ASTM D 1709 Impact Resistance of Plastic Film by the Free-Falling Dart Method / Testing Equipment

Description

Apparatus

5.1 The apparatus shall be constructed essentially as shown in Fig. 1, using the following components common to both test methods:

5.1.1 Dart Well—If the dart impact machine utilizes an enclosed dart well, it must contain a single unobstructed vent with a minimum area of 625 mm2 (~1 in.2) to provide adequate venting.
NOTE 3—Some dart impact machine designs utilize enclosed dart wells that do not permit adequate venting to the atmosphere during impact. Data have shown that this has a significant effect on the observed impact value, especially with films that exhibit high elongation during testing, resulting in atypically high impact values.
NOTE 4—The use of smaller, multiple vents is permitted if it can be demonstrated that the venting efficiency is comparable and has no statistically significant effect on the values obtained.

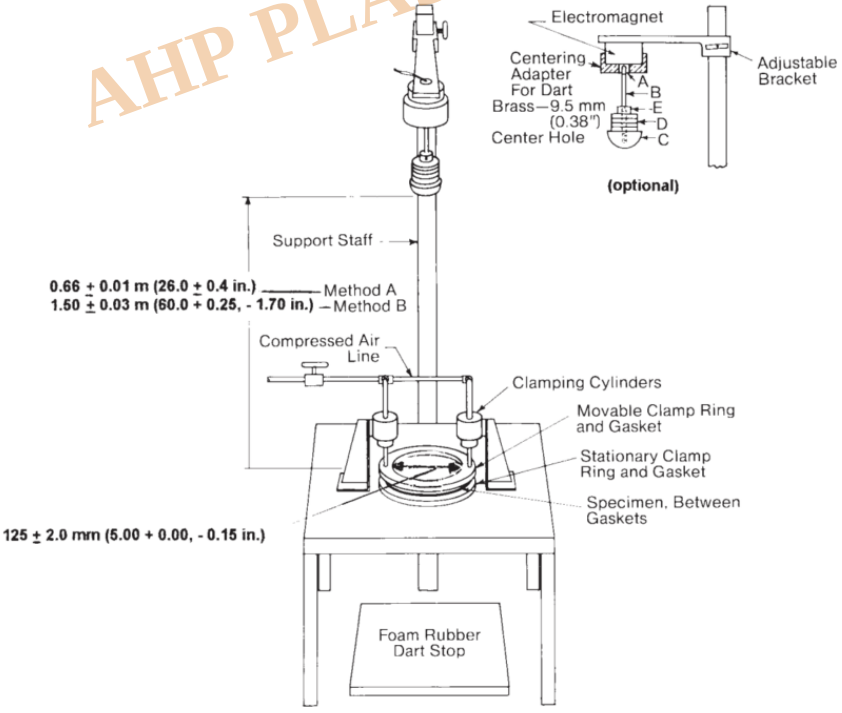
5.1.2 Specimen Clamp—A two-piece annular specimen clamp having an inside diameter of 125 +- 2.0 mm [5.0 + 0.0, ?0.15 in.] and conforming to the following requirements: 5.1.2.1 The lower or stationary half of the clamp shall be mounted rigidly so that the plane of the specimen is horizontal. 5.1.2.2 The upper or movable part of the clamp shall be designed to maintain positive and plane contact with the lower part of the clamp when in position. The clamps shall be provided with suitable means of maintaining sufficient contact to hold the film sample firmly in place during the test. Pneumatically operated clamps have been successfully employed.

5.1.2.3 Rubber-like gaskets may be affixed to the specimen contact surfaces of both clamps to provide a cushion which minimizes thickness variation effects. Rubber gasketing 3.0 +- 1 mm [0.125 + 0.025,

?0.04 in.] thick, of 50 to 60 Shore A durometer hardness, 125 +- 2.0 mm [5.00 + 0.00, ?0.15 in.] in inside diameter and 150 +- 3.0 mm [6.0 + 0.02, ?0.2 in.] in outside diameter has been found satisfactory for this purpose. 5.1.2.4 Slippage of films greater than 0.10 mm [0.004 in.] in thickness may be minimized or eliminated by securing crocus cloth or 50D garnet abrasive paper to the gaskets with double sensitive tape so that the abrasive surface is in direct contact with the film. There should be sufficient clamping force to eliminate detectable slippage. Other means of reducing slippage such as additional clamping devices or positive clamping surfaces may be used provided that the film is not weakened at the inside wall of the specimen clamps and that the effective diameter of 125 +- 2.0 mm [5.00 + 0.00, ?0.15 in.] of the film is not changed.
5.1.3 Dart Release Mechanism, capable of supporting a 2-kg weight shall be used for supporting and releasing the dart assembly. It shall be equipped with a centering device, such as a removable plumb bob, to ensure a reproducible drop. Either an electromagnetic- or pneumatic-operated release mechanism may be used.

5.1.4 Positioning Device—The apparatus shall be able to drop the dart from heights of 0.66 +- 0.01 m [26.0 +- 0.4 in.] for Test Method A and 1.50 +- 0.03 m [60.0 + 0.25, ?1.70 in.] for Test Method B. The distance between the impinging surface of the dart head and the surface of the test specimen is considered to be the drop height. The dart shall be positioned vertically above the center of the test specimen.

5.1.5 Micrometer, accurate to +-0.0025 mm [60.0001 in.] in the range from 0.0025 mm [0.0001 in.] to 1 mm [0.4 in.] for measuring specimen thickness (see Test Methods D 374).



NOTE—Legend Dart Assembly:
A. Steel shaft tip 6.5 ± 1 mm [0.25 + 0.04, −0.03 in.] OD by 12.5 ± 0.2 mm [0.50 + 0.00, −0.02 in.] long.
B. Dart shaft: 6.5 ± 1 mm [0.25 + 0.04, −0.03 in.] OD and at least 115 mm [4.5 in.] long: ¼ –20 thd. (N.C.) 12.5 ± 0.2 mm [0.50 + 0.00, −0.02 in.] long on bottom: No. 5–40 thd. (N.F.) for steel tip.
C. Hemispherical head: Method A—38.10 ± 0.13–mm [1.500 ± 0.005–in.] in diameter. Method B—50.80 ± 0.13–mm [2.000 ± 0.005 in.] in diameter.
D. Removable weights.
E. Collar and screw.

FIG. 1 Apparatus for Free-Falling Dart Impact Test for Plastic Film

5.1.6 Cushioning and Shielding Devices, to protect personnel and to avoid damaging the impinging surface of the dart. These devices shall not interfere with the dart or the specimen prior to penetrating the specimen. 5.1.7 Collar with inside diameter of approximately 7 mm [0.28 in.] and with set screw for securing collar to dart shaft.
5.2 Darts for Test Methods A and B shall have hemispherical heads, each fitted with a 6.5 +- 1-mm [0.25 + 0.04, ?0.03- in.] diameter shaft at least 115 mm [4.5 in.] long to accommodate removable incremental weights. Each dart weight shall be known to +-0.5 % relative. Dart head surfaces shall be free of nicks, scratches, or other irregularities. The shaft shall be attached to the center of the flat surface of the head with its longitudinal axis perpendicular to the surface. If an electromagnet is used, the shaft shall be made of material that is not magnetic and shall have a steel tip 125 +- 0.2 mm [0.50 + 0.00, ?0.02 in.] long at the end held by the electromagnet. 5.2.1 For Test Method A, the dart head shall be 38.10 +- 0.13–mm [1.500 +- 0.005–in.] in diameter. It may be constructed of smooth, polished aluminum, phenolic, or other low-density material of similar hardness.
5.2.2 For Test Method B, the dart head shall be 50.80 +- 0.13–mm [2.000 +- 0.005 in.] in diameter. It may be constructed of smooth, polished stainless steel or other material of similar durability.
5.3 The material of construction of the dart head shall be referenced in the report using the following designations:

Material Construction	Designation
Stainless Steel	A
Aluminum	B
Phenolic	C
Composite	D
Other	E

NOTE 5—Data have shown a sensitivity of impact results related to the material of construction and finish of the dart head used. The differences have been especially significant when testing films exhibiting high impact, or high elongation characteristics, or both. This issue, together with related concerns, is currently under study in Subcommittee D20.19.

5.4 Incremental Weights for Test Methods A and B shall be of stainless steel or brass and cylindrical in shape. Each shall have a center hole 6.6 + 1.0, ?0.00 mm [0.26 + 0.03, ?0.00 in.] in diameter. The thickness of each shall be adjusted to obtain the specified weight within +-0.5 %. The diameter of the weights shall not exceed the diameter of the dart head. Suggested combination of weights for the specified diameters are as follows:
5.4.1 For Test Method A, 31.5+-1 -mm [1.25 + 0.03, ?0.05- in.] diameter weights:

Number	Weight, g
2 or more	5
8	15
8	30
8	60

5.4.2 For Test Method B, 45.0 ± 1-mm [1.75 + 0.06, −0.02- in.] diameter weights.

Number	Weight, g
2 or more	15
8	45
8	90

5.4.3 Optionally, additional weights, each 120 g +- 0.5 % for Test Method A or 180 g +- 0.5 % for Test Method B, may be constructed for use if it is necessary to extend the missile weight beyond that attainable when using all weights in the standard set.

Test Specimen
6.1 Test specimens shall be large enough to extend outside the specimen clamp gaskets at all points. The specimens shall be representative of the film under study and shall be taken from the sheet or tube in a manner representative of sound sampling practice. This is to ensure that the whole of the sheet be represented in the test unless such sampling constitutes a variable under study.
6.2 The specimens shall be free of pinholes, wrinkles, folds, or other obvious imperfections, unless such imperfections constitute variables under study.

Conditioning
7.1 Conditioning—Follow the conditioning requirements specified in the materials specification for the material that is being tested. Otherwise, condition the test specimens at 23 +- 2°C [70 to 77°F] and 50 +- 5 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D 618, for those tests where conditioning is required. In cases of disagreement, the tolerances shall be +-1°C [+-1.8°F] and +-2 % relative humidity.
7.2 Test Conditions—Conduct tests in the standard laboratory atmosphere of 23 +- 2°C [73.4 +- 3.6°F] and 50 +- 5 % relative humidity unless otherwise specified in the materials specification. In cases of disagreement, the tolerances shall be +-1°C [+-1.8°F] and +-2 % relative humidity.

Preparation of Apparatus
8.1 Set up the apparatus for testing by Test Method A or by Test Method B.

8.1.1 For Test Method A select a dart with a 38.10 +- 0.13- mm [1.500 +- 0.005-in.] diameter hemispherical head. For Test Method B, select a dart with a 50.80 +- 0.13-mm [2.000 +- 0.005-in.] diameter hemispherical head.
8.1.2 Activate the dart release mechanism and insert the steel shaft tip into the mechanism. The dart should be held in place by the dart release mechanism. Adjust the drop height (the vertical distance from the plane of a clamped specimen to the bottom surface of the dart head) to 0.66 +- 0.01 m [26.0 +- 0.4 in.] for Test Method A or to 1.50 +- 0.03 m [60.0 + 0.25, ?1.70 in.] for Test Method B. (Caution—For safety reasons, remove the dart while making position adjustments.)
8.1.3 With a trial film specimen clamped between the specimen clamps and with no added weights on the dart, release the dart and observe the point at which the dart impacts the specimen, catching the dart after it bounces off the film surface. If necessary, adjust the dart release mechanism so that, in repeated trials, the dart reproducibly impacts the center of the clamped portion of the film.
8.2 Check the apparatus periodically to make sure specimen slippage during testing is not occurring. If slippage occurs, this is reason to reject the results. The likelihood of occurrence of slippage increases with increasing dart weight and with increasing drop height and is greater with some materials than with others. Slippage may be checked conveniently during the course of testing of a routine sample at a missile weight wherein both failures and non-failures are being observed. Either of the following procedures is effective.
8.2.1 Before dropping the missile on a clamped specimen, draw a circle on the film using a ball-point pen in contact with the inside wall of the upper clamp. Apply only the pressure of the pen itself to the film. (Caution—For safety reasons, the dart should not be in the dart release mechanism while drawing

the circle.) After the dart is dropped and prior to removing the plastic film, draw another circle using a ball-point pen of another color. If the lines are drawn, distinct double lines at any point on the circumference show that slippage has occurred.
8.2.2 If crocus cloth or sandpaper is affixed to the gaskets to effect greater gripping, determine slippage simply by inspecting the clamped film area after impact for evidence of scratch marks produced as slippage occurred.

STAIRCASE TESTING TECHNIQUE

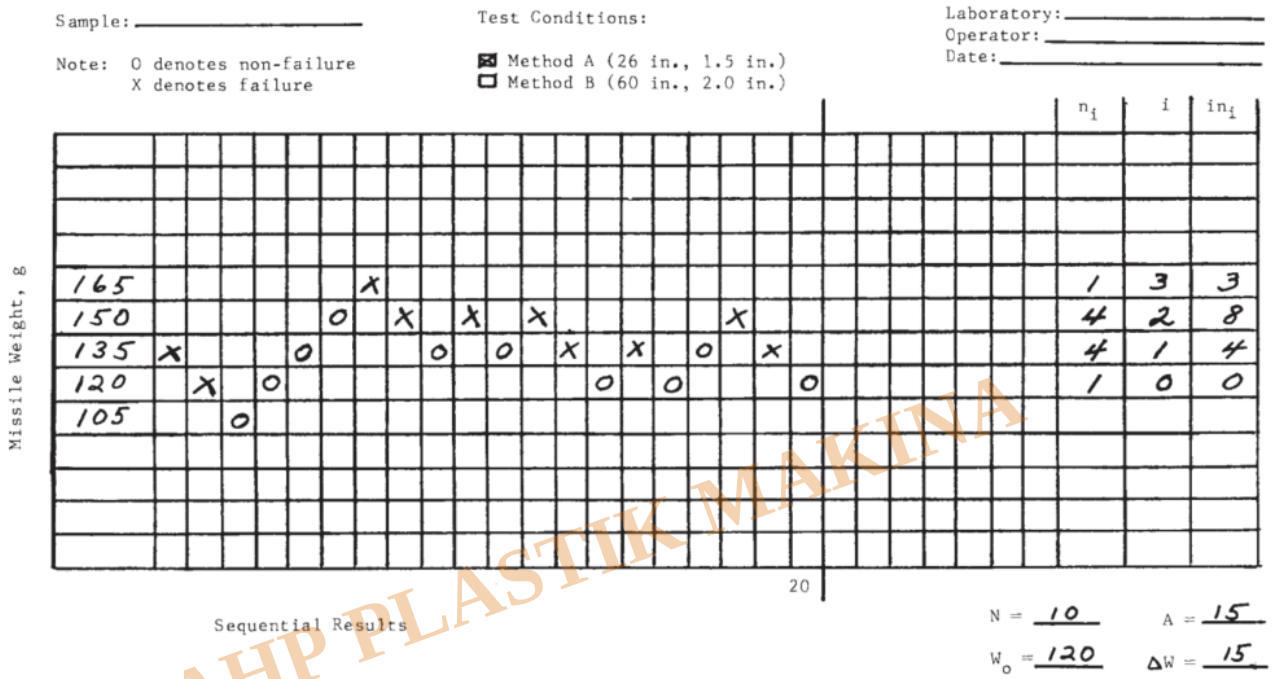
Procedure
9.1 By this technique, a uniform missile weight increment is employed during test and the missile weight is changed after test of each specimen.
9.2 Select Test Method A or Test Method B for use, as desired, or as required by the relevant material specification. Set up the apparatus for testing as described in 8.1. If desired, carry out a slippage check as described in 8.2 at some point during the course of testing.
9.3 Measure and record the average thickness of the test specimens in the area of impact to the nearest 0.0025 mm [0.0001 in.].
9.4 For a starting point, select a missile weight near the expected impact failure weight. Add the necessary number of incremental weights onto the dart shaft and put the locking collar into place so that the weights are held securely in place. 9.5 Select a missile weight increment DW appropriate to the impact strength of the sample: The value chosen for DW should be such that three to six (but at least three) missile weights will be employed in the determination. A DW value equal to some 5 to 15 % of WF, the impact failure weight, is usually appropriate.
9.6 Place the first test specimen over the bottom part of the clamp, making sure that it is uniformly flat, free of folds, and that it covers the gasket at all points. Clamp in place with the top part of the annular clamp.
9.7 Activate the dart release mechanism and put the dart into position. Release the dart. If the dart bounces off the specimen surface, catch the dart after it bounces to prevent both multiple impact with the specimen surface and damage to the hemispherical contact surface of the dart resulting from impact with metal parts of the apparatus.
9.8 Examine the test specimen for any evidence of slippage. If slippage occurs, this is reason to reject the results.
9.9 Examine the specimen to determine whether it has or has not failed. Record the result on a form such as that shown in Fig. 2, using a 0 to denote non-failure and an X to denote failure, or any other similar convention to indicate non-failure or failure.

9.10 If the first specimen failed, decrease the missile weight by DW. If the first specimen did not fail, increase the missile weight by DW. Test the second specimen. Continue testing successive specimens, decreasing or increasing the missile weight by DW between drops depending upon whether the preceding specimen did or did not fail. 9.11 After 20 specimens have been tested, count the total number, N, of failures, (X's). If N = 10 at this point, testing is complete. If not, complete testing as follows: 9.11.1 If N < 10, continue testing additional specimens until N = 10, then stop testing.
9.11.2 If N > 10, continue testing additional specimens until the total number of non-failures (0's) reaches 10, then stop testing.

10. Calculation 10.1 On the data record-calculation form (see Fig. 2), record under ni the total number

of X's at each missile weight, counting only the last 10 X's during test.

NOTE 6—If, during test, after 20 drops, N < 10 or N = 10, there will be only 10 X's after testing is complete. Only where N > 10 after 20 drops will it be necessary to omit some of the earlier X results.
10.2 Under i, enter integers 0, 1, 2, etc. for each ni entry. Enter 0 for the lowest missile weight at which an ni value has been entered, a 1 for next higher missile weight, etc.



NOTE—

$$W_F = W_o + [\Delta W\,(A/N - 1/2)]$$
$$= 120 + [15(15/10 - 1/2)]$$
$$= 120 + [15(1.5 - 0.5)]$$
$$= 135\ g.$$

FIG. 2 Determination of Dart Impact Failure Weight

10.3 Under in_i, enter the product of i times n_i.

10.4 Add the n_i's and enter as N; by the procedure described, N will always be 10. Add the in_i's and enter as A. Enter W_o, the missile weight to which an i value of zero is assigned. Enter ΔW the uniform missile weight increment employed.

10.5 Calculate the impact failure weight W_F, g, as follows:

$$W_F = W_o + [\Delta W\,(A/N - 1/2)]$$

- According to ISO 7765, ASTM D1709
- Touch display
- Thermal printer report out
- USB data out to excel
- Pneumatic sample grip
- Includes dart weights
- Full calculation as per standard method
- Manual heigh adjustment
- Magnetic or pneumatic release of dart
- n. 2 g. 5 diam. 31 mm
- n. 8 g.15 diam. 31 mm
- n. 8 gr.30 diam. 31 mm
- n. 8 gr. 60 diam. 31 mm

Category

1. Equipment for Standards
2. Standards