Designation: D 2947 – 88 (Reapproved 2002)

Standard Test Method for Screen Analysis of Asbestos Fibers[1]

This standard is issued under the fixed designation D 2947; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a dry screen analysis for asbestos fiber by means of a mechanical sieve shaker.

1.2 This test method is limited in its application to Group 4 and shorter chrysotile asbestos fiber samples[2] as defined in Test Method D 3639. However, some short amphibole asbestos fibers may be suitable for evaluation by this method.

1.3 The values stated in SI units are standard. The inch-pound (customary) units in brackets are presented for information only.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 2590 Test Method for Sampling Chrysotile Asbestos[3]

D 2946 Terminology for Asbestos and Asbestos-Cement Products[3]

D 3639 Test Method for Classification of Asbestos by Quebec Standard Test[3]

D 3879 Test Method for Sampling Amphibole Asbestos[3]

E 11 Specification for Wire Cloth and Sieves for Testing Purposes[4]

E 177 Practice for the Use of the Terms Precision and Bias in ASTM Test Methods[4]

3. Summary of Method

3.1 The procedure consists of screening a test specimen through a specified nest of sieves by means of a mechanical sieve shaker that reproduces the circular and tapping motion given testing sieves in hand-sieving, but with a uniform, mechanical action, assuring more accurate and dependable tests.

4. Significance and Use

4.1 Test results give some indication of the apparent fiber length distribution in the sample tested.

4.2 Sieves are ideally suited to measure particle size and particle size distribution when all three axes of the particle are equidimensional or the particle is of spherical shape. Asbestos fibers differ considerably from these ideal conditions and, therefore, results depart from a true measure of fiber length and length distribution.

4.3 Characteristics that influence screening efficiency influence test results. Among these are moisture content, degree of fiberization, harshness, and the tendency for fibers to cling together, and of short fibers and fines to cling to longer fibers.

4.4 In spite of its shortcomings, this test method is particularly useful because of its simplicity and speed and satisfactory reproducibility.

4.5 The test is suitable for specification acceptance and manufacturing control.

5. Apparatus

5.1 *Sieve Shaker*[5] for 200-mm (8-in.) diameter sieves that impart the screening and tapping action found necessary for this asbestos application.

5.1.1 The shaker shall be mounted on a suitable firm foundation, preferably concrete.

5.1.2 The eccentric shaft shall rotate at a speed of 285 ± 5 r/min. The machine shall be geared to give 152 taps/min when the eccentric shaft rotates at 285 r/min.

5.1.3 The plate supporting the nest of sieves must be set to give a clearance of 2.4 ± 0.8 mm (3⁄32 ± 1⁄32 in.) between the top of the cast iron cover and the bottom of the stops on the carrying plate (dimension *A* in Fig. 1). This clearance is sufficient to allow the nest of sieves to be easily set in place and to rotate freely when the shaker is in operation. It is important that this gap be checked periodically in order to maintain proper sieving action.

5.1.4 The cast iron cover for the nest of sieves shall be fitted with a standard No. 9 rubber stopper made of neoprene or other elastomer of equal elasticity.

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[1] This method is under the jurisdiction of ASTM Committee C17 on Fiber-Reinforced Cement Products and is the direct responsibility of Subcommittee C17.03 on Asbestos-Cement Sheet Products and Accessories.

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[2] Quebec Asbestos Mining Assn. (QAMA) standard designation of chrysotile asbestos grades.

[3] *Annual Book of ASTM Standards,* Vol 04.05.

[4] *Annual Book of ASTM Standards,* Vol 14.02.

[5] The Tyler Ro-Tap has been found satisfactory for this purpose. The criteria, settings, and adjustments specified in 5.1.2 to 5.1.6 have been found to provide reproducible results with this unit. Any other mechanical shaker that imparts to the nest of sieves a motion identical to that of this device, and that can reproduce results achieved with the Ro-Tap would be acceptable as being equivalent thereto.

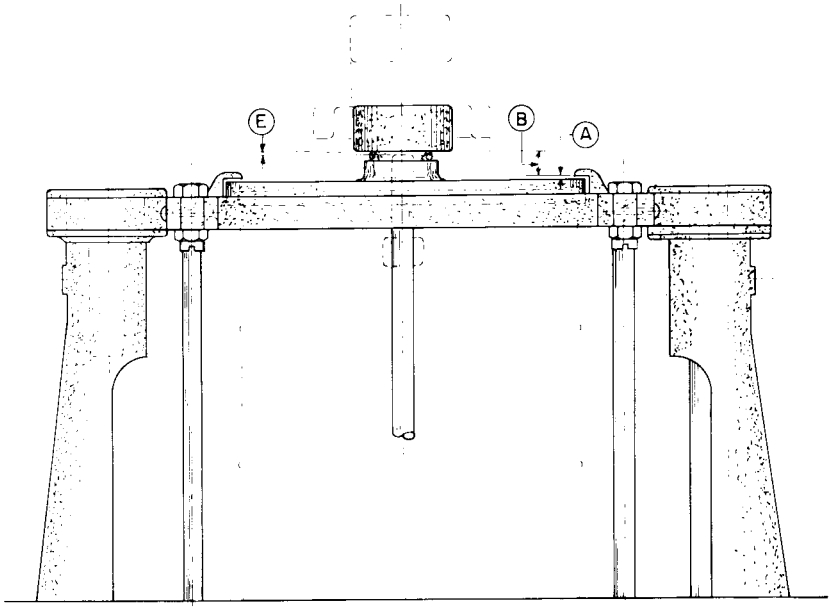

FIG. 1 Sieve Shaker

5.1.5 The height of the stopper above the top of the cast iron cover plate shall be 25.4 ± 3.2 mm (1 ± ⅛ in.) (dimension *A* plus *B* in Fig. 1) measured with the hammer resting on the stopper. With a new stopper this measurement should be taken only after the machine has been in operation for a few hours and should be set as closely as possible to the maximum setting of 28.6 mm (1⅛ in.).

5.1.6 The center of the hammer is a point in the center of the face 244.5 ± 0.4 mm (9⅝ ± 1/64 in.) from the center of the hammer pin. The hammer drop, measured from the center of the hammer in its highest position to the top of the stopper, shall be 34.9 ± 3.2 mm (1⅜ ± ⅛ in.). The hammer drop may be adjusted by adjustments in the top end of the push rod (Fig. 2) or adjustments in the location of the push rod collar, or by both adjustments. A minimum clearance of 1.6 mm (1/16 in.) between the push rod and the hammer in its lower position (dimension *E* in Fig. 1) should be maintained.

5.1.7 *Automatic Timer or Timeswitch* to energize the shaker with an accuracy of ±5 s, on periods extending from 10 to 30 min.

5.2 *Sieves*:

5.2.1 Standard 20 cm (8-in.) diameter covers, sieve frames, and pans shall be used. Sieve frames and pans shall be full height. Wire cloth of sieves, covers, frames and pans shall conform to Specification E 11, except that stainless steel may be used in place of sheet brass if desired. Alternatively, equivalent Tyler Standard Sieves may be used.

5.2.2 If calibration and standardization are desired, proceed as in the appendixes to Specification E 11.

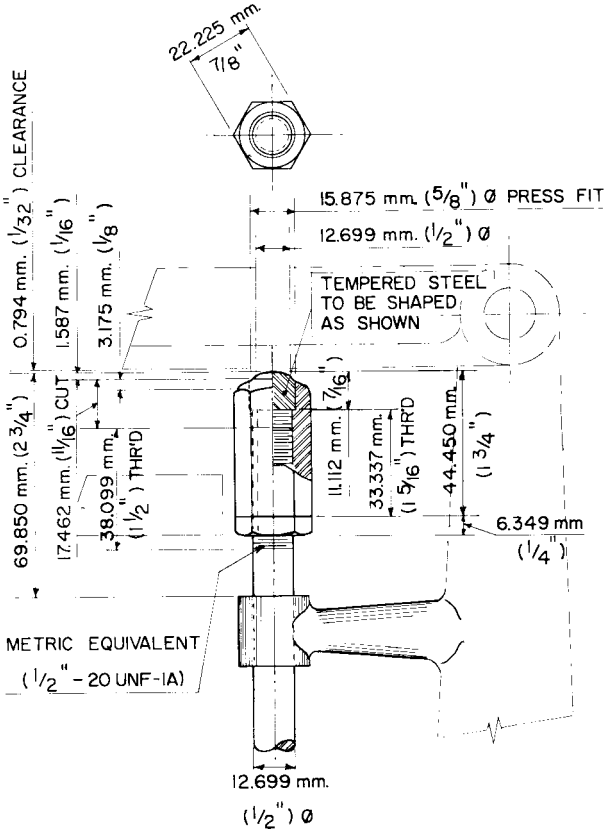

FIG. 2 Adjustable Push Rod

6. Sampling

6.1 Select samples in accordance with Test Method D 2590 for chrysotile fibers or Test Method D 3879 for amphibole fibers. If in doubt as to the type of fiber refer to the detailed descriptions of chrysotile and of commercially important amphibole fibers given in Terminology D 2946. (**Warning**—When handling asbestos fibers, use reasonable precautions to avoid creating dust. Prolonged or frequent breathing of significant concentrations of airborne asbestos dust may cause serious bodily harm.)

7. Test Specimens, Screen Sizes and Test Duration

7.1 The sample size, series of sieves, and test duration for the particular grade to be tested are shown in Table 1.

TABLE 1 Sieve Sizes, Specimen Mass and Test Duration

	Grade[A]			
	4	5	6 and 7D	7 except 7D
Sieve series, mm	6.73	...	...	...
	4.76	4.76	...	...
	3.36	3.36	3.36	3.36
	1.68	1.68	1.68	...
	...	...	1.19	1.19
Sieve series, µm	841	841	841	841
	...	...	...	595
	420	420	420	420
	...	210	210	210
	pan	pan	pan	pan
Specimen Mass, g	50 ± 0.05	50 ± 0.05	100 ± 0.05	100 ± 0.05
Test Duration, min	10	10	10	30

Equivalent Sieve Series			
SI Sieve Openings		US Standard Series Alternative Sieve Designation	Tyler Series Mesh Designation
mm	µm		
6.73		0.265 in.	3
4.76		No. 4	4
3.36		6	6
1.68		12	10
1.19		16	14
...	841	20	20
...	595	30	28
...	420	40	35
...	210	70	65

[A] Quebec Asbestos Mining Association.

8. Procedure

8.1 Select a series of sieves corresponding to the grade of fiber to be tested as listed in Table 1.

8.2 Nest the sieves in the order of decreasing opening sizes with the coarsest size on top, and a pan at the bottom.

8.3 Weigh the specimen to the mass indicated in Table 1 and place it on the uppermost sieve and close it with a sieve cover.

8.4 Set the cast iron cover in place on top of the sieve cover.

8.5 Place the sieve assembly in the shaker and lock it in position.

8.6 Start the sieve shaker and run it for the test duration specified in Table 1.

8.7 When the shaker has stopped, remove the sieves and weigh the contents of each to the nearest 0.1 g.

9. Report

9.1 Record the analysis in tabular form as the percentage by mass of material retained on each individual sieve and in the pan. Report the average of two acceptable results as defined in 10.4.1.

9.1.1 The particular sieve designation used or the nominal opening of each sieve shall be clearly indicated.

9.2 In addition, results may also be presented as cumulative percent retained, cumulative percent passing, or by graphical representation.

9.3 Fully identify the sample as to origin and grade designation.

9.4 If screen blinding or the formation of agglomerations of any kind due to the shaking action are encountered, remarks to this effect must be included in the report.

10. Precision and Bias

10.1 *Repeatability*—The single-operator, single apparatus repeatability is presented in Table 2 based upon five and two replicates. The latter is significant because two replicates are called for by this test method.

TABLE 2 Repeatability

Sieve Opening mm	Repeatability, %			
	Minimum		Maximum	
	5 Replicates	2 Replicates	5 Replicates	2 Replicates
6.73	0.71	1.6	22.7	51.2
4.76	0.78	1.8	6.6	15.2
3.36	0.92	2.0	5.9	12.8
1.68	0.77	1.7	5.6	12.4
1.19	1.74	3.9	8.4	18.8
841 µ m	0.82	1.8	4.4	9.7
595 µm	0.60	1.3	3.5	7.6
420 µm	0.33	0.7	0.8	1.7
210 µm	0.72	1.6	3.6	8.0

10.2 *Reproducibility*, (as defined in Practice E 177).

10.2.1 The intralaboratory multiple operator, apparatus and sample variation between two test results should not exceed the values presented in Table 3 in 95 % of cases.

TABLE 3 Reproducibility

Sieve Opening, mm	Reproducibility, %			
	Minimum		Maximum	
	5 Replicates	2 Replicates	5 Replicates	2 Replicates
6.73	0.80	1.6	25.6	51.2
4.76	1.83	2.4	15.5	20.3
3.36	1.46	2.3	9.3	14.7
1.68	2.36	2.8	17.1	20.3
1, 19	1.19	3.7	5.8	18.0
841 µm	0.47	1.7	2.5	9.0
595 µm	1.66	2.0	9.6	11.6
420 µm	0.43	0.8	1.0	1.9
210µ m	1.35	2.0	6.7	9.9

10.2.2 During the period 1961 to 1975, a fifteen year annual intralaboratory reproducibility study was carried out on 15 different samples of each of 91 chrysotile grades using multiple operators and apparatus. The ranges of statistics presented in Table 4 were obtained. The reproducibilities expressed as coefficients of variation are presented in Table 5 for each sieve and for each group of fibre grades.

10.3 *Bias*:

10.3.1 Bias cannot be established on asbestos fiber for lack of a suitable referee method.

10.3.2 Bias associated with each of the sieves used may be determined as described in the appendices to Specification E 11.

10.3.3 It has been observed that the retention of the fibers on each sieve may be a function of the degree to which the screen cloth is worn.

10.4 *Acceptance of Test Results*:

10.4.1 The acceptable variation in the cumulative total of the fractions weighed may not exceed ±1.0 %. In such a case, repeat the test.

11. Keywords

11.1 asbestos; fiber; fiber length distribution; Ro-Tap screen; screen analysis; sieving

TABLE 4 Ranges of Reproducibility Statistics

Grades and Quantity of Samples	Sieve Mesh mm	Range % retained		Standard Deviation, %		Variance range, %	
		min	max	min	max	min	max
Group 4	6.73	1.2	3.7	0.7	2.0	54.0	90.0
14 samples	4.76	2.3	16.1	0.6	3.25	14.9	61.5
	3.36	9.6	21.7	1.5	2.7	7.4	26.5
	1.68	29.4	42.6	1.0	8.3	2.4	28.2
	841 µm	13.0	26.0	1.2	2.3	5.5	11.5
	420µ m	4.6	15.8	0.7	2.0	7.6	17.8
	pan	4.4	11.6	0.8	2.6	13.7	25.6
Group 5	4.76	0.4	3.8	0.4	2.3	44.4	79.7
22 samples	3.36	0.45	15.4	0.35	3.5	12.3	85.7
	1.68	26.6	50.0	1.7	12.2	4.0	25.6
	841µ m	14.4	36.7	1.3	7.8	5.4	28.0
	420 µm	7.0	21.6	0.6	4.1	6.2	21.0
	210 µm	2.5	5.5	0.3	1.1	7.3	22.4
	pan	3.4	14.4	0.7	2.9	14.0	28.1
Group 6 and 7D	3.36	0.3	1.2	0.1	1.1	33.2	91.7
13 samples	1.68	8.6	27.4	1.9	6.2	13.8	36.5
	1.19	14.6	26.8	1.1	2.6	5.8	14.4
	841 µm	16.6	23.2	1.0	2.6	4.7	14.2
	420 µm	20.7	33.6	2.0	3.0	6.7	13.0
	210µ m	4.5	9.4	0.7	1.7	10.4	28.9
	pan	5.1	16.9	0.8	3.5	11.1	38.9
Group 7 except 7D	3.36	0	0	0	0	0	0
42 samples	1.19	0	3.6	0	2.8	0	120
	841µ m	0	12.8	0	2.6	0	100
	595 µm	0	28.8	0	3.8	0	100
	420 µm	1.6	38.0	0.7	7.6	4.2	76
	210 µm	7.3	64.8	0.7	9.7	4.9	26
	pan	11.9	67.7	1.5	9.8	2.6	28

TABLE 5 Reproducibility as Coefficient of Variation, %

Grades	4	5	6 and 7D	7 except 7D	7 floats	All Grades
Number of Samples	14	22	13	33	9	91
6.73 mm	66.5	...	...	...	...	66.5
4.76 mm	32.2	58.8	62.5	...	...	42.3
3.36 mm	20.6	49.0	62.5	...	...	41.9
1.68 mm	6.9	11.4	23.4	...	...	13.9
1.19 mm	...	...	9.4	50.4	...	29.9
841µ m	8.6	11.3	8.8	30.4	44.0	20.6
595 µm	...	...	...	18.3	57.5	37.9
420 µm	12.0	12.1	9.3	12.5	37.3	16.6
210µ m	...	17.8	17.1	13.7	12.9	15.4
pan	18.4	24.4	20.3	10.5	11.9	17.1