Designation: E11 – 17

Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves[1]

This standard is issued under the fixed designation E11; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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

1. Scope*

1.1 This document specifies the technical requirements for; the woven wire test sieve cloth (sieve cloth) used in test sieves, the construction of test sieves, standard and non-standard test sieve frame sizes, and test procedures used to inspect sieve cloth and the test sieves. This specification applies to test sieves manufactured with sieve cloth having a nominal aperture size ranging from 125 millimetres (mm) down to 20 micrometres (μm).

1.2 Additional reference information can be found in Specifications E161, E323, E2016, and in Test Methods C430 and E2427.

1.3 The values stated in SI units shall be considered standard for the dimensions of the sieve cloth openings and the wire diameters used in the sieve cloth. The values stated in inch-pound units shall be considered standard with regard to the sieve frames, pans, and covers.

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

1.5 *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]

C430 Test Method for Fineness of Hydraulic Cement by the 45-μm (No. 325) Sieve

E161 Specification for Precision Electroformed Sieves

E323 Specification for Perforated-Plate Sieves for Testing Purposes

E1638 Terminology Relating to Sieves, Sieving Methods, and Screening Media

E2016 Specification for Industrial Woven Wire Cloth

E2427 Test Method for Acceptance by Performance Testing for Sieves

2.2 *ASTM Manual:*[2]

Manual 32 Test Sieving Methods: Guidelines for Establishing Sieve Analysis Procedures; 5th Edition

2.3 *Federal Standard:*[3]

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

2.4 *Military Standard:*[3]

MIL-STD-129 Marking for Shipment and Storage

2.5 *ISO Standard:*[4]

ISO 3310-1 Test Sieves—Technical Requirements and Testing – Part 1: Test Sieves of Metal Wire Cloth

3. Terminology

3.1 *Definitions*—Additional terms can be found in Terminology E1638.

3.1.1 *aperture*—the dimension defining an opening in a screening surface.

3.1.2 *backing cloth*—a wire mesh support layer used directly under the sieve cloth with an opening coarser than the sieve designation.

3.1.3 *crimp*—the corrugation in the warp and shute wire, or both. The crimp in the wires is formed either during the weaving process, or with a crimping machine prior to weaving. If formed during the weaving process, the tension existing between the warp and shute wires fundamentally determines the respective amount or depth of crimp, which locks the wires in place, and in part establishes the firmness of the sieve cloth.

[1] This specification is under the jurisdiction of ASTM Committee E29 on Particle and Spray Characterization and is the direct responsibility of Subcommittee E29.01 on Sieves, Sieving Methods, and Screening Media.

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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.

[3] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.

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

***A Summary of Changes section appears at the end of this standard**

TABLE 1 Nominal Dimensions and Permissible Variations for Sieve Cloth and Compliance, Inspection and Calibration Test Sieves

(1)	(2a)	(2b)	(3)[A]	(4)	(5)	(6)	(7)	(8)	(9)[B, C]	(10)	(11)[B, C]	(12)	(13)	(14)	(15)
Sieve Designation			Nominal Sieve Opening	±Y Variation for Average Opening	+X Maximum Variation for Opening	Resulting Maximum Individual Opening	Compliance Sieves		Inspection Sieves		Calibration Sieves		Typical Wire Diameter	Permissible Average Wire Diameter	
Standard	U.S. Alternative	Supplementary Size					Sample Openings per 100 ft^2	Maximum Standard Deviation	Sample Openings per Sieve	Maximum Standard Deviation	Sample Openings per Sieve	Maximum Standard Deviation		Min	Max
mm		mm	in.	mm	mm	mm							mm		
125	5 in.		5.00	3.30	4.06	129.06	20	–	all	–	all	–	8.00	6.8	9.2
		112	4.41	2.96	3.74	115.74	20	–	all	–	all	–	8.00	6.8	9.2
106	4.24 in.		4.24	2.80	3.59	109.59	20	–	all	–	all	–	6.30	5.4	7.2
100	4 in.		4.00	2.65	3.44	103.44	20	–	all	–	all	–	6.30	5.4	7.2
90	3½ in.		3.50	2.39	3.18	93.18	20	–	all	–	all	–	6.30	5.4	7.2
		80	3.15	2.13	2.91	82.91	20	–	all	–	all	–	6.30	5.4	7.2
75	3 in.		3.00	2.00	2.78	77.78	20	–	all	–	all	–	6.30	5.4	7.2
		71	2.80	1.89	2.67	73.67	20	–	all	–	all	–	5.60	4.8	6.4
63	2½ in.		2.50	1.69	2.44	65.44	20	–	all	–	all	–	5.60	4.8	6.4
		56	2.20	1.50	2.24	58.24	20	–	all	–	all	–	5.00	4.3	5.8
53	2.12 in.		2.12	1.42	2.15	55.15	20	–	all	–	all	–	5.00	4.3	5.8
50	2 in.		2.00	1.34	2.06	52.06	20	–	all	–	all	–	5.00	4.3	5.8
45	1¾ in.		1.75	1.21	1.91	46.91	20	–	all	–	all	–	4.50	3.8	5.2
		40	1.57	1.08	1.75	41.75	20	–	all	–	all	–	4.50	3.8	5.2
37.5	1½ in.		1.50	1.01	1.67	39.17	20	1.103	all	–	all	–	4.50	3.8	5.2
		35.5	1.40	0.961	1.60	37.10	20	1.035	all	–	all	–	4.00	3.4	4.6
31.5	1¼ in.		1.25	0.855	1.47	32.97	20	0.907	all	–	all	–	4.00	3.4	4.6
		28	1.10	0.762	1.35	29.35	20	0.802	all	–	all	–	3.55	3.0	4.1
26.5	1.06 in.		1.06	0.722	1.29	27.79	20	0.758	all	–	all	–	3.55	3.0	4.1
25	1.00 in.		1.00	0.682	1.24	26.24	20	0.715	all	–	all	–	3.55	3.0	4.1
22.4	⅞ in.		0.875	0.613	1.14	23.54	150	0.641	15	0.431	30	0.460	3.55	3.0	4.1
		20	0.787	0.548	1.05	21.05	150	0.575	15	0.387	30	0.413	3.15	2.7	3.6
19	¾ in.		0.750	0.522	1.01	20.01	150	0.548	15	0.368	30	0.393	3.15	2.7	3.6
		18	0.709	0.495	0.97	18.97	150	0.521	15	0.350	30	0.374	3.15	2.7	3.6
16	⅝ in.		0.625	0.441	0.89	16.89	150	0.467	15	0.314	30	0.335	3.15	2.7	3.6
		14	0.551	0.387	0.81	14.81	150	0.414	15	0.278	30	0.297	2.80	2.4	3.2
13.2	0.530 in.		0.530	0.365	0.78	13.98	150	0.393	15	0.264	30	0.282	2.80	2.4	3.2
12.5	½ in.		0.500	0.346	0.75	13.25	150	0.374	15	0.251	30	0.268	2.50	2.1	2.9
11.2	7⁄16 in.		0.438	0.311	0.69	11.89	150	0.340	15	0.229	30	0.244	2.50	2.1	2.9
		10	0.394	0.279	0.64	10.64	150	0.308	15	0.207	30	0.221	2.50	2.1	2.9
9.5	⅜ in.		0.375	0.265	0.61	10.11	150	0.294	15	0.198	30	0.211	2.24	1.9	2.6
		9	0.354	0.251	0.59	9.59	150	0.281	15	0.189	30	0.202	2.24	1.9	2.6
8	5⁄16 in.		0.312	0.224	0.54	8.54	150	0.254	15	0.171	30	0.182	2.00	1.7	2.3
		7.1	0.280	0.200	0.50	7.60	150	0.230	15	0.155	30	0.165	1.80	1.5	2.1
6.7	0.265 in.		0.265	0.189	0.48	7.18	150	0.219	15	0.147	30	0.157	1.80	1.5	2.1
6.3	¼ in.		0.250	0.178	0.46	6.76	150	0.208	15	0.140	30	0.149	1.80	1.5	2.1
5.6	No. 3½		0.223	0.159	0.42	6.02	150	0.189	15	0.127	30	0.136	1.60	1.3	1.9
		5	0.197	0.142	0.39	5.39	150	0.172	15	0.116	30	0.123	1.60	1.3	1.9
4.75	No. 4		0.187	0.135	0.37	5.12	150	0.165	15	0.111	30	0.118	1.60	1.3	1.9
		4.5	0.177	0.128	0.36	4.86	150	0.158	15	0.106	30	0.113	1.40	1.2	1.7
4	No. 5		0.157	0.114	0.33	4.33	150	0.143	15	0.096	30	0.103	1.40	1.2	1.7
		3.55	0.140	0.102	0.30	3.85	200	0.130	20	0.092	40	0.097	1.25	1.06	1.50
3.35	No. 6		0.132	0.096	0.29	3.64	200	0.125	20	0.088	40	0.093	1.25	1.06	1.50
		3.15	0.124	0.091	0.28	3.43	200	0.119	20	0.084	40	0.089	1.25	1.06	1.50
2.8	No. 7		0.110	0.081	0.26	3.06	200	0.108	20	0.076	40	0.081	1.12	0.95	1.30
		2.5	0.0984	0.073	0.24	2.74	200	0.099	20	0.070	40	0.074	1.00	0.85	1.15
2.36	No. 8		0.0937	0.069	0.23	2.59	200	0.095	20	0.067	40	0.071	1.00	0.85	1.15
		2.24	0.0882	0.065	0.22	2.46	200	0.091	20	0.064	40	0.068	0.90	0.77	1.04
2	No. 10		0.0787	0.059	0.20	2.20	250	0.083	25	0.060	50	0.064	0.90	0.77	1.04
		1.8	0.0709	0.053	0.19	1.99	250	0.077	25	0.056	50	0.059	0.80	0.68	0.92
1.7	No. 12		0.0661	0.050	0.18	1.88	250	0.074	25	0.054	50	0.057	0.80	0.68	0.92

TABLE 1 *Continued*

(1)	(2a)	(2b)	(3)[A]	(4)	(5)	(6)	(7)	(8)	(9)[B, C]	(10)	(11)[B, C]	(12)	(13)	(14)	(15)
Sieve Designation			Nominal Sieve Opening	±Y Variation for Average Opening	+X Maximum Variation for Opening	Resulting Maximum Individual Opening	Compliance Sieves		Inspection Sieves		Calibration Sieves		Typical Wire Diameter	Permissible Average Wire Diameter	
Standard	U.S. Alternative	Supplementary Size					Sample Openings per 100 ft^2	Maximum Standard Deviation	Sample Openings per Sieve	Maximum Standard Deviation	Sample Openings per Sieve	Maximum Standard Deviation		Min	Max
		1.6	0.0630	0.047	0.17	1.77	250	0.070	25	0.051	50	0.054	0.80	0.68	0.92
1.4	No. 14		0.0555	0.042	0.16	1.56	400	0.064	40	0.050	80	0.052	0.71	0.60	0.82
		1.25	0.0492	0.038	0.15	1.40	400	0.058	40	0.045	80	0.047	0.63	0.54	0.72
1.18	No. 16		0.0469	0.036	0.14	1.32	400	0.056	40	0.043	80	0.045	0.63	0.54	0.72
		1.12	0.0441	0.034	0.14	1.26	400	0.054	40	0.042	80	0.044	0.56	0.48	0.64
1	No. 18		0.0394	0.030	0.13	1.13	400	0.050	40	0.039	80	0.040	0.56	0.48	0.64
µm		µm	in.	µm	µm	µm							mm		
		900	0.0354	27.6	118	1018	400	45.51	40	35.22	80	36.74	0.500	0.43	0.58
850	No. 20		0.0331	26.2	114	964	400	43.66	40	33.79	80	35.25	0.500	0.43	0.58
		800	0.0315	24.8	109	909	400	41.79	40	32.34	80	33.74	0.450	0.38	0.52
710	No. 25		0.0278	22.2	101	811	500	38.36	50	30.43	100	31.62	0.450	0.38	0.52
		630	0.0248	19.9	93	723	500	35.23	50	27.95	100	29.04	0.400	0.34	0.46
600	No. 30		0.0234	19.0	91	691	500	34.04	50	27.00	100	28.06	0.400	0.34	0.46
		560	0.0220	17.9	87	647	500	32.43	50	25.73	100	26.73	0.355	0.30	0.41
500	No. 35		0.0197	16.2	80	580	600	29.96	60	24.21	120	25.09	0.315	0.27	0.36
		450	0.0177	14.7	75	525	600	27.86	60	22.51	120	23.32	0.280	0.24	0.32
425	No. 40		0.0165	14.0	73	498	600	26.79	60	21.65	120	22.43	0.280	0.24	0.32
		400	0.0157	13.3	70	470	600	25.71	60	20.78	120	21.52	0.250	0.21	0.29
355	No. 45		0.0139	12.0	65	420	800	23.72	80	19.68	160	20.30	0.224	0.19	0.26
		315	0.0124	10.8	60	375	800	21.90	80	18.17	160	18.75	0.200	0.17	0.23
300	No. 50		0.0117	10.4	58	358	800	21.20	80	17.59	160	18.15	0.200	0.17	0.23
		280	0.0110	9.8	56	336	800	20.26	80	16.81	160	17.34	0.180	0.15	0.21
250	No. 60		0.0098	8.9	52	302	800	18.82	80	15.61	160	16.11	0.160	0.13	0.19
		224	0.0088	8.1	49	273	800	17.53	80	14.54	160	15.01	0.160	0.13	0.19
212	No. 70		0.0083	7.8	47	259	800	16.93	80	14.05	160	14.49	0.140	0.12	0.17
		200	0.0079	7.4	45	245	800	16.32	80	13.54	160	13.97	0.140	0.12	0.17
180	No. 80		0.0070	6.8	43	223	1000	15.27	100	12.91	200	13.28	0.125	0.106	0.150
		160	0.0063	6.3	40	200	1000	14.20	100	12.00	200	12.34	0.112	0.095	0.130
150	No. 100		0.0059	6.0	38	188	1000	13.65	100	11.53	200	11.86	0.100	0.085	0.115
		140	0.0055	5.7	37	177	1000	13.09	100	11.06	200	11.38	0.100	0.085	0.115
125	No. 120		0.0049	5.2	34	159	1000	12.23	100	10.33	200	10.63	0.090	0.077	0.104
		112	0.0044	4.8	32	144	1000	11.46	100	9.68	200	9.96	0.080	0.068	0.092
106	No. 140		0.0041	4.7	31	137	1000	11.10	100	9.38	200	9.65	0.071	0.060	0.082
		100	0.0039	4.5	30	130	1000	10.73	100	9.07	200	9.33	0.071	0.060	0.082
90	No. 170		0.0035	4.2	29	119	1000	10.10	100	8.53	200	8.78	0.063	0.054	0.072
		80	0.0031	3.9	27	107	1000	9.45	100	7.99	250	8.33	0.560	0.048	0.064
75	No. 200		0.0029	3.7	26	101	1000	9.12	100	7.70	250	8.04	0.050	0.043	0.058
		71	0.0028	3.6	25	96	1000	8.85	100	7.48	250	7.80	0.050	0.043	0.058
63	No. 230		0.0025	3.4	24	87	1000	8.29	100	7.01	250	7.31	0.045	0.038	0.052
		56	0.0022	3.2	22	78	1000	7.79	100	6.58	250	6.87	0.040	0.034	0.046
53	No. 270		0.0021	3.1	21	74	1000	7.56	100	6.39	250	6.67	0.036	0.031	0.041
		50	0.0020	3.0	21	71	1000	7.34	100	6.20	250	6.47	0.036	0.031	0.041
45	No. 325		0.0017	2.8	20	65	1000	6.95	100	5.87	250	6.13	0.032	0.027	0.037
		40	0.0016	2.7	19	59	1000	6.55	100	5.54	300	5.83	0.032	0.027	0.037
38	No. 400		0.0015	2.6	18	56	1000	6.38	100	5.39	300	5.69	0.030	0.024	0.035
		36	0.0014	2.6	18	54	1000	6.22	100	5.26	300	5.54	0.030	0.024	0.035
32	No. 450		0.0012	2.4	17	49	1000	5.87	100	4.96	300	5.23	0.028	0.023	0.033
25	No. 500		0.0010	2.2	15	40	1000	5.23	100	4.42	300	4.66	0.025	0.021	0.029
20	No. 635		0.0008	2.1	13	33	1000	4.73	100	4.00	300	4.22	0.020	0.017	0.023

[A] Column 3—These numbers are only approximate but are in use for reference; the sieve shall be identified by the standard designation in millimetres or micrometres.
[B] Columns 9 and 11—See Annex A1, which specifies that all openings will be inspected for test sieves having 15 openings or less.
[C] Columns 9 and 11—These number of sample openings are based on an 8-in. diameter test sieve.

3.1.4 *firmness*—a subjective term referring to the planar rigidity of sieve cloth (as a roll good, not mounted in a test sieve frame), established by the tensile strength of the material, the relationship of the mesh to wire diameters, the type of weave, and amount of crimp in the wires. The absence of firmness in sieve cloth is termed *sleaziness*.

3.1.5 *matched test sieve*—a test sieve that reproduces the performance results of another test sieve within user defined limits for a designated material (for information only and may not be in compliance with this specification).

3.1.6 *mesh*—the number of wires or openings per linear inch (25.4 mm) counted from the center of any wire to a point exactly 1 in. (25.4 mm) distant, including the fractional distance between either thereof.

3.1.7 *plain weave*—sieve cloth in which the warp wires and shute wires pass over one and under one in both directions.

3.1.8 *shute wires*—the wires running the short way of, or across the cloth as woven (also referred to as the shoot, fill, or weft wires).

3.1.9 *sieve*—an apparatus for the purpose of sieving, consisting of a separating media mounted in a frame.

3.1.10 *sieve cloth*—woven wire cloth conforming to this specification.

3.1.11 *test sieve (wire cloth)*—a sieve manufactured by mounting sieve cloth in a frame, designed for use in particle size analysis by sieving.

3.1.11.1 *compliance test sieve*—a test sieve manufactured using sieve cloth which has been inspected prior to being mounted in the sieve frame; and that meets the requirements of Table 1 in part based on the standard deviation of the required number of sample openings per 100 square feet of sieve cloth (Column 7) not exceeding the maximum allowable for a confidence level of 66 % (Column 8).

3.1.11.2 *inspection test sieve*—a test sieve manufactured using sieve cloth which has been inspected after being mounted in the sieve frame; and that meets the requirements of Table 1 in part based on the standard deviation of the required number of sample openings in the test sieve (Column 9) not exceeding the maximum allowable for a confidence level of 99 % (Column 10).

3.1.11.3 *calibration test sieve*—a test sieve manufactured using sieve cloth which has been inspected after being mounted in the sieve frame; and that meets the requirements of Table 1 in part based on the standard deviation of the required number of sample openings in the test sieve (Column 11) not exceeding the maximum allowable for a confidence level of 99.73 % (Column 12).

3.1.11.3.1 *Discussion*—Calibration sieves have had at least twice as many openings measured as Inspection sieves.

3.1.12 *twill weave*—sieve cloth in which the warp wires and shute wires pass over two and under two wires in both directions.

3.1.13 *warp wires*—the wires running the long way of the cloth as woven.

4. Ordering Information

4.1 Orders for items under this specification should include the following information as required:

4.1.1 Description of item(s) (Test Sieve or Sieve Cloth),

4.1.2 ASTM E11 designation and year of issue,

4.1.3 Quantity of each item, and

4.1.4 Sieve designation (Table 1, Standard Column 1, Alternate Column 2).

4.1.4.1 Test sieves can be supplied based on different levels of confidence as Compliance Sieves, Inspection Sieves, and Calibration Sieves.

4.2 Test sieves in standard circular or nonstandard frame:

4.2.1 Nominal sieve frame diameter (see Table 2), and

4.2.2 Nominal sieve frame height (see Table 2).

4.3 Description of nonstandard sieve.

5. Sieve Cloth Requirements

5.1 The sieve cloth used in test sieves shall meet the requirements of Table 1 and shall be designated Specification E11 Sieve Cloth. The number of inspected apertures shall be in accordance with Table 1 (Column 7). Sieve cloth conforming to this specification shall be woven from stainless steel, brass, or bronze. Sieve cloth with openings greater than or equal to 75 micrometres shall be woven using a plain weave. For sieve cloth with openings equal to or less than 71 micrometres the sieve cloth may be supplied using a twill weave. The sieve cloth shall not be coated or plated.

5.2 All measurements of openings and wire diameters shall be made along the midpoints of the openings as shown in Fig. 1.

5.3 There shall be no punctures or obvious defects in the sieve cloth.

TABLE 2 Dimensions of Standard Frames

Nominal Diameter, in.	Diameter Tolerance, in. (mm)	Typical Frame[A]
	Inside at Top[B]	Nominal Height, in. (mm)
3	3.000 + 0.030/–0.000 (76.2 + 0.76/–0.00)	1¼ (31.8) FH[C] ⅝ (15.9) HH
6	6.000 + 0.030/–0.000 (152.4 + 0.76/–0.00)	1¾ (44.5) FH 1 (25.4) HH
8	8.000 + 0.030/–0.000 (203.2 + 0.76/–0.00)	2 (50.8) FH 1 (25.4) HH
10	10.000 + 0.030/–0.000 (254 + 0.76/–0.00)	3 (76.2) FH 1½ (38.1) HH
12	12.000 + 0.030/–0.000 (304.8 + 0.76/–0.00)	3¼ (82.6) FH 2 (50.8) IH 1⅝ (41.3) HH

[A] Frame height measured from top of frame to top of sieve cloth.
[B] Measured 0.2 in. (5 mm) below the top of the frame.
[C] FH = full height; HH = half height; IH = intermediate height.

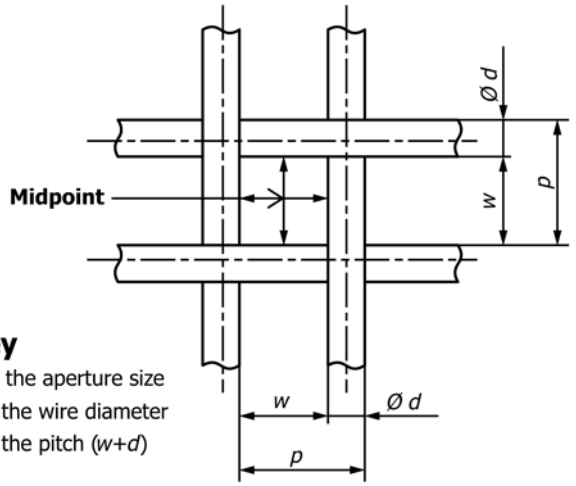


FIG. 1 Aperture Size

6. Technical Requirements

6.1 *Opening Sizes, Tolerances, and Standard Deviation:*

6.1.1 Four tolerances shall be applied: the variation for average opening (*Y*), the maximum variation (*X*), the maximum standard deviation and the average wire diameter. The opening tolerances apply to the opening sizes, measured on the mid-point of the opening (see Fig. 1), and applied separately in both the warp and shute directions.

6.1.2 The average opening size shall not exceed the sieve designation by more than $\pm Y$ (Table 1, Column 4):

$$Y = \left(\frac{w^{0.98}}{27} + 1.6 \right) 0.9 \tag{1}$$

where *Y* and *w* are expressed in micrometres.

6.1.3 The maximum opening size measured shall not exceed the nominal opening size *w* (Table 1, Column 1), by more than *X* (Table 1, Column 5):

$$X = \left(\frac{2w^{0.75}}{3} + 4\ w^{0.25} \right) 0.9 \tag{2}$$

where *X* and *w* are expressed in micrometres.

6.1.4 The intermediate value *Z* shall be stated as follows:

$$Z = \frac{X+Y}{2} \tag{3}$$

6.1.5 The maximum standard deviation is calculated based on the Gaussian normal distribution curve, truncated at the left end at 0 and at the right end at $w + X$. The area under the curve to the maximum value $w + X$ minus the area under the curve to the intermediate value Z, is equal to this critical area between $(w + Z)$ and $(w + X)$ not exceeding more than 5 % of the openings (see Appendix X2). The tolerances for sigma are then calculated based on:

$$\frac{\Phi\left(\frac{X}{\sigma}\right) - \Phi\left(\frac{Z}{\sigma}\right)}{\Phi\left(\frac{X}{\sigma}\right) - \Phi\left(\frac{-w}{\sigma}\right)} = 0.05 \text{ (see Appendix X4)}$$

and the results are given in Table 1 for Compliance sieve cloth (Column 8).

6.1.5.1 In order to increase the probability or acceptance confidence level from 66 % at one-sigma to $X\sigma$, specifically 99 % (2.58σ) and 99.73 % (3σ) for Inspection and Calibration sieves respectively, these maximum standard deviation values are determined by dividing sigma by a correction or K-factor. These K-factors are determined based on approximation to a Chi-square distribution for the sample variance as follows:

$$K = 1 + X\sigma/\sqrt{2(n-1)} \tag{4}$$

6.1.5.2 The applicable resulting K-factors (see Appendix X3) are then applied and the maximum standard deviation tolerances are determined as follows:

$$\sigma_x = \text{sigma}/K \tag{5}$$

6.1.5.3 The resulting tolerances are given in Table 1 for Inspection Sieves (Column 10) and for Calibration Sieves (Column 12), and are presented for convenience based on the K-factors per the required minimum number of openings.

6.1.6 The actual standard deviation of the openings in the warp and weft directions, when taken separately, shall not exceed the values shown in Table 1 for each type. If the number of sample openings is less than 15, the maximum standard deviation is not evaluated. If more than the minimum number of openings are measured, the maximum standard deviation shall be calculated (see Eq 5) based on the corresponding K-factor calculation (see Eq 4).

6.1.6.1 The population standard deviation σ is obtained by measuring all of the full openings *N* found in the test sieve and is calculated from the following equation:

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (w_i - \bar{w})^2} \tag{6}$$

6.1.6.2 The sample standard deviation *s* is calculated from the measurement of the number of apertures, *n* as listed in Table 1 (Column 8 for Sieve Cloth, Column 10 for Inspection Sieves, and Column 12 for Calibration Sieve), using the following equation:

$$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (w_i - \bar{w})^2} \tag{7}$$

6.2 *Wire Diameters:*

6.2.1 The wire diameters given in Table 1, Column 13 are typical.

6.2.2 The average wire diameter in a test sieve or sieve cloth shall fall between the tolerance (d min and d max) given in Table 1, Column 14 and 15, respectively. It is recognized that mechanical deformation of the wire occurs during weaving, and therefore the diameter measured after weaving may be different than the wire diameter before weaving. The average wire diameter shall be calculated based on the same number of sample apertures measured in accordance with Table 1.

6.2.3 The wires shall be crimped in such a manner that the cloth exhibits firmness, as agreed between the user and the supplier, as applied to roll goods.

6.3 *Test Sieve Frames:*

6.3.1 *General Requirements*—Frames for test sieves shall be constructed in such a manner to be rigid. The sieve cloth shall be mounted on a frame without distortion, looseness, or

waviness. The method used to attach the sieve cloth to the frame shall be done so the material being sieved will not become caught in the joint between the sieve cloth and the frame.

6.3.2 *Standard Frames*—Sieve frames shall be circular. Typical frame sizes are 3 in., 6 in., 8 in., 10 in., and 12 in. diameter (or 76, 152, 203, 254, or 305 mm). Tolerances for dimensions of test sieve frames are given in Table 2. Frames shall be made of a noncorrosive material such as brass or stainless steel. The bottom of the frame shall be constructed so as to provide an easy sliding or nesting fit with any sieve frame of the same nominal diameter conforming to the specified dimensions.

6.3.3 The joint or fillet at the point where the sieve cloth and frame meet will provide a minimum clear sieving surface with a diameter equal to the nominal diameter, less 0.5 in. (13 mm) on up to and including 8 in. frames, and 1.0 in. (25 mm) on greater than 8 in. frames.

6.4 *Nonstandard Sieves:*

6.4.1 *Nonstandard Frames*—Other sieve frames may be square, rectangular, circular, or non-metal. The frame may have the sieve cloth permanently attached, or it may be designed so the sieve cloth is replaceable. The provisions of 6.3.1 apply. Nonstandard test sieves may be certified in accordance with Section 7.

6.4.2 *Sieves with Backing Cloth*—Backing cloth specifications can vary in accordance with the test sieve manufacturer. The use of a backing cloth will affect the sieve performance. Test sieves with a backing cloth can only be supplied as Compliance Sieves.

7. Test Sieve and Sieve Cloth Documentation and Certification

7.1 Documentation of the measurement of the openings in the sieve cloth must assure that the test sieve is traceable and certifiable. All test sieve certificates must be traceable by the test sieve serial number. Inspection and Calibration sieves must also include the date, name and signature of the person certifying to the test sieve quality.

7.2 Test sieves may be supplied as Compliance, Inspection, or Calibration Sieves.

7.2.1 A Compliance sieve certificate shall state that the test sieve has been manufactured with sieve cloth that has been inspected and found to be in compliance with the requirements of Specification E11. The Certificate does not require any statistical documentation.

7.2.2 An Inspection sieve certificate shall state at a minimum the value for the average aperture size, separately in both the warp and shute direction of the sieve cloth. A Certificate with this inspection data must be supplied.

7.2.3 A Calibration sieve certificate shall state at a minimum the number of apertures and wire diameters measured, the average aperture size, standard deviation and average wire diameter, separately in both the warp and shute directions of the sieve cloth. A Certificate with this inspection data must be supplied.

8. Marking or Labeling of Test Sieves

8.1 Each test sieve supplied shall bear a label marked with the following information:

8.1.1 "Test Sieve,"

8.1.2 The "ASTM E11" designation,

8.1.3 Name of the manufacturer or distributor,

8.1.4 Test sieve designation from Table 1, Column 1, and

8.1.5 Alternate test sieve designation from Table 1, Column 2 (optional).

8.1.6 Each test sieve shall have a unique serial number permanently marked onto the sieve frame, skirt, or nameplate.

8.1.7 The test sieve may also be labeled with the Grade designation.

9. Keywords

9.1 aperture; calibration sieve; compliance sieve; inspection sieve; opening; particle size; sieve; sieve analysis; sieve cloth; sieve designation; test sieve; woven wire test sieve cloth

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply only when specified by the purchaser in the contract or order.

S1. Responsibility for Inspection

S1.1 Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. Except as otherwise specified in the contract or order, the producer may use his own or any other suitable facilities for the performance of the inspections and tests requirements specified herein, unless disapproved by the purchaser. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that materials meet the specification.

S2. Government Procurement

S2.1 Unless otherwise specified in the contract, the material shall be in packaged in accordance with the suppliers' standard practice that will be acceptable to the carrier at lowest rates. Containers and packing shall comply with the Uniform Freight Classification rules or National Motor Classification rules. Marking for shipment of such materials shall be in accordance with Fed. Std. No. 123 for civil agencies, and MIL-STD-129 for military agencies.

ANNEX

(Mandatory Information)

A1. PROCEDURE FOR INSPECTING SIEVE CLOTH AND TEST SIEVES

A1.1 Every opening in the sieve cloth or test sieve shall have the same probability of being inspected for compliance with the requirements shown in Table 1. For sieve cloth and test sieves having 15 openings or less, measure all full openings (see Fig. A1.1). For sieve cloth and test sieves having more than 15 openings, carry out the inspection using the following three procedures:

A1.1.1 Visually inspect the condition of the sieve cloth against a uniformly illuminated background. If obvious deviations from uniformity of appearance are found (weaving defects, creases, wrinkles, etc.) the sieve cloth or test sieve, or both, is unacceptable.

A1.1.2 Inspect for oversize openings per tolerance *X* given in Table 1 (Column 5); carefully and methodically examine the appearance of all openings in order to detect oversize openings for subsequent measurements. Openings in fine mesh sieves are best viewed when magnified optically. In the optical method, the minimum number of apertures examined shall be in accordance with Table 1 (Columns 9 or 11) for sieves and (Column 7) for sieve cloth. The magnifications listed in Table A1.1 may be used. If any opening is found to be oversize by more than tolerance *X*, the sieve cloth or test sieve is unacceptable.

A1.1.3 Determine the average opening size (*w* in millimetres), and for apertures less than one millimetre, in micrometres, the standard deviation and wire diameter. The measured openings shall be spaced over the full diameter of the test sieve. Figs. A1.1 and A1.2 indicate options to measure the individual openings in an 8 in. (203 mm) diameter test sieve. The minimum number of openings to be measured, in both the warp and shute direction, in an 8 in. diameter test sieve for Inspection and Calibration grades are shown in Table 1, Columns 9 or 11 respectively. For test sieve sizes other than the 8 in. diameter, the values shown in this table should be modified in proportion to the sieving area. For sieves greater than 8-in. diameter with designations 25 mm and larger, a maximum of, 25 apertures shall be measured for Inspection sieves and 50 apertures for Calibration sieves. Determine the average opening along the center line of the sieve cloth separately in two directions, parallel to the warp and shute wires respectively (see Figs. A1.2 and A1.3). If the sieve cloth is a twill weave (openings less than or equal to 71 micrometre), the configuration shall be as shown in Fig. A1.4 and the measurements shall be made vertically, to the wire.

A1.1.4 To determine the average opening in sieve cloth refer to Table 1 for the minimum number of sample openings to be measured. Calculate the standard deviation as in accordance with 6.1.6.2. If the wire diameter is measured separately, not at the same time the opening is measured, the number of samples shall be the same as the sample openings.

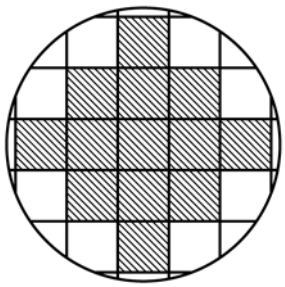
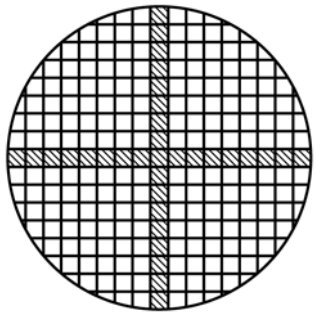
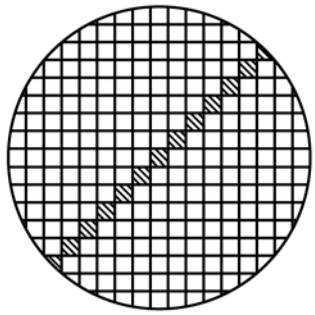


FIG. A1.1 All Full Apertures Measure up to 15 Apertures



NOTE 1—Apertures shall be randomly selected, spaced over the full sieve diameter at irregular intervals, measurement for warp and shute dimension, only one measurement per aperture.

FIG. A1.2 Example for Crosswise Spot Check



NOTE 1—Apertures shall be randomly selected, spaced over the full sieve diameter at irregular intervals, measurements for both warp and shute dimensions shall be made in any one aperture.

FIG. A1.3 Example for Diagonal Spot Check

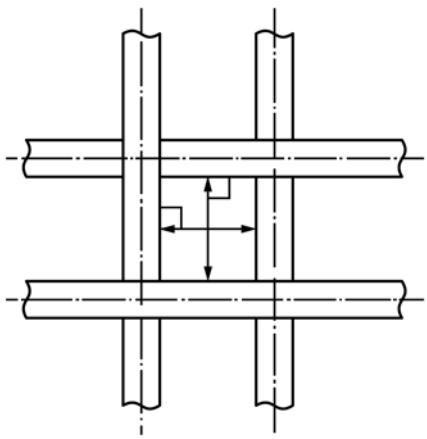


FIG. A1.4 Configuration of Twilled Weaves

TABLE A1.1 Magnifying Power in Optical Method

Nominal Aperture Size	5 mm to 500 μm	500 to 250 μm	250 to 20 μm
Magnification	5 to 20	20 to 50	50 to 500

APPENDIXES

(Nonmandatory Information)

X1. DETERMINATION OF THE STANDARD DEVIATION ON AVERAGE APERTURE SIZE

The standard deviation is calculated using equations as illustrated by the following two examples.

X1.1 Example 1

X1.1.1 Test for Inspection Grade sieve (n = 25, nominal aperture size w = 2 mm):

w_i	n_i	$n_i \times w_i$	$(w_i - \bar{w})$	$(w_i - \bar{w})^2$	$n \times (w_i - \bar{w})^2$
1.812	0	0.000	–0.132	0.017	0.000
1.859	3	5.577	–0.085	0.007	0.021
1.906	5	9.530	–0.038	0.001	0.007
1.953	11	21.483	0.009	0.000	0.001
2.000	6	12.000	0.056	0.003	0.019
2.047	0	0.000	0.103	0.011	0.000
2.094	0	0.000	0.150	0.023	0.000
2.141	0	0.000	0.197	0.039	0.000
2.188	0	0.000	0.244	0.060	0.000
n =	25	48.590			0.049

$$\bar{w} = \frac{1}{n}\sum_{i=1}^{n} w_i$$

$$\bar{w} = \frac{48.590}{25} = 1.944 \text{ mm}$$

$$s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(w_i - \bar{w})^2}$$

$$s = \sqrt{\frac{1}{24}\cdot 0.049} = 0.045$$

X1.1.2 Standard deviation $\sigma s = 0.045$ shall be compared with the value of $\sigma_x = 0.060$ given in Table 1, Column 10.

X1.2 Example 2

X1.2.1 Test for Calibration Grade sieve (n = 50, nominal aperture size w = 2 mm):

w_i	n_i	$n_i \times w_i$	$(w_i - \bar{w})$	$(w_i - \bar{w})^2$	$n \times (w_i - \bar{w})^2$
1.812	0	0.000	–0.187	0.035	0.000
1.859	2	3.718	–0.140	0.020	0.039
1.906	4	7.624	–0.093	0.009	0.035
1.953	9	17.577	–0.046	0.002	0.019
2.000	20	40.000	0.001	0.000	0.000
2.047	10	20.470	0.048	0.002	0.023
2.094	3	6.282	0.095	0.009	0.027
2.141	2	4.282	0.142	0.020	0.040
2.188	0	0.000	0.189	0.036	0.000
n =	50	99.953			0.183

$$\bar{w} = \frac{1}{n}\sum_{i=1}^{n} w_i$$

$$\bar{w} = \frac{99.953}{50} = 1.999 \text{ mm}$$

$$s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(w_i - \bar{w})^2}$$

$$s = \sqrt{\frac{1}{49}\cdot 0.183} = 0.061$$

X1.2.2 Standard deviation $\sigma s = 0.061$ shall be compared with the value of $\sigma_x = 0.064$ given in Table 1, Column 12.

X2. CRITICAL AREA OF NORMAL DISTRIBUTION CURVE

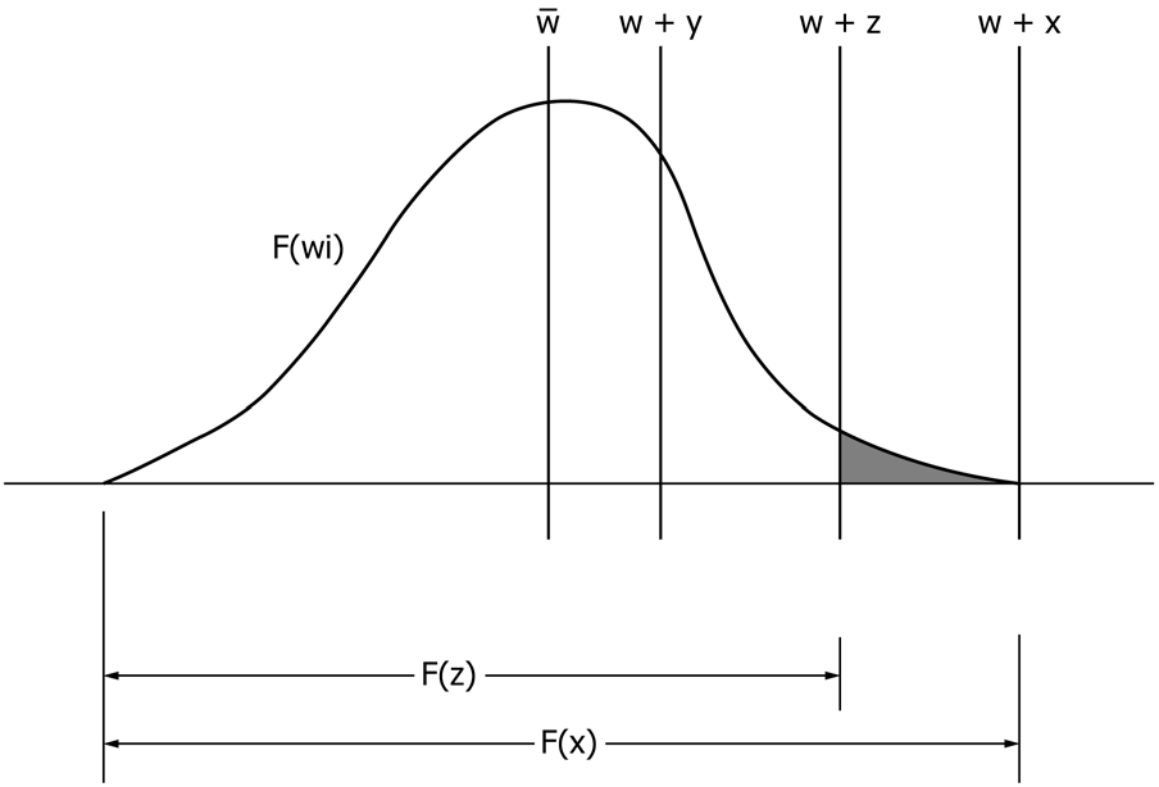


FIG. X2.1 Critical Area of Normal Distribution Curve

X3. K-FACTORS

TABLE X3.1 K Factors

Samples *n*	Xσ K-factors	
	2.58 99 %	3.00 99.73 %
15	1.49	1.57
20	1.42	1.49
25	1.37	1.43
30	1.34	1.39
40	1.29	1.34
50	1.26	1.30
60	1.24	1.28
80	1.21	1.24
100	1.18	1.21
120	1.17	1.19
160	1.14	1.17
200	1.13	1.15
250	1.12	1.13
300	1.11	1.12

Reference: Courtesy of Professor Aridaman K. Jain, New Jersey Institute of Technology, 2008. The acceptance confidence levels 2.58 and 3.00 are conservative as applied to the inspection of sieves, and the large sample K-factors are derived by using the normal distribution as an approximation to a Chi-square distribution for the sample variance.

X4. STANDARD DEVIATION OF THE TRUNCATED NORMAL DISTRIBUTION CURVE

(courtesy of Professor Ji Meng Loh, New Jersey Institute of Technology, 2015)

X4.1 The stated requirement is that the probability of the area under the truncated normal curve from 0 to $w + X$ minus the probability of the area under the truncated normal curve from 0 to $w + Z$ is equal to 0.05, expressed where N^* is the truncated normal variable within the interval $(0, w + X)$ as:

$$P(N^* < w + X) - P(N^* < w + Z) = 0.05$$

X4.2 Then, the probability density function of a truncated normal can be related to the density of the regular normal by rescaling the truncated normal density by a factor, such that where N is the regular normal variable with mean w and standard deviation σ the scaling factor is:

$$P(N < w + X) - P(N < 0)$$

X4.3 Multiplying by this factor to change N^* to N, the equation becomes:

$$P(N^* < w + X) - P(N^* < w + Z) = \frac{P(N < w + X) - P(N < w + Z)}{P(N < w + X) - P(N < 0)}$$

X4.4 Then standardizing where Φ is the standard normal cumulative distribution function with mean = 0 and variance = 1 results in:

$$= \frac{\Phi\left(\frac{X}{\sigma}\right) - \Phi\left(\frac{Z}{\sigma}\right)}{\Phi\left(\frac{X}{\sigma}\right) - \Phi\left(\frac{-w}{\sigma}\right)}$$

X4.5 Hence, we solve for the value of σ so that:

$$\frac{\Phi\left(\frac{X}{\sigma}\right) - \Phi\left(\frac{Z}{\sigma}\right)}{\Phi\left(\frac{X}{\sigma}\right) - \Phi\left(\frac{-w}{\sigma}\right)} = 0.05$$

SUMMARY OF CHANGES

Committee E29 has identified the location of selected changes to this standard since the last issue (E11 – 16) that may impact the use of this standard. (Approved April 1, 2017.)

(1) Added a reference for Manual 32 which was inadvertently omitted in the version balloted.
(2) Revised Table 1, column 2b, heading from "Metric Alternative" to "Supplementary Size" as better description.
(3) Revised Table 1 to include Supplementary Size designations 112, 80, and 71 mm previously omitted.
(4) Revised 5.1 and A1.1.3 to correct from 63 to 71 micrometres, sieve cloth that may be supplied as twill, which corresponds with the 71 designation in Table 1.
(5) Revised explanation notes in Fig. A1.2 and Fig. A1.3 for clarification.
(6) Revised A1.1.3 to include information regarding sampling of apertures for large diameter sieves with large openings, to be in alignment with ISO 3310.
(7) Revised A1.1.4 to correct regarding the number of wire diameters inspected (from 10 to same as the number of openings), which corresponds with 6.2.2.

Committee E29 has identified the location of selected changes to this standard since the last issue (E11 – 15) that may impact the use of this standard. (Approved Aug. 1, 2016.)

(1) Revised Table 1 to add the 'Metric Alternative' designations column with corresponding tolerance data for alignment with ISO 3310.
(2) Revised Table 2 to change heading to 'Diameter Tolerance.'
(3) Revised Eq 1 and Eq 2 to reduce the maximum average opening size by 10 % for alignment with ISO 3310.
(4) Revised 6.1.5 to calculate new maximum standard deviation values based on a one-sided truncated normal Gaussian distribution curve, which while having minimal impact on tolerances, is more technically correct.
(5) Revised 6.2.1 and 6.2.2 to clarify the measurement and tolerance of the wire diameter; specifically that the average wire diameter shall be calculated based on the same number of samples as the apertures and shall fall between the tolerance d min. and d max.
(6) Revised Appendix X1 to correct equations for mean, summation of w not of $n - w$, and correct termination of square root sign in equation for standard deviation.
(7) Added Appendix X4 detailing the derivation of the new maximum standard deviation values.