Designation: D1424 – 09 (Reapproved 2013)$^{\varepsilon 1}$

Standard Test Method for Tearing Strength of Fabrics by Falling-Pendulum (Elmendorf-Type) Apparatus[1]

This standard is issued under the fixed designation D1424; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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

ε[1] NOTE—In Table A3.1, typographical errors in the Useable Test Ranges were corrected editorially in January 2015.

1. Scope

1.1 This test method covers the determination of the force required to propagate a single-rip tear starting from a cut in a fabric and using a falling-pendulum (Elmendorf-Type) apparatus.

1.2 This test method applies to most fabrics including woven, layered blankets, napped pile, blanket, and air bag fabrics, provided the fabric does not tear in the direction crosswise to the direction of the force application during the test. The fabrics may be untreated, heavily sized, coated, resin-treated, or otherwise treated. Instructions are provided for testing specimens with, or without, wetting.

1.3 This test method is suitable only for the warp direction tests of warp-knit fabrics. It is not suited for the course direction of warp knit fabrics or either direction of most other knitted fabrics.

1.4 The values stated in either SI units or U.S. customary units are to be regarded as standard, but must be used independently of each other. The U.S. customary units may be approximate.

1.5 *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:*[2]

D123 Terminology Relating to Textiles
D629 Test Methods for Quantitative Analysis of Textiles
D1776 Practice for Conditioning and Testing Textiles
D2261 Test Method for Tearing Strength of Fabrics by the Tongue (Single Rip) Procedure (Constant-Rate-of-Extension Tensile Testing Machine)
D2904 Practice for Interlaboratory Testing of a Textile Test Method that Produces Normally Distributed Data (Withdrawn 2008)[3]
D2906 Practice for Statements on Precision and Bias for Textiles (Withdrawn 2008)[3]
D4848 Terminology Related to Force, Deformation and Related Properties of Textiles
D4850 Terminology Relating to Fabrics and Fabric Test Methods
D5587 Test Method for Tearing Strength of Fabrics by Trapezoid Procedure

3. Terminology

3.1 For all terminology relating to D13.59, Fabric Test Methods, General, refer to Terminology D4850.

3.2 For all terminology relating to Force, Deformation and Related Properties in Textiles, refer to Terminology D4848.

3.2.1 The following terms are relevant to this standard: cross-machine direction, CD, length of tear, machine direction, MD, tearing energy, tearing force, tear resistance, tearing strength, fabric.

3.3 For all other terminology related to textiles, refer to Terminology D123.

4. Summary of Test Method

4.1 A slit is centrally precut in a test specimen held between two clamps and the specimen is torn through a fixed distance. The resistance to tearing is in part factored into the scale reading of the instrument and is computed from this reading and the pendulum capacity.

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.60 on Fabric Test Methods, Specific.

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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] The last approved version of this historical standard is referenced on www.astm.org.

5. Significance and Use

5.1 This test method for the determination of tearing strength by the falling pendulum type apparatus is used in the trade for the acceptance testing of commercial shipments of fabrics, but caution is advised since technicians may fail to get good agreement between results on certain fabrics. Comparative tests as directed in 5.1.1 may be needed.

5.1.1 In case of a dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens that are as homogeneous as possible and that are from a lot of fabric of the type in question. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using appropriate statistical analysis and an acceptable probability level chosen by the two parties before the testing began. If a bias is found, either its cause must be found and corrected or the purchaser and the supplier must agree to interpret future test results with consideration to the known bias.

5.2 Microprocessor systems for automatic collection of data can provide economical and reliable results when properly calibrated. See Test Methods D2261 and D5587.

6. Apparatus

6.1 *Falling-Pendulum (Elmendorf-Type) Tester*[4]—The tester includes: a stationary clamp, a clamp carried on a pendulum that is free to swing on a bearing, means for leveling as applicable, means for holding the pendulum in a raised position, means for instantly releasing the pendulum, and means for measuring the force to tear the test specimen.

6.1.1 A knife can be mounted on a stationary post for initial slitting of the specimens centered between the clamps and adjusted in height to give a tearing distance of 43.0 ± 0.15 mm (1.69 ± 0.005 in.); that is, the distance between the end of the slit made by the knife and the upper edge of the specimen is 43.0 ± 0.15 mm (1.69 ± 0.005 in.) when the lower edge of the 63.0-mm (2.5 ± 0.005 in.) wide specimen rests against the bottom of the clamp.

6.1.2 With the pendulum in its initial position ready for a test, the two clamps are separated by a distance of 2.5 ± 0.25 mm (0.1 ± 0.01 in.) and are aligned such that the clamped specimen lies in a plane parallel to the axis of the pendulum, the plane making an angle of 0.480 rad (27.5 ± 0.5°) with the perpendicular line joining the axis and the horizontal line formed by the top edges of the clamping jaws. The distance between the axis and the top edges of the clamping jaws is 103± 0.1 mm (4.055 ± 0.004 in.). The clamping surface in each jaw is at least 25 mm (1.0 in.) wide and 15.9 ± 0.1 mm (0.625 ± 0.004 in.) deep.

6.1.3 The tester may have a pointer mounted on the same axis as the pendulum to register the tearing force, or it may be substituted by means of calculating and displaying the required results without the use of a pointer, such as digital display and computer driven systems. Preferably the clamps may be air actuated, but manual clamping is permitted.

6.1.4 The test instrument should be equipped to provide interchangeable full scale force ranges. Typical full scale ranges are shown in Table A3.1.

6.2 *Calibration Weight(s)* for graduation of 50 % of the full scale force range, or other means as described by the manufacturer of the test apparatus.

6.3 *Cutting Die* having essentially the shape and dimensions shown in Fig. 1(a) or (b). Either die provides the basic rectangular test specimen 100 ± 2 mm (4 ± 0.05 in.) long by 63 ± 0.15 mm (2.5 ± 0.005 in.) wide, along with additional fabric at the top edge of the specimen to help ensure the bottom portion of specimen will be torn during the test. The critical dimension of the test specimen is the distance 43.0 ± 0.15 mm (1.69± 0.005 in.) which is to be torn during the test.

NOTE 1—The improved die model shown in Fig. 1(a) has two new features not found in the original model, Fig. 1(b), namely a cutout for the bottom of the specimen to aid in centering it in the clamps, and (optional) provision for cutting the 20.0 mm (0.75 in.) slit prior to inserting the specimen in the tester. These dies can be made to order by most die manufacturers.

6.4 *Air Pressure Regulator,* capable of controlling gage air pressure between 410 kPa and 620 kPa (60 psi and 90 psi), when applicable, for air clamps.

6.5 *Setting Gage for Cutting Blade* that will provide a cut slit that leaves a 43 ± 0.15 mm (1.69 ± 0.005 in.) specimen tearing distance for a 63 ± 0.15 mm (2.5 ± 0.005 in.) wide specimen, or equivalent.

6.6 *Jaw Spacing Gage* 2.5 ± 0.25 mm (0.1 ± 0.01 in.) width, or equivalent.

6.7 *Oil,* light weight, non-gumming clock type.

6.8 *Silicone Grease,* when applicable, for air clamp lubrication.

6.9 *Vacuum Cleaner,* when applicable, for cleaning dust and fiber from sensor, or equivalent.

7. Sampling and Test Specimens

7.1 *Lot Sample*—As a lot sample for acceptance testing, randomly select the number of rolls or pieces of fabric directed in an applicable material specification or other agreement

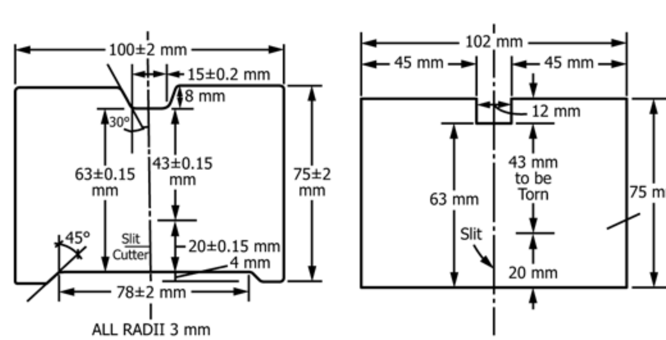

FIG. 1 Die Diagram for Cutting Notched Specimens

[4] Apparatus is commercially available.

between the purchaser and the supplier. Consider the rolls or pieces of fabric to be the primary sampling units. In the absence of such an agreement, take the number of fabric rolls or pieces specified in Table 1.

NOTE 2—An adequate specification or other agreement between the purchaser and supplier requires taking into account the variability between rolls or pieces of fabric and between specimens from a swatch from a roll or piece of fabric to provide a sampling plan with a meaningful producer's risk, consumer's risk, acceptable quality level, and limiting quality level.

7.2 *Laboratory Sample*—For acceptance testing, take a swatch extending the width of the fabric and approximately 1 m (1 yd) along the machine direction from each roll or piece in the lot sample. For rolls of fabric, take a sample that will exclude fabric from the outer wrap of the roll or the inner wrap around the core of the roll of fabric.

7.3 *Test Specimens*—From each laboratory sampling unit, take five specimens from the machine direction and five specimens from the cross-machine direction, for each test condition described in 9.1 and 9.2, as applicable to a material specification or contract order.

7.3.1 *Direction of Test*—Consider the long direction of the specimen as the direction of test.

7.3.2 *Cutting Test Specimens*—Take the specimens to be used for the measurement of machine direction with the longer dimension parallel to the machine direction. Take the specimens to be used for the measurement of the cross-machine with the longer dimension parallel to the cross-machine direction. Use the cutting die described in 6.3 and shown in Fig. 1(a) or (b), as applicable. When specimens are to be tested wet, cut from areas adjacent to the dry test specimens. Label to maintain specimen identity.

7.3.2.1 In cutting the woven fabric specimens, take care to align the yarns running in the short direction parallel with the die such that when the slit is cut, the subsequent tear will take place between these yarns and not across them. This precaution is most important when testing bowed fabrics.

7.3.2.2 Cut specimens representing a broad distribution across the width and length, and preferably along the diagonal of the laboratory sample, and no nearer the edge than one-tenth its width. Ensure specimens are free of folds, creases, or wrinkles. Avoid getting oil, water, grease, etc. on the specimens when handling.

NOTE 3—The reading obtained is directly proportional to the length of the material torn, therefore, it is essential that the specimen be prepared to the exact size specified.

8. Preparation of Apparatus and Calibration

8.1 Select test instrument force range, such that the tear occurs between 20 and 80 % or 20 and 60 % of the full-scale range as applicable. Ensure the clamps are spaced as directed in A1.4.

TABLE 1 Number of Rolls or Pieces of Fabric in the Lot Sample

Number of Rolls or Pieces in Lot, Inclusive	Number of Rolls or Pieces in Lot Sample
1 to 3	all
4 to 24	4
25 to 50	5
over 50	10 % to a max of 10 rolls or pieces

NOTE 4—For standard test apparatus, the useable portion of the full scale force range is 20 to 80 %. For the high capacity test instrument, the useable portion of the full scale force range is 20 to 60 %.

8.2 When equipped with a registering sensor, examine the scale and the complementary sensor, as applicable. Using care and without touching the sensor, vacuum away any loose fibers and dust.

8.3 Examine the knife edge for sharpness, wear, and central alignment as directed in A1.5 – A1.7.

8.4 For air clamps, set the air gage pressure to the clamps to about 550 kPa (80 psi).

8.4.1 Maximum gage pressure should be no more than 620 kPa (90 psi) and minimum gage pressure no less than 410 kPa (60 psi).

8.5 When using microprocessor automatic data gathering systems, set the appropriate parameters as defined in the manufacturer's instructions.

8.6 Verify the calibration of the selected pendulum full scale force range using the procedure described in Annex A2, unless otherwise specified.

9. Conditioning

9.1 *Condition 1, Standard Testing Conditioning:*

9.1.1 Precondition the specimens by bringing them to approximate moisture equilibrium in the standard atmosphere for preconditioning textiles as directed in Practice D1776, unless otherwise directed in a material specification or contract order.

9.1.2 After preconditioning, bring the test specimens to moisture equilibrium for testing in the standard atmosphere for testing textiles as directed in Practice D1776 or, if applicable, in the specified atmosphere in which the testing is to be performed, unless otherwise directed in a material specification or contract order.

9.2 *Condition 2, Wet Specimen Testing Conditioning:*

9.2.1 When desizing treatments are specified prior to wet testing, use desizing treatments that will not affect the normal physical property of the fabric as directed in Test Method D629.

9.2.2 Submerge the specimens in a container of distilled or deionized water at ambient temperature until thoroughly soaked (see 8.2.1.1).

9.2.2.1 The time of immersion must be sufficient to wet out the specimens, as indicated by no significant change in tearing force followed by longer periods of immersion. For most fabrics this time period will be about 1 h. For fabrics not readily wet out with water, such as those treated with water-repellent, or water resistant materials, add a 0.1 % solution of a nonionic wetting agent to the water bath.

10. Procedure

10.1 Test the conditioned specimens in the standard atmosphere for testing textiles, which is 21 ± 1°C (70 ± 2°F) and 65 ± 2 % relative humidity, unless otherwise directed in a material specification or contract order.

10.2 Position the pendulum to the starting position and the force recording mechanism to its zero-force position.

10.3 *For Tester-Slit Specimens:*

10.3.1 Place the long sides of the specimen centrally in the clamps with the bottom edge carefully set against the stops and the upper edge parallel to the top of the clamps. Close the clamps, securing the specimen with approximately the same tension on both clamps. The specimen should lie free with its upper area directed toward the pendulum to ensure a shearing action.

10.3.2 Using the built-in knife blade cut a 20 mm (0.787 in.) slit in the specimen extending from the bottom edge and leaving a balance of fabric 43.0 ± 0.15 mm (1.69 ± 0.005 in.) remaining to be torn.

10.4 *For Die-Cut or Manually Slit Specimens:*

10.4.1 If a die without a slit is used, manually cut a 20 mm (0.787 in.) long slit in the center of one edge of the long direction of the specimen. Ensure that the balance of the fabric remaining to be torn is 43 ± 0.15 mm (1.69 ± 0.005 in.).

NOTE 5—The length of the cut is important, see Note 3.

10.4.2 Place the parallel, unslit sides of the specimen in the clamps with the bottom edge carefully set against the stops, the upper edge parallel to the top of the clamp and the slit centrally located between the clamps. Close the clamps, securing the specimen with approximately the same tension on both clamps. The specimen should lie free with its upper area directed toward the pendulum to ensure a shearing action.

10.5 *For Wet Specimen Testing:*

10.5.1 Remove a specimen from the water and immediately mount it on the testing machine in the normal set-up. Perform the test within 2 min after removal of the specimen from the water. Otherwise, discard the specimen and replace with another one.

10.6 Depress the pendulum stop downward to its limit and hold it until the tear is completed and the pendulum has completed its forward swing. Catch the pendulum just after the threshold of its backward swing and return to its locked starting position. When equipped, be careful not to disturb the position of the pointer. Record the scale reading required to completely tear the test specimen.

10.6.1 The decision to discard the results of a tear shall be based on observation of the specimen during a test and upon the inherent variability of the material. In the absence of other criteria, such as in a material specification, if an unusual cause is detected, the value may be discarded and another specimen tested.

10.6.2 Reject readings obtained where the specimen slips in the jaw or where the tear deviates more than 6 mm (0.25 in.) away from the projection of the original slit. Note when puckering occurs during the test.

10.6.3 For microprocessor systems, follow the manufacturer's directions for removing values from memory when the decision to discard a tear value has been made. Otherwise, for some test instruments manual calculation of the average is required.

10.6.4 If, during the test, the scale reading does not reach 20 % or reaches over 80 % (60 % when applicable, see Table A3.1) of full scale range, change to the next lower or higher full scale range, as applicable. See 8.6.

10.6.5 Record if the tear was cross-wise to the normal (parallel) direction of tear and report that specimen, or that sample, as applicable, as untearable.

10.7 Remove the torn specimen and continue until five tears have been recorded for each test direction and test condition, as required, from each laboratory sampling unit.

11. Calculations

11.1 *Tearing Force, Individual Specimens:*

11.1.1 *Standard Test Instrument*—Determine the tearing force for individual specimens to the nearest 1 % of full-scale range using Eq 1.

$$F_t = R_s \times C_s/100 \tag{1}$$

where:

F_t = tearing force, cN (gf) or lbf,
R_s = scale reading,
C_s = full scale capacity, cN (gf) or lbf.

11.1.2 *Heavy Duty Test Instrument*—Determine the tearing force for individual specimens to the nearest 1 % of full-scale range using Eq 2.

$$F_t = R_s \times 100 \tag{2}$$

where:

F_t = tearing force, cN (gf) or lbf, and
R_s = scale reading, cN (gf) or lbf.

11.2 *Tearing Strength*—Calculate the tearing strength as the average tearing force for each test direction and testing condition of the laboratory sampling unit and for the lot, to the nearest 1 % of full-scale range in cN, (gf) or lbf.

11.3 *Standard Deviation and Coefficient of Variation*—Calculate when requested.

11.4 *Computer-Processed Data*—When data are automatically computer-processed, calculations are generally contained in the associated software. Record values as read from the direct reading scale to the nearest mN (gf). In any event, it is recommended that computer-processed data be verified against known property values and its software described in the report.

12. Report

12.1 Report that the Elmendorf tearing strength was determined as directed in Test Method D1424. Describe the fabric or product sampled and the method of sampling used.

NOTE 6—Some instruments may require different calculations than percentage of scale. In those cases, refer to manufacturer's recommended calculations.

12.2 Report the following information for each laboratory sampling unit and for the lot as applicable to a material specification or contract order.

12.2.1 Elmendorf tearing strength for each test direction and testing condition, as requested.

12.2.2 Condition of test (with or without wetting).

12.2.3 Puckering, if it occurs during the test.

12.2.4 Number of tests rejected because of crosswise tearing.

12.2.5 When calculated, the standard deviation or the coefficient of variation.

TABLE 2 Elmendorf Tear Strength, g

Machine Type and Materials[B]	Number of Observations in Each Average	Single-Operator Precision	Within-Laboratory Precision	Between-Laboratory Precision
	Critical Differences for the Conditions Noted[A]			
Standard Machine				
Plain, spun yarns, MAT 2	1	556	556	632
	2	393	393	495
	5	249	249	391
	10	176	176	349
Plain, spun yarns, MAT 4	1	135	146	184
	2	95	111	158
	5	60	83	140
	10	43	72	133
Plain, cont. fil. yarns, MAT 5	1	538	557	765
	2	380	407	664
	5	240	281	595
	10	170	224	570
Heavy Duty Machine				
Twill, spun yarns, MAT 1	1	405	482	497
	2	286	387	406
	5	181	317	340
	10	128	290	315
Plain, spun yarns, MAT 3	1	934	934	1280
	2	660	660	1097
	5	418	418	970
	10	295	295	924
Denin twill, spun yarns, MAT 9	1	561	653	1478
	2	397	519	1224
	5	251	418	1390
	10	177	378	1379

[A] The critical differences were calculated using $t = 1.960$, which is based on infinite degrees of freedom.
[B] See 13.2 and 13.3 for additional material description.

12.2.6 For computer-processed data, identify the program (software) used.

12.2.7 Make, model and capacity of testing machine.

12.2.8 Type of clamps used, manual or pneumatic (including pressure).

12.2.9 Any modification of the test method.

13. Precision and Bias

13.1 *Summary*—In comparing two averages, the differences should not exceed the single-operator precision values shown in Table 2 for the respective number of tests, and for fabrics having averages similar to those shown in Table 2, in 95 out of 100 cases when all the observations are taken by the same well-trained operator using the same piece of equipment and specimens are randomly drawn from the sample of fabric. Larger differences are likely to occur under all other circumstances.

13.2 *Elmendorf Tearing Strength, Standard Equipment, Interlaboratory Test Data*—An interlaboratory test was run in 1994–1995 in which randomly-drawn samples of three fabrics were tested in each of eleven laboratories. Two operators in each laboratory each tested eight specimens of each fabric using Test Method D1424. Four of the eight specimens were tested on one day and four specimens were tested on a second day. Analysis of the data was conducted using the Practice D2904 and Practice D2906. The components of variance for Elmendorf tear strength expressed as standard deviations were calculated to be the values listed in Table 3. The three woven fabric types were:

(1) Material 2—S/1016H, 2/1 basket plain weave sheeting, with spun yarns,

(2) Material 4—S/0008H, plain weave sheeting, with spun yarns,

(3) Material 5—S/2438, plain weave, oxford, spun yarns.

13.3 *Elmendorf Tearing Strength, Heavy Duty Equipment, Interlaboratory Test Data*—An interlaboratory test was run in 1994 in which randomly-drawn samples of three fabrics were tested in six laboratories. Two operators in each laboratory each tested eight specimens of each fabric using Test Method D1424. Four of the eight specimens were tested on one day and four specimens were tested on a second day. Analysis of the data was conducted using Practice D2904 and Practice D2906. The components of variance for Elmendorf tear strength expressed as standard deviations were calculated to be the values listed in Table 3. The three woven fabric types were:

(1) Material 1—S/179B, twill weave, with spun yarns,

(2) Material 3—S/1008H, plain weave sheeting, with spun yarns,

(3) Material 9—Denin, twill weave, with spun yarns.

13.4 *Precision*—For the components of variance reported in Table 3, two averages of observed values should be considered significantly different at the 95 % probability level if the difference equals or exceeds the critical differences listed in Table 2 for "Elmendorf" tear strength. There were sufficient differences related to the fabric type and structure to warrant listing the components of variance and the critical differences separately. Consequently no multi-fabric comparisons were made.

NOTE 7—The tabulated values of the critical differences should be

TABLE 3 Elmendorf Tear Strength, g

Machine Type and Materials[A]	Grand Average	Components of Variance Expressed as Standard Deviations[B]		
		Single-Operator Component	Within-Laboratory Component	Between Laboratory Component
Standard Machine				
Plain, spun yarns, MAT 2	1878	200	0	109
Plain, spun yarns, MAT 4	1246	49	21	40
Plain, cont. fil. yarns, MAT 5	3190	194	52	189
Heavy Duty Machine				
Twill, spun yarns, MAT 1	4707	146	94	44
Plain, spun yarns, MAT 3	5186	337	0	316
Denin twill, spun yarns, MAT 9	5264	202	120	478

[A] See 13.2 and 13.3 for additional material description.
[B] The square roots of the components of variance are being reported to express the variability in the appropriate units of measure rather than as the squares of those units of measure.

considered to be a general statement, particularly with respect to between-laboratory precision. Before a meaningful statement can be made about two specific laboratories, the amount of statistical bias, if any, between them must be established, with each comparison being based on recent data obtained on specimens taken from a lot of fabric of the type being evaluated so as to be as nearly homogeneous as possible and then randomly assigned in equal numbers to each of the laboratories.

13.5 *Bias*—The value of Elmendorf tear strength can only be defined in terms of a test method. Within this limitation, Test Method D1424 has no known bias.

14. Keywords

14.1 Elmendorf; fabric; strength; tear

ANNEXES

(Mandatory Information)

A1. ADJUSTMENT OF APPARATUS: USE THE FOLLOWING INFORMATION AS APPLICABLE

A1.1 *Instrument Mounting*—Place the tester on a sturdy, level bench (or table). Ensure that there is no perceptible movement of the tester base or bench during the swing of the pendulum. Movement of the instrument during the swinging of the pendulum is a significant source of error.

A1.2 *Instrument Balance*—Level the instrument such that, with the sector free, the line on the sector indicating that vertical from the point of suspension is bisected by the edge of the pendulum stop mechanism. Verify this by holding down the pendulum stop and allowing the pendulum to swing free. When the pendulum comes to rest, the positioning line at the center of the pendulum should be directly above the edge of the pendulum stop. Align, if necessary, by turning the leveling thumb screw at the left end of the tester base.

A1.3 *Clamp Alignment*—Raise the pendulum and position the lower edge against its stop. Visually check the alignment of the clamps. If the clamps are not in alignment, replace the pendulum stop or the pendulum bearing and shaft assembly, or both, following the manufacturer's instructions.

A1.4 *Clamp Space Setting, Interchangeable Pendulums*—Set the jaw spacing to 2.5 ± 0.25 mm (0.1 ± 0.01 in.). Loosen the shoulder head screw on top of the pendulum support. With both clamps in the open position, gently pull the pendulum out until the jaw spacer gage will fit into the grips. Gently push the pendulum in until the jaw spacer gage has just enough clearance to slide out the top of the clamps. With the jaw spacer in place, tighten the shoulder head screw on the pendulum support. Remove the jaw spacer gage.

A1.5 *Knife Sharpness*—Check the sharpness of the knife by inserting a spare specimen in the clamps and cutting a slit with the knife blade in the normal manner. If the knife is dull it will produce a V-notch near the top of the cut and push the material outward. When the knife is determined to be dull, sharpen it with a rough stone, alternately, continuing specimen knife cuts, until no V-notch is observed. Replace the knife blade if necessary.

A1.6 *Knife Alignment*—Check that the knife position is centrally located between the clamps. If the knife cannot be positioned centrally, replace one or any combination of: the pendulum bearing and shaft assembly, the cutter handle, the cutter handle bearing pin, knife blade.

A1.7 *Specimen Tearing Distance*—Check the specimen tearing distance with the knife setting gage. Place the gage in the stationary specimen clamp in the usual manner for testing fabric. Ensure the gage is positioned with the wide dimension upwards and the projection extending over the edge of the stationary clamp far enough such that the knife can be adjusted to the bottom edge of the gage. Adjust the knife position such that the highest point of the blade just touches the bottom edge of the gage and then secure it in place. Replace the knife when it no longer can be adjusted to the gage, or optionally.

A1.7.1 Check the tearing distance by using the die to cut a specimen from coordinate paper graduated in millimetres. Apply a small amount of graphite (from an ordinary lead pencil) to the cutting knife or the edge of the die used for cutting the slit so that when the cut is made some of the graphite transfers to the paper; this serves to contrast the cut from the uncut portion of the paper and facilitates the measurement. Make this measurement either with a precision steel rule graduated in 0.2 mm (0.01 in.) or better and, under magnification, or alternatively, by use of a go-no-go gage available from the manufacturer of the instrument. If necessary, adjust the height of the knife.

A1.7.2 Do not change the specimen dimensions to adjust the tear distance.

A1.8 *Main Bearing Friction*—Clean, oil and adjust the bearing. Raise the pendulum to its cocked position. When equipped, set the pointer against its stop. Press and hold down the pendulum stop and let the pendulum swing freely. Ensure the pendulum is free swinging and the calibration can be verified.

A1.9 *Scale Inspection*—When soiled, or calibration cannot be attained, clean the white area at the bottom of the pendulum with mild soap and water. Ensure the mirrored divisions of the scale are clean and free of any foreign matter. Ensure the black sensing strip on the pendulum is clean of fibers and not scratched. Blow off fibers and dust from the black strip using a low pressure air nozzle. When scratches are evident, touch up with flat black paint enamel.

A1.10 *Pendulum Stop Release*—Check the pendulum or the pendulum stop release for any wear, such as a notch, when a jerky release is observed. Adjust the height of the pendulum stop until a smooth release is obtained. If a smooth release cannot be obtained by this adjustment the pendulum or the pendulum stop may require repair or replacement. If the pendulum stop height is changed, verify clamp alignment and zero position.

A1.11 *Zero Pointer Stop*—Operate the leveled instrument several times with nothing in the clamps, the movable clamp being closed. If zero is not registered, adjust the pointer stop until the zero reading is obtained. Do not change the level to adjust the zero.

A1.12 *Pointer Friction*—Set the pointer at the zero reading on the scale before releasing the sector, and after the release, ensure that the pointer is not pushed more than three scale divisions (4 mm) or less than two scale divisions (2.5 mm) beyond the zero. If the pointer friction does not lie between two and three divisions, remove the pointer, wipe the bearing clean, and apply a trace of clock oil to the groove of the bearing. Reassemble and check pointer friction. Recheck zero and readjust the pointer stop if necessary.

A1.13 *Oil and Grease*—Apply a very small amount of clock oil in the groove of the bearing and sleeve assembly. Do not oil the flat surfaces of the bearing and sleeve assembly. Apply a small amount of silicone grease to the air clamp plunger rods.

A2. VERIFICATION OF PENDULUM FULL SCALE FORCE RANGE

A2.1 In some cases verification of the scale reading of the test instrument can be accomplished by weighing the pendulum weights following the manufacturer's instructions. In other cases, the procedure outlined in A2.2 has been used in the industry for some test apparatuses.

A2.1.1 For other methods of verification of the scale, refer to the manufacturer's instructions.

A2.2 Use a calibrated mass for a value of 50 % of the selected Elmendorf tester scale. Each capacity scale requires its own calibrated mass. For example, at 800 grams of the 1600 gram scale. The calibrated mass shall be constructed such that the mass can be inserted in the clamps in the same manner as used for a fabric specimen. Generally the bulk of the calibrated mass faces downward.

A2.2.1 Position the pendulum in its cocked position against its stop, set the digital readout, or pointer, to zero (0).

A2.2.2 Depress the pendulum stop downward to its limit and hold it until the pendulum has completed its forward swing. Catch the pendulum just after the threshold of its backward swing and return it to its locked starting position. The pointer, or when equipped, the digital readout should read 00.0. In any event, do not change the level of the instrument to adjust the zero. (See Annex A1, if adjustment is required.)

A2.2.2.1 For the pointer system, the pointer should not be pushed less than 2.5 mm nor more than 4.0 mm beyond zero. If zero is not registered, the pointer stop should be adjusted until the zero reading is obtained, otherwise service as directed in Annex A1.

A2.2.3 With the pendulum in the raised position, open the clamp of the pendulum, slide the 50 % check weight, generally with the bulk of the mass downward, into position and fasten it securely in the clamp.

A2.2.4 Depress the pendulum stop downward to its limit and hold it until the pendulum has completed its forward swing. Catch the pendulum just after the threshold of its backward swing and return to its locked starting position. The pointer, or when equipped, the digital readout should read 50 ± 0.5 %. (See Annex A1, if adjustment is required.)

A2.2.5 Remove the 50 % calibration mass, close the clamp, and when equipped, set the pointer to zero (0).

A2.2.6 For pointer system, if zero (00.0) and 50 % readings are not obtained, clean and oil bearing and sleeve assembly as directed in A1.12–A1.3.

A2.2.7 For digital readout systems, if zero (00.0) and 50 % readings are not obtained, adjust the optical sensor as directed by the manufacturer until the target values of 00.0 and 50 % are obtained.

A2.2.8 If zero (0.00) and 50 % readings cannot be obtained, conduct maintenance described in Annex A1 as appropriate until the designated readings are obtained and calibration is verified.

A3. TYPICAL FULL-SCALE RANGES FOR ELMENDORF TEAR TESTERS

See Table A3.1.

TABLE A3.1 Typical Pendulum Full Scale Force Ranges

NOTE 1—Heavy-duty capacity and high capacity terms are used synonomously in the textile industry.

Elmendorf Tear Tester	Capacity, gf	Capacity, cN	Useable Test Range, gf (cN)
			20 to 80 %
Standard capacity	200	...	40 to 160
Standard capacity	400	...	80 to 320
Standard capacity	800	...	160 to 640
Standard capacity	1600	...	320 to 1280
Standard capacity	3200	...	640 to 2560
Standard capacity	6400	...	1280 to 5120
Standard capacity	...	150	(30 to 120)
Standard capacity	...	350	(70 to 280)
Standard capacity	...	800	(160 to 640)
			20 to 60 %
Heavy-duty capacity	6400	...	1280 to 3840
Heavy-duty capacity	12 800	...	2560 to 7680
Heavy-duty capacity	25 600	...	5120 to 15 360
Heavy-duty capacity	...	1800	(360 to 1080)
Heavy-duty capacity	...	4200	(840 to 2520)
Heavy-duty capacity	...	9600	(1920 to 5760)