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Standard Guide for Conducting Internal Pressure Tests on United Nations (UN) Packagings¹

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1. Scope

1.1 This guide is intended to provide a standardized method and a set of basic instructions for performing internal and hydrostatic pressure testing on packaging designs.

1.2 This guide provides information to help clarify various terms used as part of the United Nations (UN) certification process that may assist in determining the applicable test.

1.3 This guide provides the suggested minimum information that should be documented when conducting pressure testing.

1.4 This guide provides information for recommended equipment and fittings for conducting pressure tests.

1.5 This guide is based on the current information contained in 49 CFR, §173.27 and §178.605.

1.6 When testing packaging designs intended for hazardous materials (dangerous goods), the user of this guide 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. No other units of measurement are included in this standard.

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 and health practices and determine the applicability of regulatory limitations prior to use.*

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.*

¹ This guide 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. Referenced Documents

2.1 *ASTM Standards*:²

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

D4991 Test Method for Leakage Testing of Empty Rigid Containers by Vacuum Method

2.2 *Federal Standard*:³

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

2.3 *UN Standard*:⁴

UN United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations

2.4 *IATA Standard*:⁵

IATA Dangerous Goods Regulations

2.5 *ICAO Standard*:⁶

ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air

2.6 *IMDG Standard*:⁷

IMDG Code International Maritime Dangerous Goods Code

3. Terminology

3.1 *Definitions*:

3.1.1 *bar, n*—metric unit of atmospheric pressure equal to 14.50 psi (lb/in.²), 1.02 kg/cm², 29.53 in.-Hg, or 0.9869 atmosphere.

3.1.2 *hydrostatic pressure test, n*—internal pressure test conducted on a container or packaging filled with water and pressurized with water or other suitable means; regulatory

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 U.S. Government Printing Office Superintendent of Documents, Washington, DC 20402-9371, <http://phmsa.dot.gov/hazmat>.

⁴ Available from the UN Economic Commission for Europe, Information Service, Palais des Nations, CH-1211 Geneva 10, Switzerland, <http://www.unece.org/trans/danger/danger.htm>.

⁵ Available from the International Air Transport Association (IATA), 800 Place Victoria, PO Box 113, Montreal, Quebec, H4Z 1M1, Canada, <http://www.iata.org>.

⁶ Available from the International Civil Aviation Organization (ICAO), 999 University St., Montreal, Quebec, H3C 5H7, Canada, <http://www.icao.org>.

⁷ Available from the International Marine Organization (IMO), 4 Albert Embankment, London, SE1 7SR, U.K., <http://www.imo.org>.

reference sections: 49 CFR §178.605, UN 6.1.5.5, IMDG Code 6.1.5.5, ICAO 6.4.5, and IATA 6.3.5.

3.1.2.1 *Discussion*—This test is required for all single and composite packagings intended for shipping liquid dangerous goods (hazardous materials). For single and composite packagings, the test pressure rating will appear as part of the UN specification marking sequence. This test may also be used to comply with the pressure differential requirements for air transportation (49 CFR §173.27) for inner packagings of combination packagings intended for shipping liquid hazardous materials. For further discussion and clarification, refer to the pressure differential section.

3.1.3 *inches-mercury, in.-Hg, n*—pressure exerted by a 2.54-cm high column of mercury that has a density of 13.5951 g/cm³ when the acceleration of gravity has the standard value of 9.8 m/s²; used as a unit in the measurement of atmospheric pressure. One in.-Hg is equal to 3.3864 kPa or 0.491154 psi.

3.1.4 *kilopascal, kPa, n*—unit of pressure in the SI system of international units, the primary, standard system used by the United Nations (UN) and the U.S. Department of Transportation (DOT) throughout their respective regulations per 49 CFR §171.10.

3.1.4.1 *Discussion*—To convert kPa to psi, multiply by 0.14513 (95 kPa × 0.14513 = 13.8 psi). For single and composite packagings, the test pressure rating will appear as part of the UN specification marking sequence and shall be shown in kPa.

3.1.5 *leakproofness test, n*—pressure test conducted on an empty container or packaging and pressurized with air or other suitable means; regulatory reference sections: 49 CFR §178.604, UN 6.1.5.4, IMDG Code 6.1.5.4, ICAO 6.4.4, and IATA 6.3.4.

3.1.5.1 *Discussion*—All packagings intended to contain liquids, except the inner packagings of combination packagings, shall be capable of passing a leakproofness test. Methods to comply are outlined in Appendix B to Part 178 of DOT, 49 CFR.

3.1.5.2 *Discussion*—The definition for leakproofness is provided in this guide, but the test methods will be addressed in a separate standard.

3.1.6 *packagings, n*—receptacles and any other components or materials necessary for the receptacle to perform its containment function and includes nonbulk packagings and composite packagings and are: designed to contain a net mass not exceeding 400 kg; designed with a capacity not exceeding 450 L; not intended to transport most gases; not intended to transport infectious substances; not intended to transport most radioactive materials; and not an intermediate bulk container (IBC) as defined in UN Recommendations 6.5.

3.1.7 *pounds per square inch, psi, n*—unit of measure in the English measurement system.

3.1.7.1 *Discussion*—To convert psi to kPa, multiply by 6.89 (13.8 psi × 6.89 = 95 kPa).

3.1.8 *pressure differential test, n*—combination packagings with inner packagings containing liquid hazardous materials shall be capable of meeting the pressure differential require-

ments for transport by air; regulatory reference sections: 49 CFR §173.27(c), ICAO 4; 1.1.6, and IATA 5.0.2.9.

3.1.8.1 *Discussion*—The pressure differential is intended to consider both the reduced external pressure as a result of changes in altitude as well as increased internal pressure as a result of the vapor pressure of the hazardous materials in the package. To meet the pressure differential requirement, the following tests may be used:

(1) *hydrostatic pressure, n*—The hydrostatic pressure test method should be used for all nonrigid containers and inner packagings. Nonrigid containers are those that expand under pressure such as plastic bottles or vials and thin walled metal containers;

(2) *vacuum pressure, n*—The vacuum pressure test is an appropriate method for rigid containers and inner packagings if the required test pressure (pressure differential) is 95 kPa or less. A container is considered rigid if it does not volumetrically expand more than 0.5 % of its nonpressurized volume at ambient temperature when subjected to an internal pressure of 1 atmosphere (100 kPa) as specified in Test Method D4991. Rigid containers are those such as glass bottles and vials, earthenware, and plastic and metal containers with thicker walls that do not significantly expand under pressure.

3.1.8.2 *Discussion*—The appropriate pressure differential test method shall be validated to confirm the minimum required internal pressure has been met.

3.1.8.3 *Discussion*—The vacuum pressure method should not be used for “nonrigid” or flexible containers. When a flexible packaging such as a plastic bag is subjected to a vacuum test, the air (fill material) inside the bag will cause the flexible packaging to expand and, subsequently, the internal pressure will decrease. The pressure differential of the test is inversely related to the volume increase of the sample; therefore, large volume increases detract from the severity of the test.

3.1.9 *torr, n*—unit of measure for the pressure exerted by 1 mm of mercury equal to 1/760 th of standard atmospheric pressure; used to measure pressure in vacuum systems.

3.1.9.1 *Discussion*—The corresponding SI unit is the pascal (Pa). It is a unit of pressure that is equal to approximately 1.316×10^{-3} atmospheres or 133.3 Pa (0.1333 kPa).

4. Significance and Use

4.1 Dangerous goods (hazardous materials) regulations require performance tests to be conducted on packaging designs before being authorized for use. The regulations do not include standardized procedures for conducting performance tests and, because of this, may result in a non-uniform approach and differences in test results between testing facilities.

4.2 The purpose of this guide is to provide guidance and to establish a set of common practices for conducting internal pressure tests on packagings under going UN certification testing or packagings required to meet pressure capability requirements. For more information on the UN certification requirements, refer to Guide D4919.

5. Equipment

5.1 Recommended Test Equipment :

5.1.1 *Appropriate Packaging Closing Equipment (Calibrated as Applicable)*—Closing equipment such as torque wrench, torque meter, lid press, cover/closure crimping tools, and so forth to prepare the packaging as for transport.

5.1.2 *Water Supply Source:*

5.1.2.1 Water supply source system should be designed to minimize water pressure fluctuations during the test.

5.1.2.2 The water source can be building supplied water provided fluctuations in pressure do not occur during the test.

5.1.2.3 Recommended to have a separate water supply tank assembly. Air pressure may be used to pressurize the water supply tank to provide adequate water pressure to the test sample. Refer to Fig. 1, Fig. 2, and Fig. 3.

5.1.3 Regulator valve to maintain proper water pressure to test containers used to maintain an even pressure throughout the duration of the test.

5.1.4 Manifold station to distribute water from water supply source through the regulator to the test containers. Refer to Fig. 1, Fig. 2, and Fig. 3.

5.1.5 Hose or hard piping as required.

5.1.6 Pressure gauge(s), psi/kPa, dual marked and calibrated (digital preferred).

5.1.6.1 Gauge to monitor water supply pressure.

5.1.6.2 Gauge(s) to monitor pressure inside test packaging(s).

5.1.6.3 Any gauges used should be calibrated and have an accuracy in the range of $\pm 3\%$.

5.1.7 *Connection Fitting/Valves, Adaptors, Gaskets, and Bushings (or Other Equally Effective Means) as Needed*—

5.1.7.1 Fitting/valve for water inlet to test container.

5.1.7.2 Fitting/valve for air release, drainage, and pressure monitoring.

5.1.7.3 Fitting/valve for pressure monitoring (if this is not combined with air release fitting).

NOTE 1—When combining fittings and valves, take care to make sure the assembly does not interfere with the reading on the gauge. A long extension of the fitting may not provide an accurate pressure reading of the test container. Fittings extending above or beyond the test container

should be kept as short as possible to maintain accurate values and stable fittings.

5.1.8 Drill and appropriate drill bit.

5.1.9 *Thermometer*—Calibrated 0 to 50°C minimum range.

5.1.10 *Timer with Audible Alarm*—0 to 60 min.

5.2 *Recommended Safety Equipment:*

5.2.1 Safety glasses with side shield.

5.2.2 *Gloves*—fabric, leather, or rubber slip resistant, as appropriate.

6. Sample Size

6.1 *Inner Packagings for Air Transport*—The regulations currently do not have a required sample size specified for the pressure differential test on the inner packaging of a combination packaging, but three specimens are recommended. Reference 49 CFR, § 173.27(c) for additional information.

NOTE 2—The number of test specimens does not invalidate the test results.

6.2 *Packagings (Nonbulk)*—Three specimens are required.

7. Containers

7.1 *Selection:*

7.1.1 Randomly select appropriate specimens to be tested.

7.1.2 Visually inspect specimens to:

7.1.2.1 Verify all closures, plugs, gasket, accessories, and so forth match the closing instructions, and

7.1.2.2 Determine if the container has a properly formed sealing surface (record any blemishes or defects).

7.2 *Preparation:*

7.2.1 *Location of Fittings and Gauges*—Care should be taken not to attach fittings to container embossments or other geometries that could possibly compromise the integrity of the container or invalidate the test. The report should describe in general how many fittings are used and where fittings and gauges are located. Photo documentation is appropriate.

NOTE 3—To reduce the possibility of inconsistent results between test samples, gauges and fittings should be located in the same location.

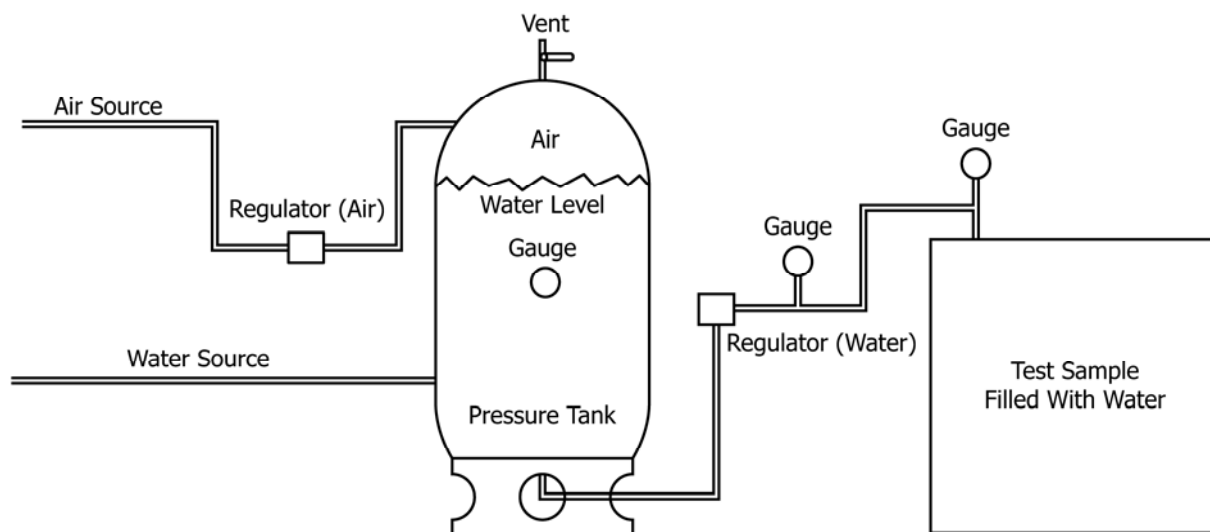


FIG. 1 Larger Container Internal Hydrostatic Pressure Station Example (Drawing)