NOT MEASUREMENT SENSITIVE

MIL-STD-3010C
01 August 2013
SUPERSEDING
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31 March 2008

DEPARTMENT OF DEFENSE

TEST METHOD STANDARD

TEST PROCEDURES FOR PACKAGING MATERIALS AND CONTAINERS

AMSC N/A

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FOREWORD

1. This standard is approved for use by all Departments and Agencies of the Department of Defense (DoD).

2. This standard was developed to document uniform test methods for the evaluation of materials and containers used in military packaging applications. Reference to the test methods included herein ensures standardization of testing procedures and also eliminates unnecessary repetition of detailed test instructions within each individual packaging specification or standard.

3. The test methods included herein were previously documented in FED-STD-101. FED-STD-101A contained 250 test methods. This number was reduced to 172 in FED-STD-101B, then to 31 in FED-STD-101C, by deleting test methods no longer deemed relevant or as a result of supersession by industry standards. The remaining 31 standard test methods were then reviewed to verify need and extent of usage. That review indicated that only 15 unique test method standards are required to support the testing of packaging materials used in military packaging applications. For MIL-STD-3010 revision C, it was determined that 12 standard test methods are required to support the testing of containers. These 12 test methods have been incorporated to this Military Standard.

4. For additional guidance on the technical contents of this document, contact the Commander, Naval Air Warfare Center Aircraft Division Lakehurst, (Code 6.7.2.4), Bldg. 596-2, Highway 547, Lakehurst, NJ 08733 or emailed to frank.magnifico@navy.mil.

5. Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Air Warfare Center Aircraft Division, Highway 547, (Code 4L8000B120-3), Lakehurst, NJ 08733-5100 or emailed to michael.sikora@navy.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

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1. SCOPE

1.1 Scope. This document provides a centralized listing of detailed and uniform test methods that have been developed to evaluate relevant properties of materials and containers used in military packaging applications.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in section 3, 4, or 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL SPECIFICATION

QQ-S-698	-	Steel, Sheet and Strip, Low Carbon.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-131	-	Barrier Materials, Watervaporproof, Greaseproof, Flexible, Heat-Sealable.
MIL-PRF-81705	-	Barrier Materials, Flexible, Electrostatic Discharge Protective, Heat-Sealable.

DEPARTMENT OF DEFENSE STANDARD

MIL-STD-2073-1	-	Standard Practice for Military Packaging

(Copies of these documents are available online at https://assist.dla.mil/quicksearch/ or https://assist.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM D471	-	Standard Test Method for Rubber Property – Effect of Liquids
ASTM D880	-	Standard Test Method for Impact Testing for Shipping Containers and Systems
ASTM D996	-	Standard Terminology of Packaging and Distribution Environments

(Copies of these documents are available online at www.astm.org or from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein (except for related specification sheets), the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 General. Definitions of terms unique to this standard are listed below. Definitions of other terms commonly used in the packaging community may be found in ASTM D996.

3.1.1 Blocking. Cohesion or adhesion between contiguous layers of similar or dissimilar materials in roll or sheet form which interferes with the satisfactory and efficient use of the material.

3.1.2 Curl. Tendency of an unrestrained flat strip of material to roll-up on itself.

3.1.3 Large containers. A large container may be a box, case, crate, or other container constructed of wood, metal, or other material, or any combination of these materials. A container is considered large if it meets any of the following criteria:

a. Gross weight over 150 pounds.
b. Length of any edge over 60 inches.
c. Gross weight under 150 pounds and the container is equipped with skids.

3.1.4 Leak. Any opening in a container, contrary to design intent, that either allows the contents to escape or permits substances to enter.

3.1.5 Octave. A change in frequency by a factor of either 2 or 0.5.

3.1.6 Stain. Color changes formed only on a surface without any evidence of rust, pitting, etching, or deterioration of the surface.

3.1.7 Top dunnage. Piece(s) of relatively stiff material (usually wood) laid across the top of a container under test to evenly distribute the weight of the superimposed load.

3.2 Water Vapor Transmission Rate (WVTR). The mass of water vapor transmitted through a given area of test material in a given time when the test material is maintained at a constant temperature, and when one surface is exposed to very low relative humidity and the other surface to a high relative humidity.

4. GENERAL REQUIREMENTS

4.1 Test method format. The standard format used to describe packaging material test methods herein is as follows:

a. Scope
b. Definitions (When required)
c. Apparatus
d. Test specimens
e. Test procedure
f. Notes

4.2 Test documentation format. Documentation shall contain, as a minimum, the following information:

a. A statement that the test was conducted in compliance with the procedure(s) detailed herein, or a description of any deviations from same.
b. Identification of each specimen/material tested.
c. Results of the test.
d. An indication of compliance or non-compliance with specification requirements.

4.3 Test methods. Each standard test method is described in detail in section 5. The test method numbers have been retained from their originally assigned designations.

4.4 Test conditions.

4.4.1 Materials testing. Unless otherwise specified, all material testing shall be conducted at 73 ±3.5 °F (23 ±2 °C) and 50 ±5 percent relative humidity after conditioning the test specimens for at least 24 hours at those conditions.

4.4.2 Container testing. Unless otherwise specified, all container testing shall be at ambient temperature of 70 ±20 °F (21 ±11 °C).

4.5 Test report. Test reports shall be in accordance with the test plan.

4.6 Container inspection. Each specimen shall be opened after each test series and the contents/container shall be inspected for evidence of inadequacies or damage and observations recorded.

5. DETAILED REQUIREMENTS

5.1 Dimensional properties test methods.

5.1.1 Test Method 1003 – Thickness.

5.1.1.1 Scope. This test procedure details a method for determining the thickness of flexible packaging materials. Method A is intended for use as rapid thickness test. Method B shall be used in laboratory thickness measurements.

5.1.1.2 Apparatus.

5.1.1.2.1 Method A. A handheld digital caliper reading in thousandths of an inch and calibrated accurate to within 0.001 inch.

5.1.1.2.2 Method B. A dial micrometer reading in thousandths of an inch and calibrated to be accurate within 0.5 percent or 0.001 inch, whichever is greater. The micrometer shall be securely mounted on a rigid test stand so that it measures the travel of a movable platen from a fixed base plate. The face of the movable platen shall be not less than 0.03 in^2, shall be not greater than 0.15 in^2, and shall travel perpendicular to the base plate. Contact pressure shall be not less than 1.5 lb/in^2 and shall be not greater than 2 lb/in^2.

5.1.1.3 Test specimens. Five specimens, each measuring 2 by 2 inches, shall be selected at random from representative locations of the material being evaluated.

5.1.1.4 Test procedures.

5.1.1.4.1 Method A. The digital caliper shall be zeroed by closing it manually and activating the zeroing mechanism. To make a measurement, the digital caliper shall be closed manually on a sample so that the sample is between all mating faces of the caliper. Within 5 seconds the caliper shall be read to the nearest 0.001 inch.

5.1.1.4.2 Method B. The dial of the micrometer shall be zeroed with the movable platen flush against the base plate at the contact pressure specified in 5.1.1.2.2. The test specimen shall be placed on the base plate so as to be centered beneath the movable platen. The movable platen shall then be lowered onto the specimen so as not to impact load the surface. Within 5 seconds, the micrometer shall be read to the nearest 0.001 inch.

NOTE

When 0.0001 inch accuracy is required, the thickness of 10 stacked specimens shall be determined and divided by 10.

5.2 Strength and elastic properties test methods.

5.2.1 Test Method 2015 – Curl.

5.2.1.1 Scope. This test procedure details a method to determine the curling tendencies of barrier materials when exposed to room temperature (see 4.4.1).

5.2.1.2 Test specimens. Specimens shall be selected at random to adequately represent any variation of the material being evaluated. Each specimen shall measure 12 ±1/16 inches by 36 ±1/16 inches. Six specimens shall be tested, three taken from each principal direction of the material.

5.2.1.3 Test procedure. The specimens shall be placed on a horizontal surface with the heat-sealable (or inside) surface face up. After 30 minutes, the apparent horizontal length shall be measured to the nearest 1/16 inch to determine the curling tendencies of the material. If any curling is observed in the opposing direction, specimens shall also be turned upside down for an additional 30 minutes and the apparent horizontal length measured. Percent curl shall be calculated as follows:

$$\text{Curl}\,(\%) = \frac{(36 - \text{Curled length}) \times 100}{36}$$

If the specimen curls back on itself so that contact is made, this shall be noted.

5.2.2 Test Method 2017 – Flexing Procedure for Barrier Materials.

5.2.2.1 Scope. This test procedure details standard methods for repeatedly flexing barrier materials to simulate their use and handling.

5.2.2.2 Apparatus.

5.2.2.2.1 A Gelbo Flex-Tester or equivalent, as approved by the qualifying activity, shall be used to provide a standard flexing motion to materials being tested. The testing apparatus shall consist essentially of a 3½-inch diameter stationary head and a 3½-inch diameter movable head spaced at a distance of 7 inches from face-to-face at the starting position of the flexing stroke. The specimen supporting shoulders on each head are ½ inch wide. The motion of the movable head is controlled by a grooved shaft to which it is attached. For the full stroke operation the groove is so designed as to give a twisting motion of 440 degrees in the first 3½ inches of the stroke of the movable head followed by a straight horizontal motion of 2½ inches. The motions of the movable head are uniform except for that portion where the rotary motion is changing to straight translational motion. The motion of the machine is reciprocal, a full cycle consisting of the forward and return strokes. For an alternate short stroke operation, the movable head travels only 3¼ inches in each direction in such a manner that a twisting motion of only 400 degrees is imparted to the material. The flexing speed for all materials shall be 40 cycles per minute.

5.2.2.2.2 A heat sealer equipped with controls for temperature, dwell time, and pressure.

5.2.2.3 Test specimens. Four 8- by 12-inch specimens shall be cut from the barrier material, two in each principal direction. Four additional 9- by 13-inch specimens shall be cut out, two in each principal direction, and shall be aged by exposing the specimens in an atmosphere of 80 to 85 percent relative humidity at 160 ±2 °F for 72 consecutive hours. At the completion of the aging exposure, the test specimens shall be returned to test room temperature (see 4.4.1) for 4 hours and then trimmed to produce 4 aged specimens each 8 by 12 inches. Each test specimen, unaged and aged, shall be prepared for flexing by applying a ½-inch heat seal (or joining by another means) to the two shorter edges of the sheet, thus producing an approximate 3 ½-inch diameter cylinder or sleeve 8 inches long.

5.2.2.4 Test procedure. The flexing procedure shall be performed in a test room maintained at 73 ±3.5 °F and 50 ±5 percent relative humidity. The sleeve, in cylindrical form, shall be positioned and clamped on the circular heads of the flexing apparatus. The drive shaft of the Gelbo Flex-Tester shall be at dead center; i.e., perfectly horizontal, before flexing is initiated. Each sample shall be flexed for 20 cycles using the full stroke or short stroke as specified in the specification referencing this procedure. If not specified, the full stroke shall be used. The water vapor transmission rate after flexing shall then be determined by forming the specimen into a pouch and testing according to Method 3030 (see 5.3.6) of this standard.

5.2.3 Test Method 2024 – Heat-sealed Seam Strength.

5.2.3.1 Scope. This test procedure details a method to assess the adequacy of heat seals made on sheet materials (5.2.3.3) and those made in the fabrication of bags or pouches (see 5.2.3.4).

5.2.3.2 Apparatus.

5.2.3.2.1 Appropriate heat-sealing equipment with accurate controls of temperature, pressure, dwell time, or other sealing criteria required to fuse heat seals of reproducible quality.

5.2.3.2.2 One-inch-wide clamps from which test weights can be suspended. The test weights shall be as shown in the table (see 5.2.3.5).

5.2.3.2.3 Test frame. A test frame to allow the weighted load to act freely on the test specimen.

5.2.3.3 Sheet materials. Figure 1 shall be used to cut eighteen 6- by 12-inch representative samples of the material being evaluated. Each of the samples shall be designated either Key 1 (as-received), Key 2 (heat sealed and then aged), or Key 3 (aged and then heat sealed).

5.2.3.3.1 Test specimen preparation and conditioning.

5.2.3.3.1.1 As-received (Key 1). Each of the 6 samples shall be folded in half with the crease perpendicular to the long axis and the 6-inch ends heat sealed together. The fold shall then be cut off. Then three adjacent 1-inch-wide specimens shall be cut from the center of the sample and perpendicular to the heat seal. One of the specimens from each sample shall be tested at room temperature (see 4.4.1) (Test A), one from each sample at 100 °F (Test B), and the remaining one from each sample at 160 °F (Test C).

5.2.3.3.1.1.1 In the securing of the three 1-inch seam strength specimens from their respective samples, specimens shall not be removed:

(1) From points in the sealed sample where seal overlapping has occurred.

(2) From points in the sealed sample that were within 1-inch of either end of the sealer jaw during the sealing operation.

5.2.3.3.1.2 Sealed and then aged (Key 2). Each of the 6 samples shall be folded in half with the crease perpendicular to the long axis and the 6-inch ends heat sealed together. These sealed samples shall then be aged at 160 °F for 12 days. Specimens shall then be cut and designated for test as in 5.2.3.3.1.1.

5.2.3.3.1.3 Aged and then sealed (Key 3). Each of the 6 samples shall be aged at 160 °F for 12 days. After cooling to room temperature, each of the 6 samples shall be folded in half with the crease perpendicular to the long axis and the 6-inch ends heat sealed together. Specimens shall be then be cut and designated for test as in 5.2.3.3.1.1.

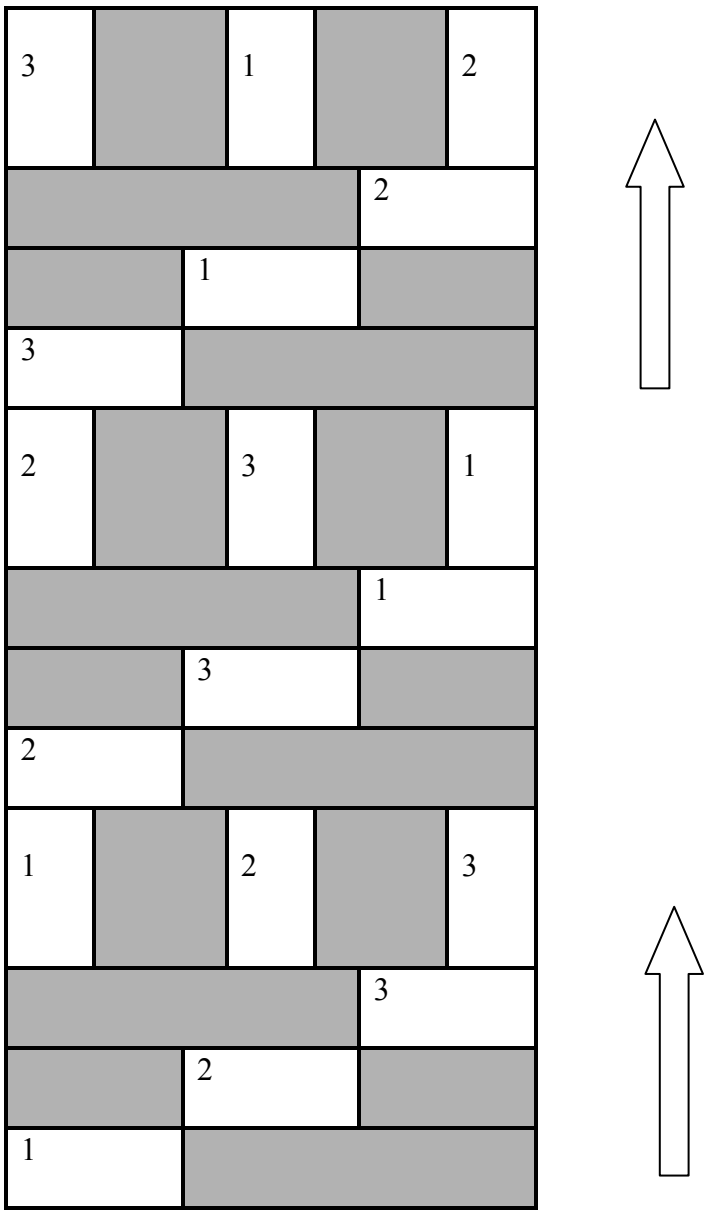
5.2.3.4 Fabricated bags and pouches. Three 1-inch-wide heat-seal specimens shall be cut from representative locations of the bag or pouch. Areas within 1 inch of the bag or pouch opening or corner shall be avoided when obtaining test specimens. Specimens shall be tested in an as-received condition at room temperature (see 4.4.1) (Test A).

5.2.3.5 Test procedure. Prior to testing, conditioned specimens shall have been exposed for a minimum of 1 hour as specified in 4.4. Each sealed specimen shall then be laid on a horizontal surface. A beveled (45 ± 5 degrees) plastic straight edge shall be slid between the unsealed ends of the specimen and held against the seal. On the outside of the specimen, the position of the straight edge against the seal shall be marked using a fine ball point pen. Specimens shall be tested using the temperature, weight, and time shown below.

TABLE I. Temperature, weight and time for specimen testing.

Test	Temperature (°F)	Weight (ounces)	Time (minutes)
A	73 ±3.5	56 ±0.5	5
B	100 ±2	32 ±0.5	60
C	160 ±2	10 ±0.5	60

One end of each specimen shall be clamped so that the other end of the specimen hangs freely, at the test temperature. The test weight shall then be carefully attached to the free end of the specimen so as not to impact load the seal. The weight shall be allowed to act for the indicated time at the indicated temperature, whereupon the weight shall be removed and the specimen examined for separation of the heat-sealed faces. The beveled plastic straight edge shall be slid to the seal as before and the position of the straight edge marked. The distance between the two pen lines shall be measured to the nearest $\frac{1}{32}$ of an inch and shall indicate any seam separation.



KEY

1 - 6- by 12-inch sample for " As Received" testing
2 - 6- by 12-inch sample for " Sealed before Aging" testing
3 - 6- by 12-inch sample for " Sealed after Aging" testing

FIGURE 1. Sampling method for seam strength test.

5.2.4 Test Method 2065 – Puncture Resistance.

5.2.4.1 Scope. This procedure details a test method for determining the puncture resistance of flexible barrier materials used in military packaging.

5.2.4.2 Apparatus.

5.2.4.2.1 A test specimen holding fixture as shown on figure 2.

5.2.4.2.2 Compression test equipment for measuring the load required to puncture a specimen held by the above fixture.

5.2.4.3 Test specimens. Ten specimens, each measuring 2 by 2 inches, shall be selected at random from a representative area of the material being evaluated that is free of obvious flaws or defects.

5.2.4.4 Test procedure.

5.2.4.4.1 Calibrate the compression test equipment.

5.2.4.4.2 Attach the test specimen holding fixture to the compression test equipment so that the fixture plates are horizontal and the probe is perpendicular to the plates and centered on the specimen hole. The fixture shall be installed as shown on figure 2 or inverted.

5.2.4.4.3 Adjust the initial position of the compression test equipment so that the probe does not interfere with the installation of specimens. Zero the load.

5.2.4.4.4 Set the speed of the probe relative to the specimen holder at 20 inches per minute.

5.2.4.4.5 Install a specimen in the holding fixture by removing the hold-down plate and placing the specimen between either silicon carbide or 240 grit aluminum oxide cloth abrasive. Tighten the hold-down plate so that the specimen edges do not move during the test.

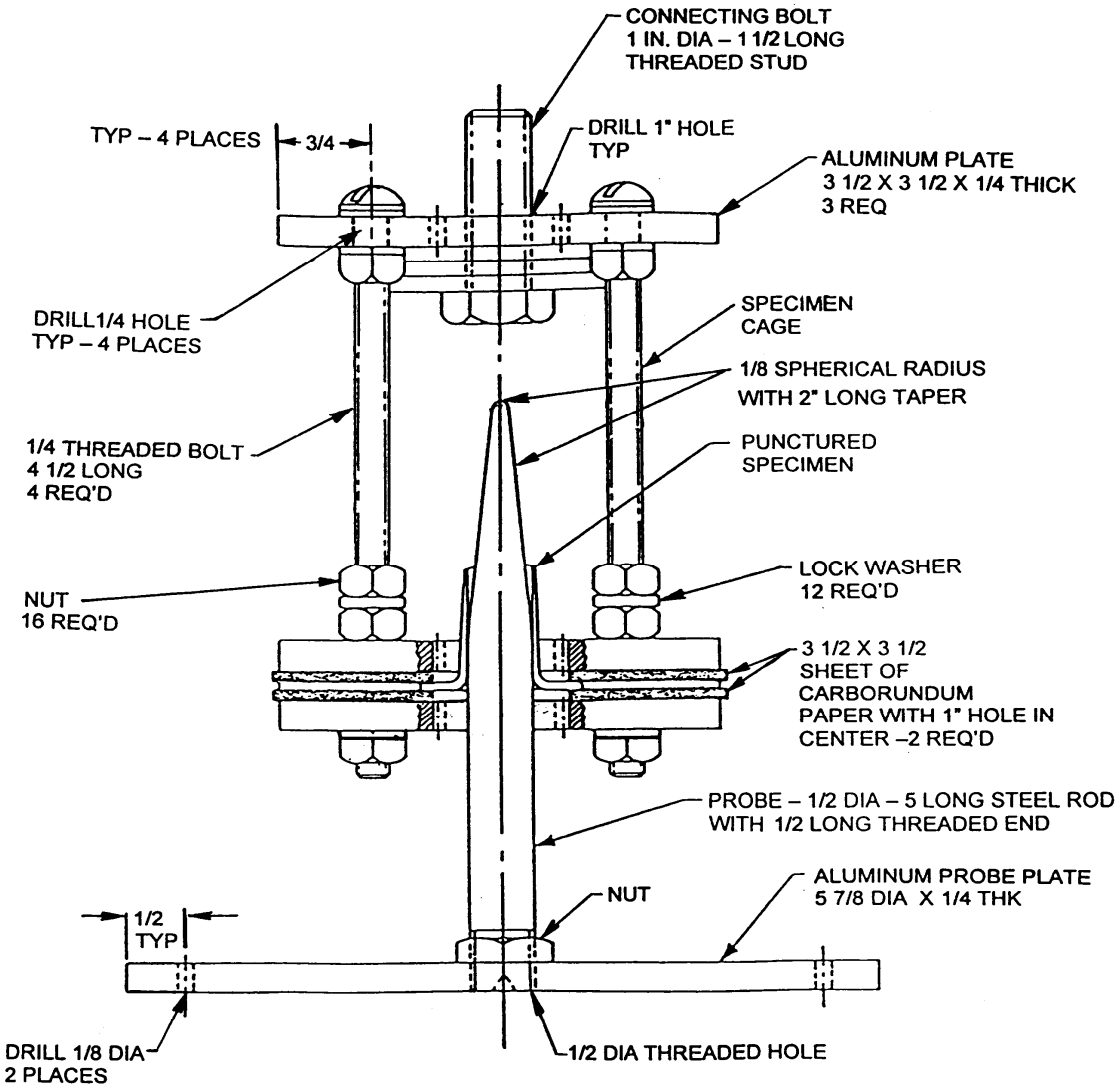
CAUTION

Ensure that the maximum compression load is not exceeded and that the probe does not make direct contact with the specimen holding fixture.

5.2.4.4.6 Start the test and record the maximum load (to the nearest 0.1 pound) measured by the compression tester. Repeat the test until 5 specimens have been tested in the sealable side

up orientation, then average the results. Repeat the test until 5 specimens have been tested in the sealable side down orientation, and again average the results.

5.2.4.4.7 Note the lowest result.



NOTES:
1. ALL DIMENSIONS ARE IN INCHES.
2. ROUGH SURFACES OF CARBORUNDUM PAPER SHALL FACE EACH OTHER.

FIGURE 2. Test specimen holding fixture.

5.3 Resistance properties.

5.3.1 Test Method 3003 – Blocking Resistance.

5.3.1.1 Scope. This test procedure details test methods for determining the resistance of packaging materials adhering to similar or dissimilar packaging materials with which they might come in contact during their storage and service life.

5.3.1.2 Apparatus.

5.3.1.2.1 A circulating air oven that can be maintained at temperatures up to 160 ±2 °F.

5.3.1.2.2 Two resilient pads, each measuring 2 by 2 by $\frac{1}{8}$ inches.

5.3.1.2.3 Two glass or smooth flat plates, each measuring 4 by 4 inches.

5.3.1.3 Test specimens. Eight specimens, each 3 by 3 inches, shall be selected at random from representative locations of the sheet material being tested.

5.3.1.4 Test procedure. The test specimens shall be stacked under room temperature (see 4.4.1) in the following sequence:

Bottom smooth flat plate
Resilient pad
One test specimen, face up
One test specimen, face down
One test specimen, face down
One test specimen, face up
A neutral interleaving material (paper or foil)
One test specimen, face up
One test specimen, face down
One test specimen, face down
One test specimen, face up
Top smooth flat plate

All items shall be centered over the member beneath them. A weight that produces a 3.0 psi load on the specimens shall be placed on the top plate. The entire assembly shall then be placed in a circulating air oven maintained at 160 ±2 °F (71 ±1 °C) for 24 hours. After removal of the stack from the oven, the weight shall be removed and the test stack shall be allowed to cool at test room conditions for 30 minutes. The specimens shall be disassembled and examined in sequence for any adhesion or cohesion between adjacent surfaces. If two surfaces appear to be blocked, the free end of one surface shall be vertically clamped so that the other surface hangs down freely. A 200-gram weight shall then be gently attached to the corresponding free end of

the second surface. If the two surfaces are not completely separated after 2 minutes, the specimens are considered blocked. Delamination or rupture of any test surface during separation is also considered blocking.

5.3.1.5 Notes. Procedure letters previously specified in packaging material specifications referencing this test method shall be disregarded. The method described herein is intended to replace both Procedure A and Procedure D with one standard test to determine resistance to blocking.

5.3.2 Test Method 3005 – Contact Corrosivity.

5.3.2.1 Scope. This test method details a procedure to determine the corrosive tendencies of packaging materials when in intimate contact with a test surface.

5.3.2.2 Apparatus.

5.3.2.2.1 Test apparatus A.

Circulating air oven that can be maintained at 150 ±5 °F.

Chamber that can be maintained at 120 ±2 °F and 65 ±3 percent relative humidity.

5.3.2.2.2 Test apparatus B.

Programmable heat/humidity chamber

5.3.2.2.3 Rectangular steel weights, each measuring 1 by 1 by 3 inches, weighing 0.85 ±0.05 pound.

5.3.2.3 Test specimens. Four specimens representative of the material being tested shall be selected at random. When testing flexible sheet material, each test specimen shall measure 2 by 3 inches. When testing cushioning or blocking materials, each specimen size shall be not less than 1 by 3 inches. When testing granular material, each test specimen shall be approximately 20 grams of material ground to a size that passes a U.S. No. 40 sieve, but is retained by a U.S. No. 80 sieve.

5.3.2.4 Test panel preparation. The test surfaces for this evaluation shall be panels, each measuring 2 by 4 by 1/8 inches. Panel material shall be low carbon steel conforming to QQ-S-698, condition 5 or SAE 1010 steel (cold rolled). Panels shall be ground to remove surface scale, pits, and other irregularities from all surfaces. One of the large flat surfaces of the panel shall then be hand abraded with 240 grit aluminum oxide or silicon carbide abrasive paper. The abraded test panel shall then be wiped with a methanol wet laboratory tissue. Repeat with a new methanol wet laboratory tissue at least 2 times or until the wet tissue is clean after wiping. Panels shall then be allowed to dry in clean air and used immediately.

5.3.2.5 Test procedure.

5.3.2.5.1 Flexible sheet materials. Two of the 2- by 3-inch flexible sheet specimens shall be placed across the central portion of the test panel surface seal side down, as shown on figure 3. The remaining two specimens shall be placed on the test panel, seal side up. A glass slide measuring 1 by 3 by 1/16 inches with a weight superimposed and coinciding shall be centered on

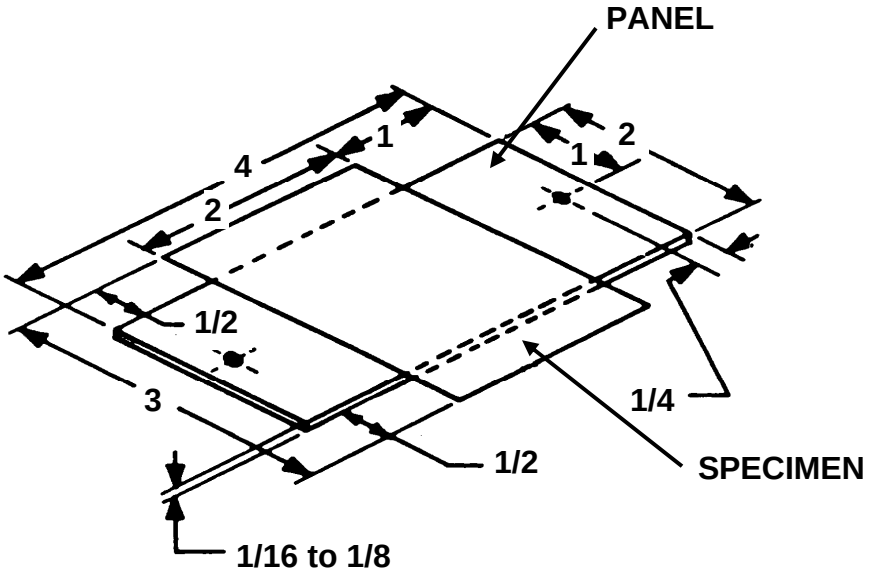
top of the specimen with the longitudinal centerline of the slide and weight coinciding with that of the test specimen as shown on figure 4.

5.3.2.5.2 Cushioning or blocking materials. Cushioning or blocking material specimens shall be placed across the central portion of the test surface so that the specimen extends over the edges of the panel. Large specimens shall be placed off center so an area of the test surface not less than 2 by 2 inches shall remain uncovered.

5.3.2.5.3 Granular materials. If granular specimens are being tested, they shall be placed and leveled between parallel lines 1 inch apart across the central portion of the test surface of a panel. The specimen shall be carefully covered with a glass slide, and the steel weight shall then be placed upon the glass slide.

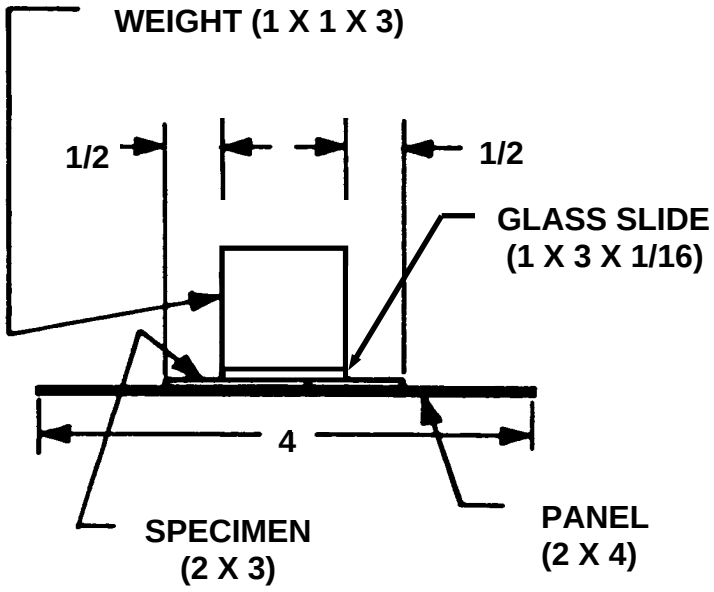
5.3.2.5.4 Exposure. In all cases, the specimen and test surface so arranged shall be exposed for ½ hour in air, maintained at a temperature of 150 ±5 °F, followed immediately by exposure in air at 120 ±2 °F and 65 ±3 percent relative humidity for 20 hours. At the end of the exposure period, the specimens shall be separated from the test surface that shall be immediately examined for evidence of corrosion. Note for each area – the one covered by the specimen, and the other not covered – whether or not corrosion occurred and a description including the severity and distribution of any corrosion.

5.3.2.6 Notes. The given exposure environment and duration are such that corrosion is not visible on unprotected clean steel, but corrosion is visible on the test surface if the material under test has a tendency to induce corrosion. When test surfaces are of other metals, the exposure should be specified. To establish whether or not a specimen induces corrosion of a test surface other than steel, the severity of the test environment and duration of exposure thereto must be sufficient to closely approach incipient corrosive attack of the bare (control) specimen surface. This requires a preliminary test to establish the appropriate duration of exposure. When using aluminum test panels, exposure to the humid environment shall be 72 hours.



DIMENSIONS IN INCHES

FIGURE 3. Flexible sheet material specimen placement.



DIMENSIONS IN INCHES

FIGURE 4. Contact corrosivity test assembly.

5.3.3 Test Method 3015 – Oil Resistance (Delamination).

5.3.3.1 Scope. This test procedure details a method to determine the oil resistance (delamination) of a laminated heat-sealable material.

5.3.3.2 Apparatus.

5.3.3.2.1 An oven capable of maintaining a temperature of 160 ±2 °F.

5.3.3.2.2 A heat-sealer equipped with controls for temperature, dwell time, and pressure.

5.3.3.2.3 Two smooth flat metal plates measuring 3 by 6 by ¼ inches and two 18-pound weights.

5.3.3.2.4 A sufficient quantity of the following test oils to conduct the prescribed tests:

a. IRM 903 as specified in ASTM D471.

b. Di-2-ethylhexyl sebacate synthetic oil.

5.3.3.3 Test specimens. Five specimens, each 3 by 6 inches, shall be taken at random from material being evaluated for each test oil.

5.3.3.4 Test procedure. Each test specimen shall be folded in half, heat-sealable face to heat-sealable face, to produce a 3- by 3-inch specimen. A sharp crease shall be made in the specimen by placing the folded specimen between the two smooth flat metal plates and applying one of the 18-pound weights on top of the fold for 30 seconds. The specimen shall be unfolded and recreased in a similar manner (heat-sealable face to heat-sealable face) at right angles to the first crease by placing the specimen between the two smooth flat plates again and applying both 18-pound weights side by side on top of the fold for 30 seconds. A 3- by 3-inch pouch shall be made by folding the sample in half along the first crease and sealing along the two sides using the manufacturer's recommended sealing conditions. Heat seals shall be ½ inch wide. Approximately 5 ml of oil shall be poured into each pouch, carefully keeping the sealing area free from oil. The open end of the pouch shall then be sealed keeping the enclosed air to a minimum. The pouches shall be promptly exposed in an oven maintained at 160 ±2 °F, for 24 hours by hanging each pouch from the center of its sealed end. Pouches shall be removed from the oven, and after returning to room temperature, examined for any oil leakage. If a pouch shows oil leakage, the test shall be repeated with a fresh pouch and those results noted. The three sealed edges shall be cut off and all remaining oil shall be removed. The remaining sheet shall be pulled taut and examined for evidence of swelling, delamination, embrittlement, or other visible defects. A test for delamination of the face film shall be conducted at mid-length of the test specimen by placing the specimen between the thumbs and forefingers so that the thumbs rest on the heat-sealable face. The thumbs shall then be thrust forward and outward in a finger-snapping motion in such a manner that the heat-sealable face will delaminate if it is loosely bonded.

5.3.4 Test Method 3027 – Water Resistance of Markings.

5.3.4.1 Scope. This test procedure details a method to determine the retention of markings on packaging materials after exposure to water.

5.3.4.2 Apparatus.

5.3.4.2.1 A 3-liter stainless steel beaker.

5.3.4.2.2 A magnetic stirrer and a stirring bar 2 inches long and $^{3}/_{8}$-inch diameter.

5.3.4.3 Test specimens. Two or more specimens selected at random to adequately represent any variation in the material being evaluated shall each contain one complete set of dry markings.

5.3.4.4 Test procedure. Two specimens shall be taped to the inside of the beaker with pressure sensitive tape which remains adherent throughout test so that the markings are uncovered and facing the interior of the beaker. The beaker shall be filled with distilled water to within 2 inches of its top and covering the specimen completely. The stirring bar shall be added to the beaker and spun at 200 ±40 revolutions per minute (rpm) for 2 hours at room temperature. After removal from the vessel, excess water shall be blotted off the test specimens. They shall then be examined for clarity, legibility, and shall not smear when lightly rubbed with one finger. The examination shall be repeated after the specimens have dried out at room temperature.

5.3.5 Test Method 3028 – Water Resistance of Packaging Materials.

5.3.5.1 Scope. This test procedure details a method to determine the resistance of packaging material to delamination (ply separation) as a result of exposure to water.

5.3.5.2 Apparatus.

5.3.5.2.1 A vessel capable of accommodating and securing test specimens in a manner to allow unrestricted circulation of water around the specimens.

5.3.5.2.2 An oven capable of maintaining a temperature of 160 ±2 °F.

5.3.5.3 Test specimens. Four specimens, taken at random such that the specimens represent any variation in the material being evaluated, shall be tested. Specimen size shall be 6 by 8 inches.

5.3.5.4 Test procedure. Test specimens shall be immersed in distilled water maintained between 68 to 86 °F. The specimens shall be supported in a manner allowing unrestricted circulation of water around the test material. The immersion period shall be 24 hours for fiberboard materials and 48 hours for flexible barrier materials. After removal from the water, each specimen shall be examined for evidence of swelling, delamination, embrittlement, or other visible defects. A test for ply separation of the face film shall be conducted at mid-length of the test specimen by placing the specimen between the thumbs and forefingers so that the thumbs rest on the heat-sealable face. The thumbs shall then be thrust forward and outward in a finger-snapping motion in such a manner that the heat-sealable face will delaminate if it is loosely bonded. Flexible barrier materials shall be further exposed in a circulating air oven maintained at 160 ±2 °F for 24 hours. The specimens shall be re-examined for ply separation after being allowed to cool to room temperature.

5.3.6 Test Method 3030 – Water Vapor Transmission Rate of Barrier Materials.

5.3.6.1 Scope. This test procedure details a method to determine the water vapor transmission rate (WVTR) of packaging barrier materials. The test is applicable to material either as received, after flexing, or after accelerated aging.

5.3.6.2 Apparatus.

5.3.6.2.1 A test chamber capable of maintaining a test environment of 100 ±2 °F and 90 ±2 percent relative humidity.

5.3.6.2.2 A heat sealer with controls for temperature, dwell time, and pressure.

5.3.6.2.3 Porous heat-sealable tea bag stock.

5.3.6.2.4 An analytical balance.

5.3.6.3 Test specimens. Four 8- by 12-inch specimens for each test condition shall be selected at random from the sheet material being tested. Two samples shall be taken from each principal direction of the material.

5.3.6.4 Test procedure. The test specimens shall be folded in half (to 6 by 8 inches) and formed into a pouch by making a continuous seal along the 8-inch side (if it has not been sealed already; e.g. for flexing) and another seal along one 6-inch side, using sealing conditions as recommended by the manufacturer for the material. Seal widths shall be approximately ½-inch wide. A bag to hold the desiccant shall be formed by cutting a 3½-inch wide by 10½-inch long piece from the web of tea bag stock, folding in half to 3½ by 5¼ inches, and making a seal not more than ¼-inch wide along the two sides and the folded edge with the heat sealer. The desiccant bag shall be filled with not less than 25 grams of anhydrous calcium chloride (4-20 mesh) then sealed. The desiccant bag shall then be immediately inserted into the test specimen pouch and the pouch sealed. The sealed pouch shall then be exposed in a test chamber maintained at 100 ±2 °F and 90 ±2 percent relative humidity for a stabilization period of 16 hours. After the stabilization period, the pouch shall be removed from the test chamber and a ½-inch wide strip cut from one end. The desiccant bag shall be immediately removed and replaced with a fresh preweighed desiccant bag. The pouch shall then be sealed and exposed in the test chamber for a period of 72 hours. After exposure, the pouch shall be removed and cooled for 5 minutes, then cut to remove the closure seal. The desiccant bag shall be immediately removed and reweighed. The weight gain of the desiccant bag (W) during the exposure shall be used to calculate the WVTR for the material being tested.

NOTE

To avoid the possibility of moisture change during weighings, the desiccant bag shall be transferred to a tared, closed, water vapor-impervious container for every weighing, while minimizing the time it is exposed to the open air.

5.3.6.5 Determine the WVTR as follows:

$$\text{WVTR}\,(\text{grams}/100\,\text{in}^2/24\,\text{hrs}) = \frac{2400\ \text{x}\ \text{W}\,(\text{grams})}{\text{Interior pouch area}\,(\text{in}^2)\ \text{x}\ \text{Exposure time}\,(\text{hrs})}$$

where the interior pouch area is determined by multiplying the seal to seal distances, length times width, to get the area of one side and then multiplying by 2 to get the total interior pouch area.

5.4 General physical properties.

5.4.1 Test Method 4031 – Vapor Inhibiting Ability (VIA) of Volatile Corrosion Inhibitor (VCI) Materials.

5.4.1.1 Scope. This test method details procedures to determine the corrosion inhibiting effectiveness of VCI materials in crystalline or liquid form, or VCI as a coating or treatment on substrate materials in the as received and after exhaustion (aged) conditions.

5.4.1.2 Apparatus.

5.4.1.2.1 Atomizer (see figure 5).

5.4.1.2.2 Assembled VIA test jar (see figure 6).

5.4.1.2.3 VIA test jar lids (see figure 7).

5.4.1.2.4 Exhaustion apparatus for crystalline and liquid materials (see figure 8).

5.4.1.2.5 Exhaustion apparatus for coated materials (see figure 9).

5.4.1.2.6 Steel test plugs as specified on figure 6.

5.4.1.2.7 Aluminum oxide or silicon carbide abrasive sheets (240 and 400 grit).

5.4.1.2.8 Stainless steel beakers, covers and hot plates for solvent cleaning.

5.4.1.2.9 An air pump and flowmeter with regulator.

5.4.1.2.10 A forced draft oven with temperature controls.

5.4.1.3 Test specimens. All VIA tests shall be run in triplicate. In addition, a control test shall also be run using a VIA test jar but with no VCI test specimen. Specimen sizes for the different VCI materials covered by this test method are as follows:

a. Crystalline VCI (as received) - 0.050 ±0.005 gram (g) for each replicate
b. Liquid VCI (as received) - 0.050 ±0.005 g for each replicate
c. VCI coated materials (as received) - Two strips of the material, each measuring 1 by 6 inches, for each replicate.

5.4.1.4 Test specimen conditioning. Specimens shall be tested (a) as received and (b) after exhaustion (by artificially aging the sample). Exhausted (aged) test specimens shall be

tested for VIA immediately after the exhaustion procedure. Exhaustion is accomplished as follows:

NOTE

Outlets from the exhaustion apparatus shall be ducted out of the laboratory to avoid contamination of prepared test surfaces.

5.4.1.4.1 Crystalline VCI exhaustion procedure. The crystalline VCI material shall be introduced into the exhaustion conditioning assembly shown on figure 8 and as specified in 5.4.1.5.2.1, except that 0.10 ±0.005 g of material shall be introduced. The holes in the lid shall be covered with tape. The assembly shall then be placed in a forced draft oven, with the inlet connected to the regulated air pump and the outlet connected to an exhaust duct. Air maintained at 50 ±2 percent relative humidity shall be pumped into the jar containing the VCI at a rate of 100 cubic centimeters per minute while the oven is maintained at 100 ±2 °F for 5 days. The jar containing the VCI shall then be removed from the oven and allowed to cool to room temperature prior to VIA testing.

5.4.1.4.2 Liquid VCI exhaustion procedure. The liquid VCI material shall be introduced into the exhaustion test assembly described on figure 8 and as detailed in 5.4.1.5.2.2 except that the large open end of the funnel shall be 2 inches from the bottom of the jar, and 25 cubic centimeters of material shall be introduced. The exposure shall be conducted as described in 5.4.1.4.1 except that the exposure conditions shall be at 75 ±5 °F for 7 days.

5.4.1.4.3 Non-sealable VCI coated material exhaustion procedure. Samples of the material being exhaustion-tested shall be 2 by 8 inches. Plastic coated paper clips shall be placed at each end of the sample for ease of handling. A ⅛-inch diameter hole shall be punched in the center of the sample approximately ⅛ inch from the top edge. Each sample shall be placed in an assembly as shown on figure 9. The assembly shall then be placed in a forced draft oven, with the inlet connected to the regulated air pump and the outlet connected to an exhaust duct. Air maintained at 50 ±2 percent relative humidity shall be pumped into the jar containing the sample at a rate of 100 cubic centimeters per minute while the oven is maintained at 140 ±2 °F for 12 days. The test sample shall then be removed from the assembly and cut into two 1- by 6-inch specimens.

5.4.1.4.4 Sealable VCI coated material after exhaustion. This exhaustion test is the same as that for non-sealable VCI material except that the test sample shall be a 5- by 8-inch section of the material under test, folded to 2½ by 8 inches and sealed using ¼-inch heat seals on the open edges.

5.4.1.5 VIA test.

5.4.1.5.1 Test plug preparation.

NOTE

Test plugs treated with preservative may be purchased in the polished condition but shall be cleaned of preservative, then abraded and polished with both 240 and 400 grit abrasive sheets as specified below. The use of iron oxide abrasives and any abrasive paper that leaves residues not removable by the cleaning methods specified is prohibited. Some abrasive papers and cloths that are intended to be used dry or wet have been found to leave such residues.

The test plug shall be constructed of low carbon steel meeting the requirements of QQ-S-698, Condition 5 or SAE 1010 steel (cold rolled). A cold finished round bar of this material shall be machined to the dimensions specified on figure 6. The undrilled end shall be hand-abraded to a uniform finish with 240 grit silicon carbide or aluminum oxide abrasive sheet. The abraded test surface shall then be hand-polished with 400 grit aluminum oxide abrasive sheet at 90 degrees to the previous abrasion marks. Each polished plug shall be wiped clean with surgical gauze and examined at 10X magnification to ensure that all 240 grit marks have been removed and that the surface is uniform. Each plug shall then be placed in a container of reagent methanol until it can be further cleaned, but for no more than 4 hours. Further cleaning shall be accomplished by (a) immersion in a container of boiling reagent methanol and scrubbing the polished surface with surgical gauze, (b) immersion in a second container of boiling reagent methanol for 1 minute, and (c) immersion in a third container of boiling reagent methanol for 1 minute. During and after this cleaning process, the plugs shall be handled only with forceps and without touching the polished surface except for scrubbing with gauze. Upon removal from the third container of methanol, a plug shall be dried by waving it in the ambient air for 20 seconds then immediately installed in the VIA test jar fitted with the appropriate lid (see figure 7). Clean, low-lint laboratory tissue shall be used to force the plug into the stopper as shown on figure 6. The appropriate test procedure shall be initiated immediately.

5.4.1.5.2 VIA test setup. There are four different variations in the test setup depending on the nature of the material: crystalline VCI (see 5.4.1.5.2.1), liquid VCI (see 5.4.1.5.2.2), exhausted crystalline or liquid VCI (see 5.4.1.5.2.3), and VCI coated materials (see 5.4.1.5.2.4). VIA test lids are assembled for the different setups by fitting stoppers, aluminum tube, sleeve and test plug to the jar lids shown on figure 7. Following assembly of the test lids, all samples shall be tested in accordance with 5.4.1.5.3 without delay.

5.4.1.5.2.1 Crystalline VCI. An assembled VIA test lid shall be screwed onto a test jar. For material of this nature, 1 gram (g) of the material being tested shall be placed in a glass vial which shall be attached to the atomizer (see figure 5). The material shall then be sprayed into a

test jar through one of the small holes in the lid until 0.05 ± 0.005 g, as determined by weight loss, is dispensed. As an alternate procedure, which shall be used only when specified in the material specification test method, 0.05 ± 0.005 g of the material being tested shall be placed in a 1½- by 2-inch pouch made from tea bag material and hung on a jar lid with coated wire. The tea bag shall not touch the jar and shall be centered vertically.

5.4.1.5.2.2 Liquid VCI. For material of this nature, 0.05 ±0.005 g of the material being tested shall be weighed and placed in a standard 1 ounce wide-mouth jar. The vessel shall then be placed on the bottom of a test jar and an assembled VIA test lid set on the jar.

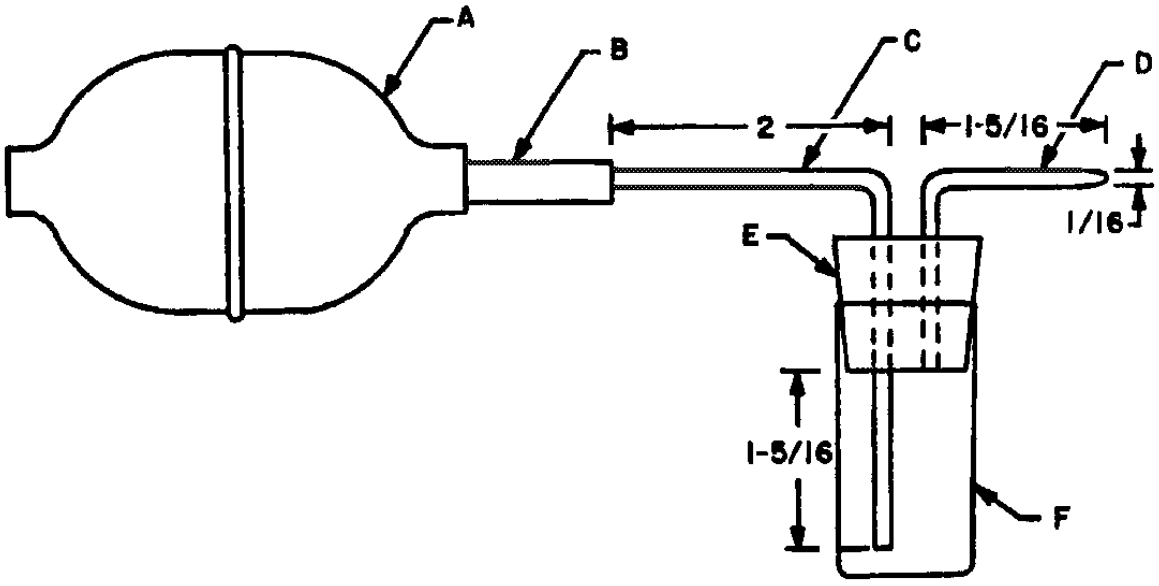
5.4.1.5.2.3 VCI in crystalline or liquid form after exhaustion. After conditioning, the exhaustion apparatus and specimen contained in it shall be used for VIA testing by removing the lid with the funnel attachment and setting an assembled VIA test lid on the jar.

5.4.1.5.2.4 VCI in coated material form as received and after exhaustion. An assembled VIA test lid for coated materials shall be set on a test jar and two 1- by 6-inch specimens shall be inserted through its slots. The specimens shall be held in position by forming a ¼-inch tab at one end of the specimen. The tab is then taped to the outer surface of the lid. Alternatively, specimens shall be hung from coated paper clips attached to the lid. The treated surfaces of the test specimens shall face toward the center of the jar.

5.4.1.5.3 VIA test procedure. The lid shall be removed from each test jar and 10 cubic centimeters of a synthetic glycerin-water solution (refractive index $n_D^{20} = 1.371$) shall be introduced into the bottom of the test assembly shown on figure 6 (producing an atmosphere of 90 to 95 percent relative humidity). The lids shall be tightly screwed onto the jars and any holes in the lids and the jar-lid interface shall be sealed with tape. The test assembly shall be exposed to a temperature of 75 ±5 °F for 20 hours. Each aluminum tube shall then be filled with cold water (32 to 35 °F). After 3 hours, the test lid shall be gently unscrewed and inverted to remove the water from the tubes. When dry, the polished surface of the test plug shall be examined for evidence of corrosion. If the polished surface of the control test plug shows no corrosion, the test shall be rerun.

5.4.1.6 Test surface evaluation. Each test surface shall be examined under 10X magnification. A rating shall be attributed to each surface based on the number of corrosion spots found: 0 = no spots, 1 = 1 spot, 2 = 2 spots, 3 = 3 spots, 4 = 4 or more spots. In addition, it shall be noted whether any of the spots exceed 300 micrometers in diameter (determined using 40X magnification and a corresponding standard of comparison).

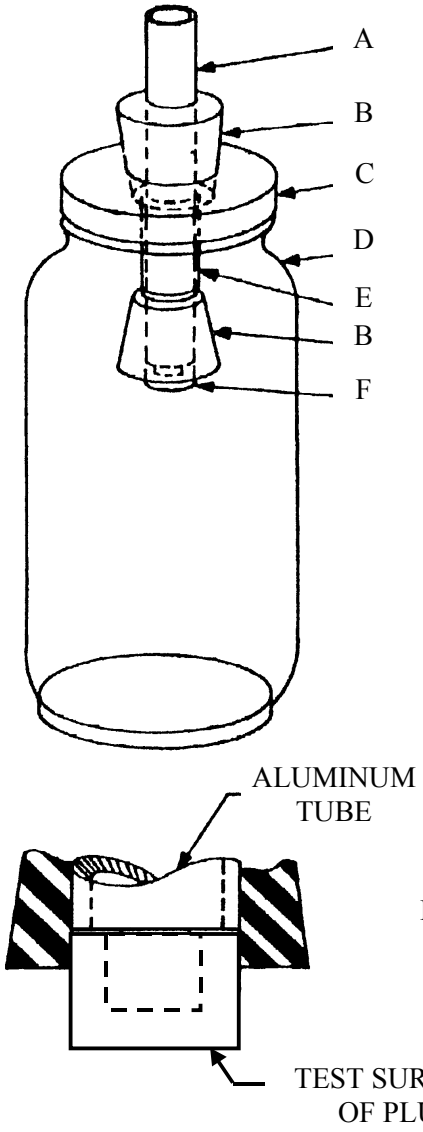
5.4.1.7 Notes. The exposure environment specified herein is intended to evaluate the corrosion preventive effectiveness of the VCI material being tested with respect to steel surfaces. For other metals, the exposure conditions and test surface would have to be adjusted to evaluate the effectiveness of VCI material.



DIMENSIONS IN INCHES

A - Rubber bulb
B - Rubber tubing - 1-inch long
C - Pyrex glass tubing - 1/8-inch ID, length to suit
D - Pyrex glass tubing - 1/8-inch ID, length to suit, with 1/16-inch nozzle
E - Rubber stopper - No. 4 with holes to accommodate glass tubing
F - Glass vial – 2 inches in height by 7/8-inch ID

FIGURE 5. Atomizer (dispenser for introducing VCI into test assembly).



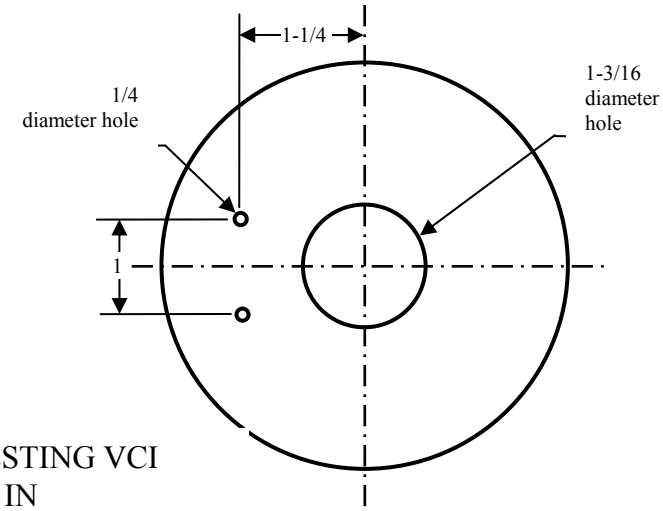
A - Aluminum tube – 4 ½ in length, 5/8 OD and ½ ID
B - Rubber stopper – #6-½ rubber stopper with ½ hole drilled through center (2 required)
C - Jar lid – See figure 7 for details
D - Jar – Quart size, 6 ¾ inches in height, 3 ½ ID
E - Insulating sleeve – ½ ID thin rubber tubing, length 1 ½
F - Test plug – ⅝ OD, ½ long with ⅜ deep, ⅜ ID flat bottom hole drilled in center

NOTES

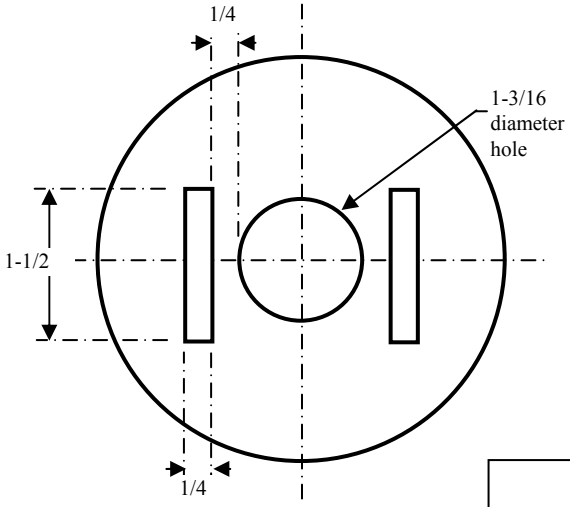
1. Dimensions in inches
2. All parts of the assembled test lid shall be in contact with adjacent part

ENLARGED VIEW OF BOTTOM OF SPECIMEN HOLDER ASSEMBLY

FIGURE 6. Test assembly.



LID FOR TESTING VCI MATERIAL IN CRYSTALLINE OR LIQUID FORM

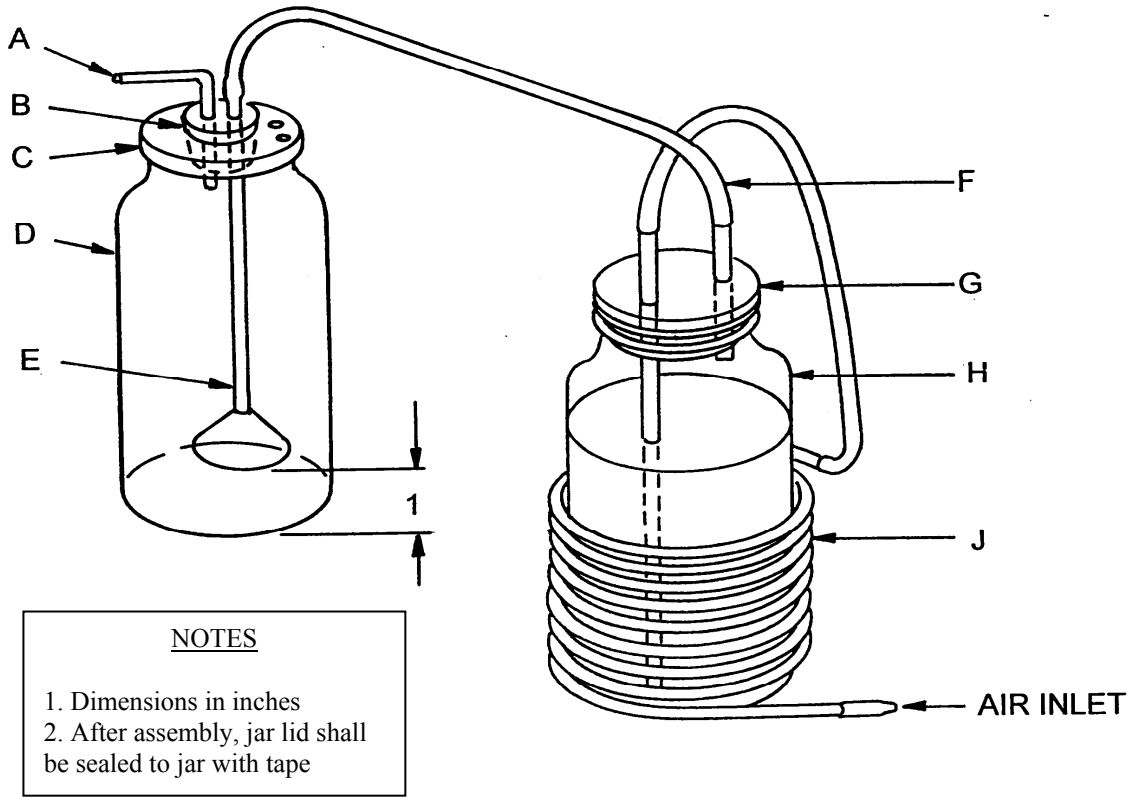


LID FOR TESTING VCI COATED MATERIALS

NOTES

1. All dimensions in inches
2. Both lids to be plastic screw type to fit quart size jar.

FIGURE 7. Jar lids.



A - Pyrex glass tubing – ⅛ ID, length to suit
B - Rubber stopper – With two holes to suit insertions
C - Jar lid – See figure 7
D - Jar – Quart size, 6¾ inches in height, 3½ ID – See figure 6, D
E - Pyrex glass funnel – Approximately 2 ID at mouth, 8 inches long
F - Pyrex glass and Tygon® (or equivalent) tubing – ¼ ID
G - Rubber stopper – With two holes to suit insertions
H - Quart glass jar – 6¾ deep, containing glycerine-water solution to effect a 50 percent relative humidity (refractive index $n_D^{20} = 1.426$) within the glass jar (D). Add distilled water periodically to maintain the solution level at 5 inches with the inlet tube immersed 4 inches in the solution.
J - Copper coil (OD ¼, ID 5/32, length 10 feet)

FIGURE 8. Apparatus for exhaustion of VCI material in crystalline form.

ALL DIMENSIONS ARE IN INCHES

A - Pyrex glass and Tygon® or equivalent tubing – ¼ ID
B - Rubber stopper – No. 12 and No. 13 with holes for insertion
C - Plastic coated paper clip
D - Pyrex glass tube – 12 by 2 $^{3}/_{8}$ ID.
E - Diffuser – Consisting of glass cylinder (2 OD by 1 high glass tubing) doubled wrapped with surgical gauze.
F - Quart glass jar – 6 $^{3}/_{4}$ deep, containing glycerine-water solution to effect a 50 percent relative humidity (refractive index $n_D^{20} = 1.426$) within the glass tube (D). Add distilled water periodically to maintain the solution level at 5 inches with the inlet tube immersed 4 inches in the solution.
G - Test specimen – 2 by 8.
H - Plastic coated paper clip
J - Copper coil – ¼ OD by $^{5}/_{32}$ ID by 10 feet long

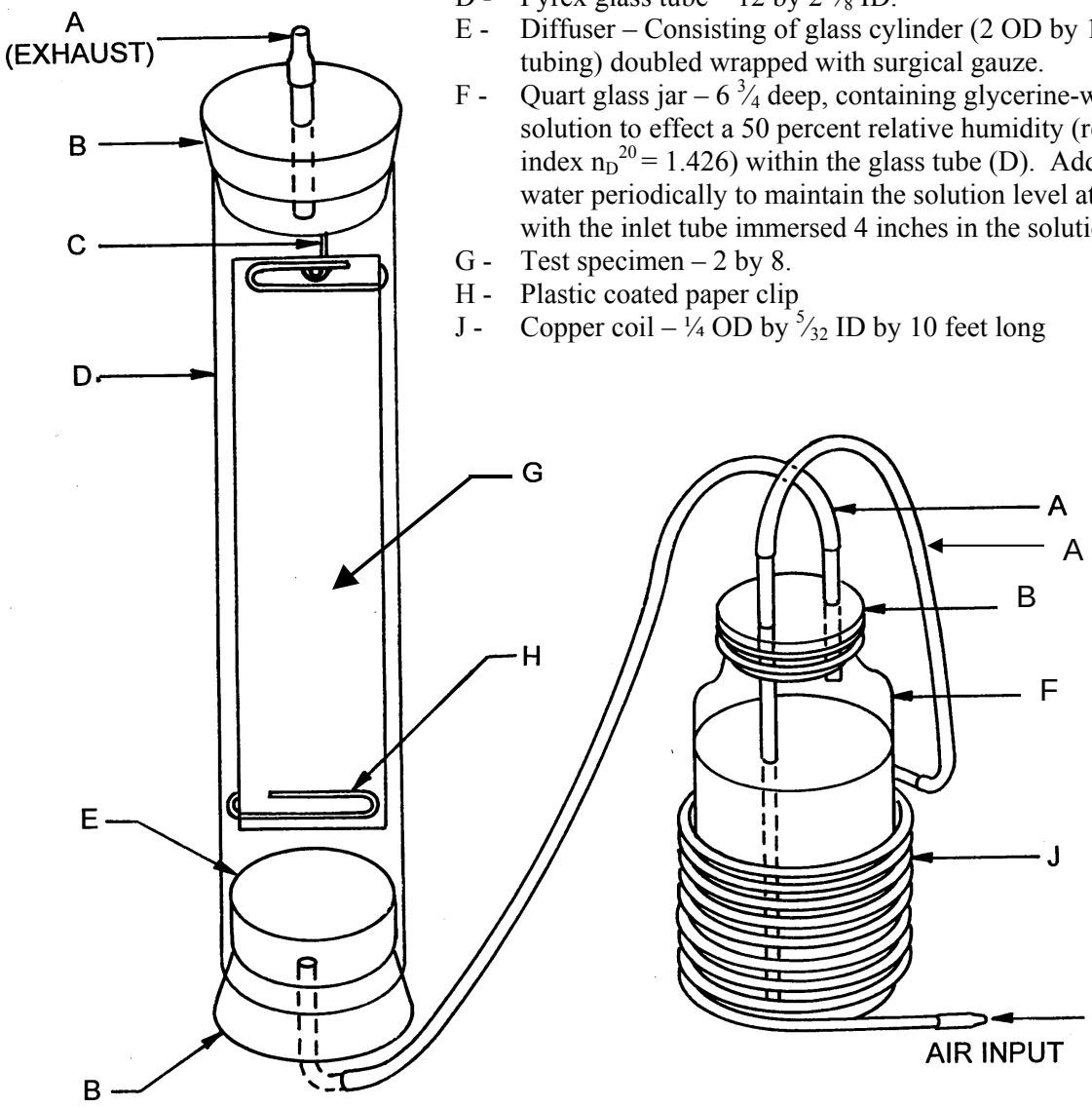


FIGURE 9. Apparatus for exhausting VCI coated material.

5.4.2 Test Method 4034 – Transparency.

5.4.2.1 Scope. This test procedure details a method for determining the degree of transparency of packaging materials.

5.4.2.2 Apparatus.

5.4.2.2.1 A laser printed 600 dots per inch legibility standard, using Times New Roman font size 16 (body size = 0.167 ±0.005 inch) in black lower case letters and at least ten digits on ultrawhite paper (96 lumens minimum).

5.4.2.3 Test specimens. At least three specimens, each 3 by 5 inches, selected at random from the material being tested.

5.4.2.4 Test procedure. The characters on the legibility standard shall be examined when viewed through the material being tested when the test material is held 3 inches away from the legibility standard.

5.4.3 Test Method 4046 – Electrostatic Properties.

5.4.3.1 Scope. The purpose of this procedure is to evaluate the electrostatic buildup and dissipation properties of packaging materials used to protect electronic parts that are susceptible to damage by electrostatic discharge. After charging to 5000 volts, a sample is grounded, and its electrostatic field is measured to determine the voltage dissipation time. A typical exponential voltage-time curve is shown on figure 10.

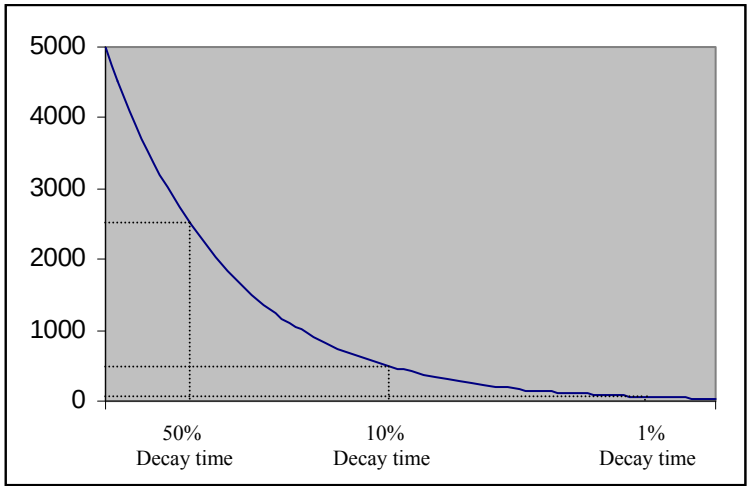


FIGURE 10. Static decay times.

5.4.3.2 Apparatus.

5.4.3.2.1 Static decay meter (consisting of a control unit and Faraday cage for sample mounting) capable of:

1) inducing a 5 kilovolt positive or negative charge on a flat sample (with a safety interlock system to prevent operator shock),

2) measuring the time required for that sample to discharge to pre-determined cutoff levels of 50 percent, 10 percent, and 1 percent, (with a digital readout of 0 to 100 seconds and a resolution of 0.01 second),

3) operating in either manual or automatic mode (where repeated measurements can be made at various time intervals), and

4) operating in a dehumidified environmental chamber.

In addition, the electrostatic voltmeter in the control unit shall have a step response of no more than one millisecond from 10 percent to 90 percent. The high voltage power supply shall be adjustable from 0 to 5.5 kV and shall produce no more than 50 microamps of current.

5.4.3.2.2 Electronic calibration module to provide a validation check on the static decay meter operation.

5.4.3.2.3 An environmental chamber capable of maintaining the test apparatus at conditions specified in 5.4.3.4.2. The chamber shall be provided with gloved hand holes for mounting and removing test specimens.

5.4.3.3 Test specimens. Unless otherwise specified in the test plan, three specimens for each pre-test conditioning shall be selected at random to represent any variation of the material. Each specimen shall be 3½ by 5½ inches and shall be free of defects such as holes, cracks, and tears.

5.4.3.4 Test procedure.

5.4.3.4.1 Pre-conditioning. Prior to testing, expose three specimens for 12 days in a circulating air oven uniformly maintained at 160 ±5 ºF. Also, expose for 24 hours to a continuous water shower the inner side and outer side of enough material from which 3 specimens each may be cut. Finally, expose three more specimens to an atmosphere uniformly maintained at 73 ±5 ºF and 50 ±5 percent relative humidity for at least 24 hours.

5.4.3.4.2 Test environment. Immediately after preconditioning, unless otherwise specified in the test plan, all specimens shall be placed in the electrostatic test chamber (maintained at 73 ±5 ºF and 12 ±3 percent relative humidity) for a minimum of 24 hours before testing. Tests shall be performed under these same conditions.

5.4.3.4.3 Calibration. Following warm-up, the static decay meter shall be checked for proper operation of the system clock and checked for accuracy using the electronic calibration module. In addition, all other routine calibration or compensation adjustments shall be made in accordance with the manufacturer's instructions.

5.4.3.4.4 Testing. Test procedures shall adhere to the manufacturer's instructions for installation and measurement of static decay. The pre-determined cutoff level for MIL-PRF-81705 is 1%. Three replicates of each of the three different types of pre-conditioned specimens shall be tested for both orientations of the sample (one side oriented toward the voltage sensor, then the reverse) and for both positive and negative charging. Three measurements shall be taken for each combination (108 total measurements).

5.4.3.5 Notes.

5.4.3.5.1 A device suitable for making this measurement is the Static Decay Meter Model 406C or Model 406D manufactured by Electro-Tech Systems, Inc. (Glenside, PA).

5.5 Container test methods.

5.5.1 Test Method 5005 - Cornerwise Drop (Rotational) Test.

5.5.1.1 Scope. This method determines the ability of large containers (see 3.1.3) ready for shipment to resist the impacts of being dropped on their corners while evaluating the ability of the preservation methods and applicable packing levels as specified in MIL-STD-2073-1 to provide protection to the contents.

5.5.1.2 Apparatus. Any convenient equipment, such as a forklift truck, a hoist, or a block and tackle may be used. A smooth, level, concrete surface (or similarly unyielding surface) to perform the cornerwise drop test.

5.5.1.3 Test specimens. One container and its contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, rigidity, shape, and center of gravity (CG) position in the container. At a minimum, the contents shall be instrumented at the CG position to record shock forces or deflections during the test. The contents, or dummy load, shall be blocked, braced, and cushioned in place, as for shipment.

5.5.1.4 Test conditions. All tests will be conducted at ambient temperature (see 4.4.2) except as specified herein.

5.5.1.5 Test procedure.

5.5.1.5.1 Number and height of drops. The specimen shall be placed on its bottom. One corner of the base of the container shall be supported on a block nominally 6 inches in height. A block nominally 12 inches in height shall be placed under the other corner of the same end. If the dimensions of the container are such that the 12-inch height cannot be attained without instability, a block of the greatest attainable height shall be substituted. The heights shall be increased, if necessary, to ensure that there is no support for the base between the ends of the container when the drop occurs. The block height shall not cause the container to slide on the supports when the drop end is raised for test. The unsupported end of the container shall be raised so that the lower corner of that end reaches the prescribed height and then allowed to fall freely to the concrete surface or similarly unyielding surface (see figure 11). Unless otherwise specified in the test plan, the height of drop for Levels A and B protection shall be as specified in table 1; the maximum heights shall not exceed 36 inches and 27 inches, respectively. Unless otherwise specified in the test plan, there shall be one drop on each corner of the base of the container (4 drops).

TABLE I. Height of rotational drops for containers of various sizes and shapes. 1/

Gross weight (within range limits) in pounds	Dimensions of any edge, height, or width (within range limits) in inches	Height of drop on corners in inches	
		Level A	Level B
150 - 250	60 - 66	36	27
250 - 400	66 - 72	32	24
400 – 600	72 – 80	28	21
600 -1000	80 -95	24	18
1,000 – 1,500	95 – 114	20	16
1,500 – 2,000	114 – 144	17	14
2,000 – 3,000	Above 144 – No limit	15	12
Above 3000		12	9

1/ Use the lowest drop height indicated by either gross weight or dimension. (For example, a container having a gross weight of 440 pounds and a maximum edge dimension of $95^{5}/_{8}$ inches shall be dropped 20 inches for Level A tests or 16 inches for Level B tests.)

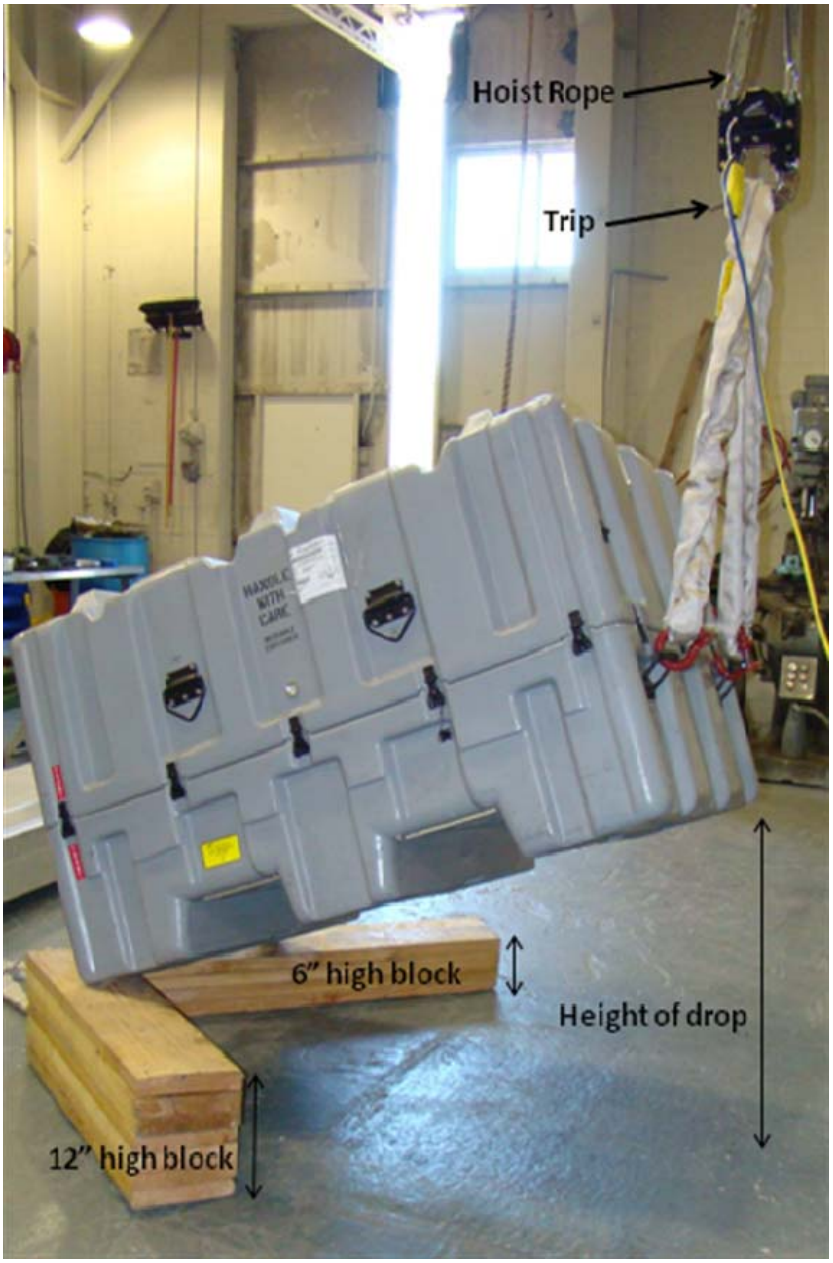


FIGURE 11. Cornerwise drop (rotational).

5.5.2 Test Method 5007 – Free Fall Drop Test.

5.5.2.1 Scope. This method determines the ability of containers to withstand free fall drop impacts while evaluating the ability of the preservation methods and applicable packing levels as specified in MIL-STD-2073-1 used to protect the contents of the container. This procedure is appropriate for use with all containers weighing up to 150 pounds, except those with skids or those having any edge or diameter over 60 inches.

5.5.2.2 Apparatus. Any apparatus that conforms to the following requirements shall be used:

a. Permits the container to be placed in a position prior to release that shall ensure free unobstructed fall that impacts the container at the orientation and in the direction required.
b. Permits accurate and convenient control of the height of the drop.
c. Utilizes lifting devices that do not damage the containers.
d. Provides an instantaneous release mechanism that does not impart rotational or sidewise forces to the test container.
e. Provides an impact surface, horizontal and flat, massive enough to be immoveable and rigid enough to be non-deformable under the test condition.

5.5.2.3 Test specimens. One container and its contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate the contents with weight, rigidity, shape, and CG position in the container. The contents, or dummy load, shall be blocked, braced, and cushioned in place, as for shipment, and appropriately instrumented at the CG position to record shock forces or deflections during the test. The test specimen shall require no special conditioning prior to test.

5.5.2.4 Test conditions. All tests shall be conducted at ambient temperature (see 4.4.2), except as specified herein.

5.5.2.5 Test procedure.

5.5.2.5.1 Bags. Each bag specimen shall be dropped once on the filling end and once flatwise, (seams horizontal) from a height of 48 inches.

5.5.2.5.2 Cylindrical containers. Cylindrical containers, barrels, pails, etc. shall be subjected to one of the procedures described below. The container is to be dropped, once flatwise, on each end. The top and bottom rim or chime drops shall be made with the container CG directly above the striking point at the instant of release. A plumb line aligned with the center point of the drop table (see figure 12) may be used to position the container. The rim drop shall be made in pairs, one drop on each half of the top rim and one on each half of the bottom

rim for a total of four drops. For the two drops of each pair, the container shall strike on diagonally opposite quadrants of the top and bottom rims. If a total of more than four rim drops is specified, the additional drops shall be on sections not tested.

Procedure A. One drop on each end (2 drops).

Procedure B. One drop on each half of the top and bottom rims (4 drops).

Procedure C. One drop on each quadrant of the top and bottom rims (8 drops).

Procedure D. One drop on each half of the top and bottom rims, one drop on each end, and two drops on the cylindrical side of the container at 90 degrees to each other (8 drops).

5.5.2.5.3 Rectangular containers. Rectangular containers shall be subjected to one or more of the following procedures, but dropped not more than once on any flat face, edge, or corner. For edgewise drops, the striking edge of the container shall be parallel with the dropping surface at the instant of release. For edgewise and cornerwise drops, the package CG shall be directly above the striking edge or corner of the package at the instant of release (see figure 12).

Procedure A. One drop on each flat face, edge and corner (26 drops).

Procedure B. One drop on each flat face (6 drops).

Procedure C. One cornerwise drop followed by one edgewise drop on each of the three edges radiating from the struck corner (4 drops).

Procedure D. One cornerwise drop on each of the four bottom corners (4 drops).

Procedure E. One cornerwise drop on each of the eight corners (8 drops).

Procedure F. One drop on each edge (12 drops).

Procedure G. One cornerwise drop on each of two sets of diagonally opposite corners; followed by one flat drop on the bottom, top, and two adjacent sides (8 drops).

5.5.2.5.4 Drop height. All package drops shall be made so that the package falls freely through the specified vertical free-fall distance (see table I).

TABLE I. Height of free fall drops for containers of various sizes and weights. 1/

Gross weight (within range limits) in pounds	Dimensions of any edge, height, or diameter (within range limits) in inches	Height of free-fall drop on corners or edges or flat faces in inches	
		Level A	Level B
0-15	0 - 30	36	27
15 -30	30 - 33	30	22
30 -50	33 -37	25	19
50 - 75	37 - 42	21	17
75 - 110	42 -50	19	15
110 -150	50 - 60	18	14

1/ Use the lowest drop height indicated by either gross weight or dimension. (For example, a container having a gross weight of 36 pounds and a maximum edge dimension of 42.625 inches shall be dropped 19 inches for Level A tests or 15 inches for Level B tests.)

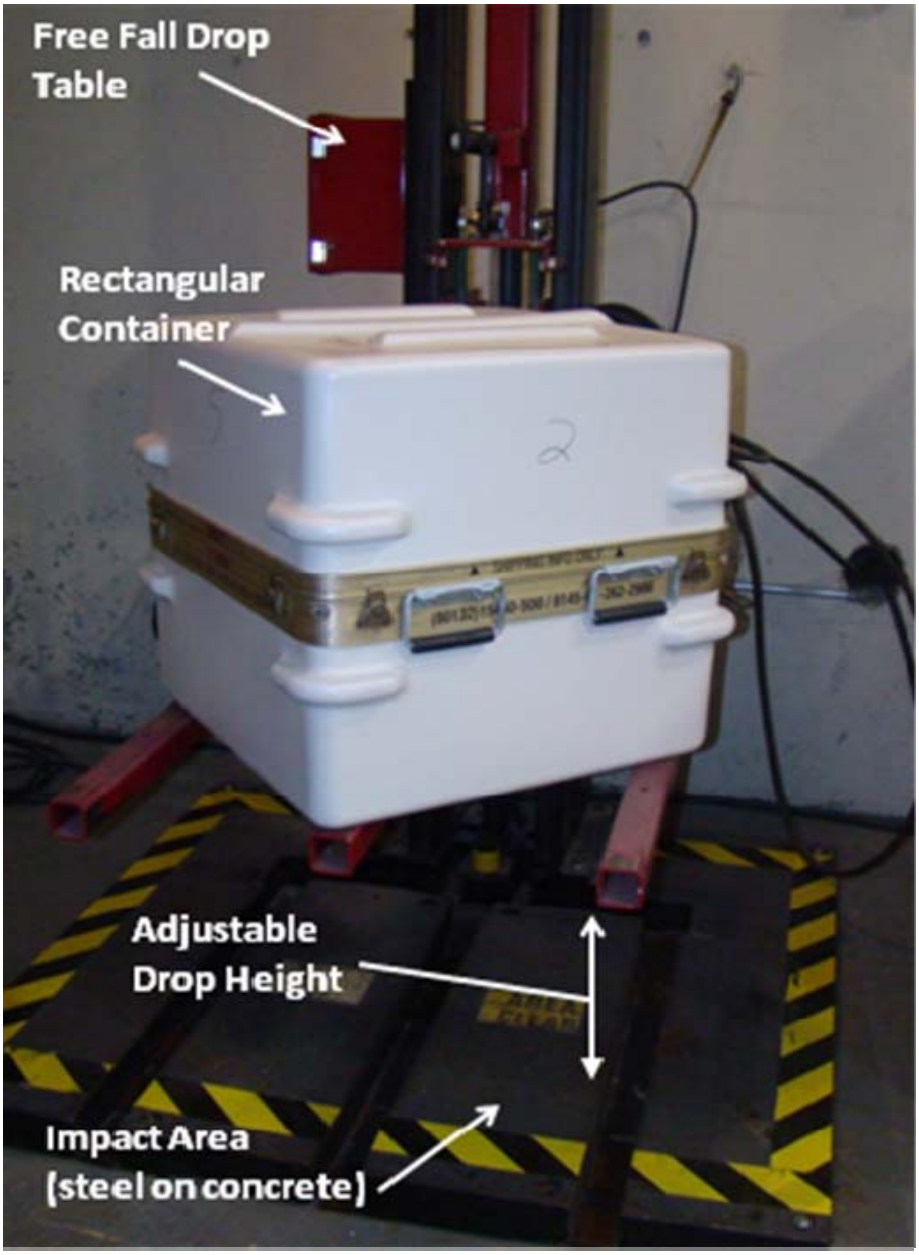


FIGURE 12. Free fall drop test.

5.5.3 Test Method 5008 – Edgewise Drop (Rotational) Test.

5.5.3.1 Scope. This method determines the ability of large containers (see 3.1.3) to resist the impacts of being dropped on their edges while evaluating the ability of the preservation methods and applicable packing levels as specified in MIL-STD-2073-1 to protect the contents.

5.5.3.2 Apparatus. Any convenient equipment, such as a forklift truck, a hoist, or a block and tackle, along with a smooth, level, concrete surface (or similarly unyielding surface) shall be used in performing the edgewise drop test.

5.5.3.3 Test specimen. One container and its contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load appropriately instrumented to record shock forces or deflections during the test shall be substituted to simulate such contents in weight, rigidity, shape, and CG position in the container. The contents or dummy load, shall be blocked, braced, and cushioned in place, as for shipment. No additional conditioning of the specimen is required before test.

5.5.3.4 Test conditions. All tests shall be conducted at ambient temperature (see 4.4.2).

5.5.3.5 Test procedure.

5.5.3.5.1 Number and height of drops. The specimen shall be placed on its bottom with one end of the base of the container supported on a sill nominally 6 inches high. The height of the sill shall be increased, if necessary, to ensure that there is no support for the base between the ends of the container when dropping takes place, but shall not be high enough to cause the container to slide on the supports when the drop end is raised for the drop. The unsupported end of the container shall then be raised and allowed to fall freely to a smooth, level concrete surface or similarly unyielding surface from a prescribed height (see figure 13). The height of drop for Levels A and B protection shall conform to table 1. The maximum heights shall not exceed 36 inches for Level A and 27 inches for Level B protection. A total of four drops constitute a complete test. If the size of the container and the location of the CG are such that the drop cannot be made from the prescribed height, the height of the sill shall be increased. Rectangular containers shall be dropped once on each edge of the container base. Cylindrical containers will be dropped on the top and bottom rims at diagonally opposite quadrants. The quadrant pairs shall be separated by approximately 90 degrees. If a total of more than four rim drops is specified, the additional drops shall be on sections not previously dropped upon.

TABLE I. Height of rotational drops for containers of various sizes and weights. 1/

Gross weight (within range limits) in pounds	Dimensions of any edge, height, or width (within range limits) in inches	Height of drops on edges	
		Level A	Level B
150 - 250	60 - 66	36	27
250 - 400	66 - 72	32	24
400 - 600	72 -80	28	21
600 – 1,000	80 - 95	24	18
1,000 – 1,500	95 -114	20	16
1,500 – 2,000	114 -144	17	14
2,000 – 3,000	Above 145 no limit	15	12
Above 3,000		12	9

1/ The lowest drop height indicated by either gross weight or dimension shall be used. (For example, a container having a gross weight of 440 pounds and a maximum edge dimension of 95.625 inches will be dropped 20 inches for Level A tests or 16 inches for Level B tests.)

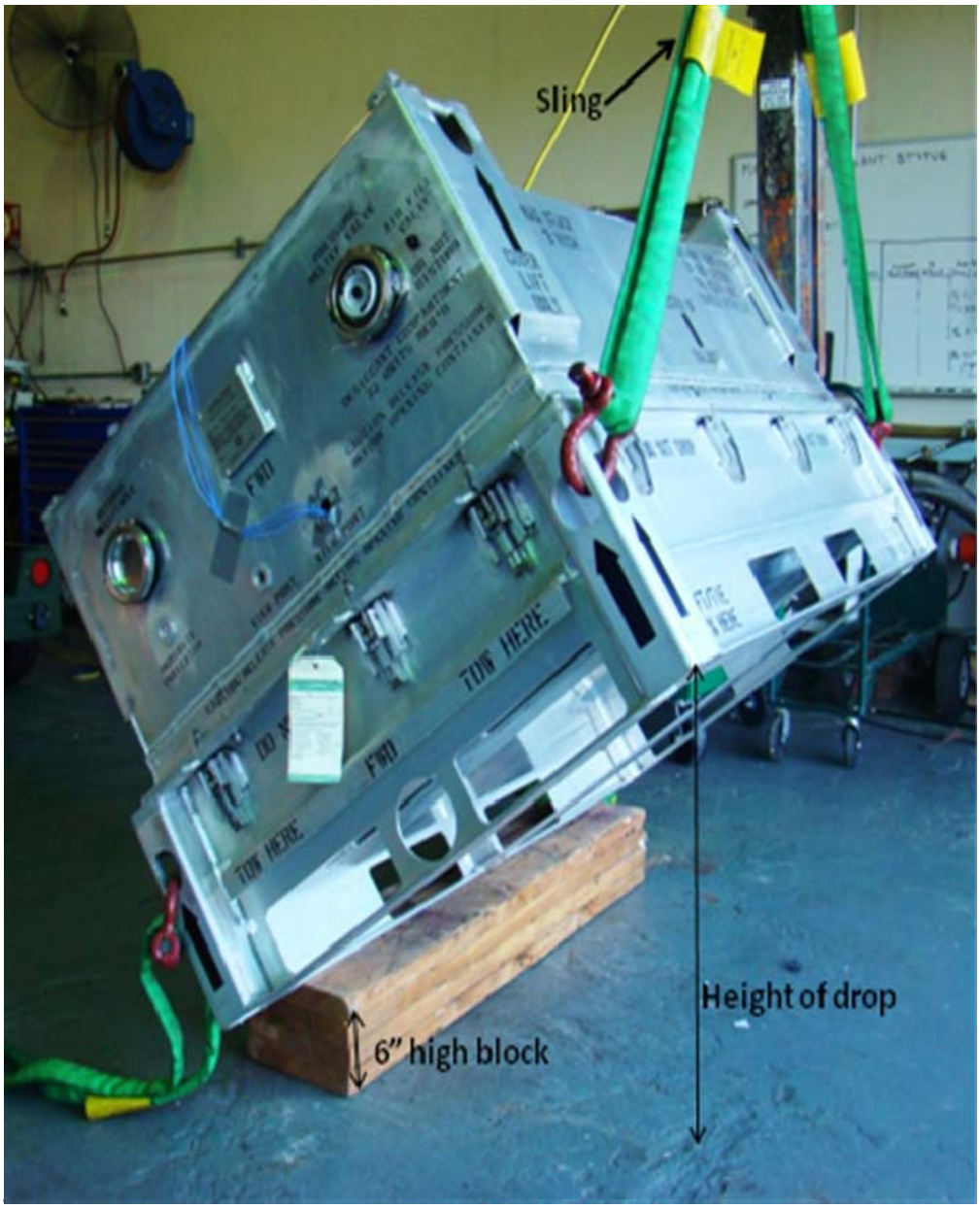


FIGURE 13. Edgewise drop (rotational).

5.5.4 Test Method 5009 – Leaks in Containers.

5.5.4.1 Scope. This test procedure details methods to determine leakage of air or liquids from sealed containers. Five test methods are specified; choice of method is determined by the physical characteristics of the container being evaluated (see 5.5.1.5).

5.5.4.2 Apparatus.

5.5.4.2.1 Vessels of sufficient size to allow complete submergence of the container being tested.

5.5.4.2.2 A vacuum pump and pressure gage if the vacuum retention test is being conducted.

5.5.4.2.3 A pressure gage and a supply of compressed air if the pneumatic pressure test is being conducted.

5.5.4.3 Test specimens. A specimen shall be one container and contents (actual or simulated), packed and sealed as for shipment.

5.5.4.4 Test procedures.

5.5.4.4.1 Vacuum retention technique.

5.5.4.4.1.1 Specimen preparation. Provisions shall be made for connection of a tube to evacuate air and installation of a gage to indicate any loss in vacuum pressure without affecting the integrity of the container.

5.5.4.4.1.2 Testing. Connect the vacuum pump to the specimen and evacuate the air until the desired vacuum is attained. The vacuum pressure shall be 9 ± 1 millimeters of mercury or 5 ± ½ inches of water. The required vacuum may be drawn more than once to ensure that equilibrium within the specimen is reached. When the specimen is evacuated to a constant specified pressure, stop evacuating air and note the vacuum pressure gage reading. After 10 minutes, the gage shall be read again to determine if there is a loss in vacuum pressure, indicating a leak.

5.5.4.4.2 Pneumatic pressure technique.

5.5.4.4.2.1 Specimen preparation. Provisions shall be made for connecting a tube, fill valve or clamp-in valve to the specimen. A pressure gage shall be used with the required accuracy and tolerance for the specified container. A tube or valve shall be sealed into an opening at one end of a seam in a flexible container, a hole drilled and tapped with a plug or a "clamp-in valve" stem incorporated in a rigid container, or other methods that will permit

removal and seal without adverse effects of the serviceability of the container.

5.5.4.4.2.2 Testing. Pressurize the specimen with air from a compressed air supply. Gradually introduce air until either the prescribed pressure in the specimen is attained or leakage becomes apparent. The pressure (P) in psi shall be calculated as follows:

$$P = \frac{\pi S}{(d_1 + d_2)}$$

where S = the specified strength of the barrier seams
d_1 and d_2 = the two smaller dimensions of the package.

(For example, to test a package 10 by 6 by 4 inches enclosed in MIL-PRF-131 barrier material, the pressure shall be the specified strength of MIL-PRF-131 barrier seam (3½ lb/in.) times pi (3.14) divided by the sum of the smaller dimensions (6 + 4 inches); that is, the pressure shall be 1.1 lb/sq. in. For other sizes other pressures shall be calculated in a similar manner or read from an appropriate curve.)

CAUTION

Pneumatic pressure may cause explosive failure of weak specimens. The applied pressure should be no greater than necessary to reveal leaks.

When the specimen is pressurized to a constant specified pressure, read and record this initial pressure. After 30 minutes, read and document the final gage pressure. If no change is noted between the initial and final gage pressure, the item is considered satisfactorily sealed.

5.5.4.4.3 Squeeze technique. Squeeze technique is applicable only to flexible specimens.

5.5.4.4.3.1 Specimen preparation. During final sealing of the specimen, entrap as much air as possible within the specimen.

5.5.4.4.3.2 Testing. Either submerge the specimen 1 to 2 inches under water and, while squeezing the specimen to force air into the area under observation, observe all seams and surface for leakage; or coat all seams, joints, or other areas likely to leak with a bubble-supporting film and observe each for leaks while squeezing the specimen to force air to the area under observation.

5.5.4.4.4 Hot water technique. Submerge the specimen in water heated to a temperature at least 50 °F above the initial temperature of the specimen but not over 110 °F for wax-dipped specimens. While holding the specimen submerged with the uppermost surface covered by not

more than 1 inch of water, observe the specimen for a minimum of 15 seconds to detect any breaks. The specimen shall be rotated and observed repeatedly until all of the specimen has been examined. Total time in hot water shall not exceed 8 minutes.

5.5.4.4.5 Submersion (or immersion) techniques. The specimen shall be submerged so that the uppermost surface is beneath the water surface not less than 1 inch or more than 2 inches for 1 hour or longer. The temperature of the water shall be maintained between ambient temperature and 40° (°F) below ambient. After submersion and before opening the specimen, carefully dry the outside of the specimen where the opening will be made. Open the specimen and inspect the inside for leakage.

5.5.4.5 Notes.

5.5.4.5.1 Selection of technique. The most appropriate technique depends principally upon the construction, size and weight of the unit pack, and the information needed. The hot water technique is appropriate for large unit packs. The squeeze technique is appropriate for small unit packs constructed of flexible materials such as plastic film. The vacuum retention technique does not specifically locate leaks and may not indicate the existence of tiny leaks in a large unit pack. The submersion (or immersion) technique for detecting water leakage is not as sensitive as the air leakage tests, but it is appropriate to reveal whether or not water might leak into the unit packs and, depending upon the duration of the test, gives some indication of the extent to which the materials used in the pack are waterproof. The pneumatic pressure technique is primarily appropriate for rigid containers. Neither the hot water nor the pneumatic pressure techniques are appropriate for rigid containers that are sealed with tapes; the submersion technique shall be used.

5.5.5 Test Method 5011 – Mechanical Handling Test.

5.5.5.1 Scope. This method determines the ability of a package or container to withstand rough handling by mechanical handling equipment. It provides procedures for:

(1) Lifting and transporting by forklift truck (see 5.5.5.4.1).
(2) Hoisting with slings (see 5.5.5.4.2).
(3) Sling handling with attachments (5.5.5.4.3).
(4) Hoisting with grabs (see 5.5.5.4.4).
(5) Pushing (5.5.5.4.5).
(6) Towing (see 5.5.5.4.6).
(7) Conveying (see 5.5.5.4.7).
(8) Pallet truck (5.5.5.4.8).

5.5.5.2 Apparatus.

5.5.5.2.1 Forklift handling. A forklift truck having hard, rubber tires of sufficient capacity for the weight to be handled. Forks shall be adjusted to spacing appropriate for the specimen under test, but not greater than 30 inches center to center and six nominal 1- by 4-inch boards longer than the width of the forklift truck.

5.5.5.2.2 Hoisting with slings. A crane, hoist, or other arrangement of sufficient capacity for the weight to be lifted and slings of the lengths required to test the specimen.

5.5.5.2.3 Hoisting with grabs. A crane, hoist, or other arrangement of sufficient capacity for the weight to be handled along with a pair of chain or cable operated gravity-type grabs. The length of the operating chain or cable shall be adjustable. The gripping surface of each grab shall prevent slippage of the specimen being tested. (For example, the surface for use on wood boxes or crates might be a flat plate with several conical teeth that with pressure will become embedded into the wood of the container and prevent slipping.)

5.5.5.2.4 Pushing. A vehicle of sufficient capacity to push the specimen.

5.5.5.2.5 Towing. A vehicle of sufficient capacity to pull the specimen equipped with a towline of sufficient strength.

5.5.5.2.6 Conveying. A level length of skate-wheel conveyor not less than 10 feet long and wide enough to handle the specimen. The width may be made up of more than one section of conveyor.

5.5.5.3 Test specimens. One container and its contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing and the actual contents for which it was designed. When actual content use is not practical, a dummy load shall

be substituted to simulate such contents in weight distribution, shape, rigidity, and position in the container. The contents, or dummy load, shall be blocked, braced, and cushioned in place, as for shipment. No special conditioning of the test specimen shall be required.

5.5.5.4 Test procedures. Handling provisions shall be tested as follows in the sequence given.

5.5.5.4.1 Lifting and transporting by forklift truck. The specimen shall be lifted clear of the ground by a forklift truck at one side of the specimen and transported on the forks in the level or the back-tilt position across a hard pavement for a distance not less than 100 feet. Parallel pairs of 1 by 4-inch boards spaced 54 inches apart shall be laid flatwise on the pavement across the path of the forklift truck. The first pair shall be placed squarely across the path of the truck and centered 30 feet from the starting point; the second pair shall be laid 60 feet from the starting point at an angle of about 60 degrees to the truck's path so the left wheel strikes first; and the third pair shall be laid 90 feet from the starting point at about 75 degrees to the truck's path so the right wheel strikes first. If the specimen is less than 40 inches high and weighs less than 500 pounds, a load shall be superimposed on the specimen throughout the test to simulate stacking of the minimum number of specimens that will attain either a height not less than 80 inches or a weight not less than 1,000 pounds. (For example, if a specimen were 30 inches high and weighed 200 pounds, the superimposed load would be required. A stack of three would measure 90 inches high, which is not less than 80, so the weight of two (400 pounds) would be superimposed on the test specimen. Similarly, if a test specimen were 15 inches high and weighed 300 pounds, a stack of four would weigh 1,200 pounds, which is not less than 1,000, so the weight of three (900 pounds) would be superimposed on the test specimen.) If the test specimen is more than 36 inches wide and is stable on 36-inch long forks, the forks shall extend only 36 inches under the specimen. The forklift truck carrying the specimen, shall travel the 100 feet in about 23 seconds at a uniform speed (normal walking speed), and then shall be brought to a stop. The specimen shall be carefully observed during the traverse and while the forklift truck is at a stop for any damage, evidence of inadequacy, or deflection of the specimen that might cause damage or displacement of the contents. A record shall be made of the observations. The specimen with its superimposed load, if any, shall then be lowered to the ground. The forklift truck shall be moved from the side to the end of the specimen. The forks shall be run under the specimen as far as possible, and then operated to lift the end 6 inches. Observe the specimen, particularly in the vicinity of the ends of the forks, and record observations. If the specimen can thus be lifted clear of the floor, transport it on the forks over the same 100-foot course, and record observations. If it cannot be lifted, report the length of forks used and state that the specimen could not be carried on the forklift truck at either end.

5.5.5.4.2 Hoisting with slings. If the specimen is less than 40 inches high and weighs less than 500 pounds, a load shall be superimposed on the specimen throughout the test to simulate stacking to not less than either a height of 80 inches or a weight of 1,000 pounds (see 5.5.5.4.1 for examples). Such superimposed load shall not contact the slings or lend reinforcement to the top structure of the package. Two slings without spreaders shall be placed

around the specimen, each passing beneath the specimen, one near each end where indicated on the package and brought to a common point above the center of balance for attachment to the hoist. Locate slings at the outside end of rubbing strips. If this configuration is not possible, the slings shall be located about midway between the center of balance and the ends (see figure 14). Lift the specimen and any superimposed load, and hold suspended for not less than 2 minutes. Observe carefully for any indications of inadequacies and then lower the specimen to the original position. Record observations.

5.5.5.4.3 Sling handling with attachments. Slings shall be attached to two hoisting attachment provisions (lift rings, eyes, lugs, or other devices), one on each side or each end, in a manner to keep specimen upright when hoisted. The length of the slings shall be such that when hoisting, they form angles between 20 and 25 degrees with a horizontal plane (see figure 15). Lift the specimen clear of the floor and hold it suspended for not less than 2 minutes. Observe carefully for any indications of inadequacies of the specimen. Record observations and lower the specimen to the start point. Repeat this procedure with other hoisting attachment provisions until each has been tested. If the specimen has only one attachment provision, attach only one sling to hold the specimen suspended for 2 minutes. If more than one attachment point is provided, remove the superimposed load, if any, from the specimen. Attach one sling to one lifting attachment provision, and lift the specimen clear of the ground (see figure 15). Observe for any indications of inadequacies of the specimen. Record observations and lower the specimen to the start point. Repeat with each lifting attachment point provided on the specimen.

5.5.5.4.4 Hoisting with grabs (see figure 16). Align the grabs on opposite sides or ends of the specimen above its center of balance. Adjust the grab operating chain or cable so that while the specimen is suspended, the grab pressure normal to the surface of the container shall be about 1.2 times the specimen's weight. (For an operating line extending continuously from the hoist attachment downward to a pulley on one grab, then horizontally to a pulley on the other grab and then upward to the hoist attachment, the required pressure will result when the inclined portion of the line forms 45-degree angles (±5 degrees) to the horizontal. For an operating line extending from one grab up to the hoist attachment and then down to the other grab (not horizontally between the grabs), the required pressure will result when the inclined portions of the line form angles of 22½ degrees (±2½ degrees) with a horizontal plane.) Connect the hoist to the lifting point of the grab operating line and slowly lift. If the specimen tilts excessively upon lifting, lower it and relocate the grabs and the lifting point, if necessary, to align with the CG of the specimen. Hoist the specimen clear of the floor, hold it suspended for 2 minutes, and return it to the floor. Observe for any evidence of inadequacy or damage to the container, or deflection of the container that might cause damage or displacement of contents. A record shall be made of observations.

5.5.5.4.5 Pushing. Position the vehicle to abut the end of the specimen near the floor. If a forklift truck is used, the mast shall be vertical or at a slight back-tilt, and the forks shall extend beneath the specimen but shall not support it. Operate the truck to push the specimen along a hard, dry pavement a distance of 35 feet in about 85 seconds at a uniform speed, observing the

specimen for any inadequacies or damage. Record observations. Move the vehicle to abut the side of the specimen near the floor and move the specimen sidewise over the same distance. Record observations.

5.5.5.4.5.1 Pushing test - optional. When specified in the test plan, the pushing test shall be repeated with one end of the container lifted off the ground about 6 inches by the tips of the forks inserted between the skids. The strength of the container structure, as well as the skids, shall survive the test without failure or permanent deformation.

5.5.5.4.6 Towing. Attach a sling to the towline attachment fittings at one end, and connect with a towing vehicle at a height not greater than the fittings. If no fittings are provided, use a sling or gravity-type grabs at the base of the specimen for attaching the towline, or some other feasible arrangement may be devised. Operate the vehicle to tow the specimens along a hard, dry pavement a distance of 100 feet in about 23 seconds at a uniform speed (normal walking speed), observing the specimen for any inadequacies or damage. Record observations and the method of attaching the towline. Then reattach the towline and tow the specimen sideways over the same distance. Record observations.

5.5.5.4.6.1 Towing test - optional. When specified in the test plan, the towing test shall be repeated with one end of the container lifted off the ground about 6 inches by the tips of the forks inserted between the skids. The strength of the container structure, as well as the skids, shall survive the test without failure or permanent deformation.

5.5.5.4.7 Conveying. Place the specimen lengthwise on the conveyor, and convey the specimen back and forth until the specified distance lengthwise is accumulated. Each movement shall be not less than the length of the container. Place the specimen crosswise on the conveyor and convey the specimen back and forth until the specified distance crosswise is accumulated. Observe and record any damage to the package or conveyor and record any difficulties in conveying the specimen. The total conveyed distance shall be 1,000 feet lengthwise and another 1,000 feet crosswise.

5.5.5.4.8 Pallet truck test. Unit loads, which are designed to accept pallet trucks, shall be lifted clear of the ground, transported a distance of at least fifty feet, and lowered. Tests shall be conducted four times, i.e., forks entering the pallet from each side of the load. Any tendency for unit load to be unstable while on forks, or any difficulty in inserting or removing forks, shall be cause for rejection.

5.5.5.4.8.1 Pallet truck test rationale. This test is conducted to determine the ability of the unit load to be safely handled by pallet trucks.

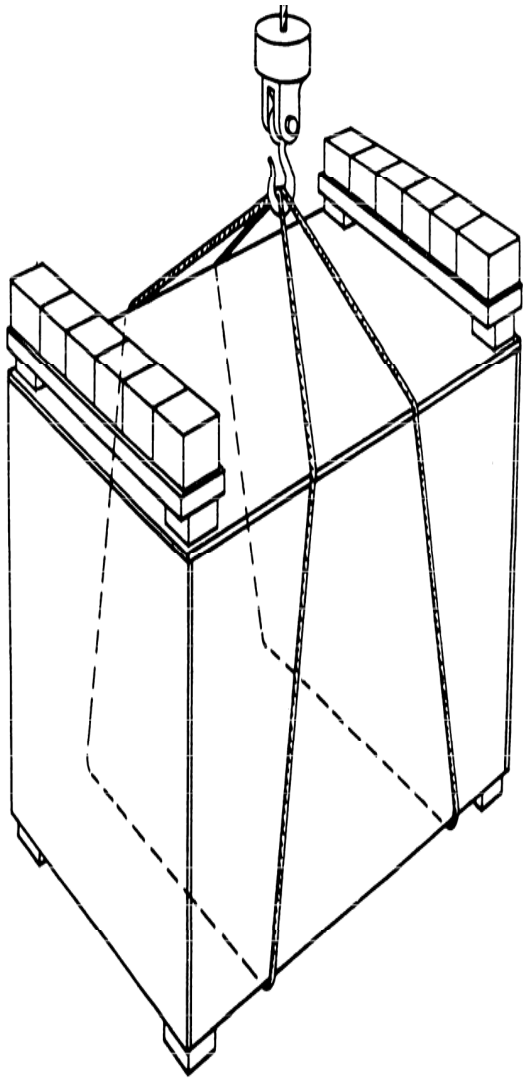


FIGURE 14. Slings placed around specimen with load superimposed.

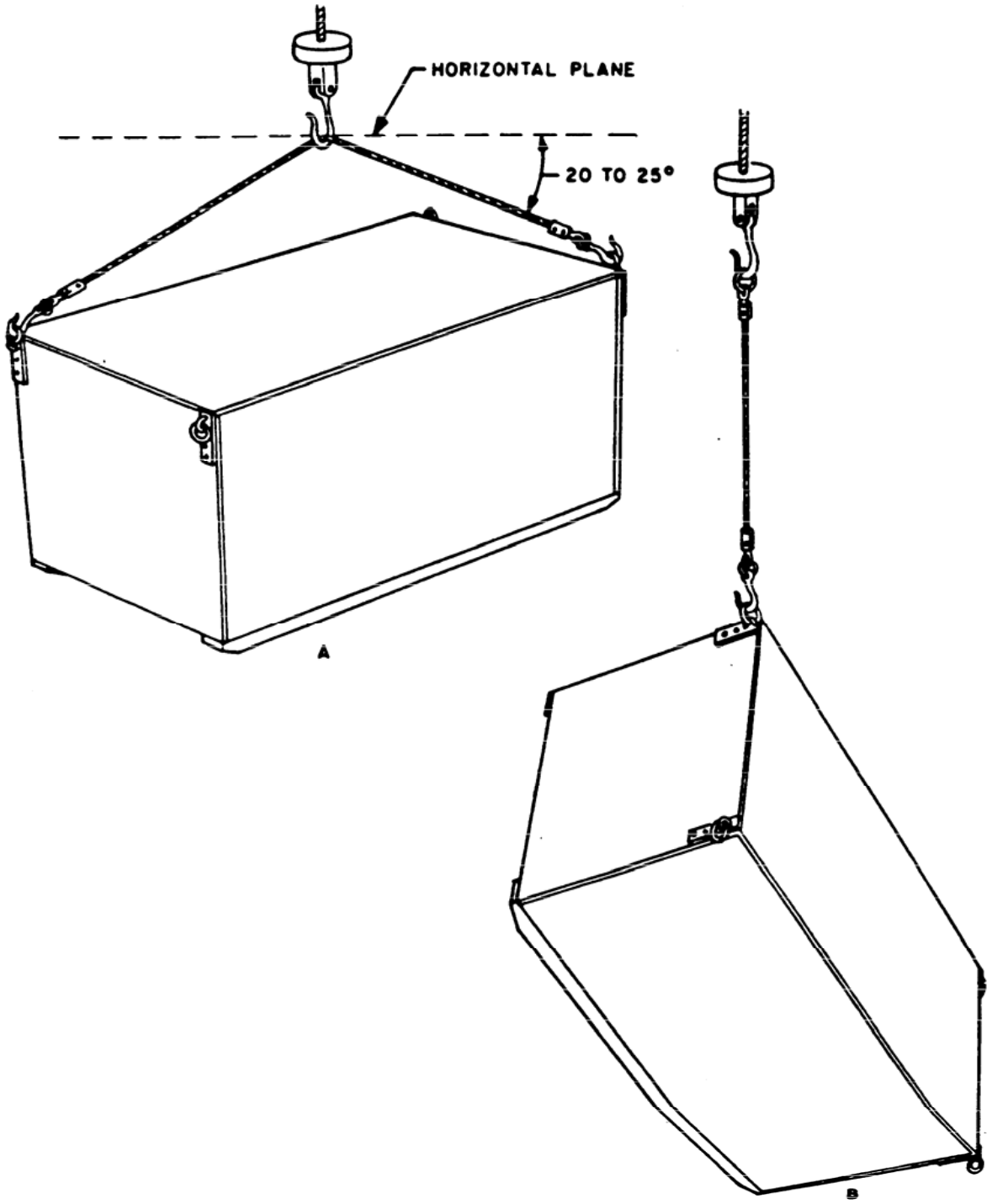


FIGURE 15. Hoisting with sling attachment provisions.

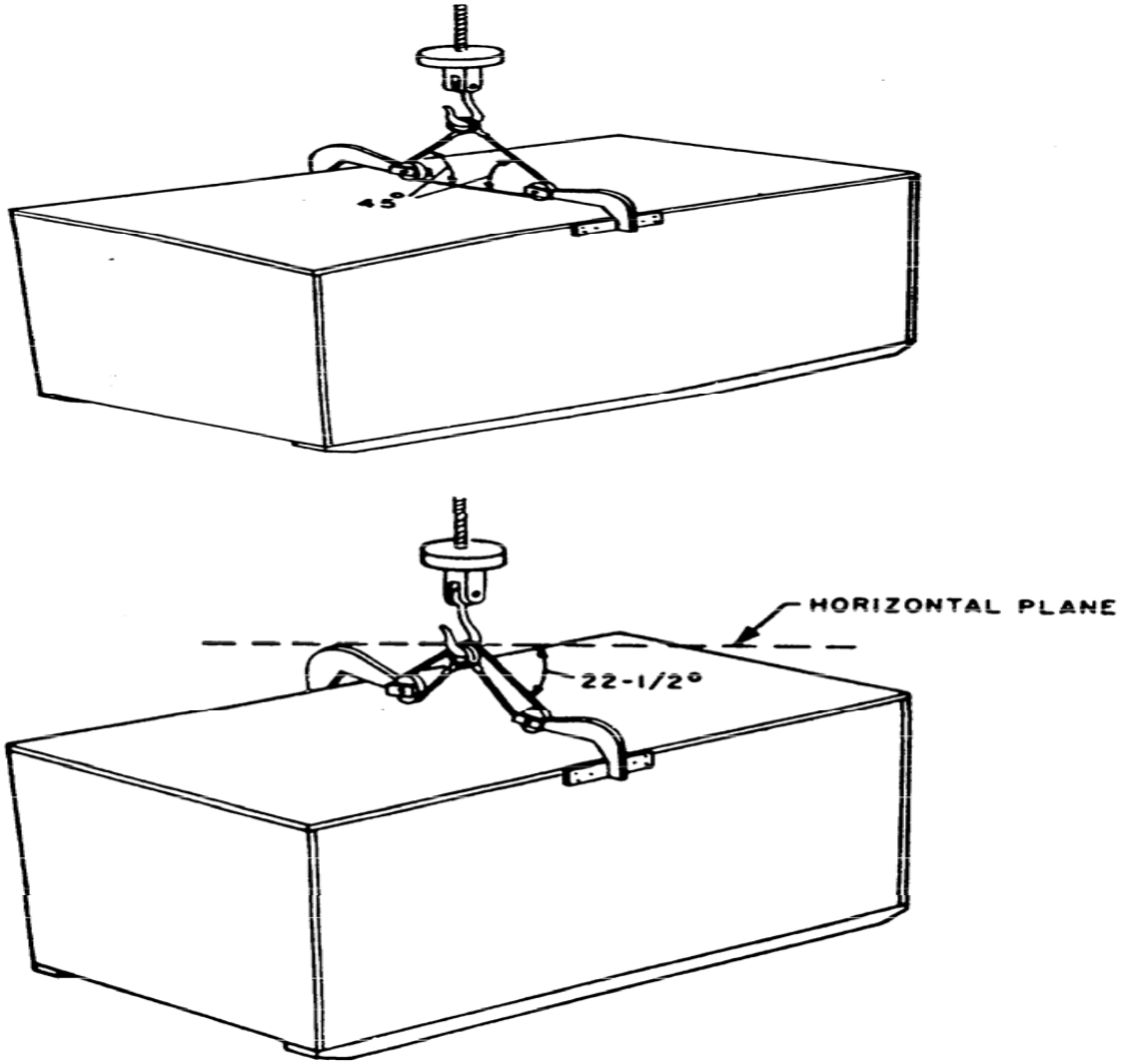


FIGURE 16. Hoisting with grabs.

5.5.6 Test Method 5014 – Rollover Test.

5.5.6.1 Scope. This method provides procedures for indicating the ability of a package to withstand rolling completely over from base to one side, to top, to other side, and onto the base again. This procedure is applicable to packages too large for testing in the revolving drum apparatus.

5.5.6.2 Apparatus. A sufficient area of level, rigid pavement or similarly unyielding surface and a forklift truck, or sufficient manpower, to topple the package for each impact.

5.5.6.3 Test specimen. One container and its contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, shape, and position in the container. The contents, or dummy load, shall be blocked, braced, and cushioned in place, as for shipment. No conditioning of the specimen is required.

5.5.6.4 Test condition. All testing shall be conducted at ambient temperature (see 4.4.2).

5.5.6.5 Test procedure.

5.5.6.5.1 Procedure. The specimen shall be placed in its normal upright position on the pavement. The specimen shall then be slowly tipped toward one side until it topples and falls by its own weight onto the side. Then topple the specimen so that it falls onto its top. Again, topple the specimen so it falls onto its other side and, finally, topple so it falls onto its base. Observe the container and record any evidence of inadequacies or damage that would impair serviceability of the container.

5.5.7 Test Method 5016 – Superimposed Load Test (Stackability, With Dunnage).

5.5.7.1 Scope. This method determines the ability of containers to resist loads, such as those imposed on the bottom container of a stack of similar containers in storage, or on a container supporting top dunnage (see 3.1.7) and superimposed lading; and for determining the ability of the preservation methods and applicable packing levels as specified in MIL-STD-2073-1 to provide protection to the contents.

5.5.7.2 Apparatus. Any convenient method may be used for placing the load on top of the container; such as a hoist, a block and tackle, or by hand. The load may also be applied and maintained by means of a testing machine.

5.5.7.3 Test specimen. One container and its contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, shape, and position in the container. The contents, or dummy load, shall be blocked, braced, and cushioned in place for shipment. No special conditioning of the test specimen is required.

5.5.7.4 Test conditions. All testing shall be conducted at ambient temperature (see 4.4.2).

5.5.7.5 Test procedure.

5.5.7.5.1 Procedure. The specimen shall be placed on its bottom on a flat, level, rigid floor. A prescribed load shall be applied to the top of the container in a manner simulating the effect of similar containers being stacked on top, and the load shall be allowed to remain in place for a prescribed period of time. The bearing of the top superimposed load shall be on the same load-bearing areas that the skids, rubbing strips, or other base members would make on the container top. The time shall be 1 hour with the load being derived from below. When the test is conducted to determine satisfactory performance of a container, the prescribed period of time shall be 1 hour and the prescribed load shall be the larger of the following:

$$W = P \times \frac{16 - H}{H} \times S \quad \text{OR} \quad W = 200 \times A \times S$$

W = Prescribed top superimposed load, in pounds.
P = Weight of the loaded container, in pounds.
H = Height of container, in feet.
A = Area of top of container, in square feet.
S = 2.0 for Level A packing.
S = 1.5 for Level B packing.

NOTE. When the principal support structure of the container is a plastic or other non-metallic material with a tendency to creep or deteriorate when exposed to elevated temperatures or very humid conditions, the test shall be repeated at a temperature of 120 ±5 °F and 90 percent relative humidity for a period of 168 hours. In this latter case, the constant "S" will be 1.0.

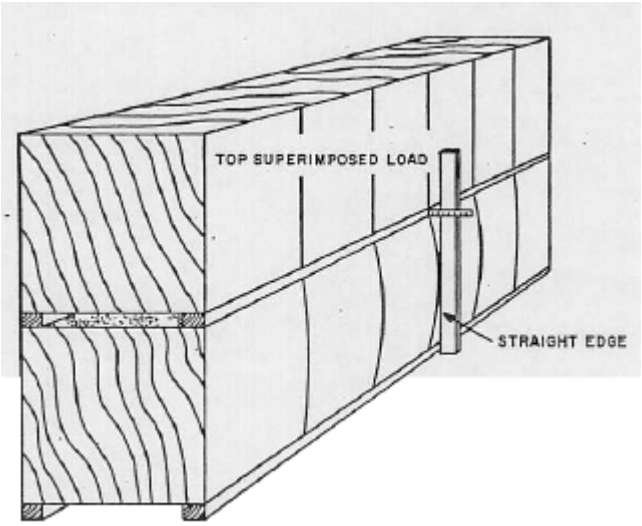


FIGURE 17. Top superimposed load test setup (stackability).

5.5.8 Test Method 5017 – Superimposed Load Test (Uniformly Distributed Without Dunnage).

5.5.8.1 Scope. This method establishes procedures for determining the ability of containers to resist loads superimposed on their tops, by piling without top dunnage (see 3.1.7), many small, heavy packages on the container, and for determining the ability of the preservation methods and applicable packing levels as specified in MIL-STD-2073-1 to provide protection to the contents when the pack is so loaded.

5.5.8.2 Apparatus. Any convenient method such as a hoist, block and tackle, or manual lifting may be used for placing the load on top of the container. A sufficient quantity of weights not greater than 10 by 10 inches in outside length and width shall be provided. Weights shall be boxes loaded with lead or other material.

5.5.8.3 Test specimen. One container and its contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, shape, and position in the container. The contents, or dummy load, shall be blocked, braced, and cushioned in place, as for shipment. No special conditioning is required before testing

5.5.8.4 Test condition. All tests shall be conducted at ambient temperature (see 3.1.1).

5.5.8.5 Test procedure.

5.5.8.5.1 Procedure. The specimen shall be placed on its bottom on a flat, level, rigid floor. Weights shall be placed on top of the container in a symmetrical pattern approximating uniform loading, so that they do not extend over the sides or ends of the top surface. There shall be one weight to each 1-foot square of top surface and each weight shall be whatever is necessary to attain the prescribed load for the top area. The time of loading will be 1 hour and the load shall be derived as follows:

$$W = A \times 50 \times S$$

Where:
W = Prescribed top superimposed load, in pounds.
A = Top area in square feet.
S = 2.0 for Level A packing.
S = 1.5 for Level B packing.

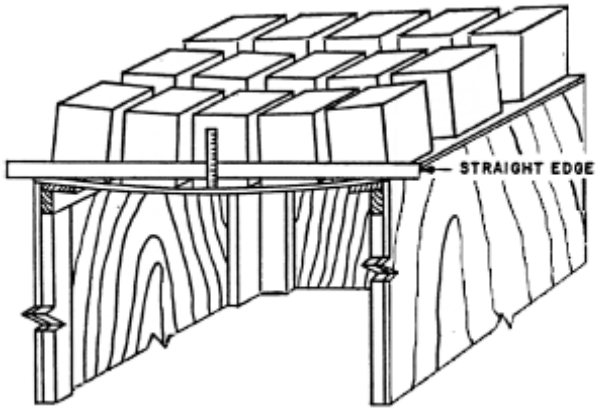


FIGURE 18. Top superimposed load test setup (uniformly distributed).

5.5.9 Test Method 5018 – Tipover Test.

5.5.9.1 Scope. This method determines the ability of large containers (see 3.1.3) to resist the impacts caused by accidental tipping, and for determining the ability of the preservation methods and applicable packing levels as specified in MIL-STD-2073-1 to provide protection to the contents when the pack is so loaded. Containers having widths greater than one-fourth the height shall not be tested in this manner.

5.5.9.2 Apparatus. The test specimen shall be handled with any convenient equipment, such as a forklift truck, a hoist, a block and tackle, or by manual lifting. The container shall be tipped onto a smooth, level, concrete slab, pavement, or similarly unyielding surface.

5.5.9.3 Test specimen. One container and its contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, shape, and position in the container. The contents, or dummy load, shall be blocked, braced, and cushioned in place, as for shipment. No special conditioning of the specimen is required.

5.5.9.4 Test procedure. The specimen shall be placed on its bottom and slowly tipped until it falls freely (by its own weight) on its side, impacting a smooth, level, concrete slab or similarly unyielding surface. Two tipovers shall be made, one on each side or 180 degrees apart on a cylinder.

5.5.10 Test Method 5019 – Vibration (Repetitive Shock) Test.

5.5.10.1 Scope. This method indicates whether or not a package is adequate to prevent damage to either the packaging or the contents when the package is tested unattached on the platform of a package vibration testing machine at frequencies below 5 Hertz. The package bounces on the platform, and receives repetitive shocks and vibration of an indiscrete and variable nature; or the package does not leave the platform. Shocks applied to the package excite each component at its own natural frequency, but when the package does not leave the platform, only those components that vibrate in resonance with the platform vibration are excited. This procedure is useful to predict whether or not such vibrations in transportation are likely to cause damage to the packaging or contents when the shipment is not securely tied down to the floor of the vehicle. Supplementary functional tests of the package contents may be necessary to evaluate functional damage. The procedure is not intended for the development of design parameters for shock and vibration isolation systems.

5.5.10.2 Apparatus.

5.5.10.2.1 Platform. A platform of suitable size and weight-carrying capacity supported on a mechanism that maintains the surface, essentially horizontal as it vibrates the platform, so that the vertical component of the motion is approximately sinusoidal. (A rotary motion of the platform is acceptable.) The amplitude of the vibration shall be ½ inch (1-inch double amplitude). The frequency shall be variable within the approximate range from 3 to 5 hertz and shall be controlled to produce the platform vibration specified in the test procedure.

5.5.10.2.2 Restraining devices. Fences, barricades, or blocking shall be attached to the platform as needed to keep the specimen in position on the platform without restricting the vertical or rotational movements of the specimen.

5.5.10.3 Test specimen. One container and its intended contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, weight distribution, rigidity, shape, and position in the container. The contents, or dummy load, shall be blocked, braced, and cushioned in place, as for shipment. When the intended contents or a fully representative dummy load, such as a reject item, are used in the package, their condition, before and after test, shall be determined by appropriate methods to establish the extent of damage suffered in the test.

5.5.10.3.1 Use of dummy load. When a dummy load is used, unless it is fully representative of the intended contents (a reject item), the ability of the package to prevent damage can be determined only by indirect methods, such as comparison of accelerations measured on the dummy load and fragility factors for the intended contents.

5.5.10.3.2 Specimen conditioning. No special conditioning of the specimen is required. The condition of the specimen and any tests performed prior to the vibration test shall be recorded.

5.5.10.4 Test procedure.

5.5.10.4.1 Specimen placement. The specimen shall be placed on but not fastened to the platform. When the specimen can be shipped in other than an upright position, the specimen shall be tested for equal periods of time in each position. At the midpoint in time for each position, the specimen shall be rotated 180 degrees if the specimen rocks on the platform. Unless failure occurs, the total time of vibration shall be 2 hours for testing in one position; and 3 hours when tested in more than one position.

5.5.10.4.2 Restraining devices. Restraining devices shall be attached to the platform to prevent the specimen from moving off the platform and to prevent excessive rocking of the specimen. The restraining devices shall be adjusted to permit unrestrained movement of the specimen from its centered position, about ½ inch, in any horizontal direction.

5.5.10.4.3 Vibration parameters. With the specimen in one position, the platform shall be vibrated at ½-inch amplitude (1-inch double amplitude) starting at a frequency of about 3 cycles per second. Steadily increase the frequency until the package leaves the platform (i.e., until a $^{1}/_{16}$-inch thick "feeler" may be momentarily slid freely between every point on the specimen and the platform at some instant during each cycle) or until the frequency reaches that at which the maximum platform acceleration is 1 ±0.1 times the acceleration of gravity. If circular input motion is used, table frequency shall be adjusted to assure that one edge of the container leaves the table not less than 0.1875 inch on each cycle. This test is normally conducted at an ambient temperature. While observing to detect development of any failure, continue to vibrate at such frequency until the total time of vibration in the position is completed. Observe and record whether or not the specimen leaves the platform and the frequency maintained. When the specimen is to be tested in more than one position, each position shall be repeated.

5.5.11 Test Method 5020 – Vibration (Sinusoidal Motion) Test.

5.5.11.1 Scope. This method provides procedures for testing packages containing items that may be susceptible to vibration encountered during shipment by common carrier. In particular, the method simulates application of the rectilinear components of the probable shipping vibration environment to packages that are tied down to the floor of the carrier in transit. By testing according to this procedure, it is possible to determine (1) the probability of the packaging to withstand this kind of shipping vibration environment and (2) the probable adequacy of the packaging to protect the item from shipping vibration. To serve this function, the actual item should be used rather than a dummy load, and functional tests, before and after vibration, should be performed. This test method is intended for packages that contain susceptible items which will be tied down to the floor of the carrier (both, not either).

5.5.11.2 Apparatus.

5.5.11.2.1 Platform. A platform of suitable size and weight, carrying capacity supported on a mechanism that shall maintain the surface, essentially horizontal, as it vibrates the platform vertically in linear motion. For this motion, the relationship between displacement and time shall be approximately a sine wave. Controls of the motion shall be capable of producing the test envelope shown on figure 20. Two machines, one to operate below 5 hertz and one to operate above 5 hertz, shall be used.

5.5.11.2.2 Fixture. A fixture shall anchor the specimen to the platform. Neither the fixture nor the platform shall have a natural frequency within the range specified in 5.5.11.4b. If unavoidable, the natural frequencies will be recorded; and the test data at these frequencies shall be interpreted with appropriate reservations.

5.5.11.2.3 Instrumentation. Instrumentation shall have a flat (±5 percent) response within the frequency range specified in 5.5.11.4b.

5.5.11.3 Test specimen. One container and its contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate the contents in weight, distribution, rigidity, shape, and position in the container. The contents, or dummy load, shall be blocked, braced, and cushioned in place, as for shipment. If the intended contents or a fully representative dynamically similar dummy load, such as a reject item, are to be used in the package, their condition, before and after the vibration test, shall be determined by appropriate methods to establish the extent of damage suffered during the vibration test.

5.5.11.3.1 Dummy contents. When a dummy load is used, unless it is fully representative of the intended contents, the ability of the packaging to prevent damage can be

estimated by indirect methods, such as comparison of accelerations measured on the dummy load and fragility factors for the intended contents, or other indirect comparisons.

5.5.11.3.2 Specimen conditioning. No special conditioning of the specimen will be required.

5.5.11.4 Test procedure.

a. Attach the specimen securely on the platform so that no point can lift off the platform during vibration. If the specimens might be shipped in other than an upright position, the specimen shall be in such a position; and if more than one position is reasonable, the test shall be extended and the position changed so that the specimen shall be tested in each reasonable shipping position. Attach electric resistance type strain gages, accelerometers, or other sensors to strategic areas of the specimen, as appropriate, for the purpose of the test.

b. Operate the apparatus for 2 hours, as follows, for each position of the specimen to encompass the test envelope shown on figure 20:

(1) For the first 15 minutes, maintain a constant amplitude at $\pm 1/32$ inch ($1 \pm 1/16$-inch double amplitude) and either vary the frequency to repeatedly sweep at 2 minutes per octave from 2 to 5 hertz and return, or maintain for 5 minutes each a constant frequency at 2, 3, and 5 hertz. This portion of the test may be deleted if it is determined that there are no elements of the test specimen which have a natural resonant frequency of less than 10 hertz. In this case, the total time of the second part of the test shall be increased by 15 minutes (to 120 minutes).

(2) For the last 105 minutes, maintain the relationship between frequency and amplitude shown on figure 20, as the frequency is progressively changed from 5 hertz to the maximum and return to 5 hertz not less than four times. The maximum frequency shall be determined on the basis of specimen weight as specified in table I:

TABLE I. Weight vs. frequency.

Weight of specimen (pound)	Maximum frequency (hertz)
100 or less	500
300 or more	50
Between 100 and 300	(725 - 2.25 x weight)

(3) For apparatus in which the frequency and the amplitude may be varied, continuously sweep the frequency at not less than 2 minutes per octave. For apparatus in which the amplitude may be varied only in increments, the amplitudes of the platform motion, frequencies, and durations shall be as specified in table II:

TABLE II. Variable frequency and amplitude.

Double amplitude constant (inches)	Frequency (f) 1/				Minimum duration of vibration (seconds)
	Sweep between f/1.23 and 1.23f (hertz)			Constant (hertz)	
0.673	5.00	to	7.56	6.15	70
0.295	7.56	to	11.44	9.30	70
0.129	11.44	to	17.30	14.07	70
0.055	17.30	to	26.6	21.6	70
0.036				32.7	70
0.036				49.5	70
0.036	26.60	to	50.0		105
0.036	50.00	to	26.6		105
0.036				49.5	35
0.036				32.7	70
0.055	26.60	to	17.30	21.6	70
0.129	17.30	to	11.44	14.07	70
0.295	11.44	to	7.56	9.30	70
0.673	7.56	to	5.00	6.15	70

1/ Either use the constant frequency or, preferably, sweep the range of frequency at not less than 2 minutes per octave.

(4) During operation of the apparatus, either record or monitor the output of the sensors on the apparatus and on the specimen. Record any indications of resonance.

c. When resonance is indicated, the specimen shall be tested an additional 15 minutes at each resonant frequency. The vibration of the platform shall be as shown on figure 20, and the frequency shall start at resonance and be adjusted, if necessary, to maintain resonance.

d. Inspect the specimen (packaging and contents) and record any evidence of damage. Make appropriate functional or other tests and record results to establish whether or not the item suffered damage during the vibration test.

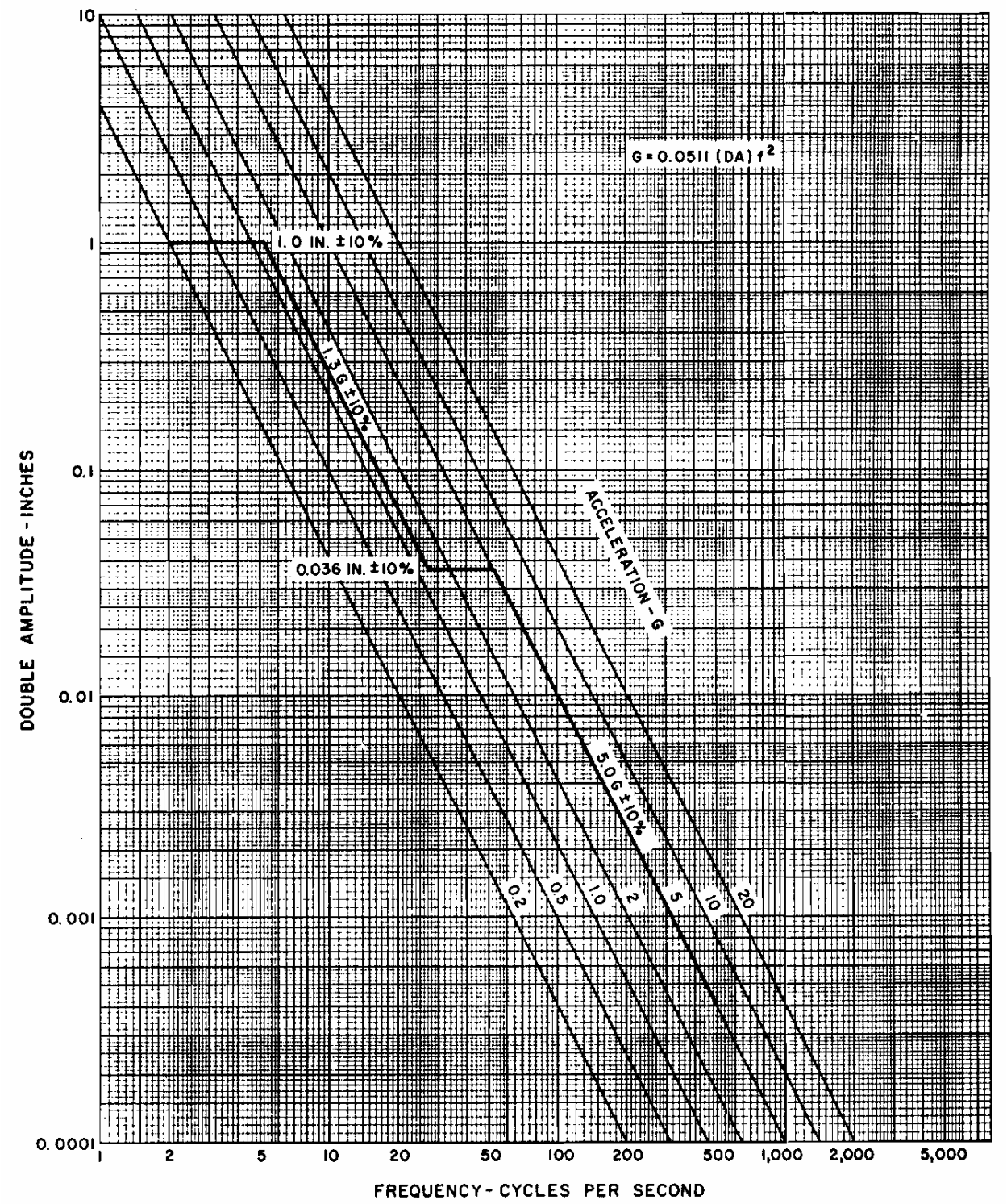


FIGURE 19. Test envelope 2 to 500 cycles per second for vibration (sinusoidal motion).

5.5.12 Test Method 5023 – Incline Impact Test.

5.5.12.1 Scope. This method provides procedures for determining the ability of large containers to resist impacts on their surfaces or edges, and for determining the ability of the preservation methods and applicable packing levels as specified in MIL-STD-2073-1 to provide protection to the contents when the pack is impacted on its surfaces or edges. This test may be applied also to unitized loads. If the container exceeds weight or dimensional limitations of incline impact sled, MIL-STD-810, Method 516.6, Procedure VII, the Pendulum Impact Test may be used.

5.5.12.2 Definition.

5.5.12.2.1 Incline impact tester. The incline-impact tester shall consist of a two-rail steel track inclined 10 degrees from the horizontal, a rolling carriage or dolly, and a rigid bumper (see figure 20).

5.5.12.3 Apparatus.

5.5.12.3.1 Inclined track. The inclined track shall accommodate a carriage equipped with steel wheels, not less than 3 inches in diameter, and a renewable face made of dense hardwood or plywood. The bumper at the bottom of the incline shall be constructed integrally with the track. Its face shall be perpendicular to the direction of movement of the carriage. The bumper shall be faced with dense hardwood members of such thickness, as to resist the impacts without breakage or excessive deflection. The faces of the bumper and the carriage shall be kept free of any projections, such as bolts or nail heads, abrasions, and splits that might affect the test results. The track shall be clean and the wheels well lubricated. The apparatus may also have a cable and winch to aid in pulling the carriage to the elevated end of the track, and an automatic tripping device for releasing the carriage from a predetermined point of the incline. A description of the apparatus is found in ASTM D880.

5.5.12.4 Test specimen. One container and its contents shall constitute a single specimen. The container shall be loaded for the test with the interior packing and the actual contents for which it was designed. If use of the actual contents is not practical, a dummy load shall be substituted to simulate such contents in weight, shape, and position in the container. The contents or dummy load shall be blocked, braced, and cushioned in place, as for shipment. Unless otherwise specified in the contract or order, no special conditioning of the test specimen is required.

5.5.12.5 Test procedure.

a. The specimen shall be placed on the carriage with the surface or edge which is to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage will be brought to a predetermined position on the incline and

released. If it is desired to concentrate the impact at any particular position on the container, a 4- by 4-inch timber may be attached to the bumper in the desired position before the test. No part of the timber will be struck by the carriage. The position of the container on the carriage and the sequence in which the surfaces and edges are subjected to impacts may be at the option of the testing activity and shall depend upon the objective of the tests. Unless otherwise specified in the contract or order, when the test is conducted to determine satisfactory performance of a container or pack the specimen shall be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified in the contract or order, the velocity at time of impact (which may be assumed equal to twice the average velocity) will be 7 feet per second.

b. A record shall be made of each impact to show velocity at impact and any changes or breaks in the container, such as apparent racking, nail pull, or broken parts and their locations. The packing (blocks, braces, cushions, or other devices) and the contents shall be examined carefully and a record made of their condition.

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FIGURE 20. Incline impact test setup.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. This standard is a listing of uniform test methods that have been developed to evaluate properties of materials and containers used in military packaging applications. It is intended that the test methods detailed in this standard be referenced (by number) in packaging specifications. This eliminates the need to repetitively detail any standard test method in each specification.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of the standard.

6.3 Subject term (key word) listing.

Blocking resistance	Oil resistance (delamination)
Contact corrosivity	Resistance
Curl resistance	Seam strength
Drop	Superimposed load
Electrostatic properties	Vibration
Flex testing	Volatile corrosion inhibitors
Impact	Water
Leakage	Water vapor transmission rate

6.4 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

CONCLUDING MATERIAL

Custodians:
Army – SM
Navy – AS
Air Force – 69

Preparing activity:
Navy – AS
(Project PACK-2013-002)

Review activities:
Army – AR, AV, CR, GL, MI, MR
Navy – OS, SA, SH
Air Force – 99
DLA – DH

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.