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# Standard Guide for Preparation of Plastic Packagings Containing Liquids for United Nations (UN) Drop Testing[1]

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## 1. Scope

1.1 This guide intends to provide a standardized method for special preparation conditioning of drop test samples for United Nations (UN) performance-oriented packaging certification.

1.2 This guide provides guidance on conditioning test samples for drop testing plastic packaging intended for liquid hazardous materials (dangerous goods) as required by 49 CFR §178.603(c)(1) and §178.810(b)(4). This guide also provides the minimum information that should be documented when conducting special preparation conditioning.

1.3 The user of this guide shall be trained in accordance with 49 CFR §172.700 and other applicable hazardous materials regulations including: the International Civil Aviation Organization (ICAO) Technical Instructions for the Safe Transport of Dangerous Goods by Air, the International Maritime Dangerous Goods Code (IMDG Code), and carrier rules such as the International Air Transport Association (IATA) Dangerous Goods Regulations.

1.4 *Units*—The values stated in SI units are regarded as the standard. No other units of measurement are included in this 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 and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

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

D4919 Guide for Testing of Hazardous Materials Packagings

2.2 *Federal Standard:*

U.S. Department of Transportation Code of Federal Regulations Title 49 (49 CFR) Parts 100-185[3]

2.3 *UN Standard:*

United Nations Recommendations on the Transport of Dangerous Goods, Model Regulations (UN Orange Book)[4]

2.4 *IATA Standard:*

International Air Transport Association (IATA) Dangerous Goods Regulations[5]

2.5 *ICAO Standard:*

International Civil Aviation Organization (ICAO) Technical Instructions for the Safe Transport of Dangerous Goods by Air[6]

2.6 *IMDG Standard:*

International Maritime Dangerous Goods (IMDG) Code [7]

## 3. Terminology

3.1 *Definitions:*

3.1.1 *ambient, adv*—the temperature and humidity of the surrounding environment where sample preparation is conducted.

3.1.2 *conditioning period, n*—minimum time required for test sample(s) and contents to reach the appropriate temperature.

3.1.3 *environmental conditioning chamber(s), n*—compartment, cabinet, or enclosed room that has the ability to achieve low temperatures and maintain those temperatures (or below) during the conditioning period. Examples are *chest*, *upright freezer*, or *walk-in freezer*.

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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: phmsa.dot.gov/hazmat).

[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, Quebec H4Z 1M1 Canada (website: http://www.iata.org).

[6] Available from the International Civil Aviation Organization, (ICAO), 999 University St., Montreal, 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).

3.1.4 *mapping, v*—collecting temperature data at multiple interior or exterior locations of a package or inside the chamber to determine the temperature variability range.

3.1.4.1 *Discussion—Units*—All temperature readings are in degrees Celsius.

3.1.5 *specific gravity, n*—ratio of the testing substance density to a standard substance (i.e., water) density at a specific temperature and pressure.

3.1.5.1 *Discussion*—For solids and liquids, the standard substance is normally water at 4.0°C with a 1.00 kg/L density.

3.1.6 *thermocouple, n*—device for measuring temperature. It consists of two dissimilar metals, joined together at one end. When the junction of the two metals is heated or cooled a voltage is produced that can be correlated back to the temperature. The thermocouple alloys are commonly available as wire.

3.1.7 *water/antifreeze solution, n*—liquid solution with a 0.95 minimum specific gravity at –18°C and does not freeze above –24°C.

3.2 *Applicable Packaging Definitions Related to Dangerous Goods Regulations:*

3.2.1 *combination package, n*—combination of packagings for transport purposes consisting of one or more inner packagings secured in a non-bulk outer packaging. It does not include a composite packaging.

3.2.2 *composite packaging, n*—packaging consisting of an outer packaging and an inner receptacle so constructed that the inner receptacle and the outer packaging form an integral packaging. Once assembled, it remains thereafter an integrated single unit and it is filled, stored, transported, and emptied as such.

3.2.3 *package, n*—the completed product; the packaging plus its contents prepared for transport.

3.2.4 *packaging(s), n*—the receptacle(s) (without contents) and any other components or materials necessary for the receptacle(s) to perform their containment function.

3.2.5 *receptacle, n*—containment vessel for receiving and holding substances or articles, including any means of closing.

3.2.6 *single packaging, n*—non-bulk packaging other than combination packaging.

3.2.7 *shipper, n*—the company or person providing the packaging and instructions for the substances or articles being transported from one location to another.

NOTE 1—Additional packaging terms and definitions are located in 49 CFR Section 171.8 and the UN Orange Book, Section 1.2.1.

## 4. Significance and Use

4.1 The purpose of this guide is to provide direction for uniform conditioning methodology when conducting special preparations of plastic packagings as prescribed for conducting United Nations (UN) drop test. This guide provides a uniform approach for conditioning of plastic packaging intended for liquid hazardous materials (dangerous goods).

4.2 The hazardous materials (dangerous goods) regulations certification process requires that plastic packagings undergo special preparations before performing the UN drop test. The regulations do not include uniform procedures for conducting special preparations. Non-uniform procedures allow for differences in methods between test facilities which may result in different test results.

4.3 The UN Orange Book and 49 CFR 178.603(c) state that drop testing conditioning is required for all plastic drums, plastic jerricans, plastic boxes (other than expanded polystyrene boxes), composite packagings (plastic material), and combination packagings with plastic inner packagings (other than plastic bags intended to contain solids or articles). It further states that drop testing shall be conducted when the temperature of the test sample (packagings and contents) has been reduced to –18°C or lower. Test liquids shall be kept in the liquid state, if necessary, by the addition of antifreeze. Water/antifreeze solutions with a minimum 0.95 specific gravity for testing at –18°C or lower are considered acceptable test liquids.

4.4 A 24-hour conditioning period *may not* be sufficient time for the packaging and contents to reach the required temperature.

4.5 This guide provides additional information not in the regulations that will facilitate consistent test sample conditioning among test facilities. The information and guidance provided here are intended to meet or exceed the minimum requirements of the regulations.

4.6 For more information on the UN certification tests, refer to Guide D4919.

## 5. Equipment

5.1 *Recommended Test Equipment:*

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

5.1.2 *Environmental Conditioning Chamber.*

5.1.3 *Calibrated Thermocouple or Thermometer,* to accurately measure the test containers and contents.

5.1.4 *Calibrated Temperature Recorder/Data Logger.*

NOTE 2—All equipment used in this guide should be calibrated as per manufacturer's recommendations with a National Institute for Standards and Technology (NIST) traceable reference standard.

## 6. Sample Size

6.1 Reference 49 CFR §178.603 and §178.810 for the number of samples required for the drop test. (Different packaging design types require a different number of samples.)

## 7. Test Samples (Specimens)

7.1 *Selection*—Randomly selected appropriate test specimens.

7.2 *Preparation*—Ensure all specimens have been properly prepared for transport per the manufacturer's closure and assembly instructions. Place the prepared specimens into the conditioning chamber. The packaging should be conditioned in its normal shipping orientation and fully assembled. Separately conditioning packaging components and then assembling the package before performing the drop test is not recommended.

7.3 *Environmental Conditioning Chamber Settings*—Interlaboratory experience has shown that lower chamber temperature settings may be necessary to achieve a –18°C specimen temperature. The lower setting can allow for chamber temperature fluctuations from defrost cycles, location within the chamber, airflow, and so forth.

NOTE 3—A –18°C or lower temperature is required for plastic packaging conditioning before a drop test. To achieve the required –18°C specimen temperature the recommended temperature setting for the conditioning chamber is –22°C to –24°C.

## 8. Temperature Monitoring

8.1 *Conditioning Chamber*—A chart recorder or data-logging system should be in place to verify the chamber temperature operates at the appropriate set point throughout the conditioning period. Test facilities should consider temperature mapping of environmental chambers to confirm an even and consistent air temperature is achieved throughout conditioning process.

8.2 *Test Samples (Specimens)*—Ensure that the instrumentation and temperature-monitoring system used for the measurements are appropriate for the application. The temperature of the contents should be monitored during conditioning or checked prior to or immediately after conducting the first drop test to ensure the conditioning requirements have be met. The following procedures should be considered to confirm proper conditioning:

8.2.1 Prepare an additional sample with a thermocouple or some other temperature-monitoring device located inside the packaging during conditioning.

8.2.2 Prepare an additional sample (not intended to be used as a drop test sample) and measure the product temperature before performing the drop test with a thermometer, thermocouple, or other temperature-measuring device.

8.2.3 Prepare and condition the appropriate number of test samples and check the temperature of the test contents immediately after the first drop test.

## 9. Conditioning Period

9.1 *Factors to Consider in Determining the Minimum Conditioning Period:*

9.1.1 The filling substance temperature before starting conditioning. If the filling material starts at ambient temperature it may require a minimum of 72 h to achieve the required test temperature.

9.1.2 The packaging volume/size. The larger the packaging, the more time it may require to achieve the required test temperature.

9.1.3 The conditioning chamber size and air flow.

9.1.4 The insulation properties of the outer packaging and inner packaging components may add time to the test sample conditioning. Example: A plastic container placed inside an insulated shell (expanded polystyrene [EPS] or other foam) may take longer to reach the required temperature.

9.1.5 The amount of cushioning, dunnage, or absorbent material being used.

9.1.6 The number of test samples being conditioned at one time in the chamber and other items in the conditioning chamber may affect conditioning.

9.2 The conditioning period duration will vary based on the factors listed in 9.1 and possibly other factors. All samples are considered to be conditioned when the temperature of the packaging and its contents has been reduced to –18°C or lower before conducting the drop test.

9.2.1 As a general guideline, the test sample conditioning time should be at least 72 h when the filling solution starts at ambient temperature; this is recommended by Practice D4332.

9.2.2 If the filling solution has been preconditioned at –18°C or lower, the sample-conditioning time may be less than 72 h.

9.2.3 It is suggested that the conditioning period not be less than 24 h regardless of the temperature monitoring data results of the filling solution. A minimum of 24 h is recommended to establish a minimum time between labs for packaging components to reach the conditioning requirements.

9.2.4 Regardless of the conditioning time used, you must comply with the regulatory temperature requirement and confirm the packaging and the contents have been properly conditioned.

9.3 *Test Solutions:*

9.3.1 The following typical antifreeze test solutions are recommended:

9.3.1.1 Propylene glycol/water mixture.

9.3.1.2 Methanol/water mixture.

9.3.1.3 Ethylene glycol/water mixture.

NOTE 4—Salt water solutions are not recommended for use.

## 10. Report

10.1 The test report should minimally include the following:

10.1.1 Test date, report identification, and person responsible for conducting the test.

10.1.2 Equipment used to measure and monitor temperature.

10.1.3 Location and method used to measure the temperature (photographs are appropriate).

10.1.4 Time for all solutions and packaging components to reach proper temperature.

10.1.5 Applicable observations during the test.

## 11. Keywords

11.1 conditioning; conditions; dangerous goods package testing; plastic packaging; preparation; temperature; UN drop testing