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Standard Test Method for Impact Testing for Shipping Containers and Systems¹

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1. Scope

1.1 This test method covers two procedures for conducting impact tests on loaded containers or shipping units (pallet loads), as follows:

1.1.1 *Procedure A*, to test the ability of a container or shipping unit to withstand impacts, and

1.1.2 *Procedure B*, to test the ability of a container or shipping unit or interior packing, or both, to provide protection to the contents, when subjected to impacts.

1.2 Either of these two procedures may be used to evaluate different designs of containers of the same size and carrying the same load. These procedures are suitable for testing various types of containers such as boxes, crates, barrels, drums, kegs, bags, sacks, or pails made of various materials or combinations of materials and for shipping units such as pallet loads or palletized units.

1.3 The procedures described in this test method are particularly suitable for testing large or heavily loaded containers.

1.4 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.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary statements are given in **Note 1** and **Section 7**.

1.6 *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.*

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. Referenced Documents

2.1 ASTM Standards:²

D996 Terminology of Packaging and Distribution Environments

D4003 Test Methods for Programmable Horizontal Impact Test for Shipping Containers and Systems

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

D5277 Test Method for Performing Programmed Horizontal Impacts Using an Inclined Impact Tester

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

2.2 ISO Standard:

ISO 2244 Horizontal Impact Test (Horizontal or Incline Plane Test: Pendulum Test)³

3. Terminology

3.1 *Definitions*—For definitions of terms applicable to this test method see Terminology D996.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *hazard, n*—removable solid object of any size or shape placed on an impact surface (backstop) so as to contact a test specimen at any desired location during the impact of the specimen into the impact surface (backstop).

4. Summary of Test Method

4.1 An apparatus having a guided carriage capable of holding a test container or shipping unit impacts into a rigid impact surface (backstop) with or without hazards at a predetermined impact velocity. When testing the ability of a container or shipping unit to withstand impact (Procedure A) multiple tests with the same impact velocity or increasing impact velocities may be conducted until failure occurs. When testing the ability of the container, shipping unit, or interior packing, or combination thereof, to provide protection to the contents (Procedure B), a predetermined number of impacts, at

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 Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

predetermined velocities, are applied and the container(s) and contents are then inspected.

5. Significance and Use

5.1 The impact test has been found useful in laboratory simulation of impacts such as those encountered in manual and mechanical handling and transportation. The impact test simulates some types of shocks that could occur in the handling of packages or shipping units and helps evaluate the ability of the package to protect the contents against these shocks. The test may also permit observation of progressive failure of a package and damage to the contents.

5.2 The test results within a given laboratory using this test method may be useful for evaluating and comparing packages. However, because of the variability of test machines that have been used in the past, especially the impact surface (backstop), it has been found that interlaboratory correlation of test results has been poor.

5.3 These procedures are not intended to simulate rail car coupling environment. Refer to Test Method [D4003](#) and Test Methods [D5277](#).

5.4 This test method fulfills the requirement of ISO 2244.

NOTE 1—ISO 2244 may not meet the requirements for this test method.

6. Apparatus

6.1 Testing Machine:

6.1.1 The test machine shall consist of a guided test carriage with a flat test specimen mounting surface and an impact surface (backstop) with the plane of the face perpendicular within ± 30 min ($1/2^\circ$) to the direction of movement of the carriage at impact.

6.1.2 There shall be an impact surface (backstop) that is integral with a solid mass at least 50 times the maximum mass of the test specimen. The impact surface firmly attached to the mass, shall be a steel plate not less than $1/2$ in. (13 mm) thick. The impact surface (backstop) must have dimensions greater than those of the impacting surface of the test specimen to permit full contact with the shipping container.

NOTE 2—The purpose of the apparatus is to provide an impact surface (backstop) and mass that will improve interlaboratory correlation of test results and the accuracy of tests between laboratories. The test can be conducted on apparatus that does not meet the requirements of [6.1.2](#), provided it is clearly stated in [14.1.1](#).

6.1.3 The test machine shall provide some means of moving the test carriage to obtain the desired impact velocity. This may be the result of mechanical or pneumatic means, gravity through the use of a 10° (nominal) incline, or a pendulum device.

NOTE 3—Depending upon the configuration of the test machine there may be other forces acting before, during, or after the impact that may affect the test results.

6.1.4 The test machine should preferably have a means of preventing multiple impacts.

6.1.5 The test carriage shall provide surface friction such that the test specimen does not move during the period from rest to impact, but will move freely upon impact.

6.1.6 The impact surface (backstop) may, if desired, be equipped with hazards that can be so placed as to contact the container at the time of impact at any desired position between top and bottom edges of the container. The dimensions, material, and location of the interposed hazard should be carefully specified.

6.2 Instrumentation:

6.2.1 Instrumentation that may be an optical or mechanical timing device is required to measure the carriage impact velocity to an accuracy of $\pm 2\%$ of the actual value. When testing is within a laboratory and for comparative purposes only, instrumentation is optional.

7. Safety Precautions

7.1 The procedures given in this test method may produce severe mechanical responses in the test specimen. Therefore, operating personnel must remain alert to potential hazards and take necessary precautions for their safety. The test area should be cleared prior to each test. Stop the test immediately if a dangerous condition should develop. The testing of hazardous materials or products may require special precautions that must be observed. Safety equipment may be required and its use must be understood before starting the test.

8. Sampling

8.1 The number of test specimens depends on the desired degree of precision and the availability of specimens. Practice [E122](#) provides guidance on the choice of sample size. It is recommended that at least three representative test specimens be used.

9. Test Specimens

9.1 When the specimen is being tested by Procedure A to determine the ability of the container or shipping unit to withstand impact stresses, either the actual contents or a dummy load simulating such contents can be used. When the specimen is being tested by Procedure B to determine the ability of the container or shipping unit or interior packing, or both, to provide protection to the contents, actual contents shall be used. For both procedures closing, strapping, or sealing should be the same as will be used in actual shipment.

NOTE 4—Certain contents or ingredients of the objects under test may be replaced by inert materials of approximately the same weight and characteristics.

9.2 *Identification of Members*—See [Annex A1](#).

10. Calibration

10.1 Calibrate the impact carriage so that the desired impact velocity ($\pm 5\%$) may be achieved.

10.2 Make the calibration using the carriage with a load simulating actual contents equivalent to the package/product's weight. Measure the velocity of the carriage just before impact.

11. Conditioning

11.1 It is recommended that atmospheres for conditioning be selected from those shown in Practice [D4332](#). Unless otherwise specified, precondition and condition fiberboard and

other paperboard containers in accordance with the standard atmosphere specified in Practice **D4332**.

12. Procedure

12.1 Procedure A:

12.1.1 *Testing of the Ability of a Container to Withstand Impacts*—Place the container or shipping unit to be tested on the carriage with the face or edge that is to receive the impact located projecting 2 in. (51 mm) beyond the impacting end of the carriage.

12.1.2 If it is desired to concentrate the impact at any particular position on the test specimen, attach an optional hazard to the impact surface (backstop) in the desired position before the test. The hazard should be strong enough to withstand the impact of the carriage if it should strike it.

12.1.3 Position the carriage so that the predetermined impact velocity will be obtained and release. Measure the impact velocity of each test to ensure it is representative of the desired impact velocity. The cycle of impacts continues by either repeating the original impact velocity or increasing the impact velocity for each cycle of impacts.

12.1.4 The sequence in which the faces and edges are subjected to impacts may be at the option of the operator and will depend on the objective of the tests. Continue the test until failure of the container or shipping unit occurs. Depending on the purpose of the test, failure is when some predetermined type of damage has occurred, that is, exposure or spillage of contents, or both.

12.2 Procedure B:

12.2.1 *Testing of the Ability of a Container, Shipping Unit, or Interior Packing, or combination thereof, to Provide Protection to the Contents*—Conduct this test in accordance with **12.1** until a predetermined number of impacts at specific impact velocities have been applied. Open the container or shipping unit to inspect the contents unless previous evidence of failure is apparent.

13. Report

13.1 Report the following information:

13.1.1 Reference to this test method, noting any deviations from the procedure,

13.1.2 A description of the test specimen in sufficient detail for proper identification,

13.1.3 Description of the contents,

13.1.4 Identification of the purpose of the test,

13.1.5 Identification of apparatus, including angle of incline if appropriate. Instrumentation used, including date of last instrument calibration. Details of any modifications to either apparatus or instrumentation, if known, shall be included,

13.1.6 Method of conditioning,

13.1.7 Description of the test sequence, the impact velocity of each test, orientation of specimens on the carriage, and the use of any optional hazards, including the dimensions, material, and location carefully specified, and

13.1.8 Detailed record of damage to the test specimen or contents, together with any other observation that may assist in correctly interpreting the results or aid in improving the design of the test specimen or the method of packing, blocking, or cushioning.

14. Precision and Bias⁴

14.1 Precision:

14.1.1 This test method is usually conducted to determine if a container or shipping system completes the prescribed test without specified damage. With this situation, no statement can be made about the precision because the results merely state whether there is conformance to the criteria for success.

14.1.2 When the test is conducted to determine the input stress required to cause a specified type of damage, the precision depends largely upon the item being tested. The equipment, instrumentation, fixturing, methodology, and personnel also play important roles in precision. A research report indicates that there can be considerable variability between replicate tests for vertical impacts; it is believed that similar conclusions are true for horizontal impacts.

14.2 *Bias*—This test method has no bias because the results are defined only in terms of this test method.

15. Keywords

15.1 impact test; incline; packages; pendulum

⁴ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D10-1004. Contact ASTM Customer Service at service@astm.org.