



# Standard Test Methods for Impact Resistance of Rigid Poly(Vinyl Chloride) (PVC) Building Products<sup>1</sup>

This standard is issued under the fixed designation D 4226; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope \*

1.1 These test methods cover the determination of the energy required to crack or break rigid poly(vinyl chloride) (PVC) plastic sheeting and profile flat sections used in building products, as well as extruded or molded test samples, under specified conditions of impact from a freefalling standard weight striking an impactor with either of two configurations in contact with the specimen.

1.2 Two test procedures are included:

1.2.1 *Procedure A*, used to determine minimum impact energy required to cause failure (hole, crack, split, shatter, or tear).

1.2.2 *Procedure B*, used to determine minimum impact energy required to cause brittle failure.

1.3 The values in inch-pound units are to be regarded as the standard.

NOTE 1—There is no similar or equivalent ISO standard.

1.4 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding, those in tables in figures) shall not be considered as requirements of this standard.

1.5 *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.* Specific precautionary statements are given in Section 8.

## 2. Referenced Documents

### 2.1 ASTM Standards:

D 374 Test Methods for Thickness of Solid Electrical Insulation<sup>2</sup>

D 618 Practice for Conditioning Plastics and Electrical

Insulating Materials for Testing<sup>3</sup>

D 883 Terminology Relating to Plastics<sup>3</sup>

D 1898 Practice for Sampling of Plastics<sup>4</sup>

D 3679 Specification for Rigid Poly(Vinyl Chloride) (PVC) Siding<sup>5</sup>

E 178 Practice for Dealing with Outlying Observations<sup>6</sup>

## 3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology D 883, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *failure (of test specimen)*—signified by the presence of a punched hole, crack, split, shatter, or tear that was created in the target area by the impact of the falling weight and is clearly visible to the naked eye when the sample is held up to the light (see Fig. 1).

3.2.2 *brittle failure*—a punched hole, split, or shatter where a piece of the specimen separates from the main part of the specimen or a crack that has a 0° angle at the tip as measured by the naked eye (see Fig. 1).

3.2.3 *mean failure height* (Procedure A)—the height from which the falling weight will cause 50 % of the specimens to fail.

3.2.4 *mean failure energy (mean impact resistance)*, (Procedure A)—energy required to produce 50 % failures; the product of the weight and mean failure height.

3.2.5 *normalized mean failure energy (normalized mean impact resistance)*—the mean failure energy per unit (average) specimen thickness (Procedure A).

3.2.6 *mean brittle failure height*—the height from which the falling weight will cause 50 % brittle failures in specimens (Procedure B).

3.2.7 *mean brittle failure energy (mean energy of ductile-to-brittle transition)*, (Procedure B)—energy required to produce 50 % brittle failures; the product of the weight and mean brittle failure height.

<sup>1</sup> These test methods are under the jurisdiction of ASTM Committee D20 on Plastics and are the direct responsibility of Subcommittee D20.24 on Plastic Building Products.

Current edition approved Dec. 10, 2000. Published February 2001. Originally published as D 4226 - 83. Last previous edition D 4226 - 99.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 10.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 08.01.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 03.06.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 08.04.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 14.02.

\*A Summary of Changes section appears at the end of this standard.

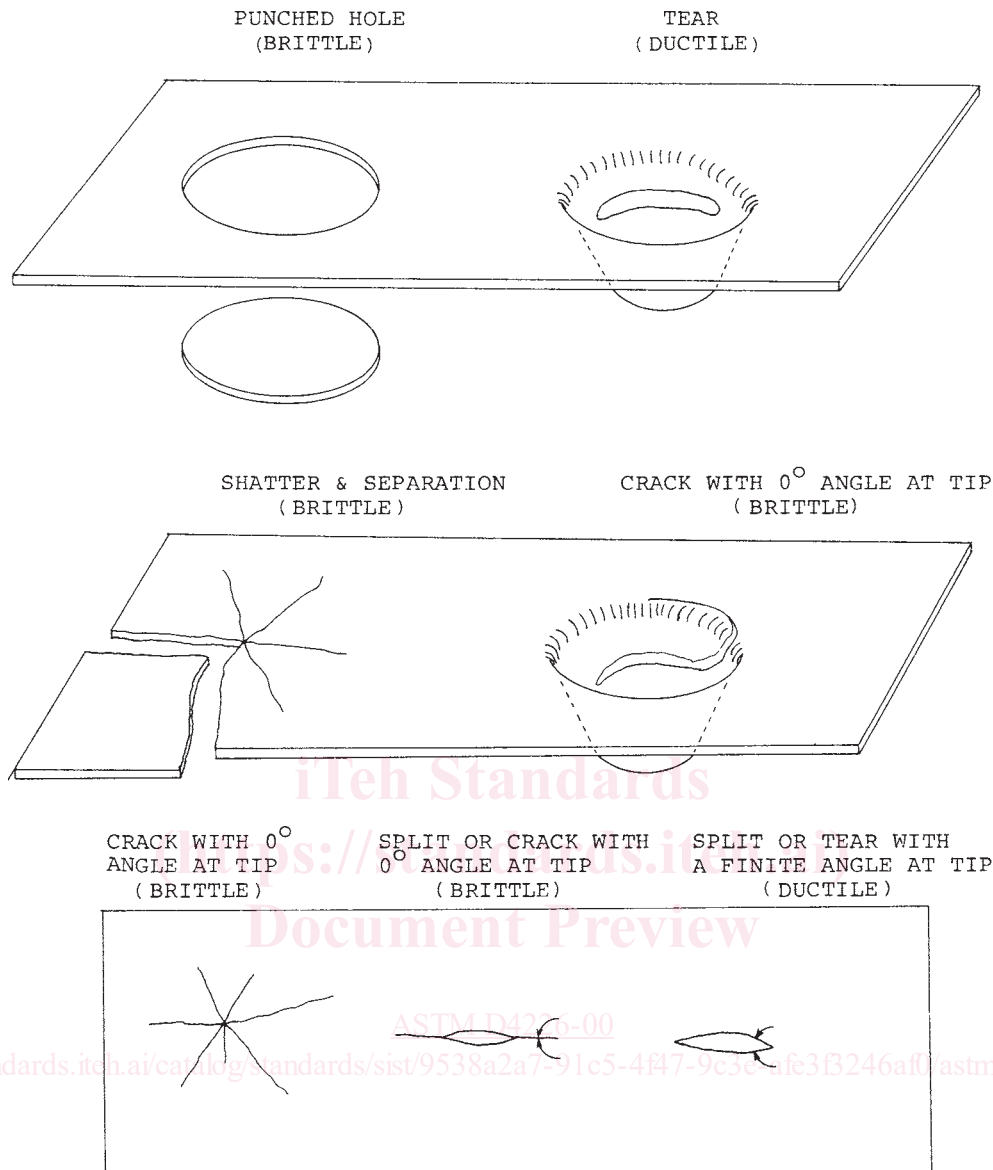


FIG. 1 Types of Failures of the Specimen

3.2.8 *normalized mean brittle failure energy (normalized mean energy of ductile-to-brittle transition)*, (Procedure B)—the mean brittle failure energy per unit (average) specimen thickness.

3.2.9 *outlier*—an observation that appears to deviate markedly from other members of the sample in which it occurs.

#### 4. Summary of Test Method

4.1 The building product profile is cut apart, if necessary, to obtain a flat specimen at least 0.75 in. (19 mm) wide.

4.2 Procedure A establishes the height from which a standard falling 8-lb (3.6-kg) weight will cause 50 % of the specimens to fail.

4.3 Procedure B establishes the height from which a standard falling 8-lb (3.6-kg) weight will cause 50 % of the specimens to fail in a brittle mode.

4.4 Both procedures employ either of two configurations of impactor heads resting on the specimen. The specimen lays on

a stand that has a 0.64-in. (16.3-mm) hole. The falling weight impacts on the impactor head tending to drive it through the specimen into the hole of the stand.

4.5 The technique used to find 50 % failure level in both procedures is commonly called the Bruceton Staircase Method or Up-and-Down Method. Testing is concentrated near the mean, reducing the number of specimens required to obtain a reasonably precise estimate.

#### 5. Significance and Use

5.1 The impact strength values obtained on the flat sections of a building product profile are relevant only to the flat section that has been tested and these values do not necessarily indicate the impact resistance of the whole product, which is affected by the configuration of the profile (that is, corners, ribs, etc).

5.2 Constant weight and variable height, employed in these test methods, allow the velocity of impact to vary and, therefore, by Procedure B, can determine the energy of

ductile-to-brittle transition, which cannot be determined if a variable weight is dropped from a constant height.

5.3 These test procedures have been found to be useful elements in rigid poly(vinyl chloride) (PVC) building product characterization. Compound qualification, finished product quality control, environmental and weatherability research and development studies, and fabrication tolerance prediction constitute useful applications.

5.4 Choice of the specific impactor head configuration used is related to a variety of product attributes, such as specimen thickness and product toughness as well as abstract factors, such as the anticipated mode of failure in a specific application. The geometric uniqueness of the impactor head configurations prevents any comparison or correlation of testing results on samples tested with differing impactor head configurations. In general, the conical impactor, C.125, is useful to ensure failure thicker specimens where the H.25 impactor caused no failure.

NOTE 2—Equivalent surface conditions are more likely to occur when specimens are prepared by compression molding or extrusion than by injection molding.

5.5 When comparing different samples tested with the same impactor head configuration, impact resistance can be normalized for average specimen thickness over a reasonably broad range (for example, 1 to 3 mm).<sup>7</sup> However, this should only be done when the surface conditions listed in 6.1 are essentially equivalent.

<sup>7</sup> O.R. Weaver, "Using Attributes to Measure a Continuous Variable in Impact Testing Plastic Bottles," Materials Research & Standards, MR & S, Vol. 6, No. 6, June, 1996, pp. 285-291.

6. Interferences

6.1 The results obtained are greatly influenced by the quality of the test specimens. Cracks usually start at the surface in tension; the surface opposite the one that is struck by the impactor head. The composition of this surface layer and the degree of orientation introduced during the formation of the specimen are very important variables. Flaws in this surface will also affect results. Because of these factors, sometimes additional information about the sample is achieved by testing the sample from a variety of locations in a product or testing from both sides of a flat section.

7. Apparatus

7.1 *Testing Machine*— The apparatus shall be constructed essentially as shown in Fig. 2 and Fig. 3 and shall consist of the following: suitable base to withstand the impact shock; steel-rod impact weight weighing  $8 \pm 0.2$  lb ( $3.6 \pm 0.1$  kg); hardened steel impactors as specified in 7.1.1; a slotted guide tube 40 in. (1.0 m) in length in which the impact weights slide, having an internal diameter sufficient so that friction does not reduce the weight velocity, and having graduations in inch-pound (newton-metre) increments, or multiples thereof. A bracket is used to hold the tube in a vertical position by attaching it to the base and also to hold the hand knob, which is a pivot-arm alignment for the impactor, about 2 in. (50 mm) under the tube. The top edge of the opening in the specimen support plate should be rounded to a 0.031-in. (0.8-mm) radius. Fig. 3 shows the specimen support configuration for this test.

7.1.1 *Impactor Configurations:*

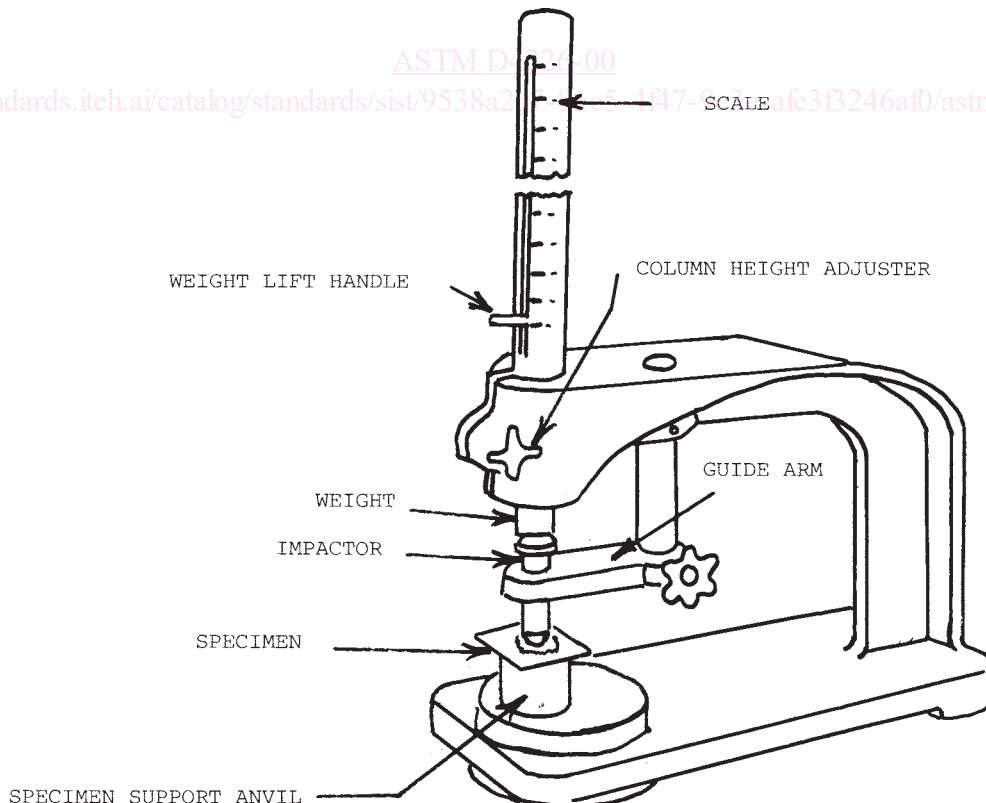


FIG. 2 Impact Tester