Designation: F 1157 – 90 (Reapproved 2001)

Standard Practice for Classifying the Relative Performance of the Physical Properties of Security Seals[1]

This standard is issued under the fixed designation F 1157; 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 practice presents methods for testing the physical properties of security seals. Where appropriate, the various tests include particular apparatus or procedural specifications required for different types of security seals.

1.2 This practice will serve as a basis for comparing the response of various security seals under different modes of attack. The security seal to be evaluated shall first be placed in an appropriate classification, and then tested in the manner designated as most suitable for that class of seal, in accordance with Classification F 832.

NOTE 1—See Guide F 1158 for procedures on the inspection and evaluation of tampering of security seals.

1.3 A security seal is a device intended to detect tampering or entry. Single use locking devices are to be evaluated under this specification. Therefore, the following procedures are to reflect the relative performance of security seals when subject to various physical attacks.

1.4 This practice is not intended to be fully comprehensive, since certain types of security seals, such as labels, are not addressed. Further, it is the responsibility of users of this practice to interpret their specific security needs concerning the application of seals, and to determine the grade of seal appropriate for their particular application. ASTM assumes no responsibility for losses occurring as a result of a defeated seal whether the defeat is apparent or the seal is not suited for its application.

1.5 The values as stated in inch-pound units are to be regarded as the standard. The values in parentheses are given for information only.

1.6 The following safety hazards caveat pertains only to the test procedures portion, Section 6, of this practice. *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:*

F 832 Classification for Security Seals[2]

F 883 Performance Specification for Padlocks[2]

F 946 Guide for Establishing Security Seal Control and Accountability Procedures[2]

F 1158 Guide for Inspection and Evaluation of Tampering of Security Seals[2]

3. Terminology

3.1 *Definition:*

3.1.1 *seal*—a passive, one-time locking device which is used to indicate tampering or entry, afford limited resistance (to entry) or provide a combination of both functional aspects.

4. Summary of Practice

4.1 A security seals shall be evaluated in accordance with its classification into one of five general groups and its performance in the following: a test to determine pull strength, a shear cutting test, a bending test, an impact test, a low-temperature impact test, and a high-temperature pull test. A total of 18 seals shall be used to complete minimum testing.

4.2 A security seal shall receive a rating designation which denotes its general classification and its performance in each of the required tests. This rating shall be obtained by testing three individual seals in each specific test, and by taking the average of the data points.

5. Seal Classification

5.1 *General*—For the purpose of defining the most appropriate configuration by which to evaluate a security seal in subsequent tests, a seal shall be classified as an initial step.

5.2 For the purpose of comparing the physical properties of security seals, seals are grouped in accordance with the following description of application seals:

5.2.1 *Groups*:

5.2.1.1 *Group 1*—Flexible cable and wire seals.

5.2.1.2 *Group 2*—Strap and cinch seals.

5.2.1.3 *Group 3*—Rigid bolt and rod seals, including heavy duty metal padlock type.

5.2.1.4 *Group 4*—Twisted rod or wire seals (pigtail).

[1] This practice is under the jurisdiction of ASTM Committee F12 on Security Systems and Equipmentand is the direct responsibility of Subcommittee F 12.50on Locking Devices.

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[2] *Annual Book of ASTM Standards*, Vol 15.07.

5.2.1.5 *Group 5*—Padlock type seals, scored seals, metal or plastic base.

5.3 If a particular security seal does not appear to fall into any of these general classifications, the closest description shall be chosen by the user, keeping in mind that effectiveness of the testing procedures may be jeopardized by a faulty classification choice. These general groupings shall be assigned the arbitrary numerical listing of one through five, respectively, as shown in 5.2.1. This listing shall then be designated in the security seal's overall evaluation to serve as a reference indicating the particular test configurations with which it was tested.

5.4 The required performance levels in any test category (see Section 11) shall not be affected by this general classification (see 5.2.1); only the manner in which the seal is physically manipulated during subsequent testing shall be affected by this portion of the evaluation. All seals will be tested in a locked position.

5.5 Seals often have unique identification to prevent duplication and reapplication. Evaluation of this uniqueness is not required.

6. Test Procedures

6.1 *Pull (Tensile) Test*:

6.1.1 Conduct a pull test to determine the strength of a security seal's locking mechanism. Apply a tensile load to the locked seal in a manner that simulates a reversal of the motion needed to lock the seal. Hardware necessary to perform this test will be indicated by the configuration of the seal. See Fig. 1(*a*), (*b*), (*c*), and (*d*) for a schematic drawing of this test, as applied to the various general classifications of seals.

6.1.2 Record the load required to forcibly open (or destroy or damage) the security seal and compare it to the rating requirements listed in Table 1. Assign the appropriate letter designation to that security seal for performance in the pull test.

6.2 *Shear Test*:

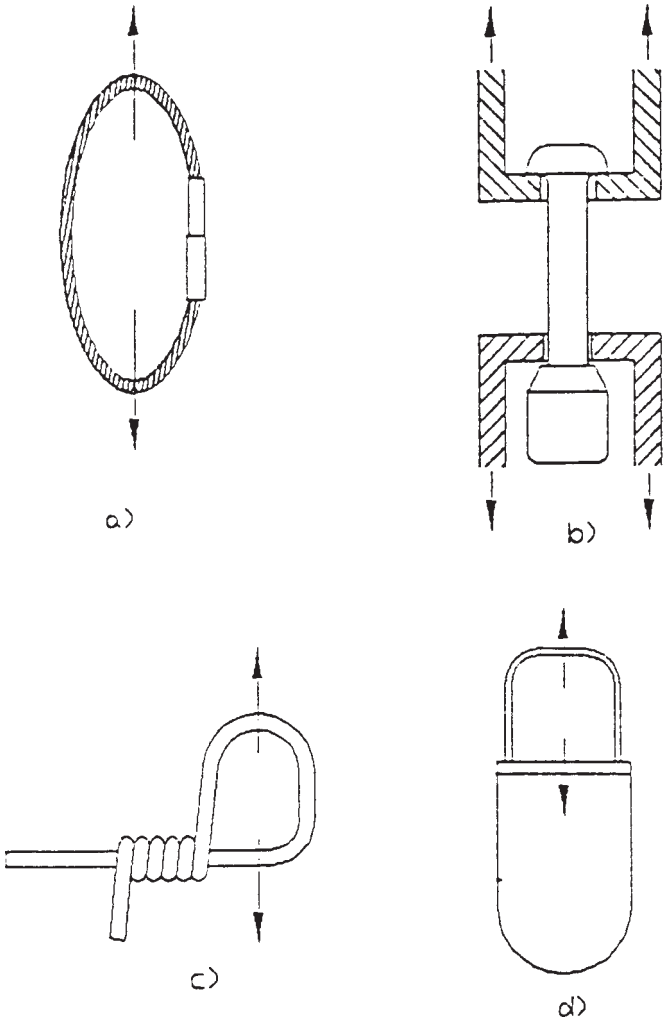
6.2.1 Test security seals for ability to withstand cutting with shearing blades, as might be implemented with bolt cutters. To perform this test, use hardware that is the same as the apparatus used in the Padlock Shackle Cutting Test in Performance Specification F 833. (See Fig. 2 for a drawing of this equipment.) This equipment may suffice for testing all classifications of security seals, with the possible exception of thin metal or plastic bands, such as strap or cinch seals. In such cases, it is conceivable that a slight misalignment in the cutting blades would not sever the seal, only deform it. In this instance, use a more precise cutting apparatus which incorporates sharp, well-aligned cutting blades.

6.2.2 Record the compressive load required to sever the security seal and compare it to the rating levels given in Table 2. Assign an appropriate rating in the shear test.

6.3 *Bending Test*:

6.3.1 Conduct a bending test to determine the resistance of a security seal to fail under bending loads in this test. Because various designs allow for seals to be categorized as either flexible or rigid, test configurations to make appropriate selections for bending resistance rating must first be made. Test flexible seals for ability to withstand repeated bending loads, and test rigid seals for resistance to deformation by bending to a specified degree. Test padlock type seals (Groups 3 or 5) using particular methods appropriate for those seals, as outlined in 6.3.6 and 6.3.7. Failure is access gained (see Table 3).

6.3.2 Flexible seals include those seals classified as being cable or wire seals (Group 1), or strap or cinch seals (Group 2), plastic or metal. Secure such flexible seals allowing enough material to be affixed in the test apparatus, such as a vise (see Fig. 3). Hold the section of the seal which comprises the



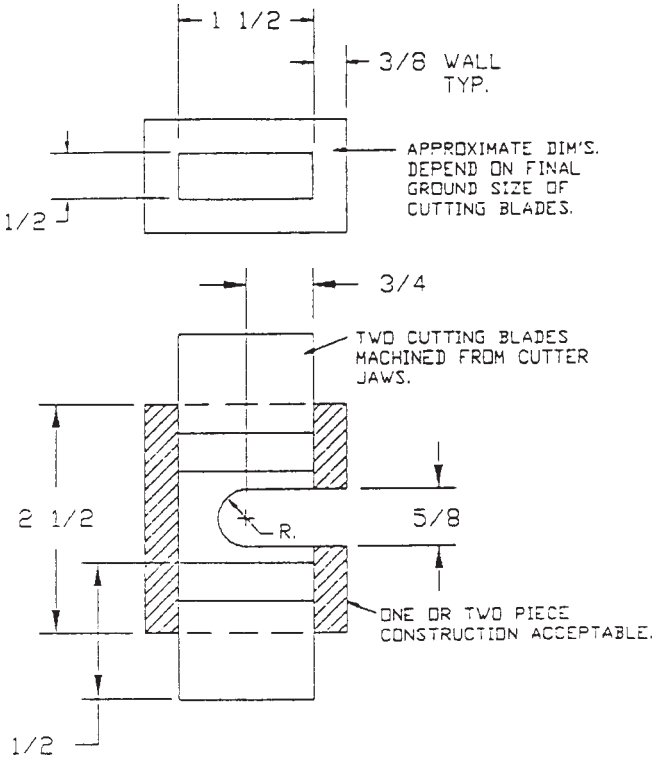
(*a*) Groups 1 and 2,
(*b*) Group 3,
(*c*) Group 4, and
(*d*) Group 5.

FIG. 1 Schematic Drawings of Pull (Tensile) Test as Applied to Security Seals:

TABLE 1 Pull (Tensile) Test Requirements for Grade Classification of Security Seals at Room Temperature 65°F (18°C), and at 180°F (82.2°C)

Load to Failure (lbf (N))	Seal Grade Level Awarded
5001 or more	F
3001 to 5000	E
1001 to 3000	D
201 to 1000	C
51 to 200	B
1 to 50	A

NOTE 1—1 lbf = 4.448222 N = 0.4536 kg.



NOTE 1—All dimensions are in inches (1 in. = 25.4 mm.)
NOTE 2—See Specification F 883 for definition of cutter jaws

FIG. 2 Suggested Fixture for Use in Shear Test for Security Seals (Patterned After Padlock Shackle Cutting Fixture in Performance Specification F 883)

TABLE 2 Shear Test Requirements for Grade Classification of Security Seals

Compressive Load to Cut, lbs (kg)	Seal Grade Level Awarded
2001 or more	F
1001 to 2000	E
751 to 1000	D
501 to 750	C
201 to 500	B
1 to 200	A

NOTE 1—1 lb = 0.4536 kg.

TABLE 3 Bending Test Requirements for Classification of Security Seals

Maximum Bending Moment, ft-lbf (Nm), for Bending of Rigid Seals or Cycles to Failure for Bending of Flexible Seals	Seal Grade Level Awarded
2001 or more	F
1001 to 2000	E
501 to 1000	D
251 to 500	C
101 to 250	B
1 to 100	A

NOTE 1—1 ft-lbf = 1.355818 Nm.

locking mechanism steady while flexing the material adjacent to this region back and forth. An analogous hand operation for this test would be to hold the seal in a vise, gripping the protruding part of the seal with pliers, and moving the pliers from side to side through an arc of 180°. Define the movement through one such arc as one cycle in this test.

6.3.3 Record the number of flexing cycles sustained by the seal prior to failure, and after comparing with the values given in Table 4, give such flexible seals a rating for performance in the bending test.

6.3.4 Rigid seals include those seals classified as bolt or rod seals, steel padlock type (Group 3), or twisted rod or wire seals (Group 4). Secure such rigid seals making sure in the case of the Group 4 seals that enough material beyond the twisted region of the seal remains available for gripping in the test apparatus (see Fig. 4). Hold the portion of the rigid seal which constitutes the locking section of the seal firmly in a holding device, such as a vise. Then affix a rigid tube or suitable extension arm over the remaining portion of the seal to act as a moment arm. Apply a load at some point along this moment arm in such a manner as to bend the rigid seal through an arc of 90°. (See Fig. 4 for a schematic set up.) The maximum applied load needed to move the seal the required amount, multiplied by the distance along the moment arm from the fixed portion of the seal, is equal to the bending moment required for the specified deformation of the seal. Bend back the seal to the original orientation, and bend through an arc of 90° in the same direction as first deformed. Continue this process until failure of the seal occurs. Failure is access gained (see 6.3.7).

6.3.5 Calculate the maximum bending moment encountered during the deformation of the rigid seal from the length of the moment arm and the maximum applied load during bending. Determine a rating for rigid security seals in the bend test by comparing with the required levels of performance given in Table 3.

6.3.6 Submit Group 5 (padlock type) seals to a bending test, using one of two possible test configurations, depending upon whether the rigid hasp is non-metallic (plastic) or metal. Affix metal hasp padlock type security seals to an appropriate stationary device and subject them to a torsional load applied to the body of the seal. Use a torque wrench or similar device to grip the seal. Record the value of torsional force needed to defeat the seal and determine the final rating to be used for evaluation of padlock type seals by comparing with values given in Table 4 (see Fig. 5).

6.3.7 Affix non-metallic (plastic) hasp padlock type security seals in a holding device such as a vise, and pass a bar or rod through the opening between the body and the shackle of the seal (see Fig. 6). Rotate this bar or rod to contact the two legs of the (shackle) seal. This will be the "rest'' position of the test fixture. Rotate the bar or rod 90° further, so as to induce bending of the shackle legs. Then rotate the bar or rod back to the rest position, completing one cycle of loading, continue (repeat) load application in this cyclic manner until failure of the seal. Failure is access gained. Determine the rating values for metallic and non-metallic (plastic) padlock type seals in accordance with Table 3. The lower test results of 6.3.6 or 6.3.7 will apply.

6.4 *Impact Test*:

6.4.1 Determine in this test the resistance of a security seal to impact loading at room temperature. Use apparatus similar to that employed in the pull test (see 6.1), adding a provision

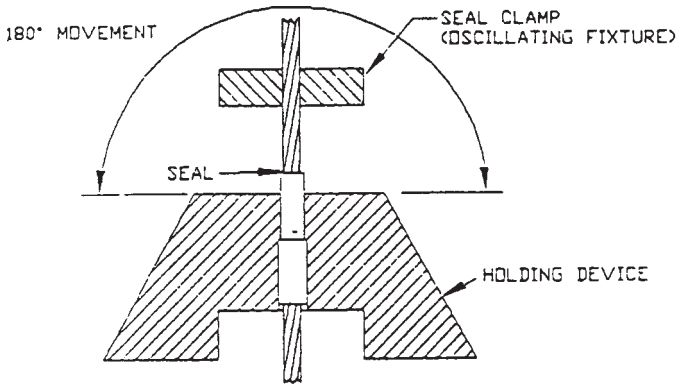


FIG. 3 Schematic Drawing of Bending Test as Applied to Flexible Security Seals

TABLE 4 Impact Test Requirements for Classification of Security Seals at Room Temperature 65°F (18°C) and at − 10°F (−26°C)

Impact Loading Sustained, ft-lbf (J)	Seal Grade Level Awarded
50 or more	F
40 to 49	E
30 to 39	D
20 to 29	C
10 to 19	B
Under 10	A

NOTE 1—1 ft-lbf = 1.355818 J.

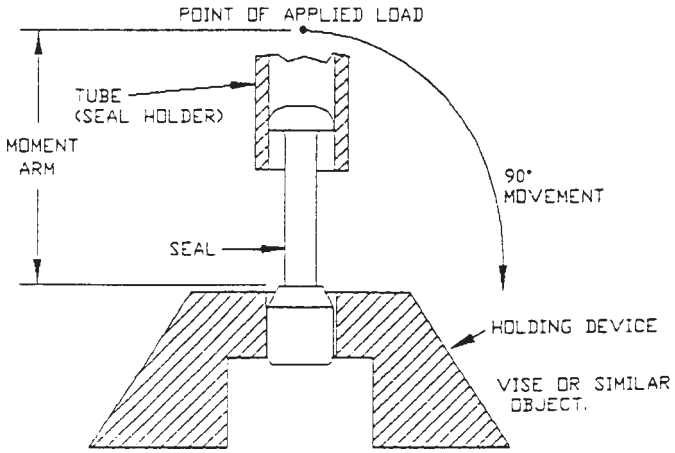


FIG. 4 Schematic Drawing of Bending Test as Applied to Rigid Security Seals

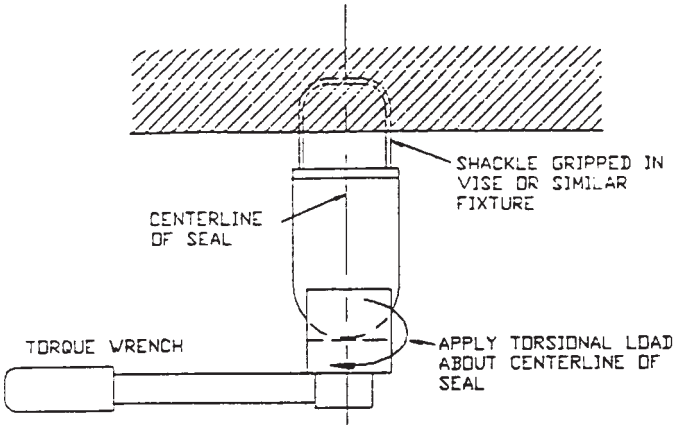


FIG. 5 Schematic Drawing of Bending Test as Applied to Metallic Class 5 Security Seals

for applying impact loads to the hardware requirements. The fixture for applying impact loading can be similarly tailored to the specific classification of security seals, in the manner outlined in the pull test requirements. Apply impact loads of a designated initial value five times to the seal. If the seal remains intact, apply the next increment of impact loading. Continue testing in this manner until the seal fails, or sustains five impact loadings at the highest designated value. See Table 4 for impact load increments and corresponding grade values. (See Performance Specification F 883.)

6.4.2 Test seals at an initial impact load equivalent to 10 ft-lbf (13.5 J), and apply a further load increased in increments of 10 ft-lbf (13.5 J). Record the highest level of impact loading experienced by a particular seal prior to failure and determine the rating of that seal in the impact test in accordance with the levels of performance listed in Table 4. If a seal fails at a certain impact load level before the five impacts have been completed, assign the next lower rating to the seal. For example, if a particular seal fails on the fifth impact loading of 30 ft-lbf (40.7 J), rate it for surviving up to the 20 ft-lbf (27.1 J) of impact load level (see 4.2).

6.5 *Extreme Temperature Tests*:

6.5.1 Conduct extreme temperature tests to determine the effect of elevated and reduced temperature on the performance of security seals. Under these test procedures, the manipulation of the security seal shall be identical to that listed in the procedures given in 6.1-6.4, with pull testing at 180°F (82.2°C), and impact testing at − 10°F (−26°C) added in the test procedures. Repeat tests with three new seals at both the

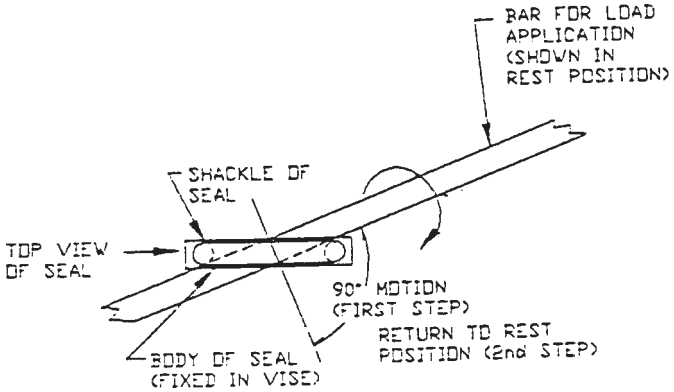


FIG. 6 Schematic Drawing of Bending Test as Applied to Nonmetallic Group 5 Security Seals

TABLE 5 Comprehensive Grade Table[A,B]

	A	B	C	D	E	F
Pull Test	1 to 50	51 to 200	201 to 1000	1001 to 3000	3001 to 5000	5001 or more
Shear Test	1 to 200	201 to 500	501 to 750	751 to 1000	1001 to 2000	2001 or more
Bending Test	1 to 100	101 to 250	251 to 500	501 to 1000	1001 to 2000	2001 or more
Room Temperature (65°F (18°C)) Impact Test	Under 10	10 to 19	20 to 29	30 to 39	40 to 49	50 or more
Heated (180°F (82.2°C)) Pull Test	1 to 50	51 to 200	201 to 1000	1001 to 3000	3001 to 5000	5001 or more
Cooled (−10°F (−27°C)) Impact Test	Under 10	10 to 19	20 to 29	30 to 39	40 to 49	50 or more
Report						

[A] Completed test results will show classification code prior to six letters designating test results of each test performed, for example, 3-E-E-D-C-D-B.
[B] A minimum of three seals to be tested in each category, total of 18 seals required to complete tests for classification rating of a specific seal.

higher and lower temperatures, and determine separate grading levels for each of the test responses. Verify test temperature by using a thermocouple.

7. Report

7.1 Report the following information concerning the performance of a given security seal tested in accordance with this practice:

7.1.1 The classification number best describing that particular seal;

7.1.2 The grade level awarded for the pull test;

7.1.3 The grade level awarded for the shear test;

7.1.4 Reporting of whether the seal in question was tested under the flexible or rigid bending test guidelines;

7.1.5 The grade level awarded for the bending test;

7.1.6 The grade level awarded for the impact test;

7.1.7 The grade level awarded for the pull test at 180°F (82.2°C); and

7.1.8 The grade level awarded for the impact test at − 10°F (−26°C).

7.1.9 The final classification of the seal will include all of the above: the classification number first, followed by six letters (see Table 5).

8. Keywords

8.1 locking device; modes of attack; security seal; single use locking device