



Designation: D4169 – 22

Standard Practice for Performance Testing of Shipping Containers and Systems¹

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This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This practice provides a uniform basis of evaluating, in a laboratory, the ability of shipping units to withstand the distribution environment. This is accomplished by subjecting them to a test plan consisting of a sequence of anticipated hazard elements encountered in various distribution cycles. This practice is not intended to supplant material specifications or existing preshipment test procedures.

1.2 Consider the use of Practice [D7386](#) for testing of packages for single parcel shipments.

1.3 The suitability of this practice for use with hazardous materials has not been determined.

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.*

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 practice 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

- [D642](#) Test Method for Determining Compressive Resistance of Shipping Containers, Components, and Unit Loads
- [D880](#) Test Method for Impact Testing for Shipping Containers and Systems
- [D951](#) Test Method for Water Resistance of Shipping Containers by Spray Method
- [D996](#) Terminology of Packaging and Distribution Environments
- [D999](#) Test Methods for Vibration Testing of Shipping Containers
- [D4003](#) Test Methods for Programmable Horizontal Impact Test for Shipping Containers and Systems
- [D4332](#) Practice for Conditioning Containers, Packages, or Packaging Components for Testing
- [D4728](#) Test Method for Random Vibration Testing of Shipping Containers
- [D5265](#) Test Method for Bridge Impact 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
- [D6179](#) Test Methods for Rough Handling of Unitized Loads and Large Shipping Cases and Crates
- [D6344](#) Test Method for Concentrated Impacts to Transport Packages

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.

D6653 Test Methods for Determining the Effects of High Altitude on Packaging Systems by Vacuum Method

D7386 Practice for Performance Testing of Packages for Single Parcel Delivery Systems

F1327 Terminology Relating to Barrier Materials for Medical Packaging (Withdrawn 2007)³

2.2 *Military Standards*:⁴

MIL-STD-810F Environmental Test Methods

MIL-STD-2073-1 DOD Standard Practice for Military Packaging

2.3 *Association of American Railroads Standards*:⁵

General Information Bulletin No. 2 Rules and Procedures for Testing of New Loading and Bracing Methods or Materials

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, n*—the acceptable quality level that must be met after the shipping unit has been subjected to the test plan. See Section 7.

3.2.2 *assurance level, n*—the level of test intensity based on its probability of occurring in a typical distribution cycle.

3.2.2.1 *Discussion*—Level I is a high level of test intensity and has a low probability of occurrence. Level III is a low level of test intensity, but has a correspondingly high probability of occurrence. Level II is between these extremes. For Distribution Cycle 18 (DC-18), see MIL-STD-2073-1 for definitions of military levels of protection.

3.2.3 *coefficient of restitution, n*—the ratio of the rebound velocity to the impact velocity.

3.2.4 *distribution cycle (DC), n*—the sequential listing of the test schedules employed to simulate the hazard elements expected to occur for a specific routing of a shipping unit from production to consumption. See Table 1.

3.2.5 *feeder aircraft, n*—small, potentially non-pressurized aircraft used to transport express packages.

3.2.6 *hazard element, n*—a specific event that occurs in a distribution cycle that may pose a hazard to a shipping unit. The element will usually be simulated by a single test schedule. See Section 9.

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

3.2.7.1 *small shipping unit, n*—for DC-18, a small shipping unit is defined as one having no edge dimension or diameter over 60 in. (1.52 m) and a gross weight of 100 lb (45 kg) or less.

3.2.7.2 *large shipping unit, n*—for DC-18, a large shipping unit is defined as one having at least one edge dimension or diameter over 60 in. (1.52 m) or a gross weight in excess of 100 lb (45 kg), or it is one that has a gross weight exceeding 100 lb (45 kg) and is secured to a base or to the base of a shipping unit.

3.2.8 *test plan, n*—a specific listing of the test sequence to be followed to simulate the hazards anticipated during the distribution cycle of a shipping unit. Included will be the test intensity and number of sequential tests to be conducted. See 8.5.

3.2.9 *test schedule, n*—the specific procedure to be used, including the three assurance level intensities, and a reference to the test method that is the basis of the schedule.

3.2.9.1 *Discussion*—The purpose of the schedule is to simulate the forces occurring during any hazard element of the distribution cycle. See Section 9.

3.2.10 *total velocity change, (ΔV), n*—the sum of the impact and rebound velocities.

3.3 *Abbreviations*:

3.3.1 *TOFC*—trailer on flatcar.

3.3.2 *COFC*—container on flatcar.

3.3.3 *TL*—truckload.

3.3.4 *CL*—carload.

3.3.5 *LTL*—less than truckload.

4. Significance and Use

4.1 This practice provides a guide for the evaluation of shipping units in accordance with a uniform system, using established test methods at levels representative of those occurring in actual distribution. The recommended test levels are based on available information on the shipping and handling environment, and current industry/government practice and experience (**1-13**).⁶ The tests should be performed sequentially on the same containers in the order given. For use as a performance test, this practice requires that the shipping unit tested remain unopened until the sequence of tests are completed. If used for other purposes, such as package development, it may be useful to open and inspect shipping units at various times throughout the sequence. This may, however, prohibit evaluating the influence of the container closure on container performance.

4.2 For Distribution Cycle 18, as referred to in MIL-STD-2073-1, the use of this practice is defined in subsequent sections identified as DC-18.

5. Test Specimen

5.1 Test specimens consist of representative samples of complete shipping units, including actual contents. Products with blemishes or minor defects may be used if the defective component is not to be studied by the test and if the defect is documented in the report. Dummy test loads are acceptable if testing the actual product might be hazardous. If a dummy load

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil>.

⁵ Available from Association of American Railroads (AAR), 425 Third St., SW, Washington, DC 20024, <http://www.aar.org>.

⁶ The boldface numbers in parentheses refer to a list of references at the end of this standard.

TABLE 1 Distribution Cycles

DC	Distribution Cycle	Performance Test Schedule Sequence (see Section 9 for Test Schedule definition)						
		First	Second	Third	Fourth	Fifth	Sixth	Seventh
1	General Cycle—undefined distribution system	Schedule A Handling	Schedule D Stacked Vibration	Schedule F Loose-Load Vibration	Schedule G Rail Switching	Schedule J Concentrated Impact	Schedule A Handling	
2	Specially defined distribution system, user specified (see Appendix X2)	select from Schedules A through I						
3	Single package without pallet or skid, LTL motor freight	Schedule A Handling—Manual	Schedule D Stacked Vibration OR Schedule C Vehicle Stacking plus Schedule E Vehicle Vibration	Schedule F Loose-Load Vibration	Schedule J Concentrated Impact	Schedule A Handling—Manual	...	
4	Single package with pallet or skid, LTL motor freight	Schedule A Handling—Mechanical	Schedule D Stacked Vibration OR Schedule C Vehicle Stacking plus Schedule E Vehicle Vibration	Schedule F Loose-Load Vibration	Schedule J Concentrated Impact	Schedule A Handling—Mechanical	...	
5	Motor freight, TL, not unitized	Schedule A Handling	Schedule D Stacked Vibration	Schedule E Vehicle Vibration	Schedule J Concentrated Impact	Schedule A Handling	...	
6	Motor freight, TL, or LTL—unitized	Schedule A Handling	Schedule D Stacked Vibration OR Schedule C Vehicle Stacking plus Schedule E Vehicle Vibration	Schedule J Concentrated Impact	Schedule A Handling	Schedule B Warehouse Stacking	...	
7	Rail only, bulk loaded	Schedule A Handling	Schedule D Stacked Vibration	Schedule G Rail Switching	Schedule A Handling	...	...	
8	Rail only, unitized	Schedule A Handling	Schedule D Stacked Vibration	Schedule G Rail Switching	Schedule A Handling	Schedule B Warehouse Stacking	...	
9	Rail and motor freight, not unitized	Schedule A Handling	Schedule C Vehicle Stacking	Schedule E Vehicle Vibration	Schedule G Rail Switching	Schedule F Loose-Load Vibration	Schedule J Concentrated Impact	Schedule A Handling
10	Rail and motor freight, unitized	Schedule A Handling	Schedule D Stacked Vibration	Schedule G Rail Switching	Schedule J Concentrated Impact	Schedule A Handling	Schedule B Warehouse Stacking	
11	Rail, TOFC and COFC	Schedule A Handling	Schedule G Rail Switching	Schedule D Stacked Vibration	Schedule F Loose-Load Vibration	Schedule A Handling	...	
12	Air (intercity) and motor freight (local), over 150 lb (68.1 kg), or unitized	Schedule A Handling	Schedule D Stacked Vibration	Schedule I Low Pressure ^A	Schedule E Vehicle Vibration	Schedule J Concentrated Impact	Schedule A Handling	
13	Air (intercity) and motor freight (local, single package up to 150 lb (61.8 kg). Consider using Practice D7386 for single parcel carrier shipments.	Schedule A Handling	Schedule C Vehicle Stacking	Schedule F Loose-Load Vibration	Schedule I Low Pressure ^A	Schedule E Vehicle Vibration	Schedule J Concentrated Impact	Schedule A Handling
14	Warehousing (partial cycle to be added to other cycles as needed)	Schedule A Handling	Schedule B Warehouse Stacking	...	...	...	...	
15	Export/Import shipment for intermodal container or roll on/roll off trailer (partial cycle to be added to other cycles as needed)	Schedule A Handling	Schedule C Vehicle Stacking	Schedule A Handling	...	...	...	
16	Export/Import shipment for palletized cargo ship (partial cycle to be added to other cycles as needed)	Schedule A Handling	Schedule C Vehicle Stacking	Schedule A Handling	...	...	...	