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Standard Specification for Molded Polyethylene Open-Head-Pails for Industrial Shipping of Nonhazardous Goods[1]

This standard is issued under the fixed designation D4504; 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 specification covers molded polyethylene, open-head, self-supporting, nonreusable pails intended for the packaging and transportation of nonhazardous goods. Pails are to have volume capacities between 1 and 7 gal (3.8 to 26.5 L).

1.2 Pails intended to contain hazardous goods (materials) shall be in accordance with and tested to United States Department of Transportation Code of Federal Regulations (CFR) Title 49, Parts (100–199).

1.3 The purpose of this specification is to establish performance requirements and test methods for molded open-head polyethylene pails.

1.4 Additives for the resin used and design of the pails are left to the discretion of the supplier, within the allowable limits of regulatory and performance requirements.

1.5 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.

1.6 The following safety hazards caveat pertains to the test method portions, Section 10, of this specification:*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]

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D996 Terminology of Packaging and Distribution Environments

D999 Test Methods for Vibration Testing of Shipping Containers

D1972 Practice for Generic Marking of Plastic Products

D1975 Test Method for Environmental Stress Crack Resistance of Plastic Injection Molded Open Head Pails

D4577 Test Method for Compression Resistance of a Container Under Constant Load

D5276 Test Method for Drop Test of Loaded Containers by Free Fall

E4 Practices for Force Verification of Testing Machines

2.2 *Other Documents:*

National Motor Freight Classification (NMFC) [3]

Uniform Freight Classification (UFC) [4]

Code of Federal Regulations Title 49 Parts 100–199 (CFR 49) [5]

3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification, see Terminology D996.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *open-head pail*—a pail with a full-diameter unrestricted opening at the top, and designed to be carried by hand. The pail body is usually of a tapered design to provide for nesting of pails during transportation and storage, prior to filling of contents. After filling of contents, the pail lid is applied to the pail body, providing a sealed container for storage and shipment of the contents. The pail lid may also have openings or fitments to allow for dispensing of contents without removing the lid. These openings are sealed with closures.

3.2.1.1 *Discussion*—The definition for open-head pail for hazardous materials differs (see Section 49 CFR Parts 100 to 199).

[1] This specification 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.

[3] Available from National Motor Freight Traffic Association, Inc. (NMFTA), 1001 N. Fairfax St., Suite 600, Alexandria, VA 22314, http://www.nmfta.org.

[4] Available from National Railroad Freight Committee, Suite 1120, 222 South Riverside Plaza, Chicago, IL 60606.

[5] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, http://www.access.gpo.gov.

4. Classification

4.1 Products to be packaged in open-head pails may be liquid (Note 1), solid, paste, granular, or powder form.

NOTE 1—For the purpose of establishing test requirements, a liquid is here defined as having a viscosity of less than 5.0 Pa.S at a temperature of 73.4± 3.6°F (23 ± 2°C), using the method described in Test Method D445.

4.2 Molded polyethylene open-head pails are classified as follows:

4.2.1 Pails for liquids.

4.2.2 Pails for nonliquids.

5. Ordering Information

5.1 A summary of ordering requirements, detailed in other sections of this specification include the following:

5.1.1 Materials of construction (see Section 6).

5.1.2 Ultraviolet protection (see 6.2).

5.1.3 Other materials not specifically covered in this specification (see 6.3 and 6.4).

5.1.4 Pail capacity (see 7.2).

5.1.5 Closure requirements, including tamper evident feature (see 7.3).

5.1.6 Provisions for handling.

5.1.7 Compatibility testing (see 7.8 and 7.9).

5.1.8 Inspection (see Section 11).

5.1.9 Marking (see Section 13).

5.1.10 Intended contents.

5.1.11 Whether pressure testing is required.

6. Materials

6.1 Materials for the construction of the pail shall be compatible with the intended contents. Effects of impact, vibration, temperature, warehouse stacking, and ultraviolet exposure should be considered.

6.2 If ultraviolet protection is required, it shall be provided by the addition of carbon black or other suitable pigments with ultraviolet stabilizers and inhibitors. These additives should be compatible with the contents and should retain their effectiveness during the life of the pail.

6.3 Materials for purposes other than ultraviolet protection may be added, provided such additives permit the pail to meet the requirements of this specification.

6.4 Used materials, except regrind from the same concurrent production process shall not be acceptable for manufacturing new pails unless otherwise specified.

7. Other Requirements

7.1 The pail shall show good workmanship such as absence of flashing, dents, and scratched surfaces.

7.2 *Capacity*—Pails covered by this specification shall be range in rated (marked) capacity from 1 to 7 gal (3.8 to 26.5 L). Minimum actual liquid capacity shall not be less than rated capacity plus 4 %, and maximum actual capacity shall not be greater than 4 % above rated capacity plus one quart, measured with cover attached and contents and pail at 73.4 ± 5°F (23.8 ± 3°C).

7.3 *Closure*—The closure for the pail (when used) shall be in compliance with carrier regulatory requirements and shall ensure protection of contents from leakage, ease of closure, and removal. Gaskets, when used with the closure, and the closure, shall be compatible with the intended contents.

7.4 *Drop Strength*— The pails shall show no evidence of rupture, cracks, or leakage when tested in accordance with 10.2.1.

7.5 *Stacking Strength*—Two vertically stacked pails shall withstand testing without sidewall buckling sufficient to cause damage and shall have a total top-to-bottom deflection of both pails of not more than 1 in. (25.4 mm), when tested in accordance with 10.2.2. In addition, there shall be no evidence of leakage or sifting of contents from the pail when tested in accordance with 10.2.2.2.

7.6 *Vibration* (*Stack*)—The pails shall show no evidence of rupture, cracks, or leakage when tested in accordance with 10.2.3.

7.7 *Repetitive Shock Test (Optional)*—The pails shall show no evidence of rupture, cracks, or leakage when tested in accordance with 10.2.4.

7.8 *Compatibility, Permeation*—The pail shall perform satisfactorily when tested in accordance with 10.2.5.

7.9 *Resistance to Environmental Stress Cracking*—The pail shall perform satisfactorily when tested in accordance with 10.2.5.3.

7.10 *Special Requirements*—Pail requirements, additional to those in 7.2 through 7.9, if needed by a purchaser, must be specified in the procurement document and as agreed between purchaser and supplier.

8. Sampling

8.1 *Lotting*—A lot shall consist of all pails of one size and design, produced from the same materials and under essentially the same manufacturing conditions and offered for delivery at one time.

8.2 *Sampling Pails*— Select sample pails for test at random from a continuous production lot. As a minimum, the number of pails required is 17 as outlined for design qualification tests (see Section 10 and Supplementary Requirements).

9. Specimen Preparation

9.1 Prepare pail specimens in accordance with NMFC, item 258 and UFC Rule 40, where applicable, and as agreed between the pail purchaser and supplier.

10. Methods of Testing Pails for Design Qualification

10.1 *General*—The test procedures described in this section are to be used to determine physical performance capability of a specific design and thereby, to qualify such a design under the performance requirements of this specification. Additional sampling and testing of these pails, as may be agreed upon between purchaser and supplier, is not precluded by this section. Test methods to determine compatibility of the contents (lading) with the pail will depend on the specific contents

to be contained. If the available technical information and prior use experience cannot substantiate an application decision, it shall be the responsibility of the shipper of the filled pail to ensure that the content is compatible with the pail, and that if the content is liquid, that it will not permeate to an extent that a damaging condition could be caused during transportation, storage, and handling.

10.2 *Specific Test Methods for Design Qualification:*

10.2.1 *Drop Strength Test:*

10.2.1.1 Perform drop strength test on pails intended for nonhazardous liquids and nonliquids as follows:

10.2.1.2 Perform drop tests in accordance with Test Method D5276 (without the rupture hazard).

10.2.1.3 *Conditioning Pails*—Fill each of nine pails to no more than the marked gross weight at normal outage with the material to be contained, or a material of similar density and viscosity. Securely close the cover, and stabilize the temperature of the pails and contents at 0°F (−18°C). Then expose them at that temperature for a minimum of 4 h. At the end of the temperature conditioning period, remove the pails and immediately perform the drop test.

10.2.1.4 *Drop Test Procedure (see Test Method D5276)*—Test the pails with a 4 ft. (1.22 m) drop. Use three pails per orientation: (*1*) The pail striking flat on its side, (*2*) On the bottom chime with the center of gravity of the pails directly above the point of impact, and (*3*) The pail striking flat on the bottom. Do not use any one pail for more than one drop. For pails containing liquid, a loss of a few drops through the closure or gasket area at impact is not to be considered failure if 5 min after dropping, the pails are rolled for a distance equal to twice its circumference, and no further leakage occurs. Otherwise, leakage or sifting out of contents constitutes failure.

NOTE 2—Uniform Freight Classification, Rule 40 and National Motor Freight Classification, Item 258 require a 45° angle at impact.

10.2.2 *Stacking Strength*—The stacking test shall conform to Test Method D4577. If a compression testing machine is used, it shall be capable of applying a constant force to an accuracy of ±1 % when determined in accordance with Practices E4.

10.2.2.1 *Conditioning Pails for Stacking Strength Test*—Fill two sample pails with intended contents, or a material of similar properties, to nominal capacity and close securely as if for use. Expose the filled pails to a temperature of at least 130°F (54.4°C) for 4 h after its contents have attained a temperature of at least 130°F. Immediately proceed to test for stacking strength.

10.2.2.2 *Stacking Strength Test Procedure (see Test Method D4577)*—Stack the one pail on top of the other on a flat horizontal surface in an ambient temperature environment of 73.4 ± 3.6°F (23 ± 2°C). Apply a top-load mass of 600 lb (272 kg) evenly to the top rim of the top pail and leave in place for a minimum of 48 h. Observe for collapse, leakage of contents, and overall stack deflection of both pails at the conclusion of the test period of 48 h. Remove the top pail, then after waiting for a minimum of 5 min, turn the bottom pail on its side, roll it a distance equivalent to twice its circumference and observe for leakage or sifting of contents. Any leakage or sifting of contents constitutes failure.

NOTE 3—The forces for stacking test are a minimum based upon requirements of NMFC, Item 258 and UFC Rule 40. Consideration should be given to using a stacking force based upon actual shipping experience.

NOTE 4—**Caution:** The potential exists for catastrophic failure causing an instability of the applied top load. Precautionary steps should be taken (that is, through restraining the top load) to reduce the chance of injury to the operator or damage to surrounding equipment.

10.2.3 *Vibration Test (Vertical Column Stack Resonance Test)*—Test three vertically stacked pails by vibrating as follows.

10.2.3.1 Perform vibration test on pails for nonhazardous liquids and nonliquids in accordance with the vibration test requirements of NMFC, Item 258, and UFC, Rule 40, using the procedures of Methods D999, Method C, but restricting the resonant frequency dwell to a vertical linear motion for a period of 1 h.

10.2.3.2 *Results*—Remove each pail from the table at once after vibrating, and turn it on its side. Then roll it a distance equal to twice its circumference. Observe for leakage or sifting of contents. Failure of any pail or leakage shall be cause for rejection of the lot (see Section 12).

10.2.4 *Repetitive Shock Test (Optional):*

10.2.4.1 The repetitive shock test shall conform to Methods D999 (Method A1).

10.2.4.2 *Condition Pails*— Fill each of three pails to no more than the marked gross weight at normal outage with the material to be contained, or a material of similar density and viscosity. Securely close the cover and condition to 73.4 ± 3.6°F (23 ± 2°C).

10.2.4.3 Perform the repetitive shock test on three pails, oriented in their normal shipping position, in accordance with Methods D999, Method A1, for a period of 1 h. Remove the pails from the table at once after vibrating. Then turn the pails on their sides and rotate them a distance equal to twice its circumference. Observe for leaking or sifting of contents. Any leakage or sifting of contents constitutes failure.

10.2.5 *Compatibility, Permeation, and Environmental Stress Crack Resistance*—For each application involving contents that are not proven in a particular pail by a period of successful use, conduct tests with the pail and its contents prior to the first shipment of that pail with these contents to ensure that they are compatible, that there is no environmental stress cracking, and that there is no permeation of the contents to an extent that pail failure product damage or any hazardous conditions could be caused during transportation, storage, and handling. Any additional test procedures and acceptance criteria shall be as agreed between the pail supplier and purchaser.

10.2.5.1 *Compatibility*— Determine the compatibility between pail and contents by observing for color or consistency, change of pail or contents, and any corrosion, cracking, softening, hardening or blistering of pail components. The observation of any of the above defects constitutes a failure.

10.2.5.2 *Permeability*— Determine the permeability of contents through the pail by observing for any wetness, tackiness, distortion of container, or detection of odor of contents on the exterior of the pail. The observation or detection of any of the above defects constitutes a failure.

10.2.5.3 *Environmental Stress Crack Resistance*—Test pails for resistance to environmental stress cracking in accordance with Test Method D1975, Method A.

11. Inspection

11.1 Inspection of the pails shall be as agreed upon between purchaser and supplier in the purchase contract.

12. Retest and Rejection

12.1 In the event that a container fails to meet a specific requirement of Section 7, when tested in accordance with Section 10, three different containers shall be tested in an identical manner without failure. Additional failures among these three containers will indicate that the lot be rejected and that corrective action be taken by the molder. Following such corrective action, the entire series of requirements in Section 7 of the new lot must be met by complete testing in accordance with Section 10 to permit acceptance. Simply repeating the earlier test in which failure occurred will not be acceptable.

13. Product Marking

13.1 Each container must be legibly and permanently embossed in characters at least ¼ in. (6.35 mm) in height. Markings must show the following information:

13.1.1 Manufacturer's name or registered trademark.

13.1.2 Container nominal capacity with units (gallons or litres, or both).

13.1.3 Minimum wall thickness with units (inches or millimetres).

13.1.4 Month and year of manufacture (date clock or other legible method). No minimum letter height requirement.

13.1.5 NRC to indicate nonreusable container.

13.1.6 The appropriate generic symbol for plastics marking in accordance with Practice D1972.

13.2 Plastic covers shall be legibly and permanently embossed with manufacturer's name or registered trademark.

14. Keywords

14.1 column stack vibration; compatibility; drop test; hazardous; open-head pails; permeability; polyethylene; repetitive shock; stacking strength test; stress crack resistance; vibration test