Designation: D6179 – 07 (Reapproved 2014)

Standard Test Methods for Rough Handling of Unitized Loads and Large Shipping Cases and Crates[1]

This standard is issued under the fixed designation D6179; 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 testing the integrity of unitized loads and large shipping cases and crates as well as the ability of the contents to endure rough handling. Not all of the test methods are applicable to all products, containers, and loads. These test methods are applicable to common means of material handling as follows:

1.1.1 *Test Method A, B, C, D, and E—Drop Test*—For measuring the ability of the case or crate or unitized load to withstand rough handling impacts and provide information useful in improving the design of the container. Normally, Test Methods A and B are not applied to unitized loads.

1.1.2 *Test Method F—Tip Test* —For determining if filled tall or top heavy cases, crates, or unitized loads will tip over when tilted to a predetermined angle.

1.1.3 *Method G—Tipover Test* —For determining the ability of filled large shipping cases or crates to resist the impacts associated with tipover hazards, and for determining the ability of the packaging and packing methods to provide protection to the contents, when the case or crate is tipped over.

NOTE 1—Test Method G fulfills the requirements of ISO 8768. ISO 8768 may not meet the requirements for Test Method G.

1.1.4 *Test Method H—Rolling Test*—For determining the ability of complete, filled large shipping cases or crates to withstand the effects of rolling.

NOTE 2—Test Method H fulfills the requirements of ISO 2876. ISO 2876 may not meet the requirements for Test Method H.

1.2 *Additional Test Procedures :*

1.2.1 Test methods for mechanical handling of unitized loads and large shipping cases and crates are set forth in Test Method D6055. Additional tests that apply to mechanical handling of unitized loads and large cases and crates include incline impact tests, described in Test Method D880 and horizontal impact tests, described in Test Methods D4003 and Test Method D5277. Test Methods D4003 includes a special pallet marshaling test and Test Methods D1185 provides test methods for pallets and related structures.

1.2.2 Practice D4169 provides a series of options for selecting and running performance tests on all types of shipping containers and systems.

1.3 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.4 *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]

D880 Test Method for Impact Testing for Shipping Containers and Systems

D996 Terminology of Packaging and Distribution Environments

D1185 Test Methods for Pallets and Related Structures Employed in Materials Handling and Shipping

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

D4169 Practice for Performance Testing of Shipping Containers and Systems

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

D5276 Test Method for Drop Test of Loaded Containers by Free Fall

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

D5487 Test Method for Simulated Drop of Loaded Containers by Shock Machines

D6055 Test Methods for Mechanical Handling of Unitized Loads and Large Shipping Cases and Crates

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

Current edition approved April 1, 2014. Published April 2014. Originally approved in 1997. Last previous edition approved in 2007 as D6179 – 07. DOI: 10.1520/D6179-07R14.

[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.

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2.2 *ISO Standards:*
ISO 2876 Packaging—Complete, Filled Transport Packages—Rolling Test[3]
ISO 8768 Packaging—Complete, Filled Transport Packages—Toppling Test[3]

3. Terminology

3.1 *Definitions:*

3.1.1 General terms in these test methods are defined in Terminology D996.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *flat—for purposes of drop tests, tip tests, tipover tests, and rolling tests*, no two points on the surface differ in level by more than 0.080 in. (2 mm); however, where one of the dimensions of the test package in contact with the surface is greater than 40 in. (1000 mm), a maximum difference in surface level of 0.20 in. (5 mm) will be acceptable.

3.2.2 *large shipping case or crate*—a case or crate of such size and weight to require mechanical handling. A case or crate of this type may weigh from 100 lb (45 kg) up to many tons and measure proportionately. The case or crate may be secured to or carried by a base or pallet. Frame members may be provided for rigidity throughout the container.

3.2.3 *rigid—for purposes of drop tests, tip tests, and tipover tests*, a surface that will not be deformed by more than 0.0040 in. (0.1 mm) when any area of 0.16 in.^{2} (100 mm^2) is loaded statically with 22 lb (10 kg) anywhere on the surface.

3.2.4 *rolling*—rotating a test package about its axis so as to impact on each face in turn.

3.2.5 *unitized load*—a type of unit load consisting of articles or containers secured together so as to be handled as an entity.

4. Significance and Use

4.1 These test methods will allow the user to determine integrity and stability of the load as well as provide guidance to improve the design of the shipping container or the unit load where deficiencies are found.

4.2 Damage to products or packages observed during testing can be expected to correlate at least in a qualitative way to damage observed in actual distribution handling systems.

4.3 The results received from shock machine testing and free fall drop testing are different for certain products. Where this test is performed to satisfy a regulatory or contractual requirement, its use is subject to approval by the agency concerned.

5. Apparatus

5.1 *Drop Test Apparatus*—In performing the drop test, the case, crate, or unitized load may be handled with any convenient equipment, such as a block and tackle, a hoist, or jacks with provision made for releasing the test item either by pulling supporting blocks from under it when tackle and jacks are used or by a release hook when a hoist is used.

5.1.1 Other apparatus may be used for dropping a case, crate, or unitized load as follows:

5.1.1.1 Lift with heavy steel strapping or wire (to release, the strapping or wire is cut), or

5.1.1.2 Lift with a forklift truck (while restraining the test item, the forklift truck is removed from under it), or

5.1.1.3 Lift with a clamp truck. (Apply sufficient force to lift test item to prescribed height, then release test item), or

5.1.1.4 Use a tractor with block and tackle (blocks are pulled from under test item) or,

5.1.1.5 Use a commercial drop tester for test items that are within the weight limitations of the machine.

5.1.2 Perform the test upon a flat, horizontally level, concrete slab, pavement, or similarly unyielding surface, massive enough to be immovable and rigid enough to be non-deformable under test conditions, with a mass at least 50 times that of the test item and large enough to ensure that the test package falls entirely upon the surface.

5.2 *Tip Test and Tipover Test Apparatus* —In performing the tip or tipover test, the test item may be handled with any convenient equipment, such as a forklift truck, a host, a block and tackle, by hand, or any means capable of applying a horizontal load to the vertical faces of the test item at a particular height above the center of gravity and of sufficient force to cause tipping without causing the test item to slide on the horizontal surface. Perform the test upon a flat, horizontally level, concrete slab, pavement, or similarly unyielding surface, massive enough to be immovable and rigid enough to be non-deformable under test conditions, with a mass at least 50 times that of the test item and large enough to ensure that the test item falls entirely upon the surface.

5.3 *Rolling Test Apparatus*—In performing the rolling test, the test item may be handled with any convenient equipment, such as a forklift truck, a hoist, a block and tackle, or by hand. Perform the test upon a flat, horizontally level, concrete slab, pavement, or similarly unyielding surface, massive enough to be immovable and rigid enough to be non-deformable under test conditions, with a mass at least 50 times that of the test item and large enough to ensure that the test item falls entirely upon the surface.

6. Test Specimen and Number of Tests

6.1 Test several cases, crates, or unitized loads of a given design, if possible, to obtain replication of results. If it is not possible to test an entire unitized load, then sufficient articles or containers should be assembled such that the height and one base dimension are nearly the same as the proposed unitized load. The same test item may often be used for all applicable tests if not tested to failure. Load the test item with the actual contents for which it was designed. If use of actual contents is not practical, a dummy load of the same total mass, size, and weight distribution may be substituted. The contents or dummy load shall be blocked, braced, and cushioned in place and the package closed normally as for shipment.

6.2 Identify faces, edges, and corners of containers as shown in Fig. A1.1 of Test Method D5276.

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

7. Conditioning

7.1 It is recommended that atmospheres for conditioning be selected from those shown in Practice D4332. Unless otherwise specified, fiberboard and other paperboard containers shall be preconditioned and conditioned in accordance with the standard atmosphere specified in Practice D4332.

8. Acceptance Criteria

8.1 Reference Practice D4169 for acceptance criteria and the correlation to relative performance criteria.

9. Drop Tests

9.1 *Test Method A—Rotational Edge Drop Test*—Raise one end of the case or crate and set it upon a timber or other support, placed at right angles to the length of the case or crate. The height of the support shall be sufficient to ensure that there will be no support for the base between the ends of the test item when dropping takes place, but should not be high enough to cause the test item to slide on the support when the drop end is raised for the drop. Raise the other end of the test item successively to prescribed heights and release to fall freely on the impact surface. Where test items are tall or top heavy, provision must be made to prevent the test item from tipping over after the drop is made. The drop test impact surface is specified fully in the Apparatus section. If the stability of the load is in question, the Tip Test (Test Method F) or the Tipover Test (Test Method G), or both, should be performed. See Annex A1 for alternative drop test procedures.

9.2 *Test Method B—Rotational Corner Drop Test*—Start up by setting up the case or crate as defined for the Test Method A rotational edge drop test. Place a 4 to 10 in. (100 to 254 mm) block flat under one corner of the end already supported in order to raise one corner higher than the other so that impacts on the diagonally opposite corner can be obtained. Raise the unsupported end of the test item so that the lower corner of that end reaches a specified height from the impact surface and allow to fall freely. Where test items are tall or top heavy, provision must be made to prevent the test item from tipping over after the drop is made. If the stability of the load is in question, the Tip Test (Test Method F) or the Tipover Test (Test Method G), or both, should be performed. See Annex A1 for alternative drop test procedures.

9.3 *Test Method C—Rotational Flat Drop Test*—With one edge of the case, crate or unitized load supported by the floor, raise the other end to prescribed heights and release to fall flat on the impact surface. Where test items are tall or top heavy, provision must be made to prevent the test item from tipping over after the drop is made. If the stability of the load is in question, the Tip Test (Test Method F) or the Tipover Test (Test Method G), or both, should be performed. See Annex A1 for alternative drop test procedures.

9.4 *Test Method D—Unsupported Free Fall Drop Test*—Raise the case, crate or unitized load above the impact surface, using apparatus as described in 5.1. Position load while in the air for flat bottom drop, edge, or corner drop as is desired. Release the test item and allow to fall freely. The angle of drop is at the user's option but must be recorded. Where test items are tall or top heavy, provision must be made to prevent the test item from tipping over after the drop is made. If the stability of the load is in question, the Tip Test (Test Method F) or the Tipover Test (Test Method G), or both, should be performed. See Annex A1 for alternative drop test procedures.

NOTE 3—When conducting a drop test using slings on a corrugated fiberboard case, it is necessary to install a nominal 2 by 6 in. (50 by 150 mm) wooden board at least 1 in. (25 mm) longer than the dimension of the case on top of the case and in line with each sling. This board will prevent each sling from collapsing the top of the corrugated fiberboard case when it is being lifted prior to the drop test.

9.4.1 *Test Method E—Shock Machine Method*—The free fall drop test may, in some instances, be performed using a programmable shock machine of appropriate dimensions using the apparatus and procedures described in Test Method D5487. See 4.3 for an equivalency statement for the shock machine method and free fall method of drop testing. See Annex A1 for alternative drop test procedures.

9.5 *Measurements During Drop Tests (Optional)*—Measure dimensions of the test item, typically diagonals, and record before the test is started and after each drop. The differences in successive measurements permit a study of the distortions and deflections that have taken place. In addition to these measures, a record should be made of any changes or breakage in the test item and their location. A recommended sample form for recording the measurements and notations made during the drop tests is shown in Fig. 1.

10. Tip Test

10.1 *Test Method F—Tip Test* —Use a case, crate, or unitized load of shipping containers each full loaded with the actual contents. If use of actual contents is not practical, a dummy load of the same total mass, size, and weight distribution may be substituted. The contents or dummy load shall be blocked, braced, and cushioned in place. Cases and crates should be closed normally as for shipment. Unitized loads should be stretch-wrapped or strapped onto a pallet as applicable.

10.2 Loose chains, slings, or similar restraints shall be positioned around the test item to prevent a complete tipover and impact. These restraints can also provide operator protection during the test.

10.3 Tilt the test item to a predetermined angle from the vertical position in the most critical direction. Unless otherwise specified, it is recommended that an angle of 22° be used. After releasing the test item, determine which way the test item begins to move, tip over, or return to base, and then return the test item gently back onto its base.

10.4 The test should be repeated in all potentially unstable directions.

10.5 If the test item begins to tip over in any direction when tilted to the specified angle, the center of gravity must be lowered or the dimensions of the base must be increased until the test item does not begin to tip over, or the case or crate and product must be able to pass the tipover test procedure described in Section 11.

SHIPPING UNIT DESCRIPTION ..... DATE .....
FLAT-EDGE DROP TEST: EDGE TESTED .....

Height of Drop	Diagonal Measurement of Each Panel										Skid Deflection		Top Edge Deflection (Side Panel)		Remarks
	End 5		Side 2		End 6		Side 4		Top 1		Side 2	Side 4	Side 2	Side 4	
	A–B	C–D	A–B	C–D	A–B	C–D	A–B	C–D	A–B	C–D					
0															

CORNER DROP TEST: CORNER TESTED .....

Height of Drop	Diagonal Measurement of Each Panel										Skid Deflection		Top Edge Deflection (Side Panel)		Remarks
	End 5		Side 2		End 6		Side 4		Top 1		Side 2	Side 4	Side 2	Side 4	
	A–B	C–D	A–B	C–D	A–B	C–D	A–B	C–D	A–B	C–D					
0															

FIG. 1 Suggested Form For Recording Drop Test Data

11. Tipover Test Procedure

11.1 *Test Method G—Tipover Test*—Use a case or crate fully loaded with the actual contents. If use of actual contents is not practical, a dummy load of the same total mass, size, and weight distribution may be substituted. The contents or dummy load shall be blocked, braced, and cushioned in place and the package closed normally as for shipment.

11.2 Place the test item in the predetermined attitude on the impact surface (such as standing on its base or one of its smaller faces).

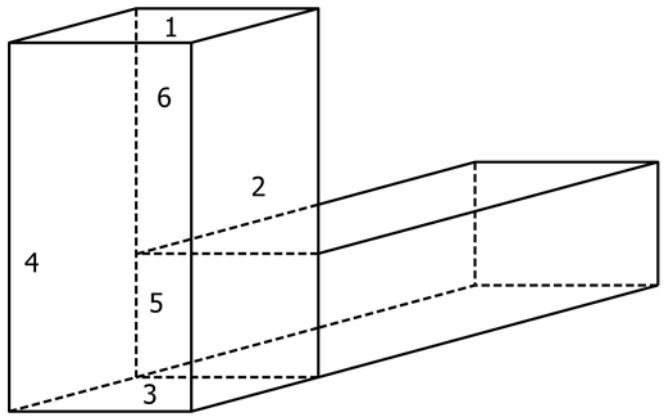
11.3 The test item shall be slowly tipped until it falls freely without thrust onto the face opposite that of load application.

11.4 Examine the test item and record any external signs of damage.

11.5 Repeat the test with the test item standing on, or impacting onto other appropriate faces. In the case of tall test items, the repeat tests shall be carried out with the test item standing on its normal base and toppling onto each side face in turn (see Fig. 2). In the case of flat test items (or tall test items where the normal base is not defined), the tests shall be carried out with the test item standing on each smaller face in turn and impacting onto each of the larger faces (see Fig. 3).

NOTE 4—The tables in Fig. 2 and Fig. 3 give appropriate sequences for tall cases or crates and flat cases or crates, respectively. For the designation of the faces referred to in the tables, see Test Method D5276.

11.6 On completion of the test sequence, open the test item and examine the condition of the contents.



Stand on Face	Tilt over Edge	Topple onto Face
3	3–6	6
3	3–5	5
3	3–2	2
3	3–4	4
1[A]	1–6[A]	6[A]
1[A]	1–5[A]	5[A]
1[A]	1–2[A]	2[A]
1[A]	1–4[A]	4[A]

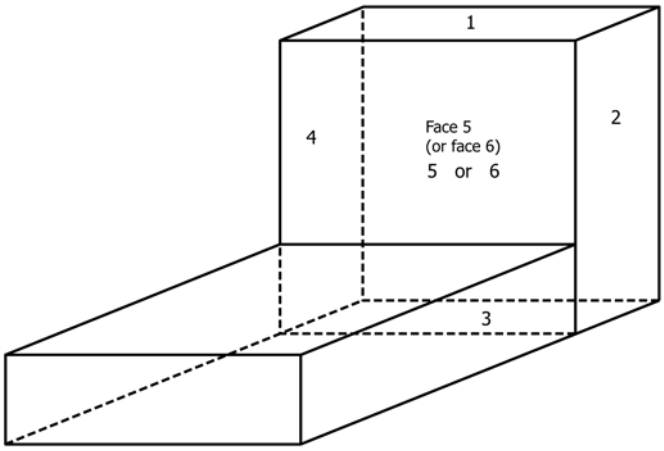
[A] This part of the sequence is only applied where the normal base is not defined.

FIG. 2 Test Sequence for Tall Cases and Crates (That Is, Where Height is Large Compared with Base Dimensions)

12. Rolling Test

12.1 *Test Method H—Rolling Test*—The test item shall normally be filled with its intended contents. If use of actual contents is not practical, a dummy load of the same total mass, size, and weight distribution may be substituted. The contents, or dummy load shall be blocked, braced, and cushioned in place and the package closed normally as for shipment.

12.1.1 Position the test item on the impact surface with Surface 1 uppermost.



Stand on Face	Tilt over Edge	Topple onto Face
1	1–5	5
2	2–5	5
3	3–5	5
4	4–5	5
1	1–6	6
2	2–6	6
3	3–6	6
4	4–6	6

FIG. 3 Test Sequence for Flat Cases or Crates (That Is, Where Height is Small Compared With Base Dimensions and Storage or Transportation Resting on a Side Face is Possible)

12.1.2 Tilt the test item with the Edge 3-4 resting on the impact surface until the point of balance on this edge is reached. Then allow it to overbalance without thrust so as to impact on Surface 4.

12.1.3 Repeat this procedure until the sequence given in Table 1 is completed.

12.2 Test items of other shapes:

12.2.1 The procedure for test items of other than rectangular or square shapes shall be as close to 12.1 as possible.

12.3 Examine the test item after each impact and record any signs of damage.

12.4 On completion of the test sequence, the test item and its contents shall be examined for damage.

13. Report

13.1 Report the following information:

TABLE 1 Rolling Test Impact Sequence

Balance on Edge	Impact on Surface
3-4	4
4-1	1
1-2	2
2-3	3
3-6	6
6-1	1
1-5	5
5-3	3

13.1.1 Statement to the effect that all tests were made in full compliance with these tests methods or a detailed explanation of any deviation.

13.1.2 Dimensions of the case, crate, or unitized load under test, its complete structural specifications, kind of material, description and specifications for blocking and cushioning (if used), spacing, size, and kind of fasteners, if used, method of closing and unitizing, if any, dimensions and specifications of the pallet, and net and gross weights.

13.1.3 Description of the contents of the case, crate, or unitized load under test. If simulated or dummy contents were used, full details shall be given.

13.1.4 Condition of the test item(s) after the test, a detailed description of any damage, and a summary of the criteria used to define damage.

13.1.5 Complete description of equipment used, including load handling attachment, forces measured, operator of equipment and instrumentation used, including dates of last instrument calibrations, manufacturer's names and model numbers. Details of any modifications thereto, if known, shall be included.

13.1.6 Detailed record of tests including procedures used, angle of free fall drop test, height of drop tests (including height of support blocks for rotational tests, if used), covering both container and contents, unitizing method, together with any observation that may assist in correctly interpreting the results or aid in improving the design of the container or the method of packing and unitizing. Record the number of replicate packages tested.

13.1.7 The sequence of attitudes in which the package was tested, using the method of identification given in Test Method D5276.

13.1.8 Type of loading apparatus used, maximum toppling force and height of the center of the applied load and if known, the height of the center of gravity.

13.1.9 Relative humidity, temperature and time of conditioning, and temperature and relative humidity of test area at time of test.

13.1.10 Date of test and signature of tester.

14. Precision and Bias

14.1 No information is presented about either the precision or bias of these test methods for tip, tipover, or rolling tests since the test results are nonquantitative.

14.2 A precision and bias statement is not applicable when a drop test is conducted at a specified drop height to determine conformance with established acceptance criteria.

14.3 The precision and bias of this test method for drop tests conducted to determine the drop height to failure are essentially as specified in Test Method D5276.

15. Keywords

15.1 drop; large shipping cases and crates; rolling; tip; tipover; unitized loads

ANNEX

(Mandatory Information)

A1. DROP TEST ALTERNATIVE PROCEDURES

A1.1 Begin all drops at some predetermined height and increase by increments of 1 in. (25 mm) or more until the maximum desired test height is reached or failure occurs.

A1.2 Alternatively, the test item may be given a predetermined number of drops from a fixed height.

A1.3 Edge drops may be made on alternate or adjacent edges.

A1.4 Corner drops may be made on alternate or successive corners.

A1.5 Free fall drops may be made in the same orientation or the dropping orientation varied for a specific number of drops.

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