



Designation: D4169 – 23^{ε1}

Standard Practice for Performance Testing of Shipping Containers and Systems¹

This standard is issued under the fixed designation D4169; 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.

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

^{ε1} NOTE—Editorial corrections made throughout in March 2024.

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.*

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
- 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

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 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.

*A Summary of Changes section appears at the end of this standard

F1327 Terminology Relating to Barrier Materials for Medical Packaging (Withdrawn 2007)³

F2825 Practice for Climatic Stressing of Packaging Systems for Single Parcel Delivery

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 *small and lightweight package: for DC's 2,3,4,6,9,13,14,15,16,17*; packages weighing under 10.00 lb (4.53 kg) and volume below 2.000 ft³ (0.056 m³).

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

3.2.8.1 *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.

3.2.8.2 *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.

3.2.9 *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**.

3.2.10 *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.

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

3.2.11 *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.