Designation: D 578 – 00

Standard Specification for Glass Fiber Strands[1]

This standard is issued under the fixed designation D 578; 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 the requirements for continuous fiber and staple fiber glass strands, including single, plied and multiple wound. It also covers textured glass fiber yarns.

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. 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.

1.3 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-140 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 This specification shows the values in both SI units and 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 stated in either acceptable metric units or in other units shall be regarded separately as standard. The values expressed in each system may not be exact equivalents; therefore, each system must be used independently of the other, without combining in any way.

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

2. Referenced Documents

2.1 *ASTM Standards:*

D 76 Specification for Tensile Testing Machines for Textiles[2]

D 123 Terminology Relating to Textiles[2]

D 1423 Test Method for Twist in Yarns by Direct Counting[2]

D 1907 Test Method for Yarn Number by the Skein Method[2]

D 2256 Test Method for Tensile Properties of Yarns by the Single-Strand Method[2]

D 2258 Practice for Sampling Yarn for Testing[2]

D 2904 Practice for Interlaboratory Testing of a Textile Test Method that Produces Normally Distributed Data[2]

D 2906 Practice for Statements on Precision and Bias for Textiles[2]

D 4963 Test Method for Ignition Loss of Glass Strands and Fabrics[3]

E 171 Specification for Standard Atmospheres for Conditioning and Testing Flexible Barrier Materials[4]

[1] This specification is under the jurisdiction of ASTM Committee D-13 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 07.01.

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

[4] *Annual Book of ASTM Standards*, Vol 15.09.

2.2 *ASTM Adjunct:*
TEX-PAC[5]
2.3 *American National Standards:*[6]
MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes
MIL-P-13949 Specification for Plastic Sheet, Laminated, Metal-Clad For Printed Wiring Board
MIL-R-60346 Roving, Glass Fibrous (for Prepreg Tape, Rovings, Filament Winding, and Pultrusion Applications)
MIL-G-55656
MIL-Y-1140 Specification for Yarn, Cord, Sleeving, Cloth, and Tape-Glass
MIL-C-9084 Specification for Cloth Finished for Resin Laminates
2.4 *Institute for Interconnecting and Packaging Circuits Standard:*
IPC-EG-140 Specification for Finished Fabric Woven from E-Glass for Printed Circuit Boards[7]

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 20°C (68°F) and no greater than 25°C (77°F).
3.1.1.1 *Discussion*—Glass textiles are used in various products such as reinforced plastics, mat-like material, tire cords, electrical insulation, etc. Each of these materials requires different testing atmospheres. It is the intent of the 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 *chopped strand*, *n— in glass textiles*, a strand made from short predetermined lengths of cut continuous filament and used as a reinforcing material. (See also *strand*).
3.1.3 *continuous filament yarn*, *n*—a yarn made of filaments that extend substantially throughout the length of the yarn.
3.1.4 *roving*, *n—in glass textiles*, a multiplicity of filaments or yarns gathered together into an approximately parallel arrangement without twist.
3.1.5 *staple glass yarn*, *n*—yarn made from filaments that are nominally 200 to 380 mm (8 to 15 in.) in length.
3.1.6 *strand*, *n*—an ordered assemblage of textile fibers having a high ratio of length to diameter and normally used as a unit, including slivers, rovings, single yarns, plied yarns, cords, braids, ropes, etc.
3.1.7 *textured glass yarn*, *n*—a yarn processed from continuous filament yarn in such a manner to induce bulk to the yarn by disorientation of the filaments.
3.1.8 For terminology of other textile terms used in this specification, refer to Terminology D 123.

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
Al_2O_3	12 to 16
SiO_2	52 to 62
MgO	0 to 5
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-140 for printed circuit boards and to MIL-G-55636. 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.

[5] PC programs on floppy disk for analyzing Committee D-13 interlaboratory data are available through ASTM. Request ADJD2904.
[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.

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."

TABLE 1 Letter Designations for Glass Strand Filament Diameters

Filament Size Designation		Nominal Range for Filament Diameter Average	
Inch-Pound System, Letter	SI System, Number	in.	μm[A]
B	3.5	0.00013 to 0.000159	3.30 to 4.05
C	4.5	0.00016 to 0.000189	4.06 to 4.82
D	5	0.00019 to 0.000229	4.83 to 5.83
DE	6	0.00023 to 0.000269	5.84 to 6.85
E	7	0.00025 to 0.000299	6.35 to 7.61
F	8	0.00030 to 0.000345	7.62 to 8.88
G	9	0.00035 to 0.000399	8.89 to 10.15
H	11	0.00040 to 0.000449	10.16 to 11.42
J	12	0.00045 to 0.000499	11.43 to 12.69
K	13	0.00050 to 0.000549	12.70 to 13.96
L	14	0.00055 to 0.000599	13.97 to 15.23
M	16	0.00060 to 0.000649	15.24 to 16.50
N	17	0.00065 to 0.000699	16.51 to 17.77
P	18	0.00070 to 0.000749	17.78 to 19.04
Q	20	0.00075 to 0.000799	19.05 to 20.31
R	21	0.00080 to 0.000849	20.32 to 21.58
S	22	0.00085 to 0.000899	21.59 to 22.85
T	23	0.00090 to 0.000949	22.86 to 24.12
U	24	0.00095 to 0.000999	24.13 to 25.40

[A] The low values stated for each micrometre range are exact equivalents to inches, rounded to the nearest hundredth micrometre. The high values stated for each micrometre range are slightly higher than exact equivalents to inches to provide continuation between ranges. They are consistent for inch-pound and SI filament size descriptions commonly used in the industry. In some publications, the SI designation for H filament size has been shown as 10.

TABLE 2 Physical Properties of Continuous Filament Yarns

Yarn Designation[A]		Nominal Twist				Approximate Yarn Number (Bare Glass)[B]		Breaking Strength, Individual Minimum	
		"Z"		"S"					
SI Unit (tex)	Inch-Pound Unit	tpm	tpi	tpm	tpi	tex	yd/lb	N	lbf
EC5 2.75 1×0	ECD 1800 1/0	20 to 40	0.5 to 1.0	...	...	2.75	180 000	1.1	0.25
EC5 2.75 1×2	ECD 1800 1/2	...	...	152 to 176	3.8 to 4.4	5.5	90 000	...	...
EC5 5.5 1×0	ECD 900 1/0	20 to 40	0.5 to 1.0	...	...	5.5	90 000	2.2	0.5
EC5 5.5 1×0	ECD 900 1/0	160 to 200	4.0 to 5.0	...	...	5.5	90 000	2.2	0.5
EC5 5.5 1×0	ECD 900 1/0	120 to 160	3.0 to 4.0	...	...	5.5	90 000	2.2	0.5
EC5 5.5	ECD 900	400	10	...	...	5.5	90 000	2.2	0.5

TABLE 2 *Continued*

Yarn Designation[A]		Nominal Twist				Approximate Yarn Number (Bare Glass)[B]		Breaking Strength, Individual Minimum	
		"Z"		"S"					
SI Unit (tex)	Inch-Pound Unit	tpm	tpi	tpm	tpi	tex	yd/lb	N	lbf
1×0 EC5 5.5	1/0 ECD 900	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	11	45 000	4.9	1.1
1×2 EC5 5.5	1/2 ECD 900	...	...	340	8.5	11	45 000	4.9	1.1
1×2 EC5 11	1/2 ECD 450	20 to 40	0.5 to 1.0	...	...	11	45 000	4.9	1.1
1×0 EC5 11	1/0 ECD 450	40 to 80	1.0 to 2.0	...	...	11	45 000	4.9	1.1
1×0 EC5 11	1/0 ECD 450	80 to 120	2.0 to 3.0	...	...	11	45 000	4.9	1.1
1×0 EC5 11	1/0 ECD 450	160 to 200	4.0 to 5.0	...	...	11	45 000	4.9	1.1
1×0 EC5 11	1/0 ECD 450	400	10	...	...	11	45 000	...	...
1×0 EC6 16	1/0 ECDE 300	20 to 40	0.5 to 1.0	...	...	16	30 000	8.0	1.9
1×0 EC5 5.5	1/0 ECD 900	...	...	152 to 176	3.8 to 4.4	16.5	30 000	8.0	1.8
1×3 EC5 5.5	1/3 ECD 900	...	...	340	8.5	16.5	30 000	8.0	1.8
1×3 EC5 11	1/3 ECD 450	160 to 200	4.0 to 5.0	...	...	22	22 500	9.8	2.2
2×0 EC5 11	2/0 ECD 450	...	...	60	1.5	22	22 500	9.8	2.2
1×2 EC5 11	1/2 ECD 450	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	22	22 500	9.8	2.2
1×2 EC5 11	1/2 ECD 450	...	...	340	8.5	22	22 500	9.8	2.2
1×2 EC5 22	1/2 ECD 225	40 to 80	1.0 to 2.0	...	...	22	22 500	10.7	2.4
1×0 EC5 22	1/0 ECD 225	20 to 40	0.5 to 1.0	...	...	22	22 500	10.7	2.4
1×0 EC5 22	1/0 ECD 225	160 to 200	4.0 to 5.0	...	...	22	22 500	10.7	2.4
1×0 EC7 22	1/0 ECE 225	20 to 40	0.5 to 1.0	...	...	22	22 500	9.8	2.2
1×0 EC7 22	1/0 ECE 225	160 to 200	4.0 to 5.0	...	...	22	22 500	9.8	2.2
1×0 EC7 22	1/0 ECE 225	400	10.0	...	...	22	22 500	9.8	2.2
1×0 EC5 11	1/0 ECD 450	160 to 200	4.0 to 5.0	...	...	33	15 000	17.3	3.9
3×0 EC5 11	3/0 ECD 450	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	33	15 000	17.3	3.9
1×3 EC5 11	1/3 ECD 450	...	...	340	8.5	33	15 000	17.3	3.9
1×3 EC3.5 33	1/3 ECB 150	20 to 40	0.5 to 1.0	...	...	33	15 000	17.8	4.0
1×0 EC3.5 33	1/0 ECB 150	120 to 160	3.0 to 4.0	...	...	33	15 000	17.8	4.0
1×0 EC4.5 33	1/0 ECC 150	20 to 40	0.5 to 1.0	...	...	33	15 000	15.6	3.5
1×0 EC4.5 33	1/0 ECC 150	120 to 160	3.0 to 4.0	...	...	33	15 000	15.6	3.5
1×0 EC6 33	1/0 ECDE 150	20 to 40	0.5 to 1.0	...	...	33	15 000	15.6	3.5
1×0 EC6 33	1/0 ECDE 150	90	2.25	...	...	33	15 000	15.6	3.5
1×0 EC6 33	1/0 ECDE 150	120 to 160	3.0 to 4.0	...	...	33	15 000	15.6	3.5
1×0 EC9 33	1/0 ECG 150	20 to 40	0.5 to 1.0	...	...	33	15 000	13.3	3.0
1×0 EC9 33	1/0 ECG 150	40 to 80	1.0 to 2.0	...	...	33	15 000	13.3	3.0
1×0 EC9 33	1/0 ECG 150	52	1.3	...	...	33	15 000	13.3	3.0
1×0 EC9 33	1/0 ECG 150	120 to 160	3.0 to 4.0	...	...	33	15 000	13.3	3.0
1×0 EC9 33	1/0 ECG 150	224	5.6	...	...	33	15 000	13.3	3.0

TABLE 2 *Continued*

Yarn Designation[A]		Nominal Twist				Approximate Yarn Number (Bare Glass)[B]		Breaking Strength, Individual Minimum	
		"Z"		"S"					
SI Unit (tex)	Inch-Pound Unit	tpm	tpi	tpm	tpi	tex	yd/lb	N	lbf
1×0 EC9 33	1/0 ECG 150	280	7.0	...	...	33	15 000	13.3	3.0
1×0 EC13 40HF	1/0 ECK 125 HF	20 to 40	0.5 to 1.0	...	...	40	12 500	14.2	3.2
1×0 EC5 11	1/0 ECD 450	160 to 200	4.0 to 5.0	...	...	44	11 250	19.6	4.4
4×0 EC5 11	4/0 ECD 450	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	44	11 250	19.6	4.4
2×2 EC5 22	2/2 ECD 225	160 to 200	4.0 to 5.0	...	...	44	11 250	21.4	4.8
2×0 EC5 22	2/0 ECD 225	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	44	11 250	21.4	4.8
1×2 EC5 22	1/2 ECD 225	...	...	340	8.5	44	11 250	21.4	4.8
1×2 EC7 22	1/2 ECE 225	160 to 200	4.0 to 5.0	...	...	44	11 250	19.6	4.4
2×0 EC7 22	2/0 ECE 225	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	44	11 250	19.6	4.4
1×2 EC7 22	1/2 ECE 225	...	...	340	8.5	44	11 250	19.6	4.4
1×2 EC11 45	1/2 ECH 110	20 to 40	0.5 to 1.0	...	...	45	11 000	18.2	3.9
1×0 EC6 50	1/0 ECDE 100	20 to 40	0.5 to 1.0	...	...	50	10 000	17.8	4.0
1×0 EC6 50	1/0 ECDE 100	28	0.7	...	...	50	10 000	17.8	4.0
1×0 EC6 50	1/0 ECDE 100	80	2.0	...	...	50	10 000	17.8	4.0
1×0 EC9 50	1/0 ECG 100	20 to 40	0.5 to 1.0	...	...	50	10 000	...	...
1×0 EC5 11	1/0 ECD 450	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	66	7 500	29.4	6.6
3×2 EC5 22	3/2 ECD 225	160 to 200	4.0 to 5.0	...	...	66	7 500	32.0	7.2
3×0 EC5 22	3/0 ECD 225	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	66	7 500	32.0	7.2
1×3 EC7 22	1/3 ECE 225	120 to 160	3.0 to 4.0	...	...	66	7 500	29.4	6.6
3×0 EC7 22	3/0 ECE 225	160 to 200	4.0 to 5.0	...	...	66	7 500	29.4	6.6
3×0 EC7 22	3/0 ECE 225	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	66	7 500	29.4	6.6
1×3 EC3.5 33	1/3 ECB 150	80 to 120	2.0 to 3.0	...	...	66	7 500	35.6	8.0
2×0 EC3.5 33	2/0 ECB 150	120 to 160	3.0 to 4.0	...	...	66	7 500	35.6	8.0
2×0 EC3.5 33	2/0 ECB 150	...	...	112 to 152	2.8 to 3.8	66	7 500	...	...
1×2 EC6 33	1/2 ECDE 150	120 to 160	3.0 to 4.0	...	...	66	7 500	31.1	7.0
2×0 EC6 33	2/0 ECDE 150	...	...	112 to 152	2.8 to 3.8	66	7 500	...	...
1×2 EC4.5 33	1/2 ECC 150	40 to 80	1.0 to 2.0	...	...	66	7 500	47.2	10.6
2×0 EC4.5 33	2/0 ECC 150	120 to 160	3.0 to 4.0	...	...	66	7 500	33.4	7.5
2×0 EC9 33	2/0 ECG 150	120 to 160	3.0 to 4.0	...	...	66	7 500	28.5	6.4
2×0 EC9 33	2/0 ECG 150	160 to 200	4.0 to 5.0	...	...	66	7 500	28.5	6.4
2×0 EC9 33	2/0 ECG 150	224	5.6	...	...	66	7 500	28.5	6.4
2×0 EC9 33	2/0 ECG 150	320	8.0	...	...	66	7 500	28.5	6.4
2×0 EC9 33	2/0 ECG 150	120 to 160	3.0 to 4.0	112 to 152	2.8 to 3.8	66	7 500	26.5	6.0
1×2 EC6 66	1/2 ECDE 75	20 to 40	0.5 to 1.0	...	...	66	7 500	25.4	5.7
1×0 EC6 66	1/0 ECDE 75	28	0.7	...	...	66	7 500	25.4	5.7

TABLE 2 *Continued*

Yarn Designation[A]		Nominal Twist				Approximate Yarn Number (Bare Glass)[B]		Breaking Strength, Individual Minimum	
		"Z"		"S"					
SI Unit (tex)	Inch-Pound Unit	tpm	tpi	tpm	tpi	tex	yd/lb	N	lbf
1×0 EC6 66 1×0 EC6 66 1×0 EC4.5 66 1×0 EC4.5 66 1×0 EC4.5 66 1×0 EC4.5 66 1×0 EC9 66 1×0 EC9 66 1×0 EC9 66 1×0 EC9 66 1×0 EC9 66 1×0 EC13 66 1×0 EC13 66 1×0 EC13 66 1×0	1/0 ECDE 75 1/0 ECDE 75 1/0 ECC 75 1/0 ECC 75 1/0 ECC 75 1/0 ECC 75 1/0 ECG 75 1/0 ECG 75 1/0 ECG 75 1/0 ECG 75 1/0 ECG 75 1/0 ECK 75 1/0 ECK 75 1/0 ECK 75 1/0	40 to 80	1.0 to 2.0	...	...	66	7 500	25.4	5.7
		120 to 160	3.0 to 4.0	...	...	66	7 500	25.4	5.7
		20 to 40	0.5 to 1.0	...	...	66	7 500	25.4	5.7
		40 to 80	1.0 to 2.0	...	...	66	7 500	25.4	5.7
		80 to 120	2.0 to 3.0	...	...	66	7 500	25.4	5.7
		120 to 160	3.0 to 4.0	...	...	66	7 500	25.4	5.7
		20 to 40	0.5 to 1.0	...	...	66	7 500	25.4	5.7
		78	0.7	...	...	66	7 500	25.4	5.7
		40 to 80	1.0 to 2.0	...	...	66	7 500	25.4	5.7
		120 to 160	3.0 to 4.0	...	...	66	7 500	25.4	5.7
		280	7.0	...	...	66	7 500	25.4	5.7
		320	8.0	...	...	66	7 500	25.4	5.7
		20 to 40	0.5 to 1.0	...	...	66	7 500	25.4	5.7
		80 to 120	2.0 to 3.0	...	...	66	7 500	25.4	5.7
		120 to 160	3.0 to 4.0	...	...	66	7 500	25.4	5.7
EC5 22 4×0	ECD 225 4/0	120 to 160	3.0 to 4.0	...	...	88	5 625	46.3	10.4
EC7 22 2×2	ECD 225 2/2	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	88	5 625	42.7	9.6
EC7 22 2×2	ECE 225 2/2	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	88	5 625	39.1	8.8
EC11 90 1×0	ECH 55 1/0	20 to 40	0.5 to 1.0	...	...	90	5 500	42.3	9.5
EC13 90 1×0	ECK 55 1/0	20 to 40	0.5 to 1.0	...	...	90	5 500	42.3	9.5
EC9 100 1×0	ECG 50 1/0	20 to 40	0.5 to 1.0	...	...	99	5 000	44.0	10.0
EC5 11 3×3	ECD 450 3/3	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	99	5 000	44.0	9.9
EC6 33 3×0	ECDE 150 3/0	120 to 160	3.0 to 4.0	...	...	99	5 000	...	...
EC6 33 1×3	ECDE 150 1/3	...	...	112 to 152	2.8 to 3.8	99	5 000	46.7	10.5
EC4.5 33 3×0	ECC 150 3/0	40 to 80	1.0 to 2.0	...	...	99	5 000	48.9	11.0
EC4.5 33 3×0	ECC 150 3/0	120 to 160	3.0 to 4.0	...	...	99	5 000	48.9	11.0
EC9 33 3×0	ECG 150 3/0	120 to 160	3.0 to 4.0	...	...	99	5 000	42.7	9.6
EC9 33 3×0	ECG 150 3/0	160 to 200	4.0 to 5.0	...	...	99	5 000	42.7	9.6
EC9 33 1×3	ECG 150 1/3	120 to 160	3.0 to 4.0	112 to 152	2.8 to 3.8	99	5 000	40.0	9.0
EC5 11 3×4	ECD 450 3/4	...	...	152 to 176	3.8 to 4.4	132	3 750	58.7	13.2
EC5 11 4×3	ECD 450 4/3	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	132	3 750	58.7	13.2
EC5 22 3×2	ECD 225 3/2	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	132	3 750	64.0	14.4
EC7 22 3×2	ECE 225 3/2	160 to 200	4.0 to 5.0	152 to 176	3.8 to 4.4	132	3 750	58.7	13.2
EC3.5 33 4×0	ECB 150 4/0	40 to 80	1.0 to 2.0	...	...	132	3 750	71.2	16.0
EC6 33	ECDE 150	120 to 160	3.0 to 4.0	...	...	132	3 750	...	TBD