



# Standard Specification for Finished Woven Glass Fabrics<sup>1</sup>

This standard is issued under the fixed designation D4029/D4029M; 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 ( $\epsilon$ ) 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 other glass types as agreed upon between the purchaser and the supplier.

1.2 This specification specifies the terminology, definitions, general requirements, and physical requirements for finished woven glass fabrics. This specification permits the application of sizing materials to the glass fiber yarn during manufacture that helps facilitate weaving. These organic materials are typically removed from the greige fabric and replaced with a finish that is compatible with the resin matrix specified in the contracting document.

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 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.

1.4 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.

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

1.6 *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:*<sup>2</sup>

- D123 Terminology Relating to Textiles
- D578 Specification for Glass Fiber Strands
- D1059 Test Method for Yarn Number Based on Short-Length Specimens (Withdrawn 2010)<sup>3</sup>
- D1423 Test Method for Twist in Yarns by Direct-Counting
- D1776 Practice for Conditioning and Testing Textiles
- D1777 Test Method for Thickness of Textile Materials
- D2408 Test Method for Finish Content of Woven Glass Fabric, Cleaned and After-Finished With Amino-Silane-Type Finishes, for Plastic Laminates (Withdrawn 1988)<sup>3</sup>
- D2409 Test Method for Finish Content of Woven Glass Fabric, Cleaned and After-Finished With Vinyl-Silane Type Finishes, for Plastic Laminates (Withdrawn 1988)<sup>3</sup>
- D2410 Test Method for Finish Content of Woven Glass Fabric, Cleaned and After-Finished With Chrome Complexes, for Plastic Laminates (Withdrawn 1988)<sup>3</sup>
- D2660 Test Method for Finish Content of Woven Glass Fabric, Cleaned and After-Finished with Acrylic-Silane-Type Finishes, for Plastic Laminates (Withdrawn 1988)<sup>3</sup>
- D3098 Test Method for Finish Content of Woven Glass Fabrics, Cleaned and After-Finished with Epoxy-Functions Silane Type Finishes for Plastic Laminates (Withdrawn 1988)<sup>3</sup>
- D3773 Test Methods for Length of Woven Fabric
- D3774 Test Method for Width of Textile Fabric
- D3775 Test Method for Warp (End) and Filling (Pick) Count of Woven Fabrics
- D3776 Test Methods for Mass Per Unit Area (Weight) of Fabric
- D4963 Test Method for Ignition Loss of Glass Strands and Fabrics

<sup>1</sup> 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

**D5035 Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)**

**D7018 Terminology Relating to Glass Fiber and Its Products**

2.2 *ANSI Standard:*

**ANSI/ASQC Z1.4 Sampling Procedures for Inspection by Attributes<sup>4</sup>**

2.3 *Military Standard and Specifications:*

**MIL-Y-1140H Yarn, Cord, Sleeving, Cloth and Tape-Glass<sup>5</sup>**

**MIL-C-9084C Cloth, Glass Finished for Resin Laminates<sup>5</sup>**

2.4 *Textile Institute Documents:*

**Textile Terms and Definitions<sup>6</sup>**

**Woven Cloth Construction<sup>6</sup>**

### 3. Terminology

3.1 For all terminology relating to D13.18, Glass Fibers and Its Products, refer to Terminology **D7018**.

3.1.1 The following terms are relevant to this specification: atmosphere for testing textiles, continuous filament, crowfoot weave, eight-harness satin, finished, leno weave, mock leno weave, twelve-harness satin.

3.2 For all other terms related to textiles, see Terminology **D123**.

## 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 yarn shall be continuous filament, unless otherwise specified, free of any free alkali metal salts, such as soda or potash, and foreign particles, dirt, and other impurities.

### 6. Fabric Count

6.1 For fabrics listed in **Table 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 shall be within two ends of the nominal count and the average count of the filling picks shall be within two picks of the nominal count.

### 7. Yarn Designations

7.1 For fabrics listed in **Table 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**. 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 **D578**. 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 **D578**.

### 10. Strand Construction

10.1 The basis for specifying strand construction is given in Specification **D578**. For fabrics listed in **Table 1** of this specification, the construction of the component strands shall conform to the requirements of Table 1 in Specification **D578**. 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 in Specification **D578** 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** of this specification.

### 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 shall 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 shall be agreed upon between the purchaser and the supplier. The average mass per unit area for the lot shall conform to the requirements of **Table 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

<sup>4</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

<sup>5</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, ATTN: NPODS.

<sup>6</sup> Available from the Textile Institute, 10 Blackfriars St., Manchester, M3 5DR England.



TABLE 1 Physical Properties of Typical “E” Glass Finished Woven Glass Fabrics

Commercial Style Designation	Fabric Count, Warp × Fill Yarns 25 mm yarns/in.	Yarn Designation tex <sup>A</sup> inch-pound units		Fabric Weave Type <sup>B</sup>	Mass per Unit Area, g/m <sup>2</sup> [oz/yd. <sup>2</sup> ]	Nominal Thickness, <sup>C</sup> mm [in.]	Breaking Force, min, <sup>C</sup> Warp × Fill N/5 cm [lbf/in.]
		Warp	Filling				
101	74 × 74	EC5 2.75 1 × 0	EC5 2.75 1 × 0	plain	16.9	0.020	162 × 162
	75 × 75	ECD 1800 1/0	ECD 1800 1/0		0.50	0.0008	19 × 19
104	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	59 × 46	EC5 5.5 1 × 2	EC5 5.5 1 × 2	plain	47.5	0.061	578 × 456
	60 × 47	D900 1/2	D900 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
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 × 47	EC7 22 3 × 2	EC7 22 3 × 2	8-H satin	542	0.470	2189 × 1970
	54 × 48	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
1000	84 × 84	BC 4 1.65 1 × 0	BC 4 1.65 1 × 0	plain	11.1	0.012	
	85 × 85	BC 3000 1/0	BC 3000 1/0		0.33	0.00047	
1012	69 × 69	BC4 2.2 1 × 0	BC4 2.2 1 × 0	plain	12.3	0.018	
	70 × 70	BC 2250 1/0	BC 2250 1/0		0.36	0.00071	
1015	94 × 94	BC4 2.20 1 × 0	BC4 2.20 1 × 0	plain	16.9	0.015	
	96 × 96	BC 2259 1/0	BC 2259 1/0		0.50	0.00059	
1017	94 × 94	BC 4 1.65 1 × 0	BC 4 1.65 1 × 0	plain	12.3	0.013	
	95 × 95	BC 3000 1/0	BC 3000 1/0		0.36	0.00053	
1020	54 × 54	EC4.5 2.76 1 × 0	EC4.5 2.76 1 × 0	plain	12.2	0.025	
	55 × 55	ECC 1800 1/0	ECC 1800 1/0		0.36	0.00098	
1024	90 × 90	BC4 3.31 1 × 0	BC4 3.31 1 × 0	plain	23.8	0.020	
	91 × 91	BC 1500 1/0	BC 1500 1/0		0.70	0.00079	
1027	74 × 74	BC4 3.31 1 × 0	BC4 3.31 1 × 0	plain	19.9	0.019	
	75 × 75	BC 1500 1/0	BC 1500 1/0		0.59	0.00075	
1030	90 × 90	EC4.5 4.1 1 × 0	EC4.5 4.1 1 × 0	plain	29.7	0.026	
	91 × 91	EC 1200 1/0	EC 1200 1/0		0.88	0.00102	

**TABLE 1** *Continued*

Commercial Style Designation	Fabric Count, Warp × Fill Yarns 25 mm yarns/in.	Yarn Designation tex <sup>A</sup> inch-pound units		Fabric Weave Type <sup>B</sup>	Mass per Unit Area, g/m <sup>2</sup> [oz/yd. <sup>2</sup> ]	Nominal Thickness, <sup>C</sup> mm [in.]	Breaking Force, min, <sup>C</sup> Warp × Fill N/5 cm [lbf/in.]
		Warp	Filling				
1035	65 × 67	EC5 5.5 1 × 0	EC5 5.5 1 × 0	plain	30	0.028	
	66 × 68	ECD 900 1/0	ECD 900 1/0		0.88	0.0011	
1037	69 × 72	EC4.5 4.1 1 × 0	EC4.5 4.1 1 × 0		23	0.028	
	70 × 73	EC 1200 1/0	EC 1200 1/0		0.68	0.0011	
1044	43 × 43	EC6 51 1 × 0	EC6 51 1 × 0	plain	171	0.142	
	44 × 44	ECDE 100 1/0	ECDE 100 1/0		5.05	0.0056	
1047	92 × 92	EC6 51 1 × 0	EC6 51 1 × 0	plain	184.4	0.147	1638 × 1638
	47 × 47	ECDE100 1/0	ECDE100 1/0		5.44	0.0058	188 × 188
1065	55 × 55	EC5 11 1 × 0	EC5 5.5 1 × 0	plain	37.3	0.053	
	56 × 56	ECD 450 1/0	ECD 900 1/0		1.08	0.0021	
1067	69 × 69	EC5 5.5 1 × 0	EC5 5.5 1 × 0	plain	30.7	0.036	
	70 × 70	ECD 900 1/0	ECD 900 1/0		0.91	0.0014	
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
1078	53 × 53	EC5 11 1 × 0	EC5 11 1 × 0	plain	47.8	0.043	
	54 × 54	ECD 450 1/0	ECD 450 1/0		1.14	0.0017	
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
1081	69 × 69	EC5 11 1 × 0	EC5 11 1 × 0	plain	58.3	0.061	
	70 × 70	ECD 450 1/0	ECD 450 1/0		1.72	0.0024	
1087	68 × 67	EC5 11 1 × 0	EC5 11 1 × 0	plain	62	0.056	
	69.5 × 68	ECD 450 1/0	ECD 450 1/0		1.83	0.0022	
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
1180	59 × 49	EC5 11 1 × 0	EC5 11 1 × 0	plain	49	0.058	
	60 × 50	ECD 450 1/0	ECD 450 1/0		1.44	0.0023	
1280	59 × 59	EC5 11 1 × 0	EC5 11 1 × 0	plain	52.6	0.0559	482 × 525
	60 × 60	ECD 450 1/0	ECD 450 1/0		1.55	0.0022	210 × 210
1316	60 × 60	EC5 22 1 × 0	EC5 22 1 × 0	plain	108	0.102	
	61 × 61	ECD 225 1/0	ECD 225 1/0		3.18	0.004	
1500	48 × 41	EC7 45 1 × 0	EC7 45 1 × 0	plain	164.1	0.1499	700 × 700
	49 × 42	ECE 110 × 1/0	ECE 110 × 1/0		4.84	0.0059	80 × 80
1501	45 × 45	EC7 44 1 × 0	EC7 44 1 × 0	plain	165	0.14	
	46 × 46	ECE 110 1/0	ECE 110 1/0		4.86	0.0055	
1502	51 × 49	EC7 42 1 × 0	EC7 42 1 × 0	plain	162	0.150	
	52 × 50	ECE 125 1/0	ECE 125 1/0		4.76	0.0059	
1503	63 × 45	EC6 33 1 × 0	EC6 33 1 × 0	plain	148	0.135	
	64 × 46	ECDE 150 1/0	ECDE 150 1/0		4.36	0.0053	
1504	59 × 59	EC6 33 1 × 0	EC6 33 1 × 0	plain	148	0.124	
	60 × 60	ECDE 150 1/0	ECDE 150 1/0		4.36	0.0049	
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

**TABLE 1** *Continued*

Commercial Style Designation	Fabric Count, Warp × Fill Yarns 25 mm yarns/in.	Yarn Designation tex <sup>A</sup> inch-pound units		Fabric Weave Type <sup>B</sup>	Mass per Unit Area, g/m <sup>2</sup> [oz/yd. <sup>2</sup> ]	Nominal Thickness, <sup>C</sup> mm [in.]	Breaking Force, min, <sup>C</sup> Warp × Fill N/5 cm [lbf/in.]
		Warp	Filling				
1634	32 × 28	ECG 150 1/0	ECG 150 1/0	plain	2.35	0.0036	35 × 30
	50 × 30	EC9 33 1 × 0	EC9 33 1 × 0		105.4	0.095	
	51 × 30	ECG 150 1/0	ECG 150 1/0		3.11	0.0037	
1643	55 × 47	EC6 33 1 × 0	EC6 33 1 × 0	crowfoot	138	0.0127	613 × 482 70 × 55
	56 × 48	ECDE 150 1 × 0	ECDE 150 1/0		4.06	0.0050	
1647	50 × 30	EC9 33 1 × 0	EC7 44 1 × 0	plain	120.5	0.105	
	51 × 30	ECG 150 1/0	ECE 110 1/0		3.55	0.0041	
1649	50 × 37	EC9 33 1 × 0	EC7 44 1 × 0	plain	135.9	0.119	
	51 × 38	ECG 150 1/0	ECE110 1/0		4.01	0.0047	
1651	50 × 27	EC9 33 1 × 0	EC9 74 1 × 0	plain	146.2	0.135	
	51 × 27	ECG 150 1/0	ECG 67 1/0		4.31	0.0053	
1652	51 × 51	EC6 33 1 × 0	EC6 33 1 × 0	plain	136.9	0.114	1591 × 1591 182 × 182
	52 × 52	ECDE150 1/0	ECDE150 1/0		4.04	0.0045	
1657	50 × 29	EC9 33 1 × 0	EC9 74 1 × 0	plain	154.2	0.150	
	51 × 29	ECG 150 1/0	ECG 67 1/0		4.53	0.0059	
1659	20 × 10	EC9 33 1 × 0	EC9 68 1 × 0	leno	54	0.0107	131 × 140 15 × 16
	20 × 10	ECG 150 1/0	ECG 75 1/0		1.60	0.0042	
1674	39 × 31	EC9 33 1 × 0	EC9 33 1 × 0	plain	95	0.109	438 × 306 50 × 35
	40 × 32	ECG 150 1/0	ECG 150 1/0		2.80	0.0043	
1675	39 × 31	EC6 33 1 × 0	EC6 33 1 × 0	plain	96	0.094	438 × 306 50 × 35
	40 × 32	ECDE 150 1/0	ECDE 150 1/0		2.83	0.0037	
1676	55 × 47	EC6 33 1 × 0	EC6 33 1 × 0	plain	136	0.122	613 × 525 70 × 60
	56 × 48	ECDE 150 1/0	ECDE 150 1/0		4.00	0.0048	
1677	39 × 39	EC6 33 1 × 0	EC6 33 1 × 0	plain	106	0.112	525 × 438 60 × 50
	40 × 40	ECDE 150 1/0	ECDE 150 1/0		3.14	0.0044	
1678	79 × 79	EC9 33 1 × 0	EC9 33 1 × 0	plain	105.8	0.091	1051 × 1051 120 × 120
	40 × 40	ECG150 1/0	G150 1/0		3.12	0.0036	
1680	71 × 69	EC6 33 1 × 0	EC6 33 1 × 0	8-H satin	188	0.152	832 × 701 95 × 80
	72 × 70	ECDE 150 1/0	ECDE 150 1/0		5.56	0.0060	
1681	55 × 35	EC6 33 1 × 0	EC6 33 1 × 0	plain	122	0.0122	525 × 394 60 × 45
	56 × 36	ECDE 150 1/0	ECDE 150 1/0		3.60	0.0048	
1687	39 × 41	EC9 33 1 × 0	EC9 33 1 × 0	plain	108.5	0.1140	578 × 525 66 × 60
	40 × 42	ECG 150 1/0	ECG 150 1/0		3.20	0.0045	
1697	43 × 37	EC9 33 1 × 0	EC9 33 1 × 0	plain	111.2	0.094	
	44 × 38	ECG 150 1/0	ECG 150 1/0		3.15	0.0037	
1800	16 × 14	EC13 275 1 × 0	EC13 275 1 × 0	plain	327	0.330	1313 × 1051 150 × 120
	16 × 14	ECK 18 1/0	ECK 18 1/0		9.65	0.0130	
1874	43 × 34	EC13 275 1 × 0	EC13 275 1 × 0	8-H satin	865	0.0681	3152 × 2758 360 × 315
	44 × 35	ECK 18 1/0	ECG 37 1/2		26.08	0.0245	
1884	43 × 34	EC13 275 1 × 0	EC13 275 1 × 0	8-H satin	847	0.7112	2627 × 2189 300 × 250
	44 × 35	ECK 18 1/0	ECK 18 1/0		25.0	0.0280	
1887	39 × 20	EC13 275 1 × 0	EC13 275 1 × 0	mock leno	715	0.584	311 × 163 2723 × 1427
	40 × 21	ECK 18 1/0	ECK 18 1/0		21.10	0.0230	
2013	46 × 44	EC7 22 1 × 0	EC7 22 1 × 0	plain	81	0.070	
	47 × 45	ECE 225 1/0	ECE 225 1/0		2.39	0.00276	
2112	39 × 38	EC5 22 1 × 0	EC5 22 1 × 0	plain	71	0.079	263 × 210 30 × 24
	40 × 39	ECD 225 1/0	ECD 225 1/0		2.10	0.0031	
2113	59 × 55	EC5 22 1 × 0	EC5 11 1 × 0	plain	81	0.0076	420 × 210 48 × 24
	60 × 56	ECD 225 1/0	ECD 450 1/0		2.38	0.0030	
2114	55 × 47	EC7 22 1 × 0	EC7 22 1 × 0	plain	90.9	0.084	
	56 × 48	ECE 225 1/0	ECE 225 1/0		2.69	0.0033	
2116	59 × 57	EC5 22 1 × 0	EC5 22 1 × 0	plain	105	0.086	350 × 280 40 × 32
	60 × 58	ECD 225 1/0	ECD 225 1/0		3.10	0.0034	
2117	65 × 64	EC7 22 1 × 0	EC7 22 1 × 0	plain	108	0.094	
	66 × 54	ECE 225 1/0	ECE 225 1/0		3.18	0.0037	
2118	39 × 62	EC7 22 1 × 0	EC7 22 1 × 0	plain	111.7	0.091	
	40 × 63	ECE 225 1/0	ECE 225 1/0		3.29	0.0036	
2119	53 × 49	EC7 22 1 × 0	EC7 22 1 × 0	plain	90.2	0.086	315 × 236 36 × 27
	54 × 50	ECE 225 1/0	ECE 225 1/0		2.66	0.0034	
2120	59 × 57	EC5 22 1 × 0	EC5 22 1 × 0	crowfoot	106	0.107	525 × 482 60 × 55
	60 × 58	ECD 225 1/0	ECD 225 1/0		3.12	0.0042	
2125	39 × 38	EC5 22 1 × 0	EC9 33 1 × 0	plain	88	0.0965	263 × 394 30 × 45
	40 × 39	ECD 225 1/0	ECG 150 1/0		2.60	0.0038	
2150	65 × 47	EC5 22 1 × 0	EC5 22 1 × 0	plain	87	0.076	
	66 × 48	ECD 225 1/0	ECD 225 1/0		2.56	0.0030	
2157	59 × 34	EC7 22 1 × 0	EC9 68 1 × 0	plain	148	0.130	
	60 × 35	ECE 225 1/0	ECG 75 1/0		4.36	0.0051	
2165	59 × 51	EC5 22 1 × 0	EC9 33 1 × 0	plain	123	0.122	482 × 525 55 × 60
	60 × 52	ECD 225 1/0	ECG 150 1/0		3.62	0.0048	



TABLE 1 Continued

Commercial Style Designation	Fabric Count, Warp × Fill Yarns 25 mm yarns/in.	Yarn Designation tex <sup>A</sup> inch-pound units		Fabric Weave Type <sup>B</sup>	Mass per Unit Area, g/m <sup>2</sup> [oz/yd. <sup>2</sup> ]	Nominal Thickness, <sup>C</sup> mm [in.]	Breaking Force, min, <sup>C</sup> Warp × Fill N/5 cm [lbf/in.]
		Warp	Filling				
2166	59 × 37	EC7 22 1 × 0	EC9 68 1 × 0	plain	155	0.140	
	60 × 38	ECE 225 1/0	ECG 75 1/0		4.6	0.0055	
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	48 × 48	EC7 22 1 × 0	EC7 22 1 × 0	plain	92.2	0.086	
	48.5 × 49	ECE 225 1/0	ECE 225 1/0		2.72	0.0034	
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	69 × 69	EC6 17.5 1 × 0	EC6 17.5	plain	93.6	0.078	1104 × 1104
	70 × 70	ECDE300 1/0	ECDE300 1/0		2.76	0.0031	133 × 133
3080	50 × 30	EC6 16.5 1 × 0	EC6 16.5 1 × 0	plain	53.4	0.059	
	51 × 30	ECDE 300 1/0	ECDE 300 1/0		1.57	0.0023	
3113	50 × 30	EC7 22 1 × 0	EC9 33 1 × 0	plain	84.8	0.081	
	51 × 30	ECE 225 1/0	ECG 150 1/0		2.50	0.0032	
3132	59 × 59	EC5 11 1 × 0	EC7 22 1 × 0	plain	79	0.071	
	60 × 60	ECD 450 1/0	ECE 225 1/0		2.32	0.0028	
3313	59 × 61	EC6 17.5 1 × 0	EC6 17.5	plain	80.5	0.084	944 × 976
	60 × 62	ECDE300 1/0	ECDE300 1/0		2.38	0.0033	114 × 118
3323	59 × 45	EC6 16.5 1 × 0	EC7 22 1 × 0	plain	81.3	0.086	
	60 × 46	ECDE 300 1/0	ECDE 300 1/0		2.4	0.0034	
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
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	59 × 59	EC6 8.75 1 × 0	EC6 8.75 1 × 0	plain	39.0	0.048	472 × 472
	60 × 60	ECDE600 1/0	ECDE600 1/0		1.15	0.0019	57 × 57

**TABLE 1** *Continued*

Commercial Style Designation	Fabric Count, Warp × Fill Yarns 25 mm yarns/in.	Yarn Designation tex <sup>A</sup> inch-pound units		Fabric Weave Type <sup>B</sup>	Mass per Unit Area, g/m <sup>2</sup> [oz/yd. <sup>2</sup> ]	Nominal Thickness, <sup>C</sup> mm [in.]	Breaking Force, min, <sup>C</sup> Warp × Fill N/5 cm [lbf/in.]
		Warp	Filling				
7196	50 × 32	EC9 74 1 × 0	EC9 74 1 × 0	plain	230	0.201	
	51 × 33	ECG 67 1/0	ECG 67 1/0		6.72	0.0079	
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 × 29	EC9 68 1 × 0	EC7 22 1 × 0	crowfoot	184	0.140	981 × 193
	57 × 30	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
7624	43 × 24	EC9 68 1 × 0	EC9 68 1 × 0	plain	184.4	0.163	
	44 × 24	G-75 1/0	ECG 75 1/0		5.44	0.0064	
7626	33 × 31	EC9 68 1 × 0	EC9 68 1 × 0	plain	176	0.157	701 × 482
	34 × 32	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	ECG75 1/0	ECG75 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	ECG75 1/0	ECG50 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
7640	59 × 33	EC9 68 1 × 0	EC9 100 1 × 0	plain	258	0.249	
	60 × 34	G-75 1/0	ECG 50 1/0		7.60	0.0098	
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 × 19	EC9 68 1 × 0	ET9 134 1 × 0	plain	220	0.254	657 × 350
	44 × 20	ECG 75 1/0	ETG 37 1/0		6.50	0.0100	75 × 40
7650	43 × 23	EC9 68 1 × 0	EC9 100 1 × 0	plain	208	0.191	
	44 × 23	ECG 75 1/0	ECG 50 1/0		6.12	0.0075	
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
	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
7667	59 × 31	EC9 74 1 × 0	EC9 74 1 × 0	plain	220	0.183	
	60 × 31	ECG 67 1/0	ECG 67 1/0		6.54	0.0072	
7669	43 × 31	EC9 68 1 × 0	EC9 74 1 × 0	plain	209	0.178	
	44 × 31	G-75 1/0	ECG 67 1/0		6.17	0.0070	
7688	43 × 34	EC9 68 1 × 0	EC9 74 1 × 0	plain	220	0.191	
	44 × 35	G-75 1/0	ECG 67 1/0		6.49	0.0075	
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

<sup>A</sup> Yarn designations are as specified in Specification D578. 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.

<sup>B</sup> See Annex A1.

<sup>C</sup> Nominal values, the type finish can affect the breaking force 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/m <sup>2</sup> [oz/yd <sup>2</sup> ]	Permissible Variation, %
136 [4.0] and under	±10
Over 136 [4.0]	± 6

listed in Table 1, the nominal thickness shall be agreed upon between the purchaser and the supplier. The average thickness of the fabric in the lot shall conform to the requirements of Table 4, unless otherwise specified.

## 16. Breaking Force

16.1 For fabrics listed in Table 1, the minimum breaking force shall conform to the requirements of Table 1. For fabrics or minimum breaking forces, or both, not listed in Table 1, the minimum breaking force shall be agreed upon between the purchaser and the supplier. The average breaking force for the lot shall exceed the specified breaking force, and no individual break shall be less than 80 % of the specified minimum breaking force.

## 17. Width

17.1 Fabric width shall be agreed upon between the purchaser and the supplier. The fabric width, including both selvages but excluding any feathered edges, shall be no narrower than the specified width and no more than 13 mm [0.5 in.] wider than the specified width.

NOTE 2—During the processing of glass fabrics the selvages may be slit to minimize tension influences. This slit distance is generally excluded when measuring the fabric width.

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

## 18. Length

18.1 The fabric roll length, length between splices, and number of splices per roll shall be agreed upon between purchaser and supplier. All splices must be thermoset unless otherwise agreed upon between the purchaser and the supplier.

## 19. Ignition Loss

19.1 The ignition loss of finished fabric shall be no less than 0.05 % and no more than 0.30 % unless otherwise agreed upon between the purchaser and the supplier.

NOTE 3—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 shall 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 to be used shall 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 150 mm [6 in.] apart.

## 21. Put-Up

21.1 Fabric shall be furnished in rolls and shall be wound on spiral tubes. The tube dimensions shall be as agreed upon between purchaser and supplier. The maximum number of pieces contained in any roll may be as specified in 18.1.

## 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.

22.2 Unless otherwise agreed upon, as when specified in an applicable contract or purchase order, each roll shall be wrapped in polyethylene not less than 0.05 mm [0.002 in.] thick in such a manner as to ensure that the fabric, during shipment and storage, will be protected against damage from exposure to moisture, weather, or any other normal hazard.



**TABLE 5 Classification of Defects<sup>A</sup>**

Defect	Description	Major	Minor
Baggy, ridgy, or wavy cloth	Clearly noticeable	x	
Cut or tear	6.5 mm [ $\frac{1}{4}$ in.] or more in any direction (body only)	x	
Hole	13 mm [5 in.] or more in diameter	x	
	Less than 13 mm [5 in.] in diameter		x
Spots, streaks, stains, foreign inclusions	Clearly noticeable	x	
Tender or weak spot	Clearly noticeable 50 mm [2 in.] or more in combined directions	x	
	Clearly noticeable less than 50 mm [2 in.] but greater than 0.6 cm [ $\frac{1}{4}$ in.] in combined directions		x
Smash	76 mm [3 in.] or more in combined directions	x	
	Less than 76 mm [3 in.] in combined directions		x
Broken, missing ends or picks	2 or more contiguous, regardless of length	x	
Floats and skips	50 mm [2 in.] or more in combined directions	x	
	Less than 50 mm [2 in.] in combined directions		x
Light marks	Greater than 6.5 mm [.25 in.] in width	x	
	2 picks less than nominal pick construction		x
Heavy marks	Puckering clearly noticeable	x	
	2 picks more than nominal pick construction		x
Crease	Hard embedded and folded over on self	x	
Waste	Clearly noticeable over 6.5 mm [.25 in.] in length	x	
	Clearly noticeable less than 6.5 mm [.25 in.] in length		x
Weave separation	Clearly noticeable 3 mm [.125 in.] or more	x	
Brittle or fused area	Any	x	
Selvage defects	Curled or folded under		x
	Cut or torn less than 6.5 mm [.25 in.] in length		x
	Cut or torn 6.5 mm [.25 in.] and over in length	x	
Selvage leno ends out	Greater than 5 m [5 yds] missing (continuously)	x	
	Less than 5 m [5 yds] missing		x
Feather edge	Greater than 5 mm [.1875 in.] running more than 5 m [5 yds]		
	Greater than 5 mm [.1875 in.] but running less than 5 m [.1875 in.]		

<sup>A</sup> At a normal viewing distance of 1 m or 3 ft.

## 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 shall 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-m [1-yd] 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 1 m [1 yd].

**TABLE 6 Sample Size Determination for Construction, Mass, Width 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

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 as directed in Practice [D1776](#), 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 [D578](#). Unless otherwise specified, during testing for strand construction as directed in Section [30](#), verify that the yarn is continuous filament. Determine the freedom from objectionable impurities during the inspection for fabric appearances as directed in Section [40](#).

## 27. Fabric Count

27.1 Determine the fabric count as directed in Test Method [D3775](#), making one count in each direction on each of the swatches in the laboratory sample.

## 28. Yarn Number

28.1 Determine the yarn number in tex (yds/lb.) for both the warp and filling yarns as directed in Test Method [D1059](#).

## 29. Filament Diameter

29.1 Determine the filament diameter for both the warp and filling yarns as directed in Specification [D578](#) 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 as directed in Test Method [D1423](#) in each of five test specimens of warp and filling yarns taken from each of the swatches in the laboratory.

## 32. Twist Level

32.1 Determine the twist level in each of the component strands as directed in Test Method [D1423](#) 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 force, durability and aesthetics. This method specifies a procedure for recognizing specified weaves.

33.2.2 This procedure for recognizing fabric weave type is considered satisfactory for acceptance testing of commercial shipments.

### 33.3 *Apparatus:*

33.3.1 *Rectangular Coordinate Graph Paper.*

33.3.2 *Linen or Magnifying Glass.*

33.3.3 *Marking Pen or Pencil.*

### 33.4 *Procedure:*

33.4.1 Place a swatch of the sample on a flat surface, face side up (see Terminology [D7018](#), eight and twelve harness satin definitions). 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-A1.3](#).

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 [D4029](#). Describe the material or product sampled and the method of sampling used.

33.5.2 Report the fabric weave type for each roll including the raiser/sinker pattern in terms of the warp ends up and down.

33.6 *Precision and Bias*—No justifiable statement can be made either on the precision or on the bias of this procedure, since the procedure merely determines whether the weave in the test specimen conforms to that specified.

## 34. Mass Per Unit Area

34.1 Determine the mass per unit area of the fabric as directed in Test Method [D3776](#), 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 **D1777**, using ten test specimens from each swatch in the laboratory sample.

35.2 For glass fabrics and tapes made with continuous filament yarns, use Table 1, Option 3 of Test Method **D1777**. For fabrics made with textured or open-end yarns, use Table 1, Option 1 of Test Method **D1777**.

## 36. Breaking Force

36.1 Determine the breaking force in newtons per 25 mm (or pounds-force per inch) of fabric in both the warp and filling directions as directed in Test Method **D5035**, unless otherwise specified between purchaser and supplier:

36.1.1 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.

36.1.2 The use of hydraulic pneumatic clamping systems with 50 by 75-mm [2 by 3-in.] serrated jaw faces is recommended for testing samples prepared as directed in **36.4** and **36.5**. The 50-mm [2-in.] dimension of the jaw face shall be in the direction of test. Manual clamping is permitted.

NOTE 4—When using jaw faces other than serrated, minimize crushing and cutting of the glass yarns in the test specimens by lining the inside surface of the jaws with cardboard 0.25 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 forces of 445 N/25 mm [100 lbf/in] or less.

NOTE 5—Fabrics having breaking force less than 445 N/25 mm [100 lbf/in.] can be prepared as outlined in **36.4** with no effect on the obtained value. Preparation Procedure 1 is provided to allow for a lower test specimen preparation cost when extensive preparation is not required.

### 36.3.1 Reagents and Materials:

36.3.1.1 *Butyl Methacrylate Solution* is prepared by mixing 45 parts by mass of butyl methacrylate with 55 parts by weight of toluene or xylene and adding a small amount of oil-soluble dye. The viscosity of this solution should be about 3000 mPa·g [cP] approximately that of honey at room temperature. It may be necessary to change the consistency for some types of fabrics to permit complete penetration of all interstices and to prevent capillary migration of the solution along the yarns into the test area.

NOTE 6—Substitute solutions can be used providing specimen damage does not occur or that specimens break or slip at the jaw faces.

36.3.1.2 **Precaution**—Butyl Methacrylate solution ingredients are flammable. Keep away from heat, sparks and open flame. Keep containers closed. Use only with adequate ventilation. Avoid prolonged breathing of vapor or spray mist. Avoid prolonged or repeated contact with skin. Spillage and fire instructions will depend on nature of solution.

36.3.1.3 *Multipurpose Paper*, 9 kg [20 lb.] bond or greater (as needed to prevent slippage in the grips).

36.3.1.4 *Paint Brush*, to 16 to 25 mm [.625 to 1.0 in.], bristles 25 mm [1 in.] long.

36.3.2 Cut two swatches of fabric from the laboratory sample each 200 by 250 mm [8 by 10 in.], one with the warp yarns and the other with filling yarns parallel to the 200-mm [8-in.] direction.

36.3.3 Lay each sample cut as directed in **36.3.2** on a piece of wrapping paper of similar size. Lay out five test specimens 38 by 150 mm [1.5 by 6 in.] on the fabric by drawing light lines with a soft wax pencil so that the yarns to be tested, warp or filling, are parallel to the longer direction. Draw lines across the specimens 40 mm [ $1\frac{5}{8}$  in.] from each end, using very light pressure on the wax pencil to avoid possible damage to the surface filaments. Thoroughly impregnate the 40 mm [.625 in.] specimen end strips with butyl methacrylate solution (or substitute) which must soak through the fabric in order to secure firm adhesion to the paper. Spread the solution in an even film to secure a uniform pressure from the testing machine jaws against the test specimen. Dry the impregnated sample slowly, 24 h without forcing, until the solvent is completely removed. Be sure to have the impregnant cover the cross lines to reinforce those sections where some of the surface fibers may have been fractured when those lines were drawn. On thick fabrics, paint both sides of the specimens by applying a coat of the impregnant to the back of the fabric or to the top surface of the backing paper.

36.3.4 Cut the 150 by 38-mm [6 by 1.5-in.] test specimen strips from the prepared sample without removing the paper backing. Ravel the central unimpregnated portion of the specimen to 25 mm [1 in.] in width as directed in Test Method **D5035**. After raveling, load samples in the test clamps, cut the 38-mm [1.5-in.] wide paper backing across midway between the ends, taking care not to damage the fabric specimen.

NOTE 7—Raveling of the specimen can be facilitated by slitting each test specimen at its center, perpendicular to the yarn components severing all yarns except those in the central 25 mm [1 in.].

36.4 *Procedure 2*—Procedure 2 is for fabrics having breaking forces greater than 445 N/25 mm [100 lbf/in.] or tending to consistently break in, or slip from, the jaws when using Procedure 1 stated in **36.3**.

36.4.1 Prepare test specimens as directed in **36.3** except as described in **36.4.2 – 36.4.10**.

36.4.2 Substitute Sub 65 grade white cardboard in place of the wrapping paper.

36.4.3 Draw two legible lines  $75 \pm 1$  mm [ $3.0 \pm 0.05$  in.] from each other and parallel across the center section of the cardboard.

36.4.4 Uniformly apply a resin solution on the cardboard along the drawn lines and outwards for a distance of  $50 \pm 1$  mm [ $2.0 \pm 0.05$  in.]. Do not include the center  $75 \pm 1$  mm [ $3.0 \pm 0.05$  in.] between the drawn lines.

NOTE 8—A mixture by weight of 60 parts CIBA Giegy 6004 Epoxy resin and 40 parts General Mills Versimid 125 polyamide resin has been found suitable for this purpose.

36.4.5 Lay the cut swatches of fabrics each 200 by 250 mm [8 by 10 in.], one with the warp yarns and the other with the filling yarns parallel to the 200-mm [8-in.] direction, centrally

and equally spaced on the resin prepared cardboard. The shorter direction of the sample is perpendicular to the drawn lines.

36.4.6 Uniformly reapply the resin mixture on the specimen directly above the first application.

36.4.7 Place a  $50 \pm 1$ -mm [ $2.0 \pm 0.05$ -in.] by 250-mm [10-in.] strip of cardboard over the resin impregnated area of the specimen. Allow to dry a minimum of 16 h.

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

36.4.8 Cut five specimens, 150 by 38 mm [8.0 by 1.5 in.] in each of the warp and filling directions, and label accordingly having the longer direction in the direction of test.

36.4.9 Ravel a sufficient number of yarns from each side of the specimen so that the central portion is a 25-mm [1.0-in.] width plus two yarns.

36.4.10 After the specimen is loaded in the test clamps, cut and ravel one yarn from each side of the test specimen and cut the cardboard backing across, midway between the ends, taking care not to damage the fabric specimen.

36.4.11 In the case of hydraulic pneumatic clamps, apply a pressure of 6750 to 7650 N [1500 to 1700 lbf] to the clamp faces. In the case of manual clamping, tighten sufficiently to prevent slippage of the test specimen.

36.5 *Procedure 3*—Procedure 3 is for fabrics having breaking forces greater than 2224 N/25 mm [500 lbf/in.] or show that cascading breaks across the specimen when using Procedure 2 stated in 36.4, or both.

NOTE 10—Glass yarns have a tendency to move within some fabrics when cut and handled in the greige state. This procedure is designed to ensure straightness of individual yarn components throughout the test.

36.5.1 Cut five specimens, 300 by 50 mm [12 by 2 in.] from the laboratory sample in each of the warp and filling directions, and label accordingly having the longer direction in the direction of test.

36.5.2 Draw two legible lines  $75 \pm 1$  mm [ $3.0 \pm 0.05$  in.] from each other and parallel to the long directions and across the center section of a 200 by 280-mm [8 by 11-in.] piece of Sub 65 white cardboard. Prepare one for each the warp and filling directions.

36.5.3 Place the cardboard sections at the outer edge of a workbench that is covered with a 19-mm [0.75-in.] thick piece of plywood. The 280-mm [11-in.] length is parallel to the bench edge.

36.5.4 Lay the cut specimens on the lined cardboard so that one end is 25 mm [1 in.] above the cardboard and the other end is hanging over the bench edge. Secure the top edge of the specimen to the plywood base by nailing through a 25 by 50-mm [1 by 2-in.] 19-mm [0.75-in.] plywood block placed above the specimen to the base. The 50-mm [2-in.] dimension is placed parallel to the specimen width. Four or five 32-mm [1.25-in.] nails equally spaced have been found acceptable for this purpose.

NOTE 11—A permanent fixture can be designed to replace the wooden blocks to facilitate testing.

36.5.5 Place two similar wooden blocks, one on each side of the other end of the specimen so that the fabric is sandwiched between the blocks. Nail the blocks and fabric together.

36.5.6 Fold the specimen upwards and away from the lined cardboard.

36.5.7 Apply a resin solution as directed in 36.4.4.

36.5.8 Secure a 2.3-kg [5-lb] 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 12—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 6 mm [ $\frac{1}{4}$  in.] of the jaws that results in a value below 50 % of the average of all the other breaks shall be discarded. No other break may be discarded unless it is known to be faulty.

NOTE 13—It is difficult to determine the precise reason why certain specimens break near the edge of the jaws or specimen tab edges. If this is caused by damage to the specimen by the jaws, then the results should be discarded. If, however, it is merely due to randomly distributed weak places, it is a perfectly legitimate result. In some cases, it may also be caused by a concentration of stress in the area adjacent to the jaws or specimen tab edges because they prevent the specimen from contracting in width as the force is applied. In these cases, a break near the edge of the jaws or specimen tab edges is inevitable and 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 D5035.

## 37. Width

37.1 Determine the width of the fabric as directed in Test Methods D3774, Option A, and the free-of-tension procedure, except that five measurements per roll shall be made on each of the rolls in the lot sample.

## 38. Length

38.1 Measure the length of each roll in the lot sample as directed in Test Methods D3773, 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 D3773 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 D4963, 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
D2408	Amino-Silane
D2409	Vinyl Complex
D2410	Chrome Complex
D2660	Acrylic-Silane
D3098	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 interruptible controlled fabric rewinding mechanism.

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

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

### 40.5 Procedure:

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

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

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

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

### 40.6 Report:

40.6.1 State that the rolls of fabric were visually inspected for defects as directed in Section 40 of Specification D4029.

Describe the fabric sampled, method of sampling, and the roll widths and lengths sampled.

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

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

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

### 40.7 Precision and Bias:

40.7.1 *Introduction*—Test results are reported as the average defect count per roll of fabric for a specific material. The precision of test results is evaluated in terms of the total defect count for all rolls of fabric included in each test result since such total counts have a Poisson distribution while the average defect counts do not have such a distribution. If the total counts for actual 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 shall agree on other procedures to establish conformance, including control charts furnished by the supplier, and other sampling plans such as sequential or double-sampling.

42.3 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification together with a report of the test results shall be furnished at the time of shipment.

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  $b$  is less than 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.

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 8 95 % Confidence Limits for Number of Defect Counts per Test Result**

Observed Count	Lower Limit	Upper Limit
0	0.0	3.7
5	1.6	11.7
10	4.8	18.4
15	8.4	24.7
20	12.2	30.9
25	16.2	36.9
30	20.2	42.8
35	24.4	48.7
40	28.6	54.5
45	32.8	60.2
50	37.1	65.9
60	45.8	77.2
70	54.6	88.4
80	63.4	99.6
90	72.4	110.6
100	81.4	121.6
120	99.5	143.5
140	117.8	165.2
160	136.2	186.8
180	154.7	208.3
200	173.2	229.7

Lower confidence limit for counts

$$= c[1 - (1/9c) - t(1/9c)^{1/2}]^3$$

Upper confidence limit for count

$$= d[1 - (1/9d) + t(1/9d)^{1/2}]^3$$

where:

$c$  = observed number of counts,

$d$  =  $c + 1$ , and

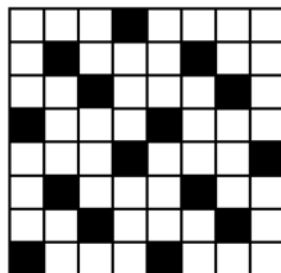
$t$  = 1.960, the value of Student's  $t$  for infinite degrees of freedom, two-sided limits, and the 95 % probability level.

## ANNEX

### (Mandatory Information)

#### A1. BASIC WEAVE DIAGRAMS

A1.1 The basic weaves illustrated in Figs. A1.1-A1.3 are forms shall be agreed upon between the purchaser and the



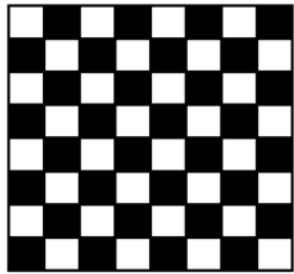
Standard Form Filling Flush

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

**FIG. A1.1 Crowfoot**

typical weaves used in conjunction with Table 6 unless otherwise specified. Other weave variations of these basic

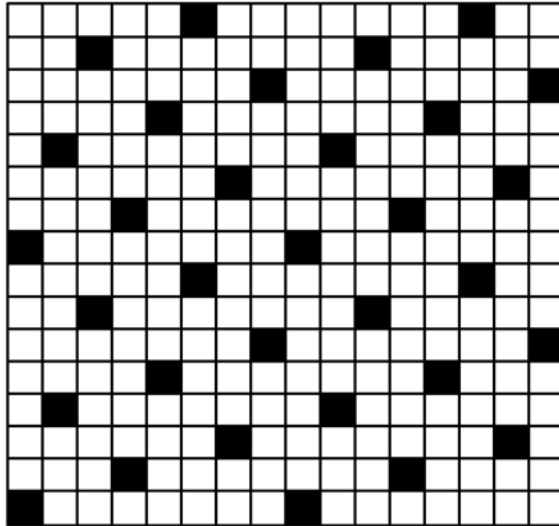
supplier. An acceptable source for reference is “Textile Terms and Definitions” by the Textile Institute, Manchester, England.



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

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