



Designation: F88/F88M – 21

Standard Test Method for Seal Strength of Flexible Barrier Materials¹

This standard is issued under the fixed designation F88/F88M; 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 the measurement of the strength of seals in flexible barrier materials.

1.2 The test may be conducted on seals between a flexible material and a rigid material.

1.3 Seals tested in accordance with this test method may be from any source, laboratory or commercial.

1.4 This test method measures the force required to separate a test strip of material containing the seal. It also identifies the mode of specimen failure.

1.5 This test method differs from Test Method F2824. Test Method F2824 measures mechanical seal strength while separating an entire lid (cover/membrane) from a rigid or semi-rigid round container.

1.6 This test method differs from Test Method F904. Test Method F904 measures the bond strength or ply adhesion of laminates made from flexible materials such as cellulose, paper, plastic film, and foil.

1.7 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.

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

1.9 *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.*

¹ This test method is under the jurisdiction of ASTM Committee F02 on Primary Barrier Packaging and is the direct responsibility of Subcommittee F02.20 on Physical Properties.

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2. Referenced Documents

2.1 ASTM Standards:²

D882 Test Method for Tensile Properties of Thin Plastic Sheeting

E171 Practice for Conditioning and Testing Flexible Barrier Packaging

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

F17 Terminology Relating to Primary Barrier Packaging

F904 Test Method for Comparison of Bond Strength or Ply Adhesion of Similar Laminates Made from Flexible Materials

F2824 Test Method for Mechanical Seal Strength Testing for Round Cups and Bowl Containers with Flexible Peelable Lids

3. Terminology

3.1 Definitions:

3.1.1 *average seal strength, n*—average force per unit width of seal required to fully separate a flexible material from a rigid material or another flexible material, under the conditions of the test.

3.1.1.1 *Discussion*—The average force normally is calculated by the testing machine from the digitized plot of force versus grip travel. The plot starts from zero force after slack has been removed from the test strip. The initial ramp-up from zero to the force level required to peel the seal is not indicative of seal strength, and data from that part of the curve should not be included in the calculation of average strength, nor should the return to zero following complete failure of the specimen. The amount of data actually discarded on each end of the measured seal-profile curve must be the same for all tests within any set of comparisons of average seal strength (see 6.1.1 and 9.8.1).

3.1.2 *maximum seal strength, n*—maximum force per unit width of seal required to completely separate a flexible material from a rigid material or another flexible material, under the conditions of the test.

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.

4. Significance and Use

4.1 Seal strength is a quantitative measure for use in process validation, process control, and capability. Seal strength is not only relevant to opening force and package integrity, but to measuring the packaging processes' ability to produce consistent seals. Seal strength at some minimum level is a necessary package requirement, and at times it is desirable to limit the strength of the seal to facilitate opening.

4.1.1 The maximum seal force is important information, but for some applications, average force to open the seal may be useful, and in those cases also should be reported.

4.2 A portion of the force measured when testing materials may be a bending component and not seal strength alone. A number of fixtures and techniques have been devised to hold samples at various angles to the pull direction to control this bending force. Because the effect of each of these on test results is varied, consistent use of one technique (Technique A, Technique B, or Technique C) throughout a test series is recommended. Examples of fixtures and techniques are illustrated in Fig. 1.

4.2.1 *Technique A: Unsupported*—Each tail of the specimen is secured in opposing grips and the seal remains unsupported while the test is being conducted.

4.2.2 *Technique B: Supported 90° (By Hand)*—Each tail of the specimen is secured in opposing grips and the seal remains hand-supported at a 90° perpendicular angle to the tails while the test is being conducted.

4.2.3 *Technique C: Supported 180°*—The least flexible tail is supported flat against a rigid alignment plate held in one grip. The more flexible tail is folded 180° over the seal and is held in the opposing grip while the test is being conducted.

5. Interferences

5.1 The value obtained for seal strength can be affected by properties of the specimen other than seal strength. These interferences are discussed in the annex.

6. Apparatus

6.1 *Tensile Testing Machine*—A testing machine of the constant rate-of-jaw-separation type. The machine shall be

equipped with a device for recording the tensile load and the amount of separation of the grips; both of these measuring systems shall be accurate to $\pm 2\%$. The rate of separation of the jaws shall be uniform and capable of adjustment from approximately 8 to 12 in. [200 to 300 mm]/min. The gripping system shall be capable of minimizing specimen slippage and applying an even stress distribution to the specimen.

NOTE 1—If the tensile testing machine utilizes a spring and hook-based apparatus to extend the sample, it is expected to impart more variation in results as it travels, as compared to modern equipment. When utilizing spring and hook-based apparatus, it is recommended to take this factor into consideration and limit the variation imparted by the weighing system movement to a maximum distance of 2 % of the specimen extension within the range being measured.

6.1.1 If calculation of average seal strength is required, the testing machine system shall have the capability to calculate its value over a specified range of grip travel programmable by the operator. Preferably, the machine shall have the capability also to plot the curve of force versus grip travel.

6.2 *Specimen Cutter*, conforming to the requirements of 6.5 of Test Method D882, sized to cut specimens to a width of 0.984 in. [25 mm], 0.591 in. [15 mm], or 1.00 in. [25.4 mm]. Tolerance shall be $\pm 0.5\%$.

NOTE 2—Alternate specimen cutting methods and tools may be utilized if deemed appropriate for the application if still in compliance with F88/F88M.

NOTE 3—Any deviation from sample tolerance shall be supported through documented rationale and/or supportive data.

7. Sampling

7.1 The number of test specimens shall be chosen to permit an adequate determination of representative performance.

7.2 Testing of samples with visual defects or other deviations from normality may or may not be appropriate depending on the purpose of the investigation. Indiscriminate elimination of defects can bias results.

8. Aging and Conditioning

8.1 If conditioning before testing is desired and appropriate, then see Practice E171.

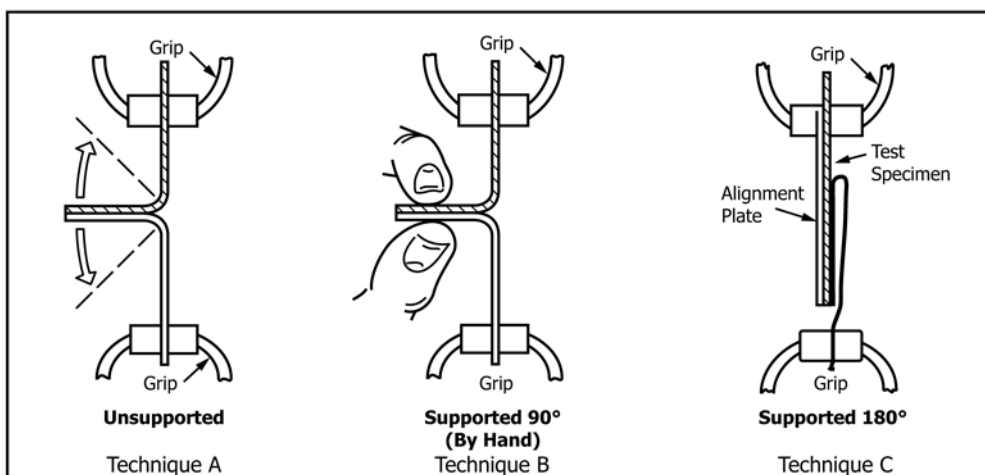


FIG. 1 Tail Holding Methods

8.2 Heat seal conditioning periods may be determined by experimentation as sufficient to achieve seal strength stability.

8.3 Modification of conditioning practices may be necessary to meet specific test objectives, such as the measurement of seal strength at specified storage or handling temperature.

9. Procedure

9.1 Calibrate the tensile machine in accordance with the manufacturer's recommendations.

9.2 Prepare sealed test specimens for testing by cutting to the dimensions shown in Fig. 2. Edges shall be clean-cut and perpendicular to the direction of seal. Specimen legs may be shorter than shown, depending on the grip dimensions of the testing machine, recommended distance between grips, or the size of the package under test. Multiple locations around the perimeter of the package may be tested.

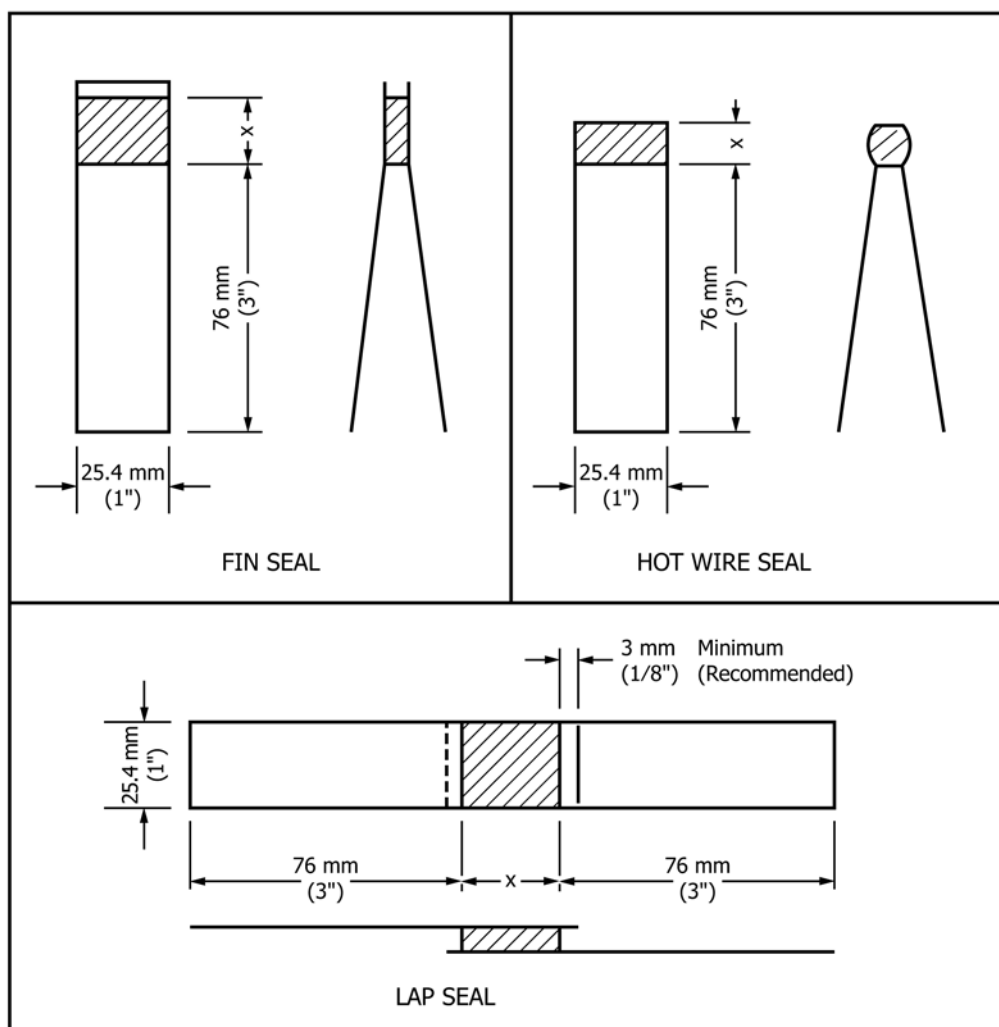
9.3 Clamp each leg of the test specimen in the tensile testing machine. The sealed area of the specimen shall be approximately equidistant between the grips. Recommended distance between grips (initial unconstrained specimen length) is:

Fin and Hot-Wire Seals		
Highly ^A extensible materials	0.39 in.	[10 mm]
Less ^A extensible materials	1.0 in.	[25 mm]
Lap Seals	$X + 10 \text{ mm}^B$	

^A Grip separation distance is recommended to be limited for highly extensible materials (100 + % elongation at seal failure) to minimize interferences (see annex).

^B Refer to Fig. 2, Note 1, for definition of X.

9.4 Center the specimen laterally in the grips. Align the specimen in the grips so the seal line is perpendicular to the direction of pull, allowing sufficient slack so the seal is not stressed prior to initiation of the test.



NOTE 1—X is the seal dimension to be tested and this dimension varies with sealer configuration.

NOTE 2—Images above represent typical designs and preparation approaches; other designs compliant with this standard may warrant alternate approaches.

NOTE 3—Sample width dimensions are referenced as examples only; reference 6.2 for options.

FIG. 2 Recommended Specimen Dimensions

9.5 The orientation of the fin-seal tail during the test can have a significant impact on the measured seal strength. The test report should indicate the details of any technique used to control tail orientation.

9.6 The seal shall be tested at a rate of grip separation of 8 to 12 in./min [200 to 300 mm/min].

9.7 For each cycle, report the maximum force encountered as the specimen is stressed to failure and identify the mode of specimen failure.

9.8 If the test strip peels apart in the seal area, either by adhesive failure, cohesive failure, or delamination, the average peel force may be an important index of performance and should be measured by the testing machine as a part of the test cycle.

9.8.1 Follow the machine manufacturer's instructions to select the desired algorithm for calculating average seal strength. Fig. 3 illustrates the effect of an algorithm that uses data only from the central 80 % of the curve to calculate the average.

9.8.2 If the test strip does not peel significantly in the seal area and failure is largely by breaking, tearing, or elongation of the substrate material, average force to failure may have little significance in describing seal performance and should not be reported in such cases (see Annex A1.1).

9.9 A plot of force versus grip travel may be useful as an aid in interpretation of results. In those cases, the testing machine should be programmed to generate the plot.

9.10 Other properties, such as energy to cause seal separation, may be appropriate in cases where grip travel results only in peel. When other failure modes (elongation, break, tear, delamination (when not a designed peel seal separation mode) or other) are present in addition to peel of the seal, energy, and other functions must be interpreted with caution.

10. Report

10.1 Report the following:

10.1.1 Complete identification of material being tested.

TABLE 1 Materials and Techniques

Test Series "A"	
(MAXIMUM Values)	
Heat Seal Coated 50# Basis Weight Paper sealed to Film (48 ga. PET/2 mil LDPE)	
Supported 90° @ 12 in./min	
Unsupported @ 12 in./min	
Unsupported @ 8 in./min	
Test Series "B"	
(Both MAXIMUM Values and AVERAGE Peel Values were reported)	
Uncoated 1073B Tyvek sealed to Film (48 ga. PET/2 mil LDPE)	
Supported 90° @ 12 in./min	
Unsupported @ 12 in./min	
Supported 180° @ 12 in./min	
Reverse direction of materials in grips @ 12 in./min	
Test Series "C"	
(MAXIMUM Values)	
Coex HDPE 3 mil film with peelable sealant layer sealed face-to-face	
Foil Composite 5 mil with same peelable sealant surface sealed face-to-face	
Unsupported @ 12 in./min	
Supported 180° @ 12 in./min	

TABLE 2 Test Equipment

Manufacturer	Models	Load Cell	
		lb	N
Dillon	AFG-50N	11.2	50
Instron	4464, 5500R, 5564,	1124, 112.4,	5 kN, 500,
	5565, S5R1123,	22.5, 11.2, 2	100, 50, 9
	4442, MN-44		
Lloyd Instruments	1300-36	22.4	100
MTS Sintech Renew	4204	25	111.2
Test Resources	2000ZR	25	111.2
Thwing Albert	EJA	11.2	50
Vinatoru Enterprises	CCT, HST	11.2	50

10.1.2 Equipment and test method or practice used to form seals, if known.

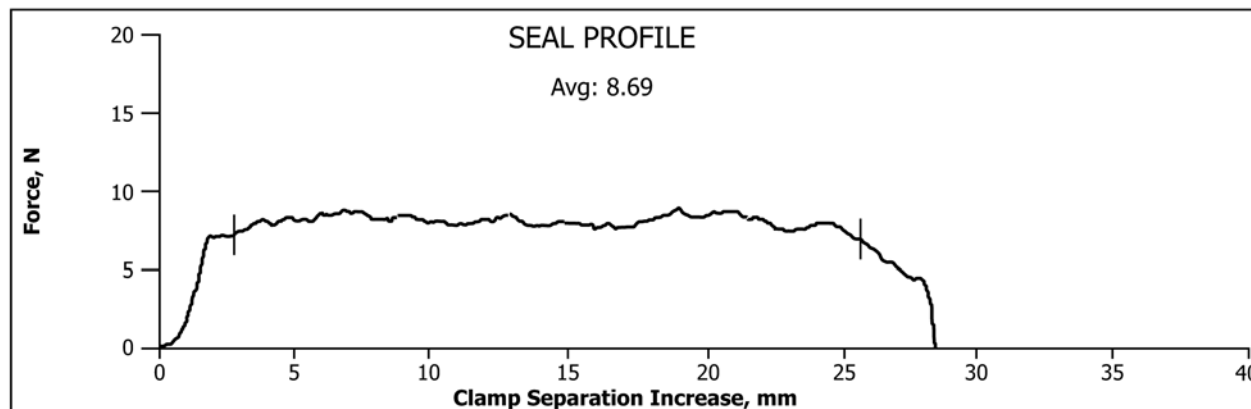
10.1.3 Equipment used to test seals.

10.1.4 Ambient conditions during tests; temperature and humidity.

10.1.5 Grip separation rate.

10.1.6 Initial grip separation distance.

10.1.7 Seal width.



MARKERS ON SEAL PROFILE PLOT AT 10% AND 90%
ESTABLISH DATA WINDOW OF 80% FOR CALCULATION

FIG. 3 Calculation of Average Seal Strength