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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Methods for Mechanical Handling of Unitized Loads and Large Shipping Cases and Crates[1]

This standard is issued under the fixed designation D 1083; 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 are suitable for testing the integrity of large shipping cases and unitized loads as well as the ability of the contents to endure normal handling. Not all of the methods are applicable to all products, containers, and loads. The test methods described are applicable to common means of material handling including: forklift, pull pack, clamp truck, crane, and spade lift type handling systems as follows:

1.1.1 *Drop Test*—For measuring the ability of the case or unitized load to withstand rough handling and provide information useful in improving the design of the container (see 9.1.2 and 10.1).

1.1.2 *Spade Lift Test*—For lifting by spade lift attachment to determine the ability of the handling flap of the case or shipping unit to withstand repeated lifting and handling by this method (see 9.2).

1.1.3 *Clamp Lift Test*—For lifting by hydraulic clamp attachment, to determine the ability of the case or shipping unit, to withstand squeeze clamp handling consisting of repeated side compressions and lifting (see 9.3).

1.1.4 *Push-Pull Handling Test*—For testing the ability of the slip sheet tab to withstand repeated pulls by the gripper jaws without tearing (see 9.4).

1.1.5 *Grabhook Test*—For lifting by grabhooks to determine the ability of the case or unitized load to withstand the horizontal pressures of grabhooks (see 10.2).

1.1.6 *Sling Test*—For lifting by wire rope, cable, or woven fiber slings to determine the ability of the case or unitized load to withstand the compression of slings (see 10.3).

1.1.7 *Tip Test*—For determining the ability of tall or top heavy cases or crates to resist tipping over (see Section 11).

1.1.8 *Tipover Test*—For determining the ability of filled large shipping containers 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 pack is tipped over (see Section 12).

NOTE 1—This test method fulfills the requirements of International Organization for Standardization standard ISO 8768. *The ISO standard may not meet the requirements for this test method.*

1.1.9 *Rolling Test*—For determining the ability of a complete, filled transport package to withstand the effects of rolling (see Section 13).

NOTE 2—This test method fulfills the requirements of International Organization for Standardization standard ISO 2876. *The ISO standard may not meet the requirements for this test method.*

1.2 *Additional Test Procedures*:

1.2.1 Additional tests that apply to mechanical handling of unitized loads and large cases and crates include incline impact tests, described in Test Method D 880 and horizontal impact tests, described in Test Method D 4003. Test Method D 4003 includes a special pallet marshalling test and Test Method D 1185 provides test methods for pallets and related structures.

1.2.2 Test Method D 4169 provides a series of options for selecting and running performance tests on all types of shipping containers and systems.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 775 Test Method for Drop Test for Loaded Boxes[2]

D 880 Test Method for Impact Testing for Shipping Containers and Systems[2]

D 996 Terminology of Packaging and Distribution Environments[2]

D 1185 Test Methods for Pallets and Related Structures Employed in Materials Handling and Shipping[2]

D 3332 Test Methods for Mechanical-Shock Fragility of Products, Using Shock Machines[2]

D 4003 Test Methods for Programmable Horizontal Impact Test for Shipping Containers and Systems[2]

D 4169 Practice for Performance Testing of Shipping Containers and Systems[2]

D 4332 Practice for Conditioning Containers, Packages, or Packaging Components for Testing[2]

E 171 Specification for Standard Atmospheres for Conditioning and Testing Flexible Barrier Materials[2]

[1] These test methods are under the jurisdiction of ASTM Committee D-10 on Packaging and are the direct responsibility of Subcommittee D10.21 on Application of Performance Test Methods.

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[2] *Annual Book of ASTM Standards*, Vol 15.09.

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*—General terms in these test methods are defined in Terminology D 996.

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*—shipping container constructed of any material, and 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 *spade lift attachment*—a lift truck attachment used for“ top handling” products packaged in interlocking flange cartons (I.F.C.) or folded cap or folded flap style cartons.

3.2.6 *unitized load*—consists of a number of packages (two or more) secured together as a shipping unit. These packages when unitized typically weigh more than 100 lb (45 kg). The unitized method may be shrink wrapping, stretch wrapping, banding, strapping, taping, or gluing. A base consisting of a pallet or slip sheet may or may not be used.

4. Significance and Use

4.1 The test methods described are designed for use in most cases with the actual equipment to be used in load handling.

4.2 These test methods may be used in evaluating cases, crates, or unitized loads as to suitability for mechanical handling by standard user specified load handling equipment.

4.3 The test methods given will allow the user to determine integrity and stability of the load as well as provide guidance to improve the design of the unit load where deficiencies are found.

4.4 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.

4.5 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 or crate may be handled with any convenient equipment, such as a block and tackle, a hoist, or jacks with provision made for releasing the case or crate either by pulling supporting blocks from under it when tackle and jacks are used or by a release hook when a hoist is used. Other apparatus may be used for dropping a case or crate as follows:

5.1.1 Lift with heavy band iron or wire (to release, the band or wire is cut), or

5.1.2 Lift with a fork truck (while restraining the container, the fork truck is removed from under it), or

5.1.3 Use a tractor with block and tackle (blocks are pulled from under loaded container).

5.1.4 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 nondeformable under test conditions, with a mass at least 50 times that of the load and large enough to ensure that the test package falls entirely upon the surface.

5.2 *Spade Lift Test Apparatus*—In performing the spade lift test, use an actual lift truck with spade lift attachment to lift the shipping unit under the lifting flap. The lift truck and blade(s) must be capable of handling the size and quantity of products as per current practice.

5.3 *Clamp Lift Test Apparatus*—In performing the clamp lift test, use an actual lift truck equipped with the appropriate load clamping device to lift the shipping unit. Provision must be made to measure the clamp force between the platens using a load cell(s) or other suitable device.

5.4 *Push-Pull Test Apparatus*—In performing the push-pull test, use an actual lift truck equipped with an appropriate gripper jaw for pulling the load by the slip sheet tab onto the load plate. Alternatively, any suitable pulling device equipped with a gripper jaw may be used.

5.5 *Grabhook Test and Sling Test Apparatus*—In lifting the case or crate with grabhooks or slings, a hoist with grabhooks or slings attached is the simplest and easiest, but the test may be made with a tackle or by lifting the case or crate with jacks and setting it into the grabhooks or slings supported by some form of truss.

5.6 *Tip Test and Tipover Test Apparatus*—In performing the tip or tipover test, the container may be handled with any convenient equipment, such as a forklift truck, a hoist, a block and tackle, by hand, or any means capable of applying a horizontal load to the vertical faces of the test package at a particular height above the center of gravity and of sufficient force to cause tipping without causing the package 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 load and large enough to ensure that the test package falls entirely upon the surface.

5.7 *Rolling Test Apparatus*—In performing the rolling test, the container may be handled with any convenient equipment,

[3] Copies of the ISO standard are available through: American National Standards Institute, 1430 Broadway, New York, NY, 10018.

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 load and large enough to ensure that the test package falls entirely upon the surface.

6. Test Specimen and Number of Tests

6.1 Test several cases or unitized loads of a given design, if possible, to obtain replication of results. If in the instance of a number of cases wrapped or banded together, it is not possible to test an entire unitized load, then sufficient cases should be assembled such that the height and one base dimension are nearly the same as the proposed unitized load. For the clamp, spade lift, or push-pull test, use an entire unit load. The same case or unitized load may often be used for all applicable tests if not tested to failure. Load the case or unitized load for the test with the actual contents for which it was designed, or if this is not possible, with a dummy load simulating such contents in mass, shape, and position in the case or unitized load.

6.2 Identify faces, edges, and corners of containers as shown in Test Method D 775, Fig. 1.

7. Conditioning

7.1 The test specimen may be conditioned to a representative temperature and humidity expected in actual distribution (see Specification E 171).

7.2 It is recommended that atmospheres for conditioning be selected from those shown in Practice D 4332. Unless otherwise specified, fiberboard and other paperboard containers shall be preconditioned and conditioned in accordance with the standard atmosphere specified in Practice D 4332.

8. Acceptance Criteria

8.1 Reference Practice D 4169 for acceptance criteria and the connection to relative performance criteria.

9. Unitized Load Tests

9.1 *Palletized Load Test Procedure*:

9.1.1 *Handling on Test Course*:

9.1.1.1 Use an actual lift truck equipped with forks to be used in actual practice. See Annex A1 for recommended standard course for lift truck handling test.

9.1.1.2 The operator is to engage, lift, and transport the load to each observation point in a manner typical of current practice until the course has been completed one cycle.

9.1.1.3 If the pallet allows fork entry from both directions, distribute the test cycles accordingly based on the probability of forking from each direction.

9.1.1.4 The minimum number of handlings required shall be specified by the user; however, it should be noted that the effects of temperature and humidity in the testing environment may vary greatly and, if so, may affect the strength of the shipping unit. For this reason, it may be useful to specify the minimum number of handlings based on test periods representing these extremes.

9.1.1.5 Examine the load during and after the test cycle to determine if failure has occurred.

9.1.2 *Raised Edge Free Fall Drop*:

9.1.2.1 With one edge of the unit load supported by the floor, raise the other end to prescribed heights and release it to fall flat on the impact surface. Where cases or crates are tall or top heavy, provision must be made to prevent the case or crate from tipping over after the drop is made.

9.1.2.2 *Measurements During Drop Tests*—Measure deflections and distortions of the unitized load and record before the

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

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 measurements, a record should be made of any changes or breakage in the shipping unit and their location. A recommended simple form for recording the measurements and notations made during the drop test is shown in Fig. 1.

9.2 *Spade Lift Test Procedure*:

9.2.1 Use an actual lift truck equipped with the spade lift attachment to be used in actual practice. See Annex A1 for recommended standard course for lift truck handling test.

9.2.2 The operator is to engage, lift, and transport the load to each observation point in a manner typical of current practice.

9.2.3 If normal handling requirements specify two or more units high, the test should be conducted with an equivalent load on the test specimen. This test can be repeated for a predetermined number of handlings or until failure occurs. The minimum number of handlings required shall be specified by the user; however, it should be noted that the effects of temperature and humidity in the testing environment may vary greatly and, if so, will affect the strength of the handling flap. For this reason, it may be useful to specify the minimum number of handlings based on test periods representing these extremes.

9.2.4 Examine the shipping unit during and after the test cycle to determine if failure of the handling flap occurred.

9.3 *Clamp Handling Test Procedure*:

9.3.1 Test the ability of the unitized load or case to withstand repeated side compressions using a lift truck equipped with hydraulic carton clamp or other suitable load clamping device. If the cases or unitized loads are normally handled two-high, a second case or equivalent dummy load should be placed on the unit to be tested prior to clamping.

9.3.2 Provision shall be made for measuring the total force applied to the load using a load cell(s) or other suitable device at critical locations.

9.3.3 Measure the clamp force between the platen and record the forces measured between the clamps at all available clamp settings (that is, low, medium, and high).

9.3.3.1 When using a single load cell clamp force indicator to measure clamp force for articulating clamps, it should be positioned as follows (see Fig. 2):

(1) Front to Back—The load cell should be positioned so that its centerline is directly in line with the pivoting axis of the clamp arms.

(2) Top to Bottom—The load cell should be positioned so that it is parallel to the clamping cylinders and its center line is between the two clamping cylinders.

NOTE 3—Measurements may be taken with multiple load cells, where the force can be measured at various positions on the clamp at the same time. This will show the force variations due to camber and toe-in. These two factors are often overlooked and cause damage and excessive forces to be applied to the package being carried.

9.3.3.2 When using a single load cell clamp force indicator to measure clamp force for nonarticulating clamps, the force gages should be positioned at the center of the clamps.

9.3.4 Clamp the package or unitized load in a manner typical of current or expected practice starting with the lowest clamp force and increasing the force until load can be successfully transported. The test then consists of clamping the package or unitized load at either.

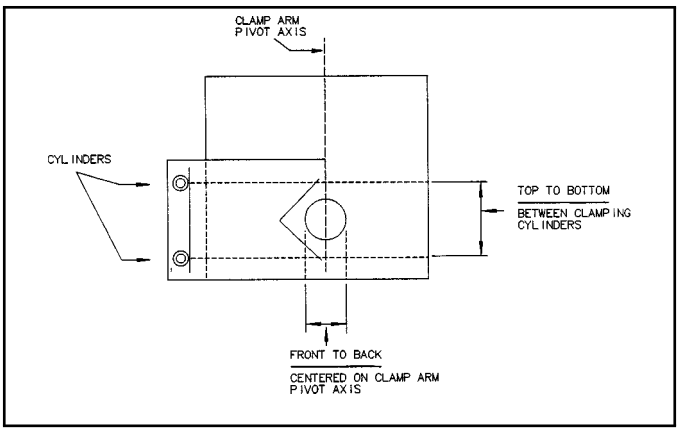

FIG. 2 Clamp Force Indicator Positioning (for Articulating Clamp Only)

9.3.4.1 The minimum clamp force on the truck to allow repeated handlings in the particular distribution system, or

9.3.4.2 The next highest clamp setting on the truck to allow repeated handlings in the particular distribution system.

9.3.5 See Annex A1 for recommended standard course for lift truck handling tests.

9.3.5.1 The operator is to clamp, lift, and transport to each observation point until the course has been completed one cycle.

9.3.5.2 If the case or unitized load is normally clamped from both directions, distribute the test cycles accordingly based on the probability of clamping from each direction.

9.3.5.3 The minimum number of handlings and platen size required shall be specified by the user; however, it should be noted that the effects of temperature and humidity in the testing environment may vary greatly and, if so, may affect the strength of the shipping unit. For this reason, it may be useful to specify the minimum number of handlings based on test periods representing these extremes.

9.3.6 Examine the package and product after the test cycle to determine if failure occurred.

9.4 *Push-Pull Handling Test Procedure*:

9.4.1 *Handling on Test Course*:

9.4.1.1 Use an actual lift truck equipped with gripper jaw for pulling the load by the slip sheet tab onto the load plate or platens. See Annex A1 for recommended standard course for lift truck handling tests.

9.4.1.2 The operator is to engage, lift, and transport the load to each observation point in a manner typical of current practice.

9.4.1.3 The minimum number of handlings required shall be specified by the user; however, it should be noted that the effects of temperature and humidity in the testing environment may vary greatly and, if so, may affect the strength of the shipping unit. For this reason, it may be useful to specify the minimum number of handlings based on test periods representing these extremes.

9.4.1.4 Examine the load during and after each test cycle to