Designation: D7387 – 20

Standard Test Method for Vibration Testing of Intermediate Bulk Containers (IBCs) Used for Shipping Liquid Hazardous Materials (Dangerous Goods)[1]

This standard is issued under the fixed designation D7387; 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 This test method covers vibration testing of filled intermediate bulk containers (IBCs) intended to contain liquid hazardous materials (dangerous goods) and is suitable for testing IBCs of any design or material type. This test method is required as part of the qualification of IBCs in accordance with the United States Department of Transportation Title 49 Code of Federal Regulations (CFR) and the United Nations Recommendations on the Transport of Dangerous Goods (UN).

1.2 This test method is appropriate for testing IBCs ranging from 450 to 3000 L (119 to 793 gal). Packagings of smaller sizes should be tested using Test Method D999 or other applicable methods.

1.3 The ISO 2247 standard may not meet the requirements for this test method.

1.4 This test method is based on the current information contained in 49 CFR, §178.819.

1.5 This test method is used to determine that the IBC maintains integrity and to prevent leakage or spillage of contents during shipping. This test method may also be used as a screening tool or as a design qualification test. Other vibration methods are available to more closely simulate vibration experienced in actual transportation.

1.6 When testing packaging designs intended for hazardous materials (dangerous goods), the user of this test method shall be trained in accordance with 49 CFR §172.700 and other applicable hazardous materials regulations such as the ICAO Technical Instructions, IMDG Code, and carrier rules such as the IATA Dangerous Goods Regulations.

1.7 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

1.8 *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. Specific precautionary statements are given in Section 6.*

1.9 *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]

D996 Terminology of Packaging and Distribution Environments

D999 Test Methods for Vibration Testing of Shipping Containers

D4169 Practice for Performance Testing of Shipping Containers and Systems

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

D4919 Guide for Testing of Hazardous Materials (Dangerous Goods) Packagings

D7887 Guide for Selection of Substitute, Non-hazardous, Liquid Filling Substances for Packagings Subjected to the United Nations Performance Tests

2.2 *Federal Standard:*[3]

U.S. Department of Transportation Code of Federal Regulations Title 49, Transportation (49 CFR) Parts 100-185

[1] This test method is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.22 on Hazardous Materials.

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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] Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9371 (website: https://www.phmsa.dot.gov/phmsa-regulations).

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

2.3 *UN Standard:*[4]
UN United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations (UN Orange Book)
2.4 *IATA Standard:*[5]
IATA International Air Transport Association (IATA) Dangerous Goods Regulations
2.5 *ICAO Standard:*[6]
ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air
2.6 *IMGD Standard:*[7]
International Maritime Dangerous Goods Code (IMDG Code)
2.7 *ISO Standard:*[8]
ISO 2247 Packaging—Complete, Filled Transport Packages—Vibration Test at Fixed Low Frequency

3. Terminology

3.1 For definitions of terms used in these test methods, see Terminology D996.

3.2 *Definitions of Terms Specific to This Standard:*
3.2.1 *double amplitude, n*—the maximum value of a sinusoidal quantity (peak-to-peak).

3.2.2 *repetitive shock, n*—impacts of a package on a test platform which occur cyclically from input oscillatory motion.

3.2.3 *resonance, n*— a condition during a vibration test, when the forcing (input) frequency of the table equals the resonant frequency of the IBC and will produce the highest transmissibility level.

NOTE 1—Testing close to or at the resonant frequency of the IBC may cause excessive, violent, and uncontrollable movement of the IBC. For this method, testing at or near the resonant frequency is overly severe and may cause damage or failure to the container not likely to be experienced in transportation.

NOTE 2—Additional packaging terms and definitions specific to the regulations are located in 49 CFR Section 171.8 and the UN Orange Book, Section 1.2.1..

4. Significance and Use

4.1 Shipping containers are exposed to complex dynamic stresses when subjected to vibration present in transportation vehicles. Approximating the actual damage, or lack of damage, experienced in shipping may require subjecting the container(s) and contents to vibration inputs.

4.2 Resonant responses during shipment can be severe and may lead to failure of the container and spillage or leakage of contents. Identification of critical frequencies and the nature of package stresses can aid in minimizing the effect of these occurrences.

4.3 This vibration test method is used for the qualification of IBCs in CFR 49 and has demonstrated successful use in transportation.

4.4 Exposure to vibration can affect the shipping container, its means of closure, and its contents. This test method allows analysis of the interaction of these components. Design modification to one or more of these components may be utilized to achieve optimum performance in the shipping environment.

4.5 This test method is suitable for individual filled containers that are transported unrestrained on the bed of a vehicle.

4.6 This test method is not intended for testing intermediate bulk containers at a frequency that causes the container to go into resonance.

5. Apparatus

5.1 *Vertical Motion Vibration Machine*—This test is to be conducted with vibration test equipment that provides vertical vibration, and is capable of producing frequencies in the range of 2 to at least 5 Hz, with a fixed double amplitude displacement of 25 mm (1 in.) ± 1 mm. The test machine shall have a platform with a known mass and with a horizontal surface of sufficient strength and rigidity so that all points of the surface will follow the vertical motion of the supporting structure when loaded with the IBC. The test surface shall protrude beyond the IBC on all sides and shall have hardness adequate for its intended use (recommend at least equal to oak wood) firmly attached to a mild steel structure. The platform shall be supported by a mechanism that moves the platform so the motion is a vertical sinusoidal input. (A rotary motion of the platform is not recommended for testing IBCs due to increase stresses, such as impacts with the backstop.) The vibration test machine shall be equipped with fences, barricades, or other restraints to keep the IBC from falling off the platform without restricting its vertical motion.

5.1.1 *Shim*—A metal shim with the following specification is used in determining when the shipping container is leaving the testing platform by a sufficient amount:
5.1.1.1 *Width*—50 mm (2.0 in.) minimum.
5.1.1.2 *Thickness*—1.6 mm (1⁄16 in.).
5.1.1.3 *Length*—254 mm (10 in.) minimum.

5.2 Fig. 1 shows an intermediate bulk container on a test apparatus.

5.3 *Instrumentation*—Instrumentation of the test unit and table as described below is not required but may be used to obtain additional data.

5.3.1 Accelerometers, signal conditioners, and data display or storage devices may be used to measure and control the accelerations at the test surface or on various locations of the intermediate bulk container to measure response. They are not required to conduct the test.

5.3.2 If an instrumentation system is used, it is recommended that it shall have a response accurate to within ±5 % over the range specified for the test.

[4] Available from the UN Economic Commission for Europe, Information Service, Palais des Nations, CH-1211 Geneva 10 Switzerland (website: http://www.unece.org/trans/danger/danger.htm).
[5] Available from the International Air Transport Association (IATA), 800 Place Victoria PO Box 113 Montreal - H4Z 1M1 Quebec - Canada (website: http://www.iata.org).
[6] Available from the International Civil Aviation Organization, (ICAO) 999 University Street, Montréal, Quebec H3C 5H7, Canada (website: http://www.icao.org/).
[7] Available from the International Marine Organization (IMO, 4 Albert Embankment, London, SE1 7SR United Kingdom (website: http://www.imo.org/).
[8] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.