Military specifications, such as, MIL-R-60346, recognize the composition limits described in this specification as meeting the respective requirements for E-Glass strands used in reinforced plastic structure applications.

1.3 Glass fiber strands have a variety of general uses under specific conditions, such as high physical or chemical stress, high moisture, high temperature, or electrical environments. Property requirements under specific conditions are agreed upon between the purchaser and the supplier. Electrical property requirements vary with specific end-use applications. For printed circuit board applications, other requirements may be needed such as the use of Institute for Interconnecting and Packaging Electronic Circuits (IPC) Specification EG 4412 A for finished fabric woven from E-Glass for printed circuit boards, or Specification MIL-P-13949 for printed wiring boards applicable to glass fabric base.

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

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

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

1.7 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D123 Terminology Relating to Textiles

D1423/D1423M Test Method for Twist in Yarns by Direct-Counting

D1907/D1907M Test Method for Linear Density of Yarn (Yarn Number) by the Skein Method

D2256/D2256M Test Method for Tensile Properties of Yarns by the Single-Strand Method

D2258/D2258M Practice for Sampling Yarn for Testing

D2904 Practice for Interlaboratory Testing of a Textile Test

[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] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

Method that Produces Normally Distributed Data (Withdrawn 2008)[3]
D2906 Practice for Statements on Precision and Bias for Textiles (Withdrawn 2008)[3]
D4963/D4963M Test Method for Ignition Loss of Glass Fiber Strands and Fabrics
D7018/D7018M Terminology Relating to Glass Fiber and Its Products (Withdrawn 2021)[3]

2.2 *ASTM Adjunct:*
TEX-PAC[4]

2.3 *ANSI Standard:*
ANSI/ASQC Z1.4 Sampling Procedures for Inspection by Attributes[5]

2.4 *Military Standards and Specifications:*
MIL-P-13949 Specification for Plastic Sheet, Laminated, Metal-Clad For Printed Wiring Board[6]
MIL-R-60346 Roving, Glass Fibrous (for Prepreg Tape, Rovings, Filament Winding, and Pultrusion Applications)[6]
MIL-G-55636B Glass Cloth, Resin Preimpregnated (B-STAGE) (For Multilayer Printed Wiring Boards) (Superseded by MIL-P-13949 1981)[6]
MIL-Y-1140 Specification for Yarn, Cord, Sleeving, Cloth, and Tape-Glass[6]
MIL-C-9084 Specification for Cloth Finished for Resin Laminates (Cancelled 1999)[6]

2.5 *Institute for Interconnecting and Packaging Circuits Standard:*
IPC EG 4412 A Specification for Finished Fabric Woven from E-Glass for Printed Circuit Boards[7]

3. Terminology

3.1 For all terminology related to D13.18, Glass Fiber and Its Products, see Terminology D7018/D7018M.

3.1.1 The following terms are relevant to this standard: atmosphere for testing textiles, chopped strand, continuous filament yarn, roving, staple glass yarn, strand, textured glass yarn.

3.2 For all other terminology related to textiles, refer to Terminology D123.

4. Classification of Glass Fiber

4.1 *"C" Glass*—A family of glasses composed primarily of the oxides of sodium, calcium, boron, aluminum, and silicon with a certified chemical composition which conforms to an applicable material specification and which produces good acid resistance (excluding HF).

4.2 *"E" Glass*—A family of glasses composed primarily of the oxides of calcium, aluminum, and silicon, which has the following certified chemical compositions.

4.2.1 The following certified chemical composition applies to E-glass fiber yarn products for printed circuit boards and aerospace.

Chemical	% by Weight
B_2O_3	5 to 10
CaO	16 to 25
Al_2O_3	12 to 16
SiO_2	52 to 56
MgO	0 to 5
Na_2O and K_2O	0 to 2
TiO_2	0 to 0.8
Fe_2O_3	0.05 to 0.4
Fluoride	0 to 1.0

4.2.2 The following certified chemical composition applies to E-glass fiber products used in general applications.

Chemical	% by Weight
B_2O_3	0 to 10
CaO and MgO	16 to 30
Al_2O_3	12 to 16
SiO_2	52 to 62
Total alkali metal oxides	0 to 2
TiO_2	0 to 1.5
Fe_2O_3	0.05 to 0.8
Fluoride	0 to 1.0

4.2.3 Electrical applications include a wide variety of uses. The composition in 4.2.1 is identical to IPC EG 4412 A for printed circuit boards and to MIL-G-55636B. Additionally, such fiber glass products often are specified for aerospace applications. Products covered by the composition range in 4.2.2 are used in general applications, such as power company equipment, high voltage devices, residential electric boxes, third rail covers, high voltage standoff rods, electrical pultrusion products, light poles, electrical tool covers, and electrical tape. Other applications include roofing, flooring, filtration, panel rovings, gun rovings, smc rovings, chopped strand reinforcements, paper yarns, and industrial yarns.

4.2.4 The nomenclature "E-CR-Glass" is used for boron-free modified E-Glass compositions for improved resistance to corrosion by most acids.

4.3 *"S" Glass*—A family of glasses composed primarily of the oxides of magnesium, aluminum, and silicon with a certified chemical composition which conforms to an applicable material specification and which produces high mechanical strength.

4.4 *"R"Glass*—A family of boron-free glasses composed primarily of the oxides of silicon, aluminum, calcium and magnesium, such glasses possessing excellent acid and water durability as well as specific strength and specific modulus levels significantly greater than E glass.

DESCRIPTION OF GLASS STRANDS

5. General

5.1 The construction of glass strands is described in a series of two to four segments of alphabetical or numerical characters.

NOTE 1—In glass fiber strand designations, and in the conversion of

[3] The last approved version of this historical standard is referenced on www.astm.org.
[4] PC programs on floppy disk for analyzing Committee D13 interlaboratory data are available through ASTM. Request ADJD2904.
[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.
[6] Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, http://quicksearch.dla.mil.
[7] Available from Institute for Interconnecting and Packaging Electronic Circuits, 7380 N. Lincoln Ave., Lincolnwood, IL 60646.

yards per pound to tex units, the following rules are used:
(1) less than 2.50 tex—round to nearest 0.01 tex
(2) 2.50 tex to less than 5.00 tex—round to nearest 0.05 tex
(3) 5.00 tex to less than 10.0 tex—round to nearest 0.1 tex
(4) 10.0 tex to less than 250 tex—round to nearest 1.0 tex
(5) 250 tex to less than 2000 tex—round to nearest 5.0 tex
(6) 2000 tex to less than 100 000 tex—round to nearest 100 tex

5.1.1 For strands described in inch-pound units, the approximate yards per pound of the final strand can be computed by multiplying the yarn number designation of the single yarn or strand by 100 to obtain yards per pound for the single yarn or strand and then dividing by the total number of single yarns or strands in the final yarn. Actual yardage is less because of organic content and twist take-up during plying.

NOTE 2—Letter designations for filament diameter averages are shown in Table 1. The yards per pound stated in Table 2 is an approximate yarn number. The "As Received" yards per pound will be less than the bare glass values stated. This may be contributed by twist take-up, sizing percent, or purchaser agreement to produce to a lower yarn number to meet other requirements for a further manufactured product, or both. For example, EC9 66 1×0 (ECG 75 1/0) stated at approximately 66 tex [7500 yd/lb] will actually be about 68 tex [7300 yd/lb] in the delivered state for use in the electrical laminate industry.

6. Continuous Filament Yarns

6.1 *Descriptions of Continuous Filament Yarns*—The description of continuous filament yarns consists of the following four segments:

Segment 1	Segment 2	Segment 3	Segment 4
Glass family Fiber form Fiber diameter	Yarn number	Construction	Twist level Twist direction

6.1.1 *Segment One*—The parts of Segment one are respectively the symbol for the glass family as directed in Section 4; the symbol for fiber form, "C" for Continuous, and a symbol for average filament diameter range as directed in Table 1.

6.1.2 *Segment Two*—The second segment of the description of continuous filament yarns specifies the yarn number of the single yarn. For yarns described in SI units, the yarn number is specified in tex. For yarns described in inch-pound units, the yarn number is specified in hundreds of yards per pound, that is yards per pound divided by 100.

6.1.2.1 Some manufacturing processes are designed specifically to produce yarns consisting of hollow filaments. For these yarns, the suffix HF is attached to the second segment of the yarn description. For example, 40 HF (125HF) represents a 40 tex [125 × 100 yd/lb] single yarn consisting of hollow filaments.

6.1.3 *Segment Three*—The third segment of the description of continuous filament yarns specifies the number of single yarns in the complete yarn. For yarn described in SI units, the description consists of a count of the single yarns twisted together, a lower-case multiplication sign or *x*, and a count of the twisted yarns plied together to form the final yarn. For yarns described in inch-pound units, the description consists of a count of the singles yarns twisted together, a division sign or "/", and a count of the twisted yarns plied together to form the final yarn.

NOTE 3—If additional stages of plying are involved, a lower-case multiplication sign for SI units or a diagonal for inch-pound units, followed by the count of plied yarns being cabled is added for each additional cabling step. The total single yarns in the final yarn will always be the product of all the counts in this segment. When 0 (zero) appears as a count it is considered as 1 (one) for multiplication purposes.

6.1.4 *Segment Four*—The fourth segment of the description of continuous filament yarns specifies the twist level and direction. For yarns described in SI units, the description consists of an *S* or *Z* to show direction of twist immediately followed by the twist level in turns per metre (tpm) to the nearest 1 tpm. For yarns described in inch-pound units, the description consists of the twist level in turns per inch (tpi) to the nearest 0.1 tpi immediately followed by an *S* or *Z* to show direction of twist.

NOTE 4—Twist in turns per metre (tpm) equals twist in turns per inch (tpi) times 40. The exact factor 39.37 is rounded to 40 to obtain the twist in turns per metre to the nearest 1 tpm when starting from turns per inch to the nearest 0.1 tpi.

6.2 *Examples of Descriptions of Continuous Filament Yarns:*

6.2.1 *Example 1a, Singles Yarn Using SI Units*—The description of a singles continuous filament yarn using SI units might be:

EC6 33 1 × 0 Z40

where:

E = symbol for glass family used in general and most electrical applications,
C = symbol for continuous filament yarn,
6 = symbol for filament diameter average range 5.50 to 6.49 μm,
33 = nominal yarn number of single yarn, tex,
1×0 = one single yarn twisted without plying or cabling, and
Z40 = a twist level of 40 tpm in the "Z" direction.

The nominal yarn number in tex of the final yarn will be approximately 33 since there is only one strand in the final yarn.

6.2.2 *Example 1b, Singles Yarn Using Inch-Pound Units*—The description of a singles continuous filament yarn using inch-pound units might be:

ECDE 150 1/0 1.0Z

where:

E = symbol for glass family used in general and most electrical applications,
C = symbol for continuous filament yarn,
DE = symbol for filament diameter average range 0.00023 to 0.000269 in.,
150 = nominal yarn number of single yarns in hundreds of yards per pound [yd/lb],
1/0 = one single yarn twisted without plying or cabling, and
1.0Z = a twist level of 1.0 tpi in the "Z" direction.

The nominal yarn number in yards per pound of the final yarn will be approximately 15 000 since there is only one strand in the final yarn.

6.2.3 *Example 2a, Plied Yarn Using SI Units*—The description of a plied continuous filament yarn using SI units might be: