INTERNATIONAL

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Standard Practices for Making Heatseals for Determination of Heatsealability of Flexible Webs as Measured by Seal Strength[1]

This standard is issued under the fixed designation F 2029; 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 These practices cover laboratory preparation of heatseals and the treatment and evaluation of heatseal strength data for the purpose of determining heatsealability of flexible barrier materials. It does not cover the required validation procedure for the materials and production equipment.

1.2 Testing strength or other properties of the heatseals formed by these practices is not included in this standard. Refer to Test ~~Methods~~Method F 88 for testing heatseal strength.

~~1.3The practices of this standard are restricted to sealing with a machine employing hot-bar jaws. Impulse, high-frequency, and ultrasonic heating methods are not included.~~

~~1.4These practices apply primarily to webs intended to be used on commercial machines employing reciprocating sealing jaws, such as most vertical form-fill packaging machines, platen heatsealers, etc. Conditions of dwell time and sealing pressure on machines of this type typically are different from those on rotary machines by an order of magnitude or more.~~

~~1.5The procedures of these practices with respect to choice of heatsealing conditions apply equally whether the application is to ultimate seal strength or hot tack measurement.~~

~~1.6Seals may be made between webs of the same or dissimilar materials. The individual webs may be homogeneous in structure or multilayered (coextruded, coated, laminated, etc.).~~

~~1.7Strength of the heatseal is the criterion for judging heatsealability employed in these practices.~~

~~1.8Determination of heatsealability as judged by seal continuity, typically measured by air-leak, dye penetration, visual examination, microorganism penetration or other techniques, are not covered by these practices.~~

~~1.9Two variations of the heatsealing procedure are described herein, differing in whether the objective of the testing is to determine, the heatsealability of the surface, or how well the entire web would heatseal in applications where the sealing interface may not reach jaw temperature.~~

~~1.9.1*Practice A, Heatsealability of a Surface*—This method measures sealability of the web surface, or sealant layer if there is one, as a function of interface temperature, which is independent of the influence of other web characteristics, such as total thickness and construction.~~

~~1.9.2*Practice B, Web Sealability at Short Dwell Time*—The test seal is made at a dwell time shorter than required for the sealing interface to reach the jaw temperature level, simulating conditions on high-speed vertical form-fill machines, or on slower machines where the condition of nonequilibrium also exists. The resulting heatseal strength, under nonequilibrium conditions, is then dependent not only on characteristics of the web's sealing surface, but also on web thickness, construction, and other factors affecting rate of heat transfer from jaws to the sealing interface. These include machine factors; (for example, anti-stick jaw treatments, etc).~~

1.3 The practices of this standard are restricted to sealing with a machine employing hot-bar jaw(s). Impulse, high-frequency, and ultrasonic heating methods are not included.

1.4 These practices apply primarily to webs intended to be used on commercial machines employing reciprocating sealing jaws, such as most form-fill-seal packaging machines, platen heatsealers, and so forth. Conditions of dwell time and sealing pressure on machines of this type typically are different from those on rotary machines.

1.5 The procedure of this practice with respect to choice of heatsealing conditions apply to ultimate seal strength or hot tack measurement.

1.6 Seals may be made between webs of the same or dissimilar materials. The individual webs may be homogeneous in structure

~~[1] These practices are under the jurisdiction of ASTM Committee F02 on Flexible Barrier Materials and are the direct responsibility of Subcommittee F02.20 on Physical Properties.~~

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[1] These practices are under the jurisdiction of ASTM Committee F02 on Flexible Barrier Packaging and are the direct responsibility of Subcommittee F02.20 on Physical Properties.

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or multilayered (coextruded, coated, laminated, and so forth).

1.7 Strength of the heatseal as measured by Test Method F 88 is the criterion for judging heatsealability employed in these practices.

1.8 Determination of heatsealability as judged by seal continuity, typically measured by air-leak, dye penetration, visual examination, microorganism penetration, or other techniques, are not covered by these practices.

1.9 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.10 *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]

F 88 Test Method for Seal Strength of Flexible Barrier Materials

F 1921~~Test Methods for Hot Seal Strength (Hot Tack) of Thermoplastic Polymers and Blends Comprising the Sealing Surfaces of Flexible Webs~~ Test Methods for Hot Seal Strength (Hot Tack) of Thermoplastic Polymers and Blends Comprising the Sealing Surfaces of Flexible Webs

D 4332 Practice for Conditioning Containers, Packages, or Packaging Components for Testing

3. Terminology

3.1 *Definitions:*

3.1.1 *dwell time*, *n*—the time interval when the sealing jaws are in contact with, and exerting pressure on, the material being sealed.

3.1.2 ~~*equilibrium dwell time*~~heatseal curve, *n*~~—any dwell time in excess of that required for the seal strength to reach its maximum level for the jaw temperature employed.~~ —a plot of measured seal strength versus sealing temperature when dwell and pressure are fixed.

3.1.2.1 *Discussion*~~—Applies only when both jaws are at equal temperature (see Annex A1.3).~~ —This is the basic curve for comparing sealability of materials. It plots the force required to extend a sealed test strip to failure, as a function of sealing temperature when dwell and pressure are fixed. The portion of the curve at higher sealing temperatures may be affected by failure of the substrate and may not be an accurate representation of seal strength.

3.1.3 ~~*heatseal curve*~~heatseal strength, *n*~~—a plot of apparent seal strength versus sealing temperature.~~ —force required to peel the seal apart, per unit width of seal.

3.1.3.1 *Discussion*~~—This is the basic curve for comparing sealability of materials. It plots the force required to extend a sealed test strip to failure, as a function of sealing temperature. The portion of the curve at higher sealing temperatures may be affected by failure of the substrate and may not be an accurate representation of seal strength.~~ —In many tests of seal strength ,it is not the seal that fails, it is the substrate or a layer. In those tests, the true heatseal strength may be somewhat higher than the measured force that caused the specimen to fail. Some materials are intentionally designed to fail in a layers not at the seal interface in order to gain other attributes such as transfer appearance. In this case, this failure is the desired outcome. Homogeneous materials with fusion seals, for example, commonly break along a line immediately adjacent to the seal, while the seal itself remains intact.

3.1.4 ~~*heatseal strength*~~heatsealability, *n*~~—force required to peel the seal apart, per unit width of seal.~~ —the property of thermoplastic polymers and blends, when comprising a surface of a flexible web, that defines how well the material bonds to itself or a dissimilar material when sealed by the application of pressure, heat, and dwell (time).

3.1.4.1 *Discussion*~~—In many tests of seal strength it is not the seal that fails, it is the substrate. In those tests, the true heatseal strength may be somewhat higher than the measured force that caused the specimen to fail. Homogeneous materials with fusion seals, for example, commonly break along a line immediately adjacent to the seal, while the seal itself remains intact (see Test Methods F88).~~ —How well the material bonds is expressed quantitatively as seal strength as a function of the sealing conditions of temperature, time, and pressure. Since strength of a heatseal can be measured either while the seal is still hot (hot tack) or after cooling and stabilizing (ultimate strength), a complete evaluation of heatsealability of a material may include both tests.

~~3.1.5 *heatsealability*, *n*—the property of thermoplastic polymers and blends, when comprising a surface of a flexible web, that defines how well the material heatseals.~~

~~3.1.5.1*Discussion*—How well the material heatseals is expressed quantitatively as seal strength as a function of the sealing conditions of temperature, time, and pressure. Since strength of a heatseal can be measured either while the seal is still hot (hot tack) or after cooling and stabilizing (ultimate strength), a complete evaluation of heatsealability of a material must include both tests.~~

~~3.1.6~~*hot tack*, *n*—strength of a hot seal measured at a specified time interval after completion of the sealing cycle but prior to the temperature of the seal reaching ambient. Refer to Test Methods ~~F 1921.~~F 1921.

[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.

3.1.73.1.6 *seal initiation temperature*, *n*—the sealing temperature at which a heatseal of significant strength (typically 0.5 N/cm; 125 g/25 mm; 0.3 lb/in.) is produced.

3.1.83.1.7 *sealing interface*, *n*—the interface between of the two web surfaces being sealed.

3.1.93.1.8 *sealing pressure*, *n*—the force per unit area of seal applied to the material by the sealing jaws during the sealing process.

3.1.9.13.1.8.1 *Discussion*—During the dwell time, the sealing pressure pulse rises from zero usually to a plateau level and then drops to zero. Frequently, there is an initial spike. Very short dwell times may not have a plateau. Sealing pressure is completely described by the curve of pressure versus time, but two Two parameters from the curve commonly are can be used instead to characterize the pressure variable. One is a calculated average pressure, that excludes the initial rise, as well as, the terminal fall of pressure, and the other is the maximum value reached either during any initial impact spike or later.

NOTE 1—A common error is to report air pressure in the cylinder applying the force as the sealing pressure.

3.1.10

3.1.9 *sealing temperature*, *n*—maximum temperature reached at the sealing interface during the dwell time of a sealing cycle.

3.1.10.1*Discussion*—Sealing temperature will equal jaw temperature (both jaws at same temperature) if the dwell time is long enough for the interface to reach temperature equilibrium with the jaws. This point has been reached when seal strength no longer rises with increasing dwell time.

3.1.11*—the setpoint in degrees of each temperature controlled sealing jaw. The actual surface temperature of the sealing jaws making contact with the materials. The Set Point Temperature is the controller setting which will produce the desired surface temperature. Often, the setpoint temperature will be numerically higher that the surface temperature.*

3.1.10 *ultimate seal strength*, *n*—the final value of strength that is reached after the heatseal has both cooled to ambient temperature and achieved stability in strength.

3.1.11.1

3.1.10.1 *Discussion*—Some materials, when cooling from a melt, continue to change in strength over extended periods of time after reaching ambient temperature.

4. Significance and Use

4.1*Practice A, Surface Heatsealability* —This practice leads to determining the heatsealability of a surface, or sealant layer if there is one, as a function of interface temperature, free of the influence of other web properties. Commercially, its applications are in development of improved polymers and blends to be used as the sealant layer in coextruded films and laminated and coated web constructions. Also it is the appropriate method for quality control in manufacture of those films and laminations, since a QC test should be affected by the property being tested for, for example, heatsealability of the surface, and, so far as possible, not by other properties of the web, for example, total thickness, that are measured independently by other methods.

NOTE2—Sealant-layer thickness may affect surface heatsealability.

4.2*Practice B, Web Sealability* —While it is necessary to have a heatseal surface layer that has adequate seal strength for the application, the web also will have a specific construction and total thickness, both chosen to satisfy requirements other than heatsealability. Practice B compares specific web constructions for their suitability for applications where the dwell time may be too short for the sealing interface to reach jaw temperature. With this test method, both web construction and thickness, in addition to properties of the sealant layer, affect sealing performance. If the rate of heat transfer through the web due to its construction or total thickness is too slow for the production rate required, it may be necessary to use a sealant layer with a lower seal-inception temperature or fusion temperature.

4.1 This practice allows determination of the heatsealability of a surface or sealant layer. While it is necessary to have a heatseal surface layer that has adequate seal strength for the application, other material properties, such as the specific construction and total thickness, both chosen to satisfy requirements other than heatsealability, will impact the sealing properties of the material. This practice allows the impact of changes in material properties on heatsealability to be measured.

5. Apparatus

5.1 *Heatsealer*Laboratory Heatsealer:

5.1.1 *Sealing Jaws*— Two-heated jaws with flat sealing surfaces. Two-heated jaws are required to conduct Practice A. Practice B may be used with one-heated jaw only when the application is to commercial sealers with like configuration. — Heat controlled jaw or jaws with appropriate sealing surfaces to provide a flat seal. If only one heated jaw is used, the unheated jaw should be covered with a gasket material such as a silicone rubber of known durometer.

5.1.1.1 *Jaw Temperature Control*—Each jaw must have independent temperature control. The recommended minimum precision of control is ± 1°C.

5.1.1.2*Jaw Coatings or Coverings*—Anti-stick or compressible jaw coatings or coverings, such as TFE-fluorocarbon, TFE-fluorocarbon/glass cloth, silicone rubber or other heat-resistant rubbers, polyester film, etc., are admissible, although test conditions may require adjustment in some cases. —Each jaw should have independent temperature control and the precision of the controlling unit should be known and calibrated. The temperature should be verified periodically using a calibrated pyrometer adequate for the range of use.

5.1.1.2 *Heated Jaw Coatings or Coverings* —Anti-stick or compressible jaw coatings or coverings, such as TFE-fluorocarbon, TFE-fluorocarbon/glass cloth, or oriented PET film are often used to prevent the test specimen from adhering to the sealing jaws. Thick or heat flow-resistance materials will impact the rate of heat transfer from jaws to sealing surface. It is important to inspect the quality of these materials periodically to prevent loss of properties causing unwanted temperature fluctuations in the sealing process.

(1) Unheated Jaw Coating or Coverings—Silicone or other heat resistant rubbers of known durometer may be used. The rubber may be covered TFE-fluorocarbon, TFE-fluorocarbon/glass cloth, or oriented PET film. It is important to inspect the quality of these materials periodically to prevent loss of properties causing unwanted temperature fluctuations in the sealing process.

5.1.1.3 *Jaw Sealing Surfaces*, must be capable of being aligned for parallelism.

5.1.1.4*Capability for Quick Jaw Change* to serrated or other jaw styles is desirable to increase the machine's range of simulation testing.

(1) The uniformity of pressure across the sealing jaws can be checked using pressure indicating materials or devices by actuating the sealing jaws while at ambient temperature.

(2) Temperature applied to sealing jaws may affect the alignment and parallelism of the jaw sealing surfaces as a result of thermal expansion.

5.1.2 *Dwell Time*—Variable control and readout of dwell time, with minimum range of 100 to 10 000 milliseconds.

5.1.2.1 Time of jaw closure should be measured directly (as by force sensor output, micro switch, optically, etc.), and controlled therefrom. so forth).

5.1.2.2 Precision of dwell time control should be ±10 ms or better.

5.1.3 *Pressure*, variable control, with readout of sealing pressure.

5.1.3.1*Machines*, that have only an air pressure gage from which sealing pressure must be calculated, should be provided with nomographs from which sealing pressure can be read directly from air pressure measurements.

5.1.3.1 The sealing pressure for machines that have only an air pressure gauge on the air supply line and whose cylinder size is known can be calculated using the formula below:

$$P_{seal} = \left(\frac{A_{line}}{A_{jaw}}\right) P_{line} - P_w \quad (1)$$

where:

P_{seal} = pressure of the sealing jaw,
P_{line} = pressure of the incoming air line,
A_{jaw} = area of the sealing jaw,
A_{line} = cross-sectional area of the incoming air line, and
P_w = pressure loss due to mechanical work which is frequently difficult to calculate with any precision.

5.1.3.2 When materials are being sealed under pressure the silicone rubber on the unheated jaw will compress. When thin materials being sealed are less than the full length of the sealing jaw, the compression can be significant enough to change the contact to the full area of the jaw. As a result, the pressure is then distributed across the entire surface and this area is what should be used in the pressure calculation. When sealing thick materials, only the area of the seal should be used to calculate the sealing pressure since contact is limited to the surface of the thicker materials.

5.1.3.3 Machines that have only an air pressure gage indicating the air supply pressure, should have a table relating sealing and supply pressure.

6. Test Specimen

6.1The number of test specimens shall be chosen to permit an adequate determination of representative performance. When heatseal strength will be measured at a series of sealing temperatures, a minimum of three replicates shall be used to determine the mean value for each material at each temperature. When the measurements will not be part of a series where an identifiable trend is expected, a minimum of five replicates shall be employed.

6.2In planning the number of specimens required, note that only one strength test should be made from each heatseal.

6.3Specimens for heatsealing can be prepared by cutting the test material into pieces 15 by 15 cm [6 by 6 in.]. Mark the transverse direction and the seal side of each piece. Superimpose the two pieces to be sealed, with the transverse directions parallel and the seal surfaces facing each other. If a group of specimens is to be prepared prior to sealing, it is convenient to staple the pairs, with caution to avoid staples in the areas to be sealed and from which the test strip will be cut subsequently. Seal the specimens with the jaws parallel to the transverse direction. A strip for seal-strength testing will subsequently be cut perpendicular to the seal at its center, and the seal will be peeled by pulling the strip in the machine direction of the web.

6.1 The number of test specimens shall be chosen to permit an adequate determination of representative performance based on a statistical rationale. When heatseal strength will be measured at a series of sealing temperatures, an adequate or agreed upon number of replicates shall be used to determine the mean value for each material at each temperature. When the measurements will not be part of a series where an identifiable trend is expected, a separate determination of the number of replicates should be made.

6.2 Mark the transverse direction and the seal side of each piece. Superimpose the two pieces to be sealed, with the transverse directions parallel and the seal surfaces facing each other. Seal each specimen with the jaws parallel to either the machine or transverse direction noting the orientation of the sample. Perform the heatseal process at the same location relative to the sealing jaws. A strip for seal-strength testing will subsequently be cut perpendicular to the seal at its center, and the seal will be peeled by pulling the strip.

~~NOTE 3—The seal must be located on the specimen so the legs of the strip on each side of the seal will be long enough to span the distance between the grips of the testing machine.~~

~~6.4 Alternatively to sealing a wide specimen and then cutting a strip for strength testing, strips of the width for strength testing may be cut in the machine direction and sealed, either to strips of similar material or to dissimilar strips. The sealed strip may then be tested for strength without further preparation. This alternative is mandatory for hot-tack testing. Comparisons should be made only among specimens sealed by the same procedure.~~

~~6.4.1 When using sealing machines that automatically load and seal a specimen strip without operator intervention, sealing of dissimilar materials is accomplished by preparing a specimen strip that is a composite of the two materials to be sealed, taped together at the center. Refer to the machine manufacturer's recommendations for details appropriate to the machine used.~~

~~NOTE 4—**Caution:** Be sure to adjust the seal area factor in calculating sealing pressure when switching from a wide seal to a strip seal.~~

~~6.4.2 Common strip widths are 25 mm (1.00 in.) and 15 mm (0.59 in.).~~

~~6.5 If the material is anisotropic and the data are expected to apply to situations where the seal may be stressed transversely, specimens cut perpendicular to those described in 6.3 also shall be taken.~~ 2—The seal must be located on the specimen so the legs of the strip on each side of the seal will be long enough to span the distance between the grips of the testing machine.

6.3 Alternatively to sealing a wide spectrum and then cutting a strip for strength testing, strips of the width for strength testing may be cut in the machine direction and sealed, either to strips of similar material or to dissimilar strips. The sealed strip may then be tested for strength without further preparation. Comparisons should be made only among specimens sealed by the same procedure.

6.4 Common strip widths are 25 mm (1.00 in.) and 15 mm (0.59 in.).

7. Procedure

7.1 *Calibration and Alignment*—Prior to starting testing, ~~insure~~ensure that the heatsealer is in proper calibration and that the jaws have been aligned for parallelism.

7.2 *Sealing Conditions*, for heatsealability testing, either ultimate seal strength or hot tack, shall be within the ranges specified below for all makes and types of heatsealers.

7.2.1 ~~*Practice A, Surface Sealability:* Heatsealability of the web surface as a function of interface temperature.~~

~~7.2.1.1 *Temperature*— Both jaws shall be set at the same temperature.~~

~~7.2.1.2~~ *Dwell Time*—The dwell time must be long enough for the sealing interface to come to the known temperature of the jaws. This depends on the thickness and construction of the web, as well as on jaw configuration factors. Typical minimum dwell times (without anti-stick jaw covering):

~~*Films:* 1 mil (25μ) and under: dwell time, 500 ms (.5 s).~~
Films: 1 mil (25μ) and under: dwell time, 500 ms (0.5 s)
~~*Films:* 1 to 2.5 mil (64μ): dwell time, 1000 ms (1 s).~~
Films: 1 to 2.5 mil (64μ): dwell time, 1000 ms (1 s)

7.2.1.1 The minimum required dwell time can be determined from a few trial sealing cycles. Refer to ~~Annex A3.1~~A2.1. This procedure usually will be necessary for thicker films, structures containing paper or foil, or when anti-stick jaw coverings are used.

~~7.2.1.3~~

7.2.2 *Sealing Pressure*~~— Set pressure in the range of 138–413 kPa (20–60 psi). See~~ —Set pressure in the range of 138 to 413 kPa (20 to 60 psi). See Appendix X1 for discussion of effect of pressure on heatseal strength.

~~7.2.1.4 *Jaw Configuration*—Use flat metal jaws, either bare or covered (see 5.1.1.2). Jaws may be steel, copper, or aluminum. Choice of metal, as well as use of a covering, may affect the minimum dwell time required for the interface to reach equilibrium with jaw temperature.~~

~~7.2.2 *Practice B, Web Sealability* —Sealability under commercial conditions.~~

~~7.2.2.1~~

7.2.3 *Web Sealability*:

7.2.3.1 *Temperature*— Choice of temperature setting of each jaw (including unheated) is dependent on application of the data. In the absence of reasons to the contrary, it is recommended both jaws be set to the same temperature.

~~7.2.2.2~~

7.2.3.2 *Dwell Time*~~—Set dwell time at 100 ms to simulate high-speed sealing or other jaw-closure interval depending on specific application.~~

~~7.2.2.3~~*—Set the dwell time to the desired period.*

(1) If the dwell time is set sufficiently long that the heat flow through the webs is at steady-state, the seal strength of the material can be measured independently of dwell time, as long as the dwell time is above the equilibrium dwell time.

7.2.3.3 *Sealing Pressure*— Set pressure in the range of ~~138–413~~ 138 to 413 kPa ~~(20–60~~(20 to 60 psi), or at other level depending on specific application. See Appendix X1 for discussion of effect of pressure on heatseal strength.

7.2.2.4

7.2.3.4 *Jaw Configuration*—Same as the commercial application being simulated. In absence of specific information on this point, flat steel jaws covered with TFE-fluorocarbon/glass cloth are recommended.

7.2.3—*The coatings or coverings applied to the sealing jaws should be nearest practical as the commercial application being simulated. In absence of specific information on this point, flat steel jaws covered with TFE-fluorocarbon/glass cloth are recommended.*

7.2.4 *Sticking of Specimen to Jaws* —Specimens having a heatsealing surface where the melting range is significantly lower than its opposite surface, usually can be sealed directly with bare metal jaws over most of the desired sealing temperature range.

7.2.3.1If the specimen is homogeneous throughout, or of ABA construction, enclose it in a folded piece of 10–15µ (approx 0.5 mil) polyester film during the sealing cycle to avoid sticking to the jaws. Alternatively, cover the jaws with 75µ (3 mil) TFE-fluorocarbon/glass cloth, or tape. See Annex A2—Specimens having a heatsealing surface where the melting range is significantly lower than its opposite surface, usually can be sealed directly with bare metal jaws over most of the desired sealing temperature range. For example, sealing a PET/LDPE to a nylon/LDPE film.

7.2.4.1 If the specimen is homogeneous throughout, or with multilayered materials where the external construction is the same ABA, enclose it in a folded piece of 10 to 15µ (approx 0.5 mil) polyester film during the sealing cycle to avoid sticking to the jaws. Alternatively, cover the jaws with 75µ (3 mil) TFE-fluorocarbon/glass cloth, or tape. The choice of coverings or coatings should be made according to 7.2.3.4.

7.3 *Heatseal Curve*— To generate the curve, temperature is typically varied in 5–10° intervals, although to locate maxima or other features, smaller steps may be desirable locally. The first temperature point typically is at about the seal initiation temperature. Commonly, testing is continued at increasing temperature levels until the web suffers excessive stretch, distortion, shrinkage, or burnthrough.

7.3.1Make a minimum of three seals at each jaw temperature selected. — To generate the curve, temperature is typically varied in 5 to 10° intervals, although to locate maxima or other features, smaller steps may be desirable locally. The first temperature point typically is at about the seal initiation temperature. Commonly, testing is continued at increasing temperature levels until the web suffers excessive stretch, distortion, shrinkage, or burnthrough.

7.3.1 Make the number of test specimens chosen to permit an adequate determination of representative performance based on a statistical rationale.

7.3.2 Dwell time can also be used as the independent variable by fixing the temperature and sealing pressure at which the test is performed.

7.4 *Conditioning*— If conditioning before testing is appropriate, normal, and desirable, then condition the test specimens at 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity for not less than 24 h prior to test. See Practice D 4332 for guidance on conditioning practices.

7.5 *Strength Testing*— The seal shall be tested when its strength no longer changes with time. See Test Method F 88.

7.6 *Single-Point Measurements (Quality Control Testing)*—Refer to Annex A1 for guidelines for selecting temperature.

7.5*Conditioning*— The seal shall not be tested until its strength no longer changes with time. Maintain standard laboratory atmosphere of 23°C and 50% RH during conditioning period.

7.6*Strength Testing*— See Test Methods F88.

8. Report

8.1 The report shall contain the following information concerning specimens tested:

8.1.1 *General Information*:

8.1.1.1 Date of sealing,

8.1.1.2 Operator,

8.1.1.3Heatsealer; type and model, and

8.1.1.4Ambient temperature and humidity.

8.1.1.3 Heatsealer; type and model,

8.1.1.4 Number of heated jaws and type of coating or covering on each, and

8.1.1.5 Where applicable, ambient temperature and humidity.

8.1.2 Complete identification of materials sealed, as appropriate.

8.1.3 Thickness and width of specimens and web construction, if known.

8.1.4 Orientation of seal with respect to machine direction.

8.1.5 *Data Table*—After strength of the sealed specimens has been tested by Test MethodsMethod F 88, prepare a data table showing sealing conditions, force to failure, and failure mode for each replicate. Show also arithmetic mean and standard deviation for each replicate set. Identify data by test Practice A or B.

8.1.6 *Heatseal Curves*— Plot heatseal curve for each material. Graphically identify failure mode at each test point (— Plot heatseal curve for each material. Identify on the graph the single failure mode or changes in the failure mode (Fig. 1). Identify each curve by test practice. Where appropriate, several curves comparing various materials may be shown on the same plot.

8.1.7*Practice B*—Typically, certain materials will be tested by both Practices A and B. In those cases, show both curves on the