Designation: D6055 – 96 (Reapproved 2014)

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

This standard is issued under the fixed designation D6055; 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 unitized loads and large cases and crates, but not individual drums or palletized drums, as well as the ability of the contents to endure normal handling, using standard mechanical handling equipment. 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, including pull pack, clamp truck, and spade lift-type handling equipment as follows:

1.1.1 *Test Method A——Fork Truck Handling*—For testing the ability of the shipping unit to withstand repeated handlings by this test method.

1.1.2 *Test Method B—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 test method.

1.1.3 *Test Method C—Clamp Handling Test*—For lifting by hydraulic clamp attachment, to determine the ability of the shipping unit to withstand squeeze clamp handling consisting of repeated side compression and lifting.

1.1.4 *Test Method D—Push-Pull Handling Test*—For testing the ability of a unitized load on a slip-sheet to withstand repeated handling by this test method.

1.1.5 *Test Method E—Grabhook Test*—For lifting by grabhooks to determine the ability of the shipping unit to withstand the horizontal pressures of grabhooks.

1.1.6 *Test Method F—Sling Tests*—For lifting by wire rope, cable, or woven fiber slings to determine the ability of the shipping unit to withstand the compression of slings.

1.2 *Additional Test Methods:*

1.2.1 Additional test methods that apply to mechanical handling and rough handling tests of unitized loads and large cases and crates include incline impact tests, described in Test Method D880; horizontal impact tests, described in Test Method D4003.

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 *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

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

3. Terminology

3.1 *Definitions*—General terms in these test methods are defined in Terminology D996.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *clamp lift attachment*—a lift truck attachment used for clamp handling products packaged in flat-sided packages.

3.2.2 *forklift attachment*—a lift truck attachment used to handle large unitized or palletized loads.

3.2.3 *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.

[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.

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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.

3.2.4 *push-pull attachment*—a lift truck attachment used for push-pull handling products packaged using slip sheets.

3.2.5 *shipping unit*—the smallest complete unit that will be subjected to the distribution environment, for example, a shipping container and its contents.

3.2.6 *spade lift attachment*—a lift truck attachment used for top handling products packaged in interlocked double-cover boxes or folded cap- or folded flap-style cartons.

3.2.7 *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 These test methods 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 the shipping unit as to suitability for mechanical handling by standard user-specified load-handling equipment.

4.3 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 unit load where deficiencies are found.

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

5. Apparatus

5.1 *Fork Truck Test Apparatus*—In performing the fork truck handling test, use an actual lift truck with fork attachment to lift the shipping unit. The lift truck and blade(s) shall be capable of handling the size and quantity of products in accorance with current practice.

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 in accordance with current practice.

5.3 *Clamp Lift Handling Test Apparatus* —In performing the clamp handling test, use an actual lift truck with the appropriate load clamping device to lift the shipping unit. Provision shall 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 with the 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 grabhooks or slings supported by some form of truss.

6. Test Specimen and Number of Tests

6.1 Test several shipping units 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 unitized load. The same case or unitized load may often be used for all applicable tests if not tested to failure. Load the shipping unit 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 shipping unit.

7. Conditioning

7.1 It is recommended that atmospheres for conditioning be selected from those in accordance with 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. Mechanical Handling Tests with Lift Trucks

9.1 *Test Method A—Fork Lift Test Procedure*

9.1.1 *Handling on Test Course:*

9.1.1.1 Use an actual lift truck equipped with user-specified fork attachments. See Annex A1 for recommended standard course for lift truck handling tests.

9.1.1.2 The operator is to lift and transport to each observation point in a manner typical of current practice.

9.1.1.3 The minimum number of handlings and fork type and size 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.

9.1.1.4 Examine the load during and after each test cycle to determine if failure occurred.

9.2 *Test Method B—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 *Test Method C—Clamp Handling Test Procedure:*

9.3.1 Test the ability of the shipping unit to withstand repeated side compression using a lift truck equipped with hydraulic carton clamp or other suitable load clamping device. If the shipping units 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 the available clamp settings (that is, low, medium, and high).

9.3.4 When using a single-load cell clamp force indicator to measure clamp force for articulating clamp, it should be positioned as follows (see Fig. 1):

9.3.4.1 *Front to Back*— Position the load cell so that its centerline is directly in line with the pivoting axis of the clamp arms.

9.3.4.2 *Top to Bottom*— Position the load cell so that it is parallel to the clamping cylinders and its centerline is between the two clamping cylinders.

NOTE 1—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 forces are often overlooked and cause damage and excessive forces to be applied to the package being carried.

9.3.4.3 When using a single-load cell clamp force indicator to measure clamp force for non-articulating clamps, position the force gages at the center of the clamps.

9.3.5 Clamp the package or the shipping unit 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.

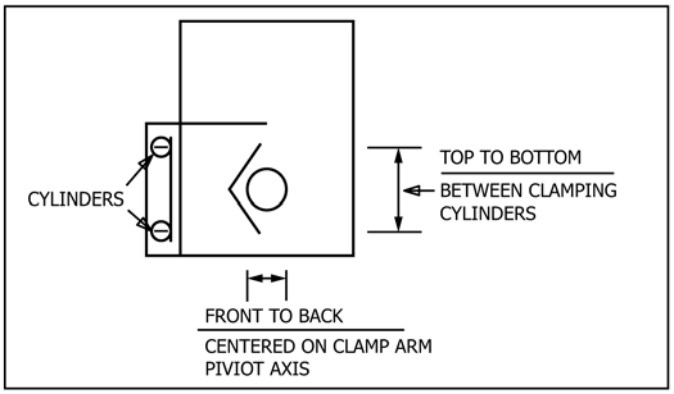

FIG. 1 Clamp Force Indicator Positioning (for Articulating Clamp Only)

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

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

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

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

9.3.6.2 If the shipping unit is normally clamped from both directions, distribute the test cycles accordingly based on probability of clamping from each direction.

9.3.6.3 The minimum number of handlings and platen size 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.

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

9.4 *Test Method D—Push-Pull Handling 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 clamp, lift, and transport to each observation point in a manner typical of current practice.

9.4.1.3 The minimum number of handlings and platen size shall be specified by the user.

NOTE 2—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 determine if failure occurred.

10. Grabhook and Sling Test Procedures

10.1 *Test Method E—Grabhook Test Procedures:*

10.1.1 Close the case or crate fully loaded with the actual contents or a dummy load of the same total mass and distribution as for shipment.

10.1.2 Grabhooks may consist of one or two pairs depending upon the case or crate dimensions, mass, and design. Points of contact for grabhooks may be stenciled on the case or crate. If no marks are shown, then contact may be made by either of the following methods:

10.1.2.1 One pair of grabhooks at any point (usually the center of balance) or

10.1.2.2 Two pairs of grabhooks at any two points along the case or crate length.

10.1.3 To determine whether the top bracing members are adequate to withstand the horizontal pressures of grabhooks, test the case crate as follows: Place the grabhooks in contact with the sides a few inches from the top of the case or crate and lift the case or crate for several minutes. Return the case to the ground for inspection. The angle of cable or chain between the

grabhooks and the lifting hook of the lifting device should be approximately 45° from the level of the container top.

10.1.4 Measure deflection of the case or crate while suspended a few inches and again after releasing the hooks. Again make observations to determine if the deflections were such as to damage or dislodge the contents of the case or crate and if the case or crate returns to its original dimensions after the test.

10.2 *Test Method F—Sling Test Procedure*—Conduct sling tests in a manner similar to the grabhook test (see 10.1) with the exception that each sling shall encircle the side and bottom of the case or crate at points of contact. The angle of slings between the top of the container and the lifting hook of the lifting device should be approximately 45° from the level of the container top. Sling tests shall consist of lifting the test container with a single sling, and lifting the test container with a double sling.

11. Report

11.1 Report the following information:

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

11.1.2 Dimensions of the shipping unit 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 or slip sheet, if used, and net and gross weights.

11.1.3 Description of the contents of the shipping unit under test. If simulated or dummy contents were used, full details shall be given.

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

11.1.5 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.

11.1.6 Detailed record of tests including procedures used, angle of free fall drop test, 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. Also record the number of replicate packages tested and the orientation of clamps or spade, if used, and the number of handlings for spade, clamp, or push-pull tests, if used.

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

11.1.8 Date of test and signature of tester.

12. Precision and Bias

12.1 No information is presented about either the precision or bias of these test methods for mechanical handling since the test results are nonquantitative.

13. Keywords

13.1 clamp handling; crates; fork truck handling; grabhook; large shipping cases; mechanical handling; push-pull handling; sling; spade lift; unitized loads

ANNEX

(Mandatory Information)

A1. RECOMMENDATIONS FOR STANDARD TEST COURSE FOR LIFT TRUCK HANDLING TEST

A1.1 A standard course shall be established on a flat rigid surface representative of worst-case warehouse conditions.

A1.2 The L-shaped course will include 10 to 11.5-ft. (3 to 3.5-m) wide aisles with a 90° turn, approximate acceleration/deceleration zones, and observation points (OP-1 through OP-5), in accordance with Fig. A1.1.

A1.3 User-defined test course obstacles may be used and are at the users option. Lift truck velocity through this area with or without obstacles shall be at a uniform "walking" speed not to exceed 5 ft/s (1.5 m/s). (A typical example of obstacle include two nominal 1 by 6-in. pieces of lumber, beveled on both top edges at 45°, secured to the floor in a staggered pattern as shown in Fig. A1.1.)

A1.4 The velocity of the lift truck in the turn shall be 3 ¼ ft/s (1-m/s) maximum.

A1.5 The unitized load under test should be examined after each cycle of handling (pickup/transport/set down).

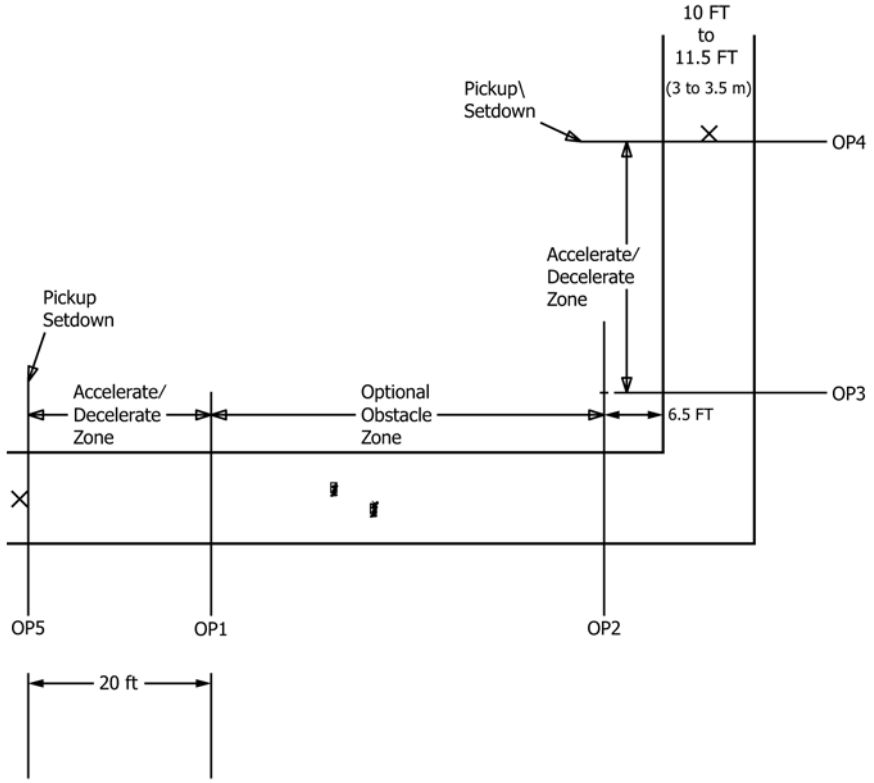

FIG. A1.1 Suggested Handling Course Layout