Designation: F450 – 13

An American National Standard

Standard Test Methods for Vacuum Cleaner Hose—Durability and Reliability (Plastic)[1]

This standard is issued under the fixed designation F450; 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 test methods cover the determination of the effect of anticipated stresses and strains that vacuum cleaner and extractor hoses will receive in normal use.

1.2 These test methods apply to plastic (regular and reinforced) vacuum cleaner and extractor hoses for household use.

1.3 The following tests are included:

	Section
Torsional flex	6
Hot and cold flex with aging	7
Abrasion, external surfaces	8
Flex	9
Pull test on hose fittings with aging	10
Crush	11
Stretch ratio	12
Extractor hoses	13

1.4 These test methods are individual tests as agreed upon between the hose and vacuum manufacturer.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *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]

D638 Test Method for Tensile Properties of Plastics

D695 Test Method for Compressive Properties of Rigid Plastics

F395 Terminology Relating to Vacuum Cleaners

F595 Test Methods for Vacuum Cleaner Hose—Durability and Reliability (All-Plastic Hose) (Withdrawn 2010)[3]

3. Terminology

3.1 *Definitions*—Refer to Terminology F395.

4. Significance and Use

4.1 These test methods can be used by buyers of vacuum cleaner hose to specify the test criteria the hose must meet to be acceptable for their purposes.

5. Sampling

5.1 The sample size shall be one that is mutually agreed upon between the hose manufacturer and the vacuum cleaner manufacturer.

TEST METHODS

6. Torsional Flex Test

6.1 *Scope*—This test method covers the determination of the adhesion of the reinforcement wire coating to the hose jacket, the jacket strength, and the strength of the reinforcement wire for plastic hose with inside diameter from 1 to 2 in. (25 to 51 mm).

6.2 *Apparatus*—The apparatus shown in Fig. 1 is suitable for this test method with the following provisions:

6.2.1 Means to rotate test mandrel in a horizontal plane at 20 ± 1 rpm, both clockwise and counter-clockwise.

6.2.2 Test weight of 48 ± 1 oz (1360 ± 28 g) with provision to attach to sample hose.

6.2.3 Suitable clamp to attach sample hose to mandrel that retains the hose without causing failure at the clamp during the test.

6.2.4 Test mandrel with diameter same as inside diameter of hose with 0.078 in. (2.0 mm) radius at the ends of the mandrel (see Fig. 1).

6.2.5 Guide for weight to prevent hose sample from swinging during test cycle.

6.2.6 Instrument to measure cycles to failure or to a specified end point.

[1] These methods are under the jurisdiction of ASTM Committee F11 on Vacuum Cleaners and are the direct responsibility of Subcommittee F11.30 on Durability-Reliability.

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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.

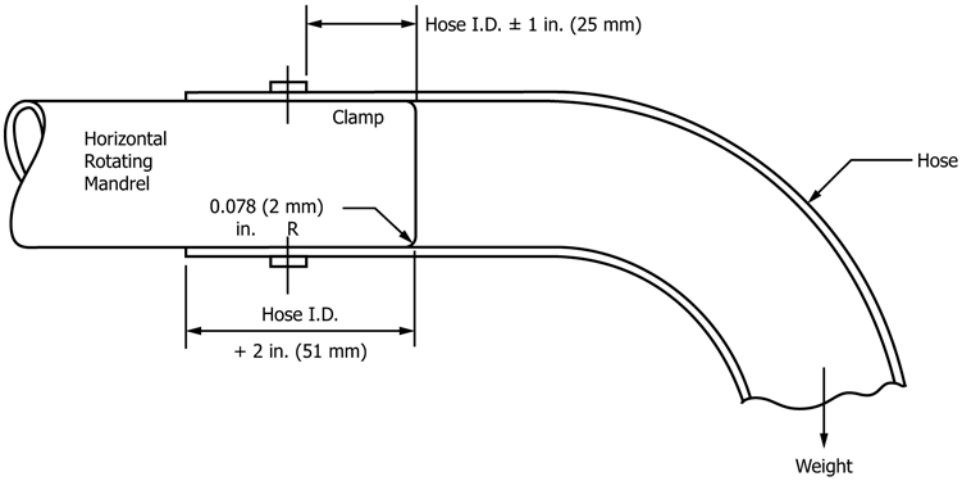

FIG. 1 Schematic for Torsional Flex Test

6.3 *Test Specimen*—The specimen shall be a length of hose 24 ± 1 in. (610 ± 25 mm) without fittings.

6.4 *Conditioning*—Condition the specimens at an ambient temperature of 68 to 81°F (20 to 27°C) for not less than 1 h prior to test.

6.5 *Procedure:*

6.5.1 Conduct the tests at 68 to 81°F (20 to 27°C).

6.5.2 Clamp the specimen to the test hose mandrel as shown in Fig. 1 and attach a weight to other end of hose sample.

6.5.3 Set measuring instrument at zero or record the initial reading.

6.5.4 Test half of the specimens by rotating clockwise and the other half by rotating counter-clockwise at 20 ± 1 rpm until failure or to a specified end point.

6.5.5 Failure may be evidenced by a broken reinforcing wire, tear, or hole that penetrates the hose jacket, or a collapsed coil or ply for a lined-type hose, or any combination thereof.

6.5.6 Additionally, breaking or damaging of the conductors, or an increase of more than 10 % of the conductor resistance, is considered to be a failure for current-carrying hoses.

7. Hot and Cold Flex Test with Aging

7.1 *Scope*—This test method covers the determination of the effect of temperature and flexing upon a hose sample with inside diameters from 1 to 2 in. (25 to 51 cm).

7.2 *Apparatus:*

7.2.1 *Air-Circulating Oven or Environmental Chamber,* to maintain 156°F (69°C) controlled to ±2°F (±1°C).

7.2.2 *Cold Box*—A cold box able to maintain 20°F (–6.7°C) controlled to ±1°F (±0.5°C).

7.3 *Test Specimen*—The specimen shall be a length of hose in which the length in inches or millimetres shall be determined as follows:

$$11.2 \times \text{inside diameter, in inches} + 2 \text{ in.}$$
$$(11.2 \times \text{inside diameter, in millimetres} + 51 \text{ mm})$$

7.4 *Conditioning*—Condition the specimens at an ambient temperature of 68 to 81°F (20 to 27°C) for not less than 1 h prior to test.

7.5 *Procedure:*

7.5.1 Bend a specimen in a "U" shape and tie the ends together at a position 1 in. (25 mm) from the ends as shown in Fig. 2.

7.5.2 Place the specimen into the oven, which has been brought to a steady test temperature of 156 ± 2°F (69 ± 1°C), and soak the sample for 20½ h.

7.5.3 Remove the specimen from the oven and allow 30 min for samples to come to ambient temperature in accordance with 7.4.

7.5.4 Next, place the specimen in the cold box, which has been brought to a steady temperature of 20 ± 1°F (–6.7 ± 0.5°C) for 2 h.

7.5.5 Remove the specimen from the cold box, untie and immediately flex it 360°, three times, 1 s per flex, as shown in Fig. 3.

7.5.6 Failure may be evidenced by a tear or hole that penetrates the hose jacket to cause air leak, or a collapsed coil or ply for a lined-type hose, or any combination thereof. Reinforcement wires that pull away or holes worn in outer jacket that do not cause air leaks are not determined to be failures.

7.5.7 Retie the hose in its original position.

7.5.8 Allow 1 h for conditioning as specified in 7.4 before starting next cycle.

7.5.9 The steps covered in 7.5.1 – 7.5.8 constitute one cycle. Conduct this complete cycle of tests for four successive days, then permit the specimens to remain at ambient conditions for the unused balance of a 7-day period, then repeat until a failure occurs or until a specified end point is reached, whichever occurs first.

7.6 *Report*—The report shall include the following:

7.6.1 Number of cycles to failure or to a specified end point, whichever occurs first,

7.6.2 Condition of the specimen,

7.6.3 Ambient test temperature,

7.6.4 Description of specimen, and

7.6.5 Number of specimens tested.

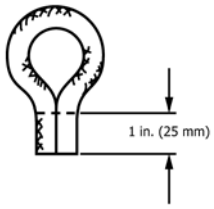

FIG. 2 Hose Position During Heat and Cold Soak

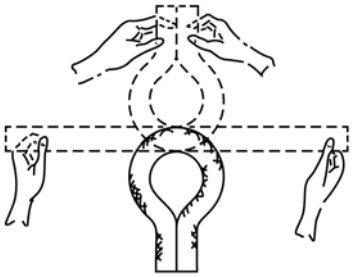

FIG. 3 Hose Flex Cycle

8. Abrasion Test of External Surface

8.1 *Scope*—This test method measures the wear characteristics of a vacuum cleaner hose subjected to an abrasive surface.

8.2 *Apparatus:*

8.2.1 *Special Abrasion Test Fixture,* as described in Fig. 4 to produce a rate of 20 ± 1 cycles/min.

8.2.2 *Cylindrical Segment,* as described in Fig. 5.

8.2.3 *Test Weight,* 16 ± 1 oz (454 ± 3 g) with provision to attach to the specimen.

8.2.4 *Abrasive Paper,* wet-dry, 500-grit, for abrasion test surface.[4]

8.2.5 *Instrument,* to measure cycles to failure or to a specified end point.

8.2.6 *Weight Guide,* to prevent weight from swinging during test cycling.

8.2.7 *Clamps,* suitable for attaching the hose to the mechanism coupling on one end and attaching the weight to the other end without causing failure of the hose at these clamps.

8.3 *Test Specimen*—The specimen shall be a full length hose, or a length of hose suitable for the test unit.

8.4 *Conditioning*—Condition the specimen at 68 to 81°F (20 to 27°C) ambient temperature for not less than 1 h prior to test.

8.5 *Procedure:*

8.5.1 Conduct the tests at 68 to 81°F (20 to 27°C).

8.5.2 Clamp a new sheet of standard wet-dry, 500-grit abrasive paper to the cylinder.

8.5.3 Clamp the specimen to the mechanism coupling. Attach the weight and place in the weight guide. The weight shall be in free suspension throughout the cycle.

8.5.4 Set the measuring instrument to zero or record starting value.

8.5.5 Cycle the specimen against the surface of the abrasive paper until failure of jacket or to a specified end point.

8.5.6 Failure may be evidenced by a tear or hole that penetrates the hose jacket to cause air leak, or a collapsed coil or ply for a lined-type hose, or any combination thereof. Reinforcement wires that pull away or holes worn in outer jacket that do not cause air leaks are not determined to be failures.

8.5.7 Additionally, exposure of the bare conductor wire is considered a failure in a current-carrying hose.

8.6 *Report*—The report shall include the following:

8.6.1 Number of cycles to failure or to a specified end point, whichever occurs first,

8.6.2 Description of failure,

8.6.3 Ambient test temperature,

8.6.4 Description of specimen, and

8.6.5 Number of pieces tested.

9. Flex Test

9.1 *Scope*—This test method covers the determination of the vacuum cleaner hose resistance to bending under an applied stress.

9.2 *Apparatus:*

9.2.1 *Special Abrasion Test Fixture,* as described in 8.2.1 and Fig. 4 except with driving arm rotating at 36 ± 1 cycles/min and the cylindrical segment replaced with pulley (9.2.2).

9.2.2 *Pulley,* a cold-rolled steel (or similar) grooved pulley as described in Fig. 6.

9.2.3 *Test Weight,* 160 ± 1 oz (4536 ± 28 g) for reinforced hoses and 80 ± 1 oz (2268 ± 28 g) for plastic hoses with provision for attaching to the specimen.

9.2.4 *Weight Guide,* to prevent weight from swinging during test cycling.

9.2.5 *Instrument,* to measure cycles to failure or to a specified end point.

9.2.6 *Clamps,* suitable for attaching the hose to the mechanism coupling on one end and attaching the weight to the other end without causing failure of the hose at these clamps.

9.3 *Test Specimen*—The specimen shall be a full length hose, or a length of hose suitable for the test unit.

9.4 *Conditioning*—Condition the specimen at 68 to 81°F (20 to 27°C) ambient temperature for not less than 1 h prior to test.

9.5 *Procedure:*

9.5.1 Conduct tests at 68 to 81°F (20 to 27°C).

9.5.2 Clamp the specimen to the mechanism coupling. Attach the weight and place in weight guide. The weight shall be in free suspension throughout the cycle.

9.5.3 Set the measuring instrument to zero or record the starting value.

9.5.4 Run the test until failure or until a specified end point is reached, whichever occurs first.

9.5.5 Failure may be evidenced by a tear or hole that penetrates the hose jacket to cause air leak, or a collapsed coil or ply for a lined-type hose, or any combination thereof.

[4] Wet-dry, 500-grit, Tri-M-Ite Abrasive Paper, available from 3M Co., St. Paul, MN, has been found suitable for this purpose.

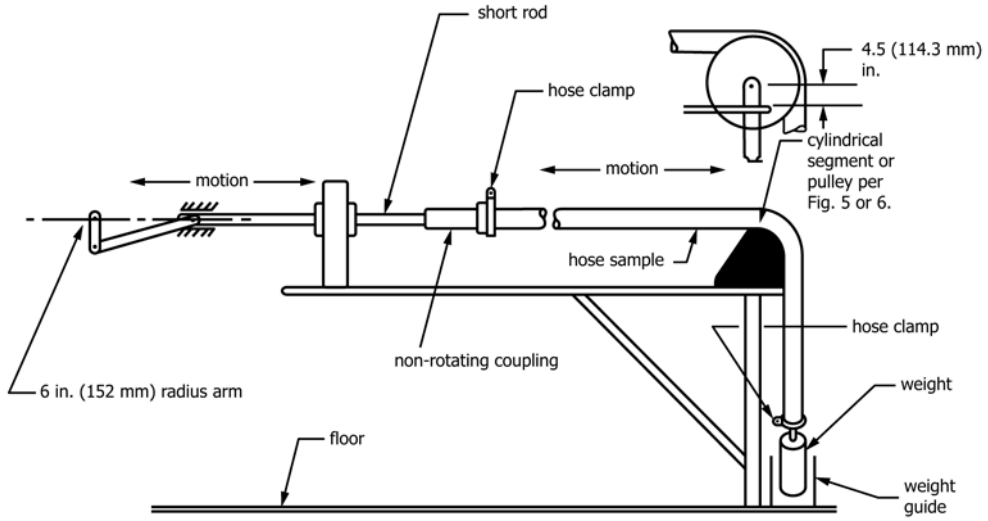

FIG. 4 Abrasion and Flex Test Fixture (Abrasion Set Up Shown)

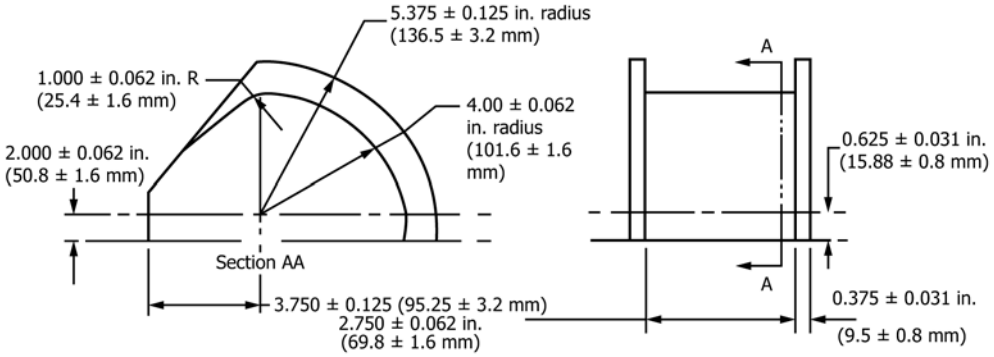

FIG. 5 Cylindrical Segment (Abrasion Test)

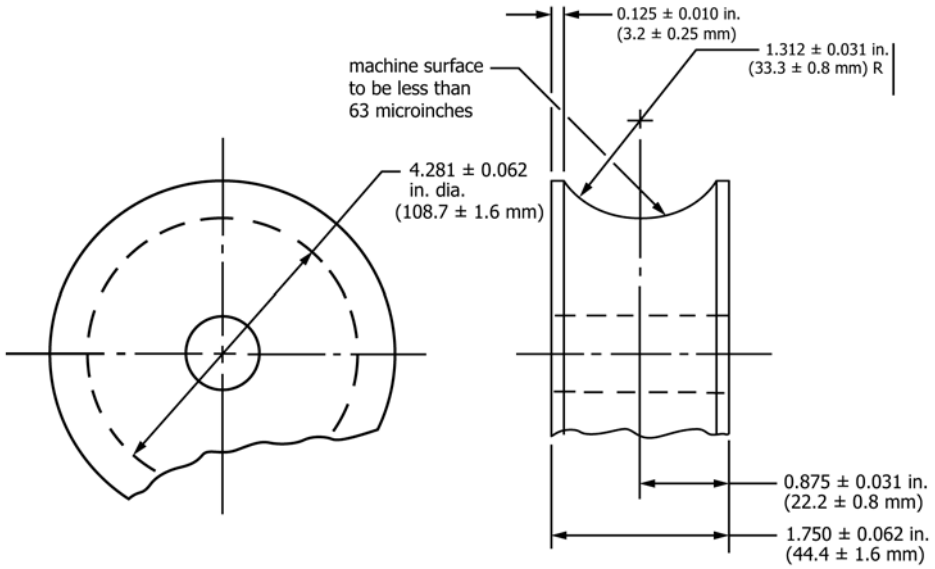

FIG. 6 Pulley Flex Test Fixture

Reinforcement wires that pull away or holes worn in outer jacket that do not cause air leaks are not determined to be failures.

9.5.6 Additionally, breaking or damaging of the conductors, or an increase of more than 10 % of the conductor resistance, is considered to be a failure for current-carrying hoses.

9.6 *Report*—The report shall include the following:
9.6.1 Number of cycles to failure or specified end point, whichever occurs first,
9.6.2 Type of failure,
9.6.3 Ambient test temperature,
9.6.4 Description of specimen, and
9.6.5 Number of pieces tested.

10. Pull Test on Hose Fittings with Aging

10.1 *Scope*—This test method covers the determination of the ability of the vacuum cleaner hose fitting connection to withstand maximum forces during use.

10.2 *Apparatus:*
10.2.1 *Oven and Cold Box,* as specified in 7.2,
10.2.2 *Total Test Weight,* in 80 ± 0.5-oz (2268 ± 14-g) increments.
10.2.3 *Testing Machine* (alternative to the dead weight)—A properly calibrated machine of the constant-rate-of crosshead movement type meeting the requirements of Test Method D638 (see 10.5.3 for tension method).

10.3 *Test Specimen*—The test specimen shall be a 1-ft (0.3-m) long section from each end of the hose containing the cleaner attachment fittings, or the hose fittings, or both. Its length shall conform to the requirements of 10.5.3.1 if the tensile machine test method is used.

10.4 *Conditioning*—Prior to test on fittings, age the specimens by performing the following heat/cold soak.
10.4.1 Place the specimen, in straight configuration, in an air-circulating oven at 156° ± 2°F (69 ± 1°C) for 20½ h.
10.4.2 Remove the specimen from the oven and allow 30 min for the specimens to come to equilibrium with ambient temperature 68 to 81°F (20 to 27°C).
10.4.3 Place the specimen in cold box at 20 ± 1°F (–6.7 ± 0.5°C) for 2 h.
10.4.4 Remove the specimens from the cold box and allow 1 h for them to return to ambient temperature before conducting the pull test.

10.5 *Procedure:*
10.5.1 Conduct the tests at ambient temperature of 68 to 81°F (20 to 27°C).
10.5.2 *Dead Weight Method:*
10.5.2.1 Clamp the fitting of the specimen to the dead weight.
10.5.2.2 Holding the hose, lift the weight slowly. Hold off the floor for 1 min.
10.5.2.3 With dead weight hold 1 min, otherwise pull until failure with increasing load on the fitting in 80-oz (2268-g) increments.
10.5.2.4 Test both ends.
10.5.3 *Tension Testing Machine Method:*
10.5.3.1 Select a specimen length short enough so that the end treatment is pulled off before the hose stretches the entire distance of travel of the instrument.
10.5.3.2 Fasten both ends of the hose firmly in the machine.
10.5.3.3 Stretch the sample at the rate of 0.50 ± 0.2 in. (12.7 ± 6.1 mm)/min until the hose pulls away from the fitting. Note the force applied.
10.5.3.4 Repeat the test with slightly decreasing amounts of force until the greatest force applied to the sample for 1 min without pulling the fitting from the hose is reached. Note this value.
10.5.3.5 If the hose failure occurs before either the fitting or fitting to hose bond, report as hose failure and note the load applied.

10.6 *Report*—The report shall include the following:
10.6.1 Maximum weight or load supported without failure,
10.6.2 Location of failure,
10.6.3 Ambient test temperature,
10.6.4 Hose and fitting description, and
10.6.5 Number of specimens tested.

11. Crush Test (Relaxed and Stretched)

11.1 *Scope*—This test method covers the determination of the resistance to crushing of the hose.

11.2 *Apparatus:*
11.2.1 *Total Dead Weight,* in convenient weight increments to apply a steady, non-impact compression force.
11.2.2 *Testing Machine* (alternative for the dead weight)—A properly calibrated compression testing machine of the constant-rate-of-crosshead movement type meeting the requirements of Test Method D695.
11.2.3 *Loading Plates*—The load shall be applied to the specimen through a 2½ in. (63.5 mm) wide plate with 0.062-in. (1.6-mm) radius edges. Thickness of the plate shall not be less than 0.50 in. (12.7 mm).

11.3 *Test Specimen*—The specimen shall be a minimum length hose of 8 in. (203 mm) with force applied in the center of the specimen. Length applies for both relaxed and stretched positions.

11.4 *Conditioning*—Condition the specimen at 68 to 81°F (20 to 27°C) prior to test for not less than 1 h.

11.5 *Procedure:*
11.5.1 Conduct tests at 68 to 81°F (20 to 27°C).
11.5.2 Measure the outside diameter of the specimen at the center.
11.5.3 *Dead Weight Method:*
11.5.3.1 Locate the hose with its axis parallel to the plane surface and loading plate (see Fig. 7).
11.5.3.2 Apply the dead test weight to the bearing plate at the hose center.
11.5.3.3 Apply a non-impact load in convenient dead weight increments for 30 s which results in a permanent deformation of 25 % reduction in the original diameter as measured after allowing a 30-min relaxation period.
11.5.4 *Compression Testing Machine Method:*
11.5.4.1 Set up compression fixture in testing machine.
11.5.4.2 Locate the hose area to be tested in a plane surface, then place loading plate with the hose axis parallel to the plate.
11.5.4.3 Apply the load at the rate of 0.50 ± 0.2 in. (12.7 ± 5.1 mm)/min until 25 % reduction in diameter is reached. Hold for 30 s. Stop the machine and remove the load. Allow 30 min for the test specimen to relax before measuring.
11.5.5 The hose may then be restored to its original shape after final reduction by hand only.

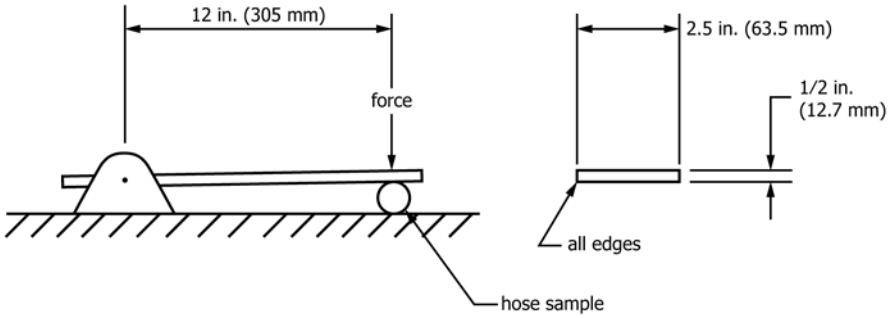

FIG. 7 Crush Test Fixture

11.5.6 Calculate the percent reduction in diameter as follows:

Percent reduction in diameter = (original – final minor diameter)/original diameter.

11.6 *Report*—The report shall include the following:
11.6.1 Original diameter,
11.6.2 State hose was tested in (relaxed or stretched),
11.6.3 Load applied to produce 25 % permanent reduction,
11.6.4 Load applied and percent reduction in diameter if 25 % permanent reduction could not be obtained,
11.6.5 Percent reduction after restoration by hand,
11.6.6 Ambient test temperature,
11.6.7 Specimen description, and
11.6.8 Number of specimens tested.

12. Stretch Ratio

12.1 *Scope*—This test method covers the determination of the stretch ratio of vacuum and extractor hoses under a prescribed weight.

12.2 *Apparatus:*
12.2.1 *Test Weight,* 10 ± 0.1 lb.
12.2.2 *Clamps,* suitable for attaching the hose to the fixture on one end and attaching the weight to the other end without causing failure of the hose at these clamps.
12.2.3 *Tape Measure.*

12.3 *Test Specimen*—The test specimen shall be 24 in. in length (relaxed state).

12.4 *Conditioning*—Prior to test, age the specimens by performing the following heat/cold soak.
12.4.1 Place the specimen, in straight configuration, in an air-circulating oven at 156 ± 2°F (69 ± 1°C) for 20½ h.
12.4.2 Remove the specimen from the oven and allow 30 min for the specimens to come to equilibrium with ambient temperature 68 to 81°F (20 to 27°C).
12.4.3 Place the specimen in cold box at 20 ± 1°F (6.7 ± 0.5°C) for 2 h.
12.4.4 Remove the specimens from the cold box and allow 1 h for them to return to ambient temperature before conducting the test.

12.5 *Procedure:*
12.5.1 Conduct the tests at ambient temperature of 68 to 81°F (20 to 27°C).
12.5.2 Attach clamp to within 2 in. of top end of hose.
12.5.3 Attach clamp to within 2 in. of bottom of hose that will attach to dead weight.
12.5.4 Measure the distance between the 2 inside edges of the hose clamps with the hose laid straight and in the relaxed condition (distance T1).
12.5.5 Attach test weight to clamp on bottom of hose.
12.5.6 Holding the top clamp, slowly lift the hose until the weight is clear from the floor. Hold for 10 s.
12.5.7 Measure distance between the inside edges of the hose clamps (distance T2).
12.5.8 Stretch ratio = T2/T1.

12.6 *Report*—The report shall include the following:
12.6.1 Values of T2, T1, and stretch ratio.
12.6.2 Ambient test temperature.
12.6.3 Hose description.
12.6.4 Number of pieces tested.

13. Extractor Hoses

13.1 *Scope*—This test method covers the pre-conditioning of the hoses used in wet conditions with extractors. This pre-conditioning shall be done prior to any of the tests outlined in Sections 6 – 12.

13.2 *Conditioning*—Prior to test, age the specimens by performing the following heat/cold/wet soak:
13.2.1 Place the specimen, in straight configuration, in an air-circulating oven at 156 ± 2°F (69 ± 1°C) for 20½ h.
13.2.2 Remove the specimen from the oven and allow 30 min for the specimens to come to equilibrium with ambient temperature 68 to 81°F (20 to 27°C).
13.2.3 Place the specimen in cold box at 20 ± 1°F (6.7 ± 0.5°C) for 2 h.
13.2.4 Remove the specimens from the cold box and allow 1 h for them to return to equilibrium with ambient temperature 68 to 81°F (20 to 27°C).
13.2.5 Soak the specimen (inside and out) at 3× concentration of the chemical fluid (68 to 81°F) that will be used in the wet appliance for a period of 24 h.
13.2.6 Proceed to perform tests from Sections 6 – 12.

14. Precision and Bias

14.1 *Precision*—No meaningful precision statement can be made due to the variability inherent in durability testing.

14.2 *Bias*—A bias statement cannot be applied to these test methods as there is no standard reference for comparison.

15. Keywords

15.1 durability; vacuum cleaner hose; vacuum cleaners