Designation: ~~D578/D578M – 05 (Reapproved 2011)$^{\varepsilon 1}$~~ D578/D578M – 18

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.

~~ε^1 NOTE—Editorial changes were made throughout in August 2011.~~

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 age 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 may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 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~~ safety, health, and ~~health~~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

[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.

~~D1423~~D1423/D1423M Test Method for Twist in Yarns by Direct-Counting
~~D1907~~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~~D2258/D2258M Practice for Sampling Yarn for Testing
D2904 Practice for Interlaboratory Testing of a Textile Test Method that Produces Normally Distributed Data (Withdrawn 2008)[3]
D2906 Practice for Statements on Precision and Bias for Textiles (Withdrawn 2008)[3]
~~D4963~~D4963/D4963M Test Method for Ignition Loss of Glass Fiber Strands and Fabrics
~~D7018~~D7018/D7018M Terminology Relating to Glass Fiber and Its Products

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 Preimpreginated (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~~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 allother 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 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 glass fiber products used in general applications.

Chemical	% by Weight
B_2O_3	0 to 10
~~CaO~~	~~16 to 25~~
CaO and MgO	16 to 30
Al_2O_3	12 to 16
SiO_2	52 to 62
~~MgO~~	~~0 to 5~~
Total alkali metal oxides	0 to 2

[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 Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.
[7] Available from Institute for Interconnecting and Packaging Electronic Circuits, 7380 N. Lincoln Ave., Lincolnwood, IL 60646.

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 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	Yarn number	Construction	Twist level
Fiber form			Twist direction
Fiber diameter			

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:

EC9 33 2 ×2 S152

where:

E = symbol for glass family used in general and most electrical applications,
C = symbol for continuous filament yarn,
9 = symbol for filament diameter average range 8.50 to 9.49 μm,
33 = nominal yarn number of single yarns, tex,
2×2 = two single yarns twisted together and two such yarns plied together, and
S152 = a twist level of 152 tpm in the "S" direction.

The nominal yarn number in tex of the final yarn will be approximately 132 or four times 33 tex.

6.2.4 *Example 2b, Plied Yarn Using Inch-Pound Units*—The description of a plied continuous filament yarn using inch-pound units might be:

ECG 150 2/2 3.8S

where:

E = symbol for glass family used in general and most electrical applications,
C = symbol for continuous filament yarn,
G = symbol for filament diameter average range 0.00035 to 0.000399 in.,
150 = nominal yarn number of single yarns in hundreds of yards per pound,
2/2 = two single yarns twisted together and two such yarns plied together, and
3.8S = a twist level of 3.8 tpi in the "S" direction.

The nominal yarn number in yards per pound of the final yarn will be approximately 3750 or 150 hundreds of yards per pound divided by four.

7. Discontinuous or Staple Filament Yarns

7.1 *Descriptions of Discontinuous or Staple Filament Yarns*—If SI units are used, the description of yarns made from staple fibers contains four segments and the fiber form is designated "D" for discontinuous. If inch-pound units are used, the description of yarns made from staple fibers contains three segments and the fiber form is designated" S" for staple.

7.1.1 The four segments in a description of yarns made from discontinuous fibers when using SI units are:

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

7.1.1.1 *Segment One*—For yarns made from discontinuous filaments and described in SI units, the parts of Segment one are respectively the symbol for the glass family as directed in Section 4; the symbol for fiber form, "D" for discontinuous; and a numeric symbol for filament diameter as directed in Table 1.

7.1.1.2 *Segment Two*—For yarns made from discontinuous filaments and described in SI units, the second segment of the description of discontinuous filament yarns specifies the yarn number of the single yarn in tex.

7.1.1.3 *Segment Three*—For yarns made from discontinuous filaments and described in SI units, the third segment of the description of discontinuous filament yarns specifies the number of single yarns in the complete yarn. The description consists of the following with no intervening spaces: (1) a count of the singles yarns twisted together, (2) a lower case multiplication sign or *x*, (3) a count of the twisted yarns plied together to form the final yarn, and (4) a symbol *R* when yarn is reinforced by a single continuous filament yarn (Note 3).

7.1.1.4 *Segment Four*—For yarns made from discontinuous filaments and described in SI units, the fourth segment of the description of discontinuous filament yarns specifies the twist level and direction. 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 (Note 4).

7.1.2 The three segments in a description of yarns made from staple fibers when using inch-pound units are:

Segment 1	*Segment 2*	*Segment 4*
Glass family Fiber form Fiber diameter	Yarn number ply count	Twist level Twist direction

7.1.2.1 *Segment One*—For yarns made from staple filaments and described in inch-pound units, the parts of Segment one are respectively the symbol for the glass family as directed in Section 4; the symbol for fiber form, *S* for staple; and a letter symbol for filament diameter average range as directed in Table 1.

7.1.2.2 *Segment Two*—For yarns made from staple filaments and described in inch-pound units, the second segment of the description of staple filament yarns specifies the number of singles yarn in the complete yarn. The description consists of the following with no intervening spaces: (1) the nominal yarn number of the single yarns in hundreds of yards per pound; that is, yards per pound divided by 100, (2) the divisor sign or "/" , (3) a count of the twisted yarns plied together in the final yarn, and (4) a symbol *R* when yarn is reinforced by a single continuous filament yarn. (Note 3)

7.1.2.3 *Segment Three*—For yarns made from staple filaments and described in inch-pound units, the third segment of the description of staple filament yarns specifies the twist level and direction. 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.

7.2 *Examples of Descriptions of Staple or Discontinuous Filament Yarns Using SI Units:*

7.2.1 *Example 3a, Yarn from Discontinuous Filaments Using SI Units*—The description of a yarn made from discontinuous filament might be:

CD10 198 1×2 S260

where:

C	=	symbol for glass family used in acid resistant applications,
D	=	symbol for discontinuous filament yarn,
10	=	symbol for filament diameter average range 6.50 to 7.49 µm,
198	=	nominal yarn number of single yarns, tex,
1×2	=	two single yarns plied, and
S260	=	a twist level of 260 tpm in the "S" direction.

The nominal yarn number in tex of the final yarn will be approximately 396 since two strands of 198 tex are combined in the final yarn.

7.2.1.1 If the above yarn were reinforced by a single strand of continuous filament yarn, *R* would be added to the second segment of the description to give: CD10 198R 1×2 S260 (Note 4).

7.2.2 *Example 3b, Yarn from Staple Filaments Using Inch-Pound Units*—The description of a staple filament yarn using inch-pound units might be:

CSH 25/2 6.5S

where:

C = symbol for glass family used in acid resistant applications,
S = symbol for staple filament yarn,
H = symbol for filament diameter average range 0.00040 to 0.000449 in.,
25/2 = nominal yarn number of single yarns in hundreds of yards per pound and two such yarns plied together, and
6.5S = a twist level of 6.5 tpi in the "S" direction.

The nominal yarn number in yards per pound of the final yarn will be approximately 1250 or 25 hundreds of yards per pound divided by two.

7.2.2.1 If the above yarn were reinforced by a single strand of continuous filament yarn, *R* would be added to the second segment of the description to give: CSH 25/2R 6.5S (Note 4).

8. Textured Yarns

8.1 The description of textured yarns consist of either three or four segments.

8.1.1 *Three Segment Description of Textured Yarns*—The segments in a three segment description of textured yarns are:

Segment 1	*Segment 2*	*Segment 3*
Glass family Yarn type Fiber diameter	Yarn number	Manufacturer's code

8.1.1.1 *Segment One*—For textured yarns the parts of Segment one are respectively the symbol for the glass family as directed in Section 4; the symbol for yarn type, *T* for textured; and a symbol for filament diameter as directed in Table 1.

8.1.1.2 *Segment Two*—The second segment of the description of textured yarns specifies the yarn number of the final yarn, not necessarily of the single yarns. For yarns described in SI units, the yarn number is specified in tex (Note 1). 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.

8.1.1.3 *Segment Three*—The third segment of the description of textured yarns specifies the manufacturer's product code.

8.1.2 *Four Segment Description of Textured Yarns*—The segments in a four segment description of textured yarns are:

Segment 1	*Segment 2*	*Segment 3*	*Segment 4*
Glass family Yarn type Fiber diameter	Yarn number	Construction	Manufacturer's code

8.1.2.1 *Segment One*—For textured yarns the parts of segment one are respectively the symbol for the glass family as directed in Section 4; the symbol for yarn type, *T* for textured; and a symbol for filament diameter as directed in Table 2.

8.1.2.2 *Segment Two*—The second segment of the description of textured yarns specifies the yarn number of the final yarn, not necessarily of the single yarns. For yarns described in SI units, the yarn number is specified in tex (Note 2). 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.

8.1.2.3 *Segment Three*—The third segment of the description of textured 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 singles yarns, a lower case multiplication sign or *x*, and a count of the single yarns fabricated together to form the final yarn. For yarns described in inch-pound units, the description consists of a count of the single yarns, a division sign or "/", and a count of the single yarns fabricated together to form the final yarn.

8.1.2.4 *Segment Four*—The fourth segment of the description of textured yarns specifies the manufacturer's product code.

8.2 *Examples of Descriptions of Textured Yarns:*

8.2.1 *Examples 5a and 5b, Textured Yarns Using SI Units*—The description of a textured yarn using SI units might be:

Three − segment description − (ET 9 134 (Manufacturer's Code))
Four − segment description − (ET 9 134 1 × 2 (Manufacturer's Code))

where:

E = symbol for glass family used in general and most electrical applications,
T = symbol for textured yarn,
9 = symbol for filament diameter average range 0.00035 to 0.000399 in.,
134 = nominal yarn number, tex,
1×2 = one singles yarn and two such yarns fabricated together, and
manufacturer's code = further identification as necessary by manufacturer to define process, sizing, etc.

The actual tex of the final yarn may vary and result in a higher value. This is dependent upon the yarn number of the input yarn and the degree of texture.

8.2.2 *Examples 5c and 5d, Textured Yarns Using Inch-Pound Units*—The description of a textured yarn using inch-pound units might be:

Three − segment description − (ETG 37 (Manufacturer's Code))
Four − segment description − (ETG 37 1/2 (Manufacturer's Code))

where:

E = symbol for glass family used in general and most electrical applications,
T = symbol for textured yarn,
G = symbol for filament diameter average range 0.00035 to 0.000399 in.,
37 = nominal yarn number in hundreds of yards per pound,
1/2 = one singles yarn and two such yarns fabricated together, and
manufacturer's code = further identification as necessary by manufacturer to define process, sizing, etc.

The actual yards per pound of the final yarn may vary and result in a lower value. This is dependent upon the yarn number of the input yarn and the degree of texture.

9. Rovings

9.1 *Descriptions of Rovings*—The description of rovings consists of either two or three segments.

9.1.1 *Two Segment Description for Rovings*—The segments in a two segment description of rovings are:

Segment 1	*Segment 2*
Product type	Yarn number

9.1.1.1 *Segment One*—For rovings, the first segment of the description of glass rovings represents the manufacturer's product type, which includes binder (sizing) and sliver (strand). It consists of number or letter designations, or both letter and number designations that reference the manufacturer's code. The designation for the manufacturer's code may directly follow the product type, or may be separated by a space.

9.1.1.2 *Segment Two*—For rovings, the second segment of the description specifies the yarn number of the total roving. For rovings described in SI units, the yarn number is specified in tex. For such rovings described in inch-pound units, the yarn number is specified in yards per pound.

NOTE 5—Roving yield is synonymously used for yarn number of roving products in the glass fiber industry. The term yarn number is used throughout Specification D578 to represent the more universal term.

9.1.2 *Three Segment Description for Rovings*—The segments in a three segment description of rovings are:

Segment 1	*Segment 2*	*Segment 3*
Product type	Yarn number	Manufacturer's product code

9.1.2.1 For rovings, the first and second segments of the three segment description are as described in 9.1.1.1 and 9.1.1.2. The third segment references a manufacturer's product code and may be represented by letters or numbers, or both.

9.2 *Examples of Descriptions of Rovings:*

9.2.1 *Examples 6a, 6b, 6c, and 6d, Rovings Using SI Units*—The description of rovings using SI units might be:

Two − segment description − (*a*) 988*AB* 4400/(*b*) 998 *BA* 4400
Three − segment description − (*c*) 526*HT* 3100 1325864355/(*d*)
995*AA* 2350 71*B*68820

where:

988AB = manufacturer's product type and manufacturer's code,
988BA = manufacturer's product type and manufacturer's code,
526HT = manufacturer's product type,
4400 = nominal yarn number for total roving, tex,
3100 = nominal yarn number for total roving in tex,
2350 = nominal yarn number for total roving in tex, and
1325864355 = manufacturer's product code.
71B68820 = manufacturer's product code

9.2.2 *Examples 6e, 6f, 6g and 6h, Rovings Using Inch-Pound Units*—The description of rovings using inch-pound units might be:

Two − segment description − (*e*) 988*AB* 113/(*f*) 998*BA* 113
Three − segment description − (*g*) 526*HT* 161 1325864355/(*h*)
995*AA* 211 71*B*68820

where:

988AB = manufacturer's product type and manufacturer's product code,
988BA = manufacturer's product type and manufacturer's product code,
526HT = manufacturer's product type,
113 = nominal yarn number for total roving, yd/lb,
161 = nominal yarn number for total roving, yd/lb,
1325864355 = manufacturer's product code, and
71B68820 = manufacturer's product code.

9.3 It is customary for producers of glass fiber rovings to indicate the compatibility of the binder (sizing) applied to the rovings to the matrix resins in which they can be used.

9.3.1 The designation shall follow the form "[matrix resin] compatible."

9.3.2 Examples of this designation would be "epoxy compatible" or "polyester compatible."

9.3.3 The resin compatibility is not part of the three segment description outlined in 9.1.2, but is available upon request from the manufacturer of the roving.

NOTE 6—Discontinued MIL-R-60346 referred to the resin compatibility by the term "Class 1" for epoxy compatible rovings and "Class 2" for polyester compatible rovings.

10. Chopped Strand from Continuous Filament Strands

10.1 *Descriptions of Chopped Strand from Continuous Filament Strands*—The description of chopped strand from continuous filament strands consists of either two, three, or four segments. For chopped strand used to reinforce thermoplastic and thermosetting plastic compounds, the description consists of two segments. For dry sized glass chopped strand, the description consists of three segments. For wet sized glass chopped strand, the description consists of four segments.

10.1.1 *Two Segment Description for Chopped Strand Used to Reinforce Thermoplastic and Thermosetting Compounds*—The segments in a description for chopped strand used to reinforce thermoplastic and thermosetting compounds are:

Segment 1	*Segment 2*
Product type	Strand length

10.1.1.1 *Segment One*—The first segment of the description of chopped strand used to reinforce thermoplastic and thermosetting compounds represents the manufacturer's product type. It consists of numbers that are sometimes followed by letter designations, or both, letter and number designations that reference the manufacturer's code. The designation for the manufacturer's code will directly follow the product type.

10.1.1.2 *Segment Two*—The second segment of the description of chopped strand used to reinforce thermoplastic and thermosetting compounds specifies the length of the chopped strand. For chopped strands described in SI units, the nominal chopped length is specified in millimetres. For chopped strands described in inch-pound units the nominal chopped length is specified in inches.

10.1.2 *Three Segment Description for Dry Sized Chopped Strand*—The segments in a description of dry chopped strand are:

Segment 1	*Segment 2*	*Segment 3*
Filament diameter	Sizing or product type	Strand length

10.1.2.1 *Segment One*—The first segment of the description of dry sized chopped strand represents the nominal filament diameter range. When using SI units, this segment consists of a number specifying the nominal filament diameter range in micrometers as directed in Table 1. When using inch pound units, this segment consists of one or two letters as directed in Table 1.

10.1.2.2 *Segment Two*—The second segment of the description of dry sized chopped strand represents the manufacturer's sizing or product type. It consists of numbers that are sometimes followed by letter designations, or both, letter and number designations that reference the manufacturer's code. The designation for the manufacturer's code will directly follow the sizing or product type.

10.1.2.3 *Segment Three*—The third segment of the description of dry sized chopped strand specifies the length of the chopped strand. For chopped strands described in SI units, the nominal chopped length is specified in millimetres. For chopped strands described in inch-pound units the nominal chopped length is specified in inches.

10.1.3 *Four Segment Description for Wet Sized Chopped Strand*—The segments in a description of wet chopped strand are:

Segment 1	*Segment 2*	*Segment 3*	*Segment 4*
Filament diameter	Sizing or product type	Moisture content	Strand length

10.1.3.1 *Segment One*—The first segment of the description of wet sized chopped strand represents the nominal filament diameter range. When using SI units, this segment consists of a number specifying the nominal filament diameter range in micrometres as directed in Table 1. When using inch-pound units, this segment consists of one or two letters as directed in Table 1.

10.1.3.2 *Segment Two*—The second segment of the description of wet sized chopped strand represents the manufacturer's sizing or product type. It consists of numbers that are sometimes followed by letter designations, or both, letter and number designations that reference the manufacturer's code. The designation for the manufacturer's code will directly follow the product type.

10.1.3.3 *Segment Three*—The third segment of the description of wet sized chopped strand specifies the nominal percent moisture content. This segment consists of a number representing the percent moisture content in both SI units and inch pound units.

NOTE 7—Some manufacturers omit this segment when describing wet sized chopped strand.

10.1.3.4 *Segment Four*—The fourth segment of the description of wet sized chopped strand specifies the length of the chopped strand. For chopped strands described in SI units, the nominal chopped length is specified in millimetres. For chopped strands described in inch-pound units the nominal chopped length is specified in inches.

10.2 *Examples of Descriptions of Chopped Strands:*

10.2.1 *Example 7a, Chopped Strand Used to Reinforce Thermoplastic and Thermosetting Compounds Using SI Units*—The description of chopped strand used to reinforce thermoplastic and thermosetting compounds using SI units might be:

405AB 13 mm

where:

405AB = manufacturer's product type and process code, and
13 = length, mm.

10.2.2 *Example 7b, Dry Sized Chopped Strand Using SI Units*—The description of dry sized chopped strand using SI units might be:

9 µm 685 13 mm

where:

9 = symbol for filament diameter average range 8.50 to 9.49 µm,
685 = manufacturer's sizing code or process code, or both, and
13 = length, mm.

10.2.3 *Example 7c, Wet Sized Chopped Strand Using SI Units*—The description of wet sized chopped strand using SI units might be:

16 µm 775 14.5 32 mm

where:

16 = symbol for filament diameter average range 15.5 to 16.49 µm,
775 = manufacturer's sizing code or process code, or both,
14.5 = moisture content, % (Note 7), and
32 = length, mm.

10.2.4 *Example 7d, Chopped Strand Used to Reinforce Thermoplastic and Thermosetting Compounds Using Inch-Pound Units*—The description of chopped strand used to reinforce thermoplastic and thermosetting compounds using inch-pound units might be:

405AB ½ in.

where:

405AB = manufacturer's product type and process code, and
½ = length, in.

10.2.5 *Example 7e, Dry Sized Chopped Strand Using Inch-Pound Units*—The description of dry chopped strand using inch-pound units might be:

G685 ½ in.

where:

G = symbol for filament diameter average range 0.00035 to 0.000399 in.,
685 = manufacturer's sizing code or process code, or both, and
½ = length, in.

10.2.6 *Example 7f, Wet Sized Chopped Strand Using Inch-Pound Units*—The description of wet sized chopped strand using inch-pound units might be:

M 775 14.5 1¼ in.

where:

M = symbol for filament diameter average range 0.00060 to 0.000649 in.
775 = manufacturer's sizing code or process code, or both,
14.5 = moisture content, %, and
1¼ = length, in.

11. Ordering Information

11.1 The purchase order or other agreement shall specify: specification conformance number, title, and year of issue; designation of strand construction; product quantity; and any special provisions.

REQUIREMENTS

12. Material

12.1 The fibers shall be free of any free alkali metal oxides, such as soda or potash, and from foreign particles, dirt, and other impurities. The glass classification shall be agreed upon between the purchaser and the supplier in an applicable material

specification or other agreement. The composition of the E-Glass classification of glass fiber shall be within the limits specified in 4.2.1 or 4.2.2 as agreed upon between the purchaser and supplier.

13. Workmanship

13.1 As agreed upon between the purchaser and the supplier, the defects listed in Table 3 shall be considered cause for rejection of the package in which they occur. The allowable quality level (AQL) shall be agreed upon between the purchaser and the supplier.

14. Physical Properties

14.1 The nominal and physical properties of glass fiber strands shall conform to the requirements of Tables 1, 2, 4, and 5, as applicable. The tolerances shall be subject to the tolerances as agreed upon between the purchaser and the supplier. However, the following maximum tolerances apply:

14.1.1 *Yarn Number, Tex [Yards per Pound), Individual Value*—Plus or minus 10 % for continuous filament yarns. Plus or minus 20 % for discontinuous or staple yarns. Plus or minus 15 % for textured yarns. Plus or minus 8.5 % for roving produced by either conventional or nonconventional roving winding processes, except certain rovings produced by other than conventional winding processes shall have a ±13 % tolerance when agreed upon between the purchaser and the supplier.

NOTE 8—Historically, it has been conventional practice to attenuate glass through bushings having 204 or 408 holes to produce strands containing those numbers of filaments. Then, rovings were made from those strands having 1, 12, 15, 20, 30, and 60 ends. Although this practice is still used by some suppliers, others are attenuating fiber glass through bushings consisting of up to several thousand holes to make heavy rovings containing only a single strand. Since the strands are not twisted, rovings made with the larger single strands are equivalent, for most purposes, to those made with the smaller conventional made multiple strands. Since many older material specifications specify in accordance with the older multiple strand designation, a purchasing activity should review and agree upon with the supplier activity, the acceptability of the single strand roving having an equivalent yarn number.

14.1.1.1 The tex [yards per pound] as determined in Section 23 and specified in Tables 2, 4, and 5 are the bare glass nominal. A commercial yarn normally has a size (binder) treatment which will increase tex [decrease yards per pound] in proportion to the amount of size.

14.1.2 *Breaking Strength*—No individual break shall be less than the specified minimum requirement in Tables 2, 4, and 5.

14.2 When required for roving and chopped strand, the nominal and physical properties shall be agreed upon between the purchaser and the supplier in an applicable material specification or other agreement, subject to the requirements of Table 2 and 14.1.1.

15. Ignition Loss (Organic Content)

15.1 The ignition loss (organic content) shall be within the tolerances as agreed upon between the purchaser and the supplier, or as specified in an applicable material specification or other agreement.

16. Packaging

16.1 The glass fiber strand shall be put up on packages, and in containers whose dimensions shall be agreed to between the purchaser and supplier.

16.2 Each package of strand, put up as specified, shall be further 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.

16.3 For government procurement, the contracting instrument shall specify the put up (see 11.1) and AQL (see 13.1).

17. Marking

17.1 Each package of strand shall be marked to show the construction designation of the glass fiber strand as specified in Sections 5 – 10. Each container of packages shall be marked as agreed upon between the purchaser and supplier.

18. Sampling, Inspection, and Number of Specimens

18.1 *Lot Size*—A lot shall consist of each shipment, date code, or consignment of a single strand designation. This may constitute all or part of any one customer order. The lot size is the total number of packages of strand in the incoming shipment date code, or consignment.

NOTE 9—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between packages of strand and between test specimens from a package of strand to produce a sampling plan with meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

18.2 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of shipping units specified in Practice ~~D2258~~D2258/D2258M. Consider shipping cases or other shipping units to be the primary sampling units.

18.3 *Laboratory Sample*—As a laboratory sample for acceptance testing, take at random from each shipping unit in the lot sample the number of packages or ends directed in 18.3.1 and 18.3.2. Preferably, the same number of packages should be taken