INTERNATIONAL

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Standard Test Method for Concentrated Impacts to Transport Packages[1]

This standard is issued under the fixed designation D6344; 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 test method covers procedures and equipment for testing complete filled transport packages for resistance against concentrated low-level impacts typical of those encountered in the distribution environment. The test is most appropriate for packages such as thin fluted/lighter grade corrugated boxes or stretch-wrapped packaging.

1.2 The test result is a pass/fail determination, based on acceptance criteria previously established, and a record of the energy dissipated by the complete filled transport package during a low level concentrated impact.

NOTE 1—This test method discusses the conduct of the test from a prescribed height that either meets or does not meet specific acceptance criteria. It may be possible to conduct this type of testing using modified procedures that provide a numerical response. These might include an incremental test where the drop height (or mass) is increased until a specific failure occurs or an up-and-down or staircase procedure used to find the average height to failure.

1.3 *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.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D996 Terminology of Packaging and Distribution Environments

D4169 Practice for Performance Testing of Shipping Containers and Systems

D4332 Practice for Conditioning Containers, Packages, or Packaging Components for Testing

E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

3. Terminology

3.1 *Definitions*—General definitions for the packaging and distribution environments are found in Terminology D996.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *acceptance criteria*—the acceptable condition of package and contents that must be met after the shipping container has been tested.

4. Significance and Use

4.1 This test method is intended to evaluate the ability of packaging to resist the force of concentrated impacts from outside sources, such as those encountered in various modes of transportation and handling. These impacts may be inflicted by adjacent freight jostling against the package in a carrier vehicle, by accidental bumps against other freight when loaded or unloaded from vehicles, by packages bumping against one another during sorting on conveyors or chutes, or many other circumstances.

4.2 This test method is intended to determine the ability of packaging to protect contents from such impacts, and to evaluate if there is sufficient clearance or support or both between the package wall and its contents.

5. Apparatus

5.1 *Cylindrical Mass with Full Radius (Hemispherical) End*—Solid steel rod 32 mm ± 2 mm (1.25 in. ± 0.1 in.) in diameter, approximately 115 mm (4.5 in.) long, one end rounded to form a hemisphere, with a mass of 680 ± 15 g (1.5 ± 0.03 lb). A threaded eye-bolt may be attached to the end for positioning and support prior to guided free fall drop, but it must be included in the 680 g (1.5 lb) mass (see Fig. 1). Threaded eyebolts must be attached to the side for positioning and support when used as a pendulum, and must be included in the 680 g (1.5 lb) mass.

5.2 *Guided Free Fall* (see Fig. 2):

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[1] This test method is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.21 on Shipping Containers and Systems - Application of Performance Test Methods.

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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.

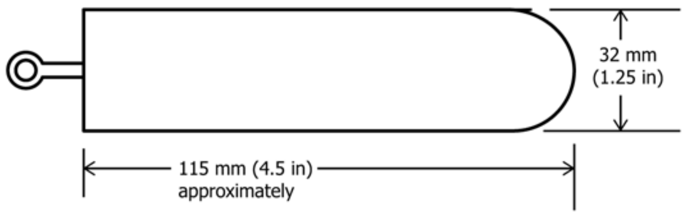

FIG. 1 Cylindrical Mass (steel rod)

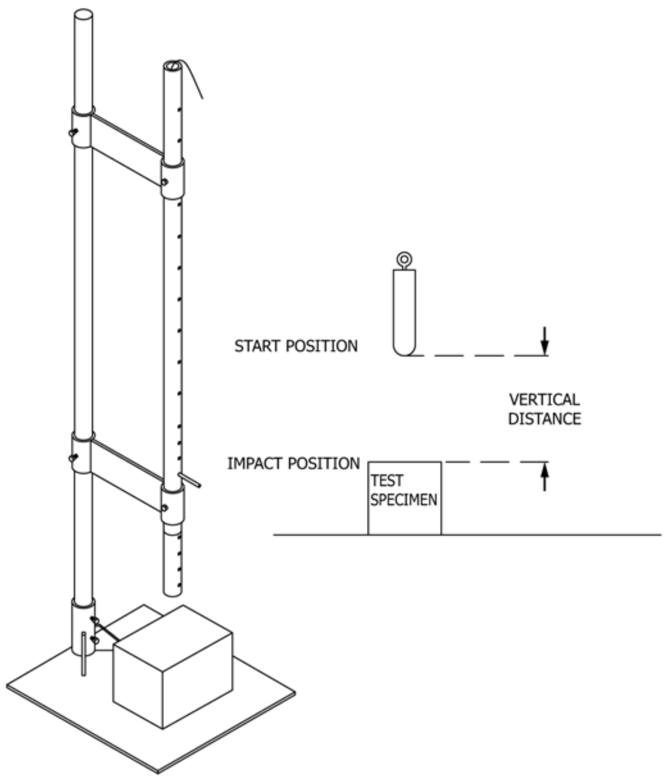

FIG. 2 Guided Free Fall

5.2.1 The cylindrical mass (rod) is held in a start position in a stiff tube of at least 38 mm (1.5 in.) diameter, such that the tube's main axis is perpendicular within 2 degrees. The end of the tube should be positioned 50 to 100 mm (2 to 4 in.) above the test specimen. The mass may be held in position, at the specified vertical distance, with either a string from the top of the tube, or by a support pin placed through the side of the tube.

5.2.2 The mass is allowed to fall freely when released to strike the test specimen with its rounded end. The free falling rod must strike the test surface within 10 mm (0.4 in.) of the desired point of impact. The test surface must be perpendicular to the direction of the falling mass.

5.3 *Non-guided Free Fall:*

5.3.1 If greater precision of impact velocity is desired, the cylindrical mass (rod) may be dropped without guidance of a tube. Means of suspending the mass and its release must be such that accuracy of positioning (drop height and impact point) are not affected.

5.3.2 The free falling rod must strike the test surface within 10 mm (0.4 in.) of the desired point of impact. The test surface must be perpendicular to the direction of the falling mass.

5.4 *Pendulum* (see Fig. 3):

5.4.1 Two cords suspend the steel rod described in 5.1, such that it may be swung as a pendulum from a specified vertical distance. The length of pendulum cords shall be at least 2 m (79 in.). Cords must be secured in the eyebolts to prevent slippage during test. The swinging rod must strike the test surface within 10 mm (0.4 in.) of the desired point of impact. The test surface must be perpendicular to the direction of the falling mass.

5.4.2 The test specimen must be braced securely so it does not move when impacted.

5.5 *Conditioning Apparatus*—Adequate facilities shall be provided for conditioning test specimens at the proper humidity and temperature prior to testing.

5.5.1 It is recommended that atmospheres for conditioning be selected from those given in Practice D4332. Unless otherwise specified, fiberboard or paperboard containers shall be conditioned in accordance with the preconditioning and standard conditioning atmospheres specified in Practice D4332.

6. Sampling

6.1 The test specimens and number of samples shall be chosen to permit an adequate determination of representative performance. Practice E122 is recommended.

7. Test Specimen

7.1 It is preferable to prepare the package with the actual contents for which it was designed (see Note 2). Close the package in the same manner that will be used in preparing it for shipment.

NOTE 2—Where the use of actual goods is not feasible because of excessive cost or danger, a dummy load simulating the goods may be used, provided the dummy load has the same exterior surfaces as the actual goods and interior packaging materials are the same as those in actual use.

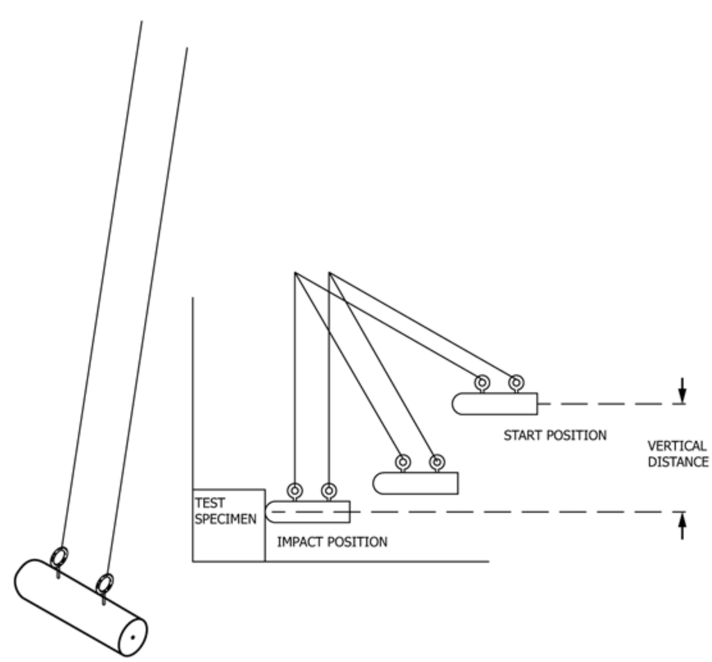

FIG. 3 Pendulum

8. Procedure

8.1 Identify faces of the package that will be tested. Normally, tests are conducted on only those faces most likely to receive concentrated low-level impacts during distribution.

8.1.1 Large containers and those with integral handling platforms, such as skids, are exposed to impacts on the four vertical faces and top. Smaller packages may be subjected to impacts on any face because of varying shipping orientations in distribution.

8.2 Identify the location of impact on each surface to be tested.

8.2.1 If a package has a specified clearance between its face (wall) and the contents, and no support between the face and the contents over an substantial span of distance, the location of impact on that face should be the geometric center of the unsupported span.

8.2.1.1 An unsupported span is considered substantial if it is equal to or more than 50 % of the width of the package face, or 50 % of the length of the package face, or measures more than 0.3 m (12 in.).

8.2.2 For packages with specified clearance between faces and contents but no substantial unsupported spans (having interior support covering a greater area than that defined in 8.2.1.1), location of impact should be the geometric center of the face.

8.2.3 If package contents are in contact with the package face (wall) or within 6 mm (0.25 in.), location of impact on that face should be located at the point contents are closest to the face.

8.3 Establish the acceptance criteria prior to the commencement of testing. (See Practice D4169 for further information.)

8.4 Where possible, test packages in the same conditioning atmosphere specified in 5.5. If testing cannot be performed in a conditioning atmosphere, conduct test immediately upon removing the package from the conditioned atmosphere.

8.5 Conduct impact tests on each package face to be tested.

8.5.1 Use the pendulum device to impact vertical faces of packages where it is convenient to maintain those faces in the vertical position for testing.

8.5.1.1 *Vertical Distance*—Swing the pendulum mass from a vertical distance that produces the specified energy at impact. (See Table 1.)

TABLE 1 Examples of Energy Generated at Impact for Some Typical Vertical Fall Distances

Vertical Distance, m (in.)	Impact Energy, J (ft-lbf)[A]
0.1 (4)	0.7 (0.5)
0.2 (8)	1.4 (1.0)
0.3 (12)	2.0 (1.5)
0.5 (20)	3.4 (2.5)
0.7 (28)	4.7 (3.5)
1.0 (40)	6.8 (5.0)

[A] The energy of impact depends on the mass of the striking object and its speed, which is generated by its fall. Table 1 gives theoretical energy levels in joules (ft-lbf), which are generated by a mass of 680 g (1.5 lb) falling from several discreet heights. The maximum recommended vertical distance for this test is 1.0 m (40 in.).

8.5.2 For small packages or any situation where horizontal positioning of the test face is most convenient for testing, drop the cylindrical mass, using either guided free fall or non-guided free fall, such that the mass impacts the previously identified location on the package face.

8.5.2.1 *Vertical Distance*—Release the cylindrical mass from a height that produces the desired energy at impact (See Table 1).

8.5.3 If higher level concentrated impacts are required than recommended in Table 1, use one of the following two options:

8.5.3.1 The cylindrical mass may be modified by adding more mass. The steel rod specifications as listed in 5.1 must be maintained, except its length may be extended to achieve the desired mass.

8.5.3.2 A higher level concentrated impact may also be achieved by using a higher drop height. It is recommended to use a guided free-fall for any drop height greater than 1.0 m (40 in.)

8.5.3.3 Equate energy at impact to free-fall drop height or vice versa as follows:

$$PE = m \cdot g \cdot h \left(\textit{solving for energy at impact}\right)$$

$$h = PE/m \cdot g \left(\textit{solving for vertical drop height}\right)$$

where:

PE = potential energy (or energy at impact),
m = mass of steel rod, kg (lb),
g = 9.8 m/sec (1 lbf/lb), and
h = vertical drop height, m (ft).

9. Report

9.1 Report the following information:

9.1.1 Reference to this test method, including a statement to the effect that all tests were conducted in full compliance with the requirements of this test method, or noting any variations and their details,

9.1.2 Dimensions of the package tested; complete structural specifications; kinds of materials; description and dimensions of blocking and cushioning, if any, and positioning of same inside the package,

9.1.3 Description of the contents of the package under testing and, if not tested with the actual contents intended to be shipped, add a description of the actual contents that will be shipped,

9.1.4 Number of specimens tested,

9.1.5 Method of conditioning the package; and results of any supplementary tests of the materials from which the package is made,

9.1.6 Description of the apparatus used,

9.1.7 Details of the acceptance criteria used,

9.1.8 Faces tested and location on each face,

9.1.9 Description of the prescribed test sequence, if any, and the free fall drop or pendulum heights used,

9.1.10 Record of the energy (mass × distance) generated by the striking mass,

9.1.11 Detailed record of the test results for each package, including damage to faces of the container or wrap and the contents, and

9.1.12 Name and address of the testing agency, date, and signature of a responsible representative of the agency.

10. Precision and Bias

10.1 *Precision*—A precision statement is not applicable since the test is conducted at a specified energy level to determine conformance with established acceptance criteria.

10.2 *Bias*—No justifiable statement can be made on the bias of this test since a true value cannot be established by an accepted referee test method.

11. Keywords

11.1 concentrated impact; corrugated boxes; guided free fall; non-guided free fall; package face; pendulum; shipping container; stretch-wrapped package; transport packages