Performance Oriented Packaging Testing

Policies & Procedures

Prepared by:

USAMC LOGSA Packaging, Storage, and Containerization Center
(AMXLS-AT)
11 Hap Arnold Boulevard
Tobyhanna, PA 18466-5097

In Support of:

U.S. Department of Transportation
Pipeline & Hazardous Materials Safety Administration
East Building, PHH-41
1200 New Jersey Avenue, SE
Washington DC 20590

Anthony Lima
Packaging Program Manager/Senior Investigator
Special Investigations
Office of Hazardous Materials Enforcement
(856) 265-3054 (mobile)
(302) 336-9693 (e-fax)
anthony.lima@dot.gov <mailto:anthony.lima@dot.gov>
website: hazmat.dot.gov

Effective Date: October 22, 2008 Version 1.2

TABLE OF CONTENTS

1. Purpose. The purpose of this procedure is to provide guidance on the procedures to be followed by USAMC LOGSA PSCC when requested by US DOT PHMSA to perform packaging testing.

2. Scope. USAMC LOGSA PSCC conducts testing of UN standards packaging intended for hazardous materials transportation. Independent compliance testing of performance certifications is intended to validate that designs being manufactured are capable of passing all applicable tests prescribed in the Hazardous Materials Regulations (HMR), Title 49 Code of Federal Regulations. Reimbursable funding for USAMC LOGSA PSCC to perform tasks and purchase samples is provided by means of an Interagency Agreement.

3. Technical Task Directives (TTDs). Individual project taskings are directed to USAMC LOGSA PSCC in writing via a numbered TTD from the US DOT PHMSA.

   3.1 Delivery of the TTD by e-mail is preferred, though by facsimile, courier, or US mail is acceptable.

   3.2 A standard format for the TTD is used.

   3.3 Each TTD shall be assigned a unique TTD Number by the US DOT PHMSA. The 8-digit number is comprised of a 2-digit year, 3-digit investigator (requestor) identification number, followed by a 3-digit sequence code as assigned by the investigator (requestor).

   3.4 Each TTD shall identify the complete UN certification markings of the packagings to be tested including the year.

      3.4.1 The determination of whether the packaging is to be tested as a single, combination, or composite packaging is to be indicated on the TTD.

      3.4.2 When more than one certification mark is present on the packaging, the TTD will stipulate which mark or markings the packaging is to be tested to. Note. This determination affects the quantity to be purchased/acquired.

   3.5 Each TTD shall name the "Vendor" and "Manufacturer" as those data elements for tracking.

   3.6 Each TTD shall identify the HMR testing references to be followed, i.e., specify what tests outside of HMR Subpart M, such as Cobb Test for Water Absorptivity (HMR §178.516). The applicable year (effective date) of the HMR to be followed is to be indicated if other than the current.

      3.6.1 The US DOT PHMSA is to specify in the TTD whether the design type is to be tested for air eligibility in accordance with HMR §173.27.

3.7 Each TTD shall be accompanied by the applicable design qualification test report and any applicable periodic retest reports.

3.8 As there is no applicable previous test report for reconditioned drums, each TTD for reconditioned drums shall be accompanied by the applicable closing/assembly instructions.

3.9 When applicable, each TTD shall be accompanied by the Special Permit, approval, or "W" approval documentation, or any additional documentation as needed.

3.10 The TTD shall indicate whether the closures (where applicable) are vented or non-vented. If vented, directions for whether non-vented closures will be provided, are to be purchased or sealed using epoxy.

3.11 A file having the TTD Number shall be established upon receipt of either the TTD or the acquisition directive (see paragraph 4). The file contents with regard to the TTD shall contain no less than the TTD, all correspondence relating to clarification of any test issues, a master copy of the previous test reports(s), a master copy of the closing instructions (when applicable), and a master copy of any applicable approval or Special Permit.

4. Procedures for Acquiring Test Samples.

4.1 USAMC LOGSA PSCC acquires the samples to be consumed in testing from the source(s) and in the quantity(s) directed by US DOT PHMSA via a written acquisition directive (e.g., Request for Purchase). For audit and tracking purposes a separate acquisition directive for each TTD is required. The acquisition document is to be directed to the assigned USAMC LOGSA PSCC team leader. E-mail is preferred, though by facsimile, courier, or US mail is acceptable.

4.2 The acquisition directive is to specify the source company name, address, phone number, and POC for the acquisition. A TTD Number has to have been assigned and is to be referenced on the acquisition directive. A cost estimate including an itemized list of *all components needed to replicate the previous testing*, and any shipping, handling, transportation, or miscellaneous charges is to accompany the acquisition directive. Each component of the design to be acquired is to be identified in sufficient detail to facilitate acquisition and to provide a *complete* item description for the test report, (e.g., manufacturer (if different), part no., catalogue no., serial no., type, grade, style, class, material, etc., as applicable). The complete UN marking (including year) for the design to be tested is to also be referenced on the acquisition directive. The acceptance of the credit card by the source for total purchase less than $3,000 must be established by the

US DOT PHMSA prior to request for acquisition and is to be so indicated on the acquisition directive.

4.2.1 Prior to having submitted the acquisition document, the US DOT PHMSA POC is to have affixed an evidence label to every specimen in the sample to be acquired. The TTD Number is to have been written on each evidence label.

4.2.2 See paragraph 5.2 if evidence tape is missing when items are received.

4.3 Upon receipt of the acquisition directive and the cost estimate, USAMC LOGSA PSCC is to make preliminary contact with the sources(s) to arrange for acquisition. No sample can be shipped prior to commitment by the credit card holder, check writer, or contract official, as appropriate for the purchase. Shipments received without USAMC LOGSA PSCC direction/permission to ship will be refused, to be returned to the shipper without payment.

4.4 Prior to purchase USAMC LOGSA PSCC must have received a legible copy of the periodic retest and/or design qualification test report(s) applicable to the design being acquired for compliance testing. See paragraph 3.7.

4.5 For any component of the design not available directly from the named source, e.g., box closing tape for combination packagings, gel packs, inner packagings, etc. the US DOT PHMSA contact shall provide written guidance for the acquisition of components.

4.6 Prior to purchase US DOT PHMSA must notify USAMC LOGSA PSCC of any applicable Special Permit, approvals, or "W" design authorization, and US DOT PHMSA must provide a copy of the SP, approval, or authorization to USAMC LOGSA PSCC prior to purchase. The TTD must specify if applicable Special Permit, approval, or "W" design testing is to be accomplished. See paragraph 3.9.

4.7 For designs, components, and/or special needs (e.g., application tools) to be purchased the terms of the Federal and Army acquisition regulations must be followed. The credit card purchase limit is $3,000 to include transportation and any handling or miscellaneous fees. A check can be written if the credit card is not accepted with a limit of $2,500. A credit card can be used for a single purchase greater than $3,000 ***only*** if a General Services Administration schedule applies to the purchase. If the total cost for a group of designs from the same source exceeds the $3,000 limit including transportation, handling and associated fees, separate purchases and purchase requests (acquisition directives) will be required. The acceptance of the credit card must be established by the US DOT PHMSA prior to request for acquisition and shall be indicated on the acquisition directive.

4.8 Once the TTD, cost estimate, previous test report(s), and where applicable, approvals have been determined to be complete, USAMC LOGSA PSCC, following internal organization purchasing procedures, shall acquire the samples per the US DOT PHMSA directive.

4.9 A file having the TTD Number shall be established upon receipt of either the acquisition directive or the TTD. The file contents with regard to acquisition shall contain no less than the acquisition directive, all correspondence relating to clarification of any purchase issues, a copy of the internal purchase email traffic approving the purchase, a master copy of the previous test reports(s), a master copy of the closing instructions (if provided), and a master copy of any applicable approval or Special Permit. When the samples and/or other components or related items are received a copy of the signed receipt document(s) are to be in the file also. When there is no receipt document, such as a GBL, the shipping labels (or a copy) should be signed, dated, and filed.

4.10 Upon receipt of each TTD USAMC LOGSA PSCC is to establish a separate record in the automated status/tracking program and complete data elements, as applicable.

4.10.1 A copy of the status is to be provided electronically to the US DOT PHMSA Packaging Program Manager NLT the 5th work day of each month.

4.10.2 A data base record is to be established and populated as data elements become known or available.

4.11 Bags having a stitched closure are to be acquired already filled with an inert material of similar physical characteristics of the original tested lading. The bags are to be stitched closed in the same manner as originally tested. Associated filling/closing costs are to be included in the cost estimate.

5. Procedures Upon Receipt of Samples.

5.1 When a shipment of specimens is received, the receiving document shall be signed and dated in accordance with organizational internal procedures. A copy shall be put in the file for *each applicable* TTD. For small parcel deliveries without documents, the label (or a photocopy thereof) shall be signed, dated, and placed in the file by TTD.

5.2 The specimens shall be checked for evidence labels. If missing altogether or only one on the exterior containment, the US DOT PHMSA shall be contacted for guidance. Evidence labels are to only be applied at direction of US DOT PHMSA.

5.3 Once the packing list is used to confirm the materials received, it is to be filed by each applicable TTD. A copy is to be filed for each TTD covered by the list in the case of multiple TTDs in one shipment.

5.4 Within 2 work days of receipt, the received materials shall be examined for condition and completeness. Any damage or discrepancies shall be noted for the record and the US DOT PHMSA is to be notified in writing. Damage shall be documented with video footage and/or photographs.

5.5 In no particular order each specimen in the sample is to be assigned a specimen number, to be written in a contrasting color in a prominent location on the packaging. Likewise, each component is to be identified in the same manner. Multiple inner packagings or components for each TTD are to be suffixed with an alpha character, e.g., 10A, 10B, etc.

5.6 As part of the receipt process USAMC LOGSA PSCC shall compare the test report(s) to the design that was received and determine if the design received and the originally tested design are the same. If the designs or applicable time periods do not match, US DOT PHMSA shall be contacted in writing for resolution. Testing will not be scheduled until resolution is made.

5.7 As part of the receipt process USAMC LOGSA PSCC shall review the test reports(s) and compare to the design received and determine if previous testing was in accordance with HMR and this procedure. Points requiring clarification are to be made in writing to US DOT PHMSA. Testing will not be scheduled until resolution is made.

5.8 As part of the receipt process USAMC LOGSA PSCC reviews the *applicable closing and assembly instructions in the previous test report* for completeness, application to the design intended to be acquired, and to determine if they match the any closing instructions provided with or marked on the packaging. If the closing instructions do not match or there are other questions about closing, US DOT PHMSA shall be notified in writing for resolution. If unique tools are required for closing and assembly, arrangements to acquire the tools shall be made prior to/during acquisition processing. Testing will not be scheduled until resolution is made, and/or any unique tools are received.

5.9 After identification, specimens are to be unitized, as applicable, and moved to the pre test staging area where they will remain until inducted into test. Specimens are to be staged in the "as received" configuration, except as noted below.

5.9.1 Fiberboard boxes and the associated components are to be staged on wire racks and located in standard conditions (23º C, 50% RH). Space for air circulation around all 6 sides for assembled boxes and both sides for flat boxes is necessary. In accordance with best laboratory practices the date and time into and out of standard conditions shall be recorded for each specimen.

5.9.2 Open head drums are not to be stacked during staging.

5.10 Combination packagings and small single packagings (e.g., pails) are to be staged in standard conditions (23º C, 50% RH) for a minimum of 3 days (72 hr).

5.10.1 At the conclusion of this initial staging, the last specimen in the order including components will be weighed, measured, filled, assembled/closed, and documented. This specimen as a whole will typically not be tested unless directed by the US DOT PHMSA PPM. Individual components may be testable.

5.10.2 After weighing and measuring, all test calculations will be completed using these initial measurements.

5.10.3 Measurements and calculations will be compared to the previous test report and other provided documentation, as applicable. Discrepancies are to be directed in writing to the US DOT PHMSA PPM for resolution before testing can be scheduled.

5.11 The data base record for the TTD is to be populated within 3 work days of receipt.

6. Scheduling Procedures for Testing.

6.1 To the greatest extent possible, USAMC LOGSA PSCC is to test designs in the order received, as determined by receipt of all specimens, components, tools, documentation, etc., as applicable. US DOT PHMSA PPM reserves the right to reprioritize the order of testing.

6.2 To the greatest extent possible, testing is to be completed and results reported (videos and signed report posted to web site) to US DOT PHMSA within 12 weeks of receipt of all associated materials, supplies, and equipment. US DOT PHMSA PPM reserves the right to reprioritize the schedule.

7. Design Documentation.

7.1 The received design is to be compared to the previously tested design to determine if the test specimens are alike in construction and within the applicable production period. Any differences are to be reported to the US DOT PHMSA for resolution before proceeding. Testing and/or documentation will not proceed until resolution has been received from the US DOT PHMSA in writing.

7.2 All specimens received for testing are to be examined for production consistency, e.g., same year of manufacture, same closures, etc.

7.3 One design specimen, usually the last specimen in the order including components, is to be filmed showing all markings, including labels, embossments, printing, specifications, instructions, as applicable. Photographs may be taken to record the design for the formal written report. See paragraph 5.10.1.

7.4 Measurements will be taken and reported in metric units. Where English units are necessary, e.g., as input to a test apparatus, conversion from metric to English will be only at the final step.

7.5 The same design specimen will be weighed and filled (both max. & 98% for liquids or 95% for solids) on film. For liquids, maximum capacity (to overflowing) and 98% fill will be based on weight using tap water. For solids, 95% of maximum is based on volume, using the gross tested mass from the UN marking.

7.6 Weights, measurements, and calculations are to be compared to the previous test report. Any significant differences are to be reported to US DOT PHMSA in writing. Testing and/or documentation will not proceed until resolution has been received from US DOT PHMSA in writing. See paragraph 5.10.

7.7 All six box faces are to be identified (marked) on each specimen in accordance with the numbering scheme given in ASTM D 5276. Drum and bag identification to be as stated in ASTM D 5276.

7.8 The same design specimen will be closed according to the provided previous test report. The closing process of the first test specimen prepared for testing is to be recorded on film. Unless otherwise specified by the HMR, closure/closing will be accomplished in ambient conditions.

7.9 Video (from tape or computer hard drive) including raw footage is to be transferred to DVD for permanent storage in accordance with records management regulations of the US DOT PHMSA. A copy on DVD is to be kept in the official file folder.

8. Preparation for Testing.

8.1 Hazardous materials as intended lading or any replacement lading deemed hazardous to the health or safety of personnel or the test facility or for disposal will not be used by USAMC LOGSA PSCC in testing. Replacement is authorized by HMR §178.602(b) and §178.602(c). Specifically, the replacement lading to be used in testing is to have the same physical characteristics as the intended hazardous lading.

8.1.1 Except for liquids, to the greatest extent possible, and if it is itemized and identified, and *is in accordance with the HMR*, USAMC LOGSA PSCC will replicate the test load used in previous reported testing.

8.1.2 When the intended lading is liquid, USAMC LOGSA PSCC uses water as the test liquid for vibration, stacking, and drop tests. Replacement of liquid hazardous lading with water for the drop and stacking tests is specifically authorized by §178.602(b) and §178.603(e)(2) HMR. Replacement of hazardous lading with an water/antifreeze solution for the cold-conditioned drop test is specifically authorized by §178.602(c) and §178.603(c) HMR.

8.1.3 For liquid or solid infectious substances, USAMC LOGSA PSCC uses water or water/antifreeze (propylene glycol) as the test lading as stipulated in §178.609(b) HMR.

8.1.4 The use of any another substance with or as a replacement for water or antifreeze solution will be as directed by the US DOT PHMSA in special circumstances only.

8.1.5 For regulated medical waste containing sharps, the test load is to replicate the previous test load including any specified sharps container. When syringes are used, they will be intact without protective covers. Lab slides, jars, etc. will be whole when initially packed as the test load.

8.2 When the UN mark indicates "S" for solid in a single packaging, for the test load (if the previous test load can not be replicated) USAMC LOGSAPSCC uses a mixture of available, inert granular materials to meet the gross tested mass mark while conforming to a minimum 95% by volume fill.

8.3 When pre-test conditioning is required by the HMR, USAMC LOGSA PSCC conditions in accordance with ASTM D 4332. For cold conditioning, USAMC LOGSA PSCC uses a water/propylene glycol antifreeze solution at ambient conditions when the packaging is filled. Unless otherwise specified by the HMR, USAMC LOGSA PSCC conducts pre-test conditioning for a minimum of 72 hours.

8.4 Vented closures will not be sealed or disabled unless specifically directed by HMR reference, previous test report, or US DOT PHMSA PPM.

8.4.1 Unless a non-vented closure is supplied, USAMC LOGSA PSCC will seal a vented closure for the leakproofness test since §178.604(c)(2) HMR stipulates the vented closure must be sealed or can be replaced.

8.4.2 Unless a non-vented closure is supplied, USAMC LOGSA PSCC will seal a vented closure for the hydrostatic pressure test since §178.605(c)(2) HMR stipulates the vented closure must be sealed or can be replaced.

8.5 Special Preparation for Open Head Drums and Pails

8.5.1 For liquids when a removable head drum/pail is received with the head in place, and the head is fitted with one or more plugs, USAMC LOGSA PSCC will fill the container through one plug. The head and other plug(s) as applicable will not be removed. USAMC LOGSA PSCC will follow the closing instructions from the previous test report only for the plug used for filling. USAMC LOGSA PSCC will verify the torque settings of any other plugs or locking rings (without loosening or removing), as stated in the closing instructions.

8.5.2 For liquids when a removable head drum/pail is received with lids separate, not in place, maximum capacity is determined by filling to overflowing then installing the head in accordance with the closing instructions in the previous test report. Maximum capacity is determined by weight after closing and drying the exterior surface.

8.5.3 For liquids when a removable head has fittings and is received with lids separate, not in place, the container will be filled before installing the head (lid) and closed as in 8.5.2 above. Any sealed fitting will be tested in the "as received" condition unless otherwise stated in the previous test report. Without loosening or removing, USAMC LOGSA PSCC will verify the torque settings of any other plugs or locking rings as stated in the closing instructions.

9. Non-Bulk Testing Procedures.

9.1 For Intermediate Bulk Containers (IBCs) see appendix E.

9.2 Unless otherwise directed, USAMC LOGSA PSCC conducts only the applicable performance tests stipulated in HMR Subpart M for the non-bulk design type. The UN *marking on the packaging* determines the parameters for the applicable tests, e.g., Packing Group, hydrostatic pressure, gross tested mass, etc. If a test method is not specifically called out, USAMC LOGSA PSCC follows ASTM D 4919.

9.2.1 The US DOT PHMSA is to specify in the TTD whether the design type is to be tested for air eligibility in accordance with HMR §173.27.

9.2.2 Unless otherwise directed, when *only* a design qualification previous test report has been provided USAMC LOGSA PSCC conducts design qualification tests applicable for the design (HMR §178.601(c)(1)).

9.2.3 Unless otherwise directed, regardless of whether a periodic retest previous test report has been provided by the US DOT PHMSA, USAMC LOGSA PSCC conducts those tests applicable for design qualification (HMR §178.601(c)(1)). A vibration test (HMR §178.608*)* is conducted to ascertain capability (HMR §173.24a(a)(5)). In lieu of the design qualification tests, USAMC LOGSA PSCC will conduct only those tests stipulated for periodic retesting (HMR §178.601(c)(2)) only when so indicated on the TTD.

9.2.4 USAMC LOGSA PSCC determines the pass/fail of each specimen tested based on the pass/fail criteria stated in the HMR for the test conducted based on the design or packaging standard. Discretionary pass/fail criteria as cited for the test may be used, e.g., No deterioration noted that could adversely affect transportation safety, or no distortion of the container likely to reduce its strength.

9.2.5 When air eligibility (HMR §173.27) is specified, USAMC LOGSA PSCC conducts both a hydrostatic pressure test and a low pressure (altitude) test. The test protocol not used for previous testing is reported as 'for information only'.

9.2.6 Unless otherwise directed by the US DOT PHMSA, USAMC LOGSA PSCC conducts applicable materials tests that are stated in the standards for the design being tested or a specified packaging paragraph, e.g., ISO 535 in HMR §178.516 for 4G packagings, or ASTM D 1922 and ASTM D 1709 for regulated medical waste inner packagings (red bags) in large packagings in HMR §173.197(e)(i).

9.2.7 Unless otherwise directed by the US DOT PHMSA USAMC LOGSA PSCC does not ascertain chemical compatibility of plastics packagings and the intended lading. Compatibility testing (a procedure specified in appendix B to part 173, as required by HMR §173.24(e)(3)(ii)) is only required for *plastics* packagings intended to contain *liquid* hazardous materials.

9.2.8 USAMC LOGSA PSCC conducts material tests not otherwise required or deemed capable for a design type, and/or any other tests *only* when directed by the US DOT PHMSA, e.g., Mullen Burst or Edge Crush tests of fiberboard.

9.3 Drop Test (HMR §178.603). USAMC LOGSA PSCC conducts the drop test (HMR §178.603) in accordance with ASTM D 5276.

9.3.1 When a choice of orientations is provided in the HMR, USAMC LOGSA will test from the same orientation(s) as noted in the previous test report, if identified and if in accordance with the HMR.

9.3.1.1 For 4G fiberboard box combination packagings, USAMC LOGSA PSCC tests both a bottom corner and a top corner if sufficient packagings are available. The corner orientation not used as reported in the previous test report is reported as 'for information only'. Unless otherwise stated in the previous test report, for the corner orientation, the top and bottom corners intersecting with the manufacturer's joint edge are the orientations tested. Unless otherwise stated in the previous test report or directed, USAMC LOGSA PSCC designates side 4 (defined by ASTM D 5276) as the long side to be tested and side 6 (as defined by ASTM D 5276) is the short side to be tested.

9.3.1.2 For drums/pails/jerricans the next weakest part to be tested by USAMC LOGSA PSCC is determined from the previous test report. If none stated, US DOT PHMSA is to provide guidance in writing before testing is undertaken.

9.3.1.3 For drums/pails/jerricans the choice of top diagonal or bottom diagonal chime or circumferential edge is determined from the previous test report. If none stated, US DOT PHMSA is to provide guidance in writing before testing is undertaken.

9.3.1.4 For drums/pails/jerricans the decision where along the orientation the impact should be is determined from the previous test report. If none stated, US DOT PHMSA is to provide guidance in writing before testing is undertaken.

9.3.2 USAMC LOGSA PSCC computes the drop height for liquids packagings based on the marking and the actual weights and measures of the packagings received. Either tap water for non-plastics or a water/antifreeze solution (propylene glycol SG @ 1.0) for plastics will be used as the liquid test lading. For combination packagings USAMC LOGSA PSCC will compute the drop height following the procedure in appendix A (Problem Statement #3) as authorized by HMR §178.603(e)(2).

9.3.2.1 USAMC LOGSA PSCC uses the specific gravity stated in the previous test report to calculate the drop height when the weights and measures of the tested packagings are comparable to the packagings and components received.

9.3.2.2 When the actual weights and/or measurements are not comparable to those reported in the previous test report, US DOT PHMSA PPM will be notified in

writing. USAMC LOGSA PSCC will derive the specific gravity following the procedure in appendix A (Problem Statement #2).

9.3.2.3 When the specific gravity is not stated in the previous test report, USAMC LOGSA PSCC will derive the specific gravity following the procedure in appendix A (Problem Statement #2).

9.3.2.4 For variation 2 (V-marked) packagings requiring an adjusted PG I drop height (HMR §178.601(g)(2)(i)), USAMC LOGSA PSCC follows the procedures in appendix B.

9.3.3 Commercially available drop fixtures for use with a hoist are used by USAMC LOGSA PSCC to the greatest extent possible for filled containers that exceed the capacity of the free fall drop arm tables. Rigging may not influence the test results or affect the packaging.

9.3.3.1 USAMC LOGSA PSCC tests the HMR stated minimum number of packagings for the test, prepared as for transport (HMR §178.602(a)).

9.3.3.2 Barring equipment malfunction, USAMC LOGSA PSCC tests all specimens in each sample using the same drop table or hoist. Alternative equipment may be utilized in the event of equipment malfunction.

9.3.3.3 The choice of conducting the drop test within the laboratory or in outside conditions is dependent on the physical container constraints and required drop height. USAMC LOGSA PSCC utilizes the outside test facility only when warranted. Ambient outside test conditions are noted and are not cause to void or cancel a test.

9.3.4 Packagings will be positioned and released from the required orientations. Aerodynamic influences and/or imbalance of inner configurations may affect the orientation(s) actually impacted and will not be cause for voiding a test. Secondary impacts are acceptable and are not cause for voiding a test.

9.3.4.1 When there is a premature release or fall, using the same specimen the test will be repeated from the prescribed drop height if there is no damage to the container exterior deemed to have an influence on the results (e.g., tape on a 4G splits and flaps remain intact) and there is no noted leakage. The results will be voided if failure results on the second drop, and included if there is no failure.

9.3.4.2 When there is a premature release or fall, if there was damage to the container exterior deemed to have an influence on the results (e.g., bent chime,

inners exited the outer) the test will be repeated from the prescribed drop height using a different, untested specimen.

9.3.4.3 When there is a premature release or fall and leakage occurs, the test will be deemed a failure and no repeat with a different specimen will take place for the initial required orientations.

9.3.4.4 Providing the orientation and drop height were as intended a release before the video equipment is available is not cause to void the test.

9.4 **Leakproofness Test (HMR §178.604).** Two leakproofness testing methods permitted by HMR §178.604 are utilized by USAMC LOGSA PSCC. The decision about which method to use is based on the previous test report and the type container.

9.4.1 All closures are in place, closed as for transport in accordance with closing instructions in the previous test report. Vented closures may be replaced or sealed per the TTD.

9.4.2 The air pressure to be applied is determined by the Packing Group in the UN marking, and is applied for a minimum of 5 minutes (HMR §178.604(d) & (e)), duration starting after container expansion for rigid containers.

9.4.3 Each packaging is separately tested.

9.4.4 Two tire fittings with the cores removed are fitted into drilled holes and sealed with a rubber gasket (see fig. 3, app D).

9.4.4.1 For tight head single and composite packagings, and open head single packagings with a 2-inch or larger plug, the holes are drilled in the top head located on a 6-inch semicircle around a 2-inch plug. A template shown in appendix D is used to replicate the semicircle. Note. When using the restrained under water method, the fittings *may* be placed in the side of the container when the container is to be placed horizontally under the water.

9.4.4.2 For removable head drums/pails the holes are drilled in the approximate center of the head and the fittings installed before the head is positioned and closed. The use of a pneumatic closing apparatus requires the use of a platen with an accommodation for the air fitting. The fittings may be placed off-center if a center placement interferes with the closing apparatus.

9.4.5 Pressurized air is applied through the fitting attached to an air hose (line); the pressure gauge is in the second fitting. The air source is closed upon reaching the designated pressure (after container expansion).

9.4.6 **Restrained under water (HMR §178.604(d))**.

9.4.6.1 For rigid packagings USAMC LOGSA PSCC conducts the leakproofness test (HMR §178.604) in accordance with Federal Test Method Standard 101C, Method 5009.1, Pneumatic pressure technique with the packaging submerged under water. Note. FTMS 101C is no longer active, having been superceded by MIL-STD-3010B. FTMS 101C method 5009.1 is preferred for clarity.

9.4.6.2 The empty packaging is restrained horizontally under water at ambient temperature by means of a weighted grate for an open tank or the lid of a tank equipped with a built-in restraining plate.

9.4.6.3 Leakage of air is demonstrated by a *steady stream* of bubbles defined to be continuous and uniformly distributed. Also, the container is considered sealed if there is no change in pressure between the initial and final recorded pressures.

9.4.7 **Solution over Seams (HMR Part 178 Appendix B)**

9.4.7.1 USAMC LOGSA PSCC conducts the solution over seams leakproofness test (HMR Appendix B to part 178 (3)) in accordance with ASTM E 515.

9.4.7.2 A commercial leak detection fluid defined in ASTM E 515 is applied over all seams, closures, and fittings.

9.4.7.3 Leakage of air is demonstrated by a *steady stream* of bubbles defined to be continuous and uniformly distributed. Also, the container is considered sealed if there is no change in pressure between the initial and final recorded pressures.

9.5 **Hydrostatic Pressure Test (§178.605 HMR).** There is no prescribed standard test method for conducting the Hydrostatic pressure test (§178.605 HMR). USAMC LOGSA PSCC follows the method in appendix D.

9.5.1 All closures are in place, closed as for transport in accordance with closing instructions in the previous test report. Vented closures may be replaced or sealed per the TTD.

9.5.2 The water pressure to be applied is determined by the Packing Group and the hydrostatic test pressure found in the UN marking on the packaging. When the marked pressure is different from the test pressure noted in the previous test report, USAMC LOGSA PSCC tests per the marked pressure if appropriate for the certification.

9.5.3 The test pressure is applied for 5 minutes, or for 30 minutes for plastics single or composite packagings. A test is considered a fail if there is any leakage of water before reaching the required pressure, or if there is any leakage of water during the specified duration after reaching the test pressure.

9.5.4 Each packaging is separately tested.

9.5.5 Three tire fittings with the core removed are fitted into drilled holes and each sealed with a rubber gasket.

9.5.5.1 For tight head single and composite packagings, and open head single packagings with a 2-inch or larger plug, the holes are drilled in the top head located on a 6-inch semicircle around a 2-inch plug. A template is used to replicate the semicircle.

9.5.5.2 For removable head drums/pails the holes are drilled in the approximate same location as stated in 9.4.5.1 above and the fittings installed before the head is positioned and closed. The use of a pneumatic closing apparatus requires the use of a platen with an accommodation for the fittings. The fittings may be placed as appropriate if placement interferes with the closing apparatus.

9.6 **Stacking Test (HMR §178.606)**. To the greatest extent possible, USAMC LOGSA PSCC utilizes a fixed platen programmable compression tester or universal testing machine set for compression to apply the static top load for the 24-hour **s**tacking test (HMR §178.606). A guided static load (weights) may be used in lieu of a compression testing machine.

9.6.1 USAMC LOGSA PSCC computes the minimum required top load using metric units following the procedure outlined in appendix A (Problem Statement #4).

9.6.2 USAMC LOGSA PSCC tests the HMR stated minimum number of packagings for the test, prepared as for transport. Each packaging is separately tested.

9.6.3 Barring equipment malfunction, USAMC LOGSA PSCC tests all specimens in the sample using the same compression tester. Alternative equipment may be utilized in the event of equipment malfunction.

9.6.4 Regardless of whether periodic retest or design qualification test, in lieu of a static top load test for 28 days at 104º F, for plastics drums or pails USAMC LOGSA PSCC conducts a dynamic compression test in accordance with HMR §178.606(c)(2)(ii).

9.6.4.1 If the deflection is greater than one inch or if the packaging should rupture, the 28-day stacking test at 104 º F is to be initiated if sufficient packagings are available.

9.6.4.2 For the 28-day stacking test at 104 º F, for plastics drums or pails the USAMC LOGSA PSCC tests each specimen individually inside an environmental chamber using guided stacks of appropriate weight.

9.6.6 USAMC LOGSA PSCC conducts the 1-hour stacking stability assessment immediately after the conclusion of any static stacking test for non-plastics. Two like specimens are placed on top of the static-tested packaging for the assessment. If the stack does not topple, the test is considered a pass. Plastics packagings are cooled to ambient conditions before assessing stacking stability.

9.6.6 If a guided load test is conducted USAMC LOGSA PSCC tests each packaging separately, and uses various weights and articles to achieve no less than the minimum computed requirement for the top load.

9.7 **Vibration Test (HMR §178.608)**. Unless otherwise directed, USAMC LOGSA PSCC conducts the vibration test (HMR §178.608) in accordance with ASTM D 999 Method A2 (rotary synchronous).

9.7.1 A vertical linear motion (ASTM D 999 Method A1) is an acceptable alternative.

9.7.2 USAMC LOGSA PSCC tests the HMR stated minimum number of packagings for the test, prepared as for shipment (HMR §178.608(b)(1)).

9.7.3 USAMC LOGSA PSCC tests each packaging separately to ensure liftoff.

9.7.4 Packagings are not restrained, except gates, fences, and/or blocks may be utilized to keep the packaging on the platform.

9.7.5 Barring equipment malfunction, USAMC LOGSA PSCC tests all samples using the same test platform and the same motion. An alternative platform or motion may be utilized in the event of equipment malfunction.

9.7.6 Impact with a gate, fence, backboard, etc., or abrasion resulting from contact with the table platform surface that may result in damage or package deterioration is not cause to void a test, as this is considered likely occurrence with vehicles and other freight while in transit.

9.8 For each test specimen where there has been a failure, USAMC LOGSA PSCC will recommend a one-for-one additional test where sufficient extra packagings are available.

US DOT PHMSA PPM will be notified in writing and will direct which additional testing is to be undertaken.

10. Test Report

10.1 Each configuration assigned a separate TTD number will have a written test report.

10.1.1 The test report will include a complete description of the tested packaging and it's components such that it can be determined if another assembled packaging is manufactured exactly the same and there have been no changes in production or materials. Reported data will be from markings, validation/verification measurements, purchasing documentation, and any process/method that can substantiate what was received for testing. Photographs may be used to document assembly, markings, labels, and unique physical characteristics.

10.1.1.1 Thickness measurements for drums and pails will be taken from 4 tested specimens, typically three sets from specimens that failed and one set from a specimen that passed. See appendix C.

10.1.2 The test report will identify the test equipment used by manufacturer, model and serial number, and date of calibration expiration.

10.1.3 The test report will include all calculations and derivation of test parameters.

10.1.4 The test report will identify each test separately, and include a description of the test procedure and reason for decisions where a choice in method or process is warranted.

10.1.5 The test report will identify when a standard test method or proprietary method is used. Lacking a test method, a description of the process shall be included in the report.

10.1.6 The test report will include the names of any person having involvement in the acquisition, testing, reporting, or reviewing the test project.

10.1.7 The test report will identify the individual test pass/fail results, and also a summary table of results. If one specimen fails for a particular test series, e.g., 1 of 6 drops tests, the series is reported as a failure. USAMC LOGSA PSCC only reports the individual results and does not make conclusions or design recommendations.

10.1.8 USAMC LOGSA PSCC prepares a .pdf version of the signed test report and forwards by e-mail to the US DOT PHMSA PPM within one work day of

receiving signature approval of Chief, USAMC LOGSA PSCC. The signed original is maintained in the TTD folder.

10.2 USAMC LOGSA PSCC provides video documentation as follows—

10.2.1 Measurements of components (weights, dimensions).

10.2.2 Identification of components (unique markings, numbers/letters, damage, etc.).

10.2.3 Proper closing demonstration (as provided by previous test report).

10.2.4 Proper testing procedures.

10.2.5 Pass/Fail determination (results) by marking outer packaging specimen.

10.2.6 Whenever possible/necessary, 4 camera angles are used to capture necessary viewpoints, such as; 2 cameras are placed to capture different angles of the required test; 1 camera is used to capture measuring device (pressure gauges, drop height display, stack load display, vibration frequency display, etc.); 1 camera is used to capture information related to particular test in progress.

10.2.7 Upon completion of testing/video documentation, video footage is edited, compiled, burned to DVD and retained with hardcopy of test report.

10.2.8 Raw footage of video documentation is burned to DVD, along with software for viewing, and retained with hardcopy of test report. Raw footage is removed from the computer hard drive after the DVD is verified.

11. Record Retention/Sample Storage

11.1 USAMC LOGSA PSCC prepares and maintains test reports in excess of the requirements of 178.601(l) in that they are maintained permanently, along with related media files.

11.2 USAMC LOGSA PSCC disposes/recycles test specimens that have passed required testing as soon as the test report is signed; test specimens that have failed required testing are retained permanently until the disposition is directed by US DOT PHMSA PPM.

Fiberboard Box Combination Packaging Test Parameter Derivations

Note. This appendix is intended to work backward from the markings on a certified package.

178.602(b)
"For the drop and stacking test, inner and single-unit receptacles must be filled to not less than 95 percent of maximum capacity in the case of solids and less than 98 percent of maximum capacity in the case of liquids. The material to be transported in the packagings may be replaced by a non-hazardous material, … ."

§178.602(c)
"If the material to be transported is replaced for test purposes by a non-hazardous material, the material used must be of the same or higher specific gravity as the material to be carried, … Water may also be used for the liquid drop test under the conditions specified in *§178.603(e)* of this subpart. …"

§178.603(c)
"Testing of … combination packagings with plastic inner packagings … must be carried out when the temperature of the test sample and its contents has been reduced to -18° C or lower. Test liquids shall be kept in a liquid state, if necessary, by the addition of antifreeze. …"

Problem Statement #1:
Determine the test load by weight and volume, or in other words,
Find the gross mass of one bottle (test load) filled for testing, as follows,

$$V_t \geq .98 * (V_m - T) + T$$

where, V_t is the computed gross mass of one filled inner packaging for testing
V_m is the gross mass of one inner packaging filled to maximum (_____kg)
T is the mass of one empty inner packaging (including cap) (_____ kg)
Thus,

$V_t \geq .98 * (\quad V_m \quad - \quad T \quad) + T$
$V_t \geq .98 * (\_\_\_\_\_ \text{ kg} - \_\_\_\_\_ \text{ kg}) + \_\_\_\_\_ \text{ kg}$
$V_t \geq .98 * (\quad \_\_\_\_\_ \text{ kg} \quad) + \_\_\_\_\_ \text{ kg}$
$V_t \geq \quad \_\_\_\_\_ \text{ kg} \quad + \_\_\_\_\_ \text{ kg}$
$V_t \geq \_\_\_\_\_ \text{ kg}$

For testing fill the container with tap water. For the cold-conditioning required plastics for the drop test, fill container with a solution of approximately 50% propylene glycol (antifreeze) and 50% water. The containers are to be filled to a net weight of between 98% and 100% of maximum capacity.

Minimum liquid (98%) for test - _____ kg Maximum liquid (100%) for test - _____ kg
Filled Minimum (98%) Mass for test - _____ kg Filled Maximum Mass (100%)for test - _____ kg

Title 49 Code of Federal Regulations
§178.503(a)(4)(ii)

Problem Statement #2:
From the marking on the packaging determine the Specific Gravity of the hazardous liquid when water is used for the test.

"A packaging conforming to a UN standard must be marked as follows: ... *A designation of the specific gravity or mass* for which the packaging design type has been tested, as follows: ... For packagings intended to contain solids or inner packagings, the designation shall be the maximum gross mass in kilograms;"

$A_m \leq B + C_m$
where, A_m is the marked maximum gross mass (_____ kg)
B is the mass of all outer and inner packaging (_____ kg)
C_m is the maximum gross mass of liquid lading based on marking
thus,

$A_m \leq B + C_m$
_____ kg ≤ _____ kg + C_m
_____ kg – _____ kg ≤ _____ kg – _____ kg + C_m
_____ kg ≤ C_m

and,
$A_t \leq B + C_t$
where, A_t is the tested maximum gross mass when full (_____ kg, avg)
B is the mass of all outer and inner packaging (_____ kg)
C_t is the maximum gross mass of liquid lading in test
thus,

$A_t \leq B + C_t$
_____ kg ≤ _____ kg + C_t
_____ kg – _____ kg ≤ _____ kg – _____ kg + C_t
_____ kg ≤ C_t Note. ≈ _____ kg * ____

The equivalent specific gravity is the ***ratio*** of the marking-filled mass (C_m) to the water-filled mass using in testing (C_t).

Equivalent SG = C_m/C_t
where, C_m is maximum mass of liquid filling from marking (_____ kg)
C_t is tested mass of water (_____ kg)

thus, Equivalent SG = C_m/C_t
Equivalent SG = _____ kg/_____ kg
Equivalent SG = _____ rounded to SG = _____ per *49 CFR §178.603(e)(2)(ii)*

Note 1. Check Specific Gravity derived above from the certification marking on the outer fiberboard box which may sometimes differ from the drop height (SG value) cited in the previous test report ( )

Title 49 Code of Federal Regulations
§178.602(c)
… Water may also be used for the liquid drop test under the conditions specified in §178.603(e) of this subpart. …

§178.603(e)
(2) *For liquids, if the test is performed with water –*
(ii) *Where the materials to be transported* have a specific gravity exceeding 1.2, the drop height must be calculated on the basis of the specific gravity (SG) of the material to be carried, rounded up to the first decimal, as follows:
[A] *Packing Group I:* SG x 1.5 m
[B] *Packing Group II:* SG x 1.0 m
[C] *Packing Group III:* SG x 0.67 m

Problem Statement #3:
Compute the PG ____ drop height for the liquid contents to be transported equivalent to the marking on the packaging when water or water /antifreeze solution was used as test liquid.

As computed above, Equivalent SG = _____

thus, h = SG x 1.5 m
h = _____ x 1.5 m
h = _____ m
where h = Packing Group I drop height

OR

thus, h = SG x 1.0 m
h = _____ x 1.0 m
h = _____ m

where h = Packing Group II drop height

OR

thus, h = SG x 0.67m
h = _____ x 0.67 m
h = _____ m

where h = Packing Group III drop height

Title 49 Code of Federal Regulations
§178.606(c)(1)
Design qualification testing. The test sample must be subjected to a force applied to the top surface of the test sample equivalent to the total weight of identical packages which might be stacked on it during transport; where the contents of the test sample are non-hazardous liquids with specific gravities differing from that of the liquid to be transported, the force must be calculated based on the specific gravity that will be marked on the packaging. The minimum height of the stack, including the test sample, must be 3.0 m …

Problem Statement #4:
Compute the top load required for the stack test using the equivalent values as determined from the package marking

Variables		***Inputs***	***Calculations***
h	*height (cm)*		XXXX
n		XXXX	
w	*gross packaging weight (kg)*		XXXX
f	*conversion factor*		XXXX

A = (n - 1) * w * f
where, h = height in cm
n = (300 / h), minimum number of containers that when stacked, reach a height of 3 m
w = marked gross packaging weight in kg
f = conversion factor, 1 for static test, 1.5 for dynamic test
and
A = applied load in kilograms
B = applied load in pounds (A*2.205)
C = applied load in Newtons (A*9.8)

A	*Stacking weight (kg)*	kg, rounded to	**kg**
B	*Stacking weight (lb)*	lb, rounded to	**lb**
C	*Stacking weight (N)*	N, rounded to	**N**

Specimen Nos. _____

§178.606(c)(2)
Periodic retesting. The test sample must be tested in accordance with:
(i) Section 178.606(c)(1) of this subpart; or
(ii) The packaging may be tested using a dynamic compression testing machine. …
The force A to then be applied must be calculated using the formula:
Liquids: A = (n-1)[w + (s)(v)(8.3)(.98)](1.5)
Solids: A = (n-1)(m)(1.5)

where: A = applied load in [kilograms]
n = minimum number of containers that when stacked, reach a height of 3 m
m = the certified maximum gross mass for the container in kilograms
1.5 is a compensation factor that converts the static load of the stacking test into a load suitable for dynamic compression testing

Appendix B

Variation 2 Test Parameter Derivations

Note. This appendix is intended to work backward from the markings on a certified package.

Title 49 Code of Federal Regulations
§178.601(g)(2)(ii)

The *total combined gross mass* of inner packagings may not exceed one-half the gross mass of inner packagings used for the drop test.

Title 49 Code of Federal Regulations
§178.601(g)(2)(vii)

… The marked maximum gross mass may not exceed the sum of the mass of the outer packaging plus one half the mass of the filled inner packagings of the tested combination packaging. …

Problem Statement #1:
Find the maximum gross mass of one bottle filled for testing, as follows
"The marked maximum gross mass (A) may not exceed the sum of the mass of the outer packaging (B) plus one half the mass of the filled inner packagings (C) of the tested combination packaging."

$A \leq B + (½)(n)(C)$

where, A is the marked maximum gross mass (_____ kg)
B is the mass of all outer and secondary packaging (_____ kg)
C is the maximum gross mass of one bottle filled for testing
n is the number of filled inner packagings (____)

Thus,

A ≤ B + (½)(___)(C)
_____ kg ≤ _____ kg + (½)(___)(C)
_____ kg – _____ kg ≤ _____ kg – _____ kg + (___)(C)
_____ kg ≤ ___C
_____/___ kg ≤ ___C/2
_____ kg ≤ C

Note. D, actual mass of 1 water-filled inner packaging is ~_____ kg

Title 49 Code of Federal Regulations
§178.602(c)
… Water may also be used for the liquid drop test under the conditions specified in §178.603(e) of this subpart. …

§178.603(e)
(2) *For liquids, if the test is performed with water –*
(ii) *Where the materials to be transported* have a specific gravity exceeding 1.2, the drop height must be calculated on the basis of the specific gravity (SG) of the material to be carried, rounded up to the first decimal, …

Problem Statement #2:
From the marking on the packaging determine the Specific Gravity of the hazardous liquid when water is used for the test.

The equivalent specific gravity is the *ratio* of marking-filled mass to water-filled mass.

Equivalent SG = C/D

where,

C is the maximum mass of one filled inner pkg from marking (_____ kg, computed above)
D is the actual mass of one water-filled inner packaging (_____ kg, measured)
t is the tare mass of empty inner & cap

Thus, to test for "V" rating,
Equivalent SG = (C – t)/(D – t)
Equivalent SG = _____ kg/_____ kg
Equivalent SG = _____ rounded up to _____

Title 49 Code of Federal Regulations
§178.602(c)
… Water may also be used for the liquid drop test under the conditions specified in §178.603(e) of this subpart. …

§178.603(e)
(2) *For liquids, if the test is performed with water –*
(ii) *Where the materials to be transported* have a specific gravity exceeding 1.2, the drop height must be calculated on the basis of the specific gravity (SG) of the material to be carried, rounded up to the first decimal, as follows:
[A] *Packing Group I:* SG x 1.5 m
[B] *Packing Group II:* SG x 1.0 m
[C] *Packing Group III:* SG x 0.67 m

§178.601(g)(2)(i)
The outer packaging must have been successfully tested in accordance with §178.603 with fragile (e.g. glass) inner packagings containing liquids at the Packing Group I drop height.

Problem Statement #3:
Compute the PG I drop height for the liquid contents to be transported equivalent to the marking on the packaging when water was used as test liquid.

As computed above, Equivalent SG = _____

thus, h = SG x 1.5 m
h = _____ x 1.5 m
h = _____ m
where h = Packing Group I drop height

OR

thus, h = SG x 1.0 m
h = _____ x 1.0 m
h = _____ m
where h = Packing Group II drop height

OR

thus, h = SG x 0.67 m
h = _____ x 0.67 m
h = _____ m
where h = Packing Group III drop height

Title 49 Code of Federal Regulations
§178.601(g)(2)(iv)

The outer packaging must have successfully passed the stacking test set forth in §178.606 of this subpart when empty, i.e., without either inner packagings or cushioning materials. The total mass of identical packagings must be based on the combined mass of inner packagings used for the drop test;

§178.606(c)(1)
Design qualification testing. The test sample must be subjected to a force applied to the top surface of the test sample equivalent to the total weight of identical packages which might be stacked on it during transport; where the contents of the test sample are non-hazardous liquids with specific gravities differing from that of the liquid to be transported, the force must be calculated based on the specific gravity that will be marked on the packaging. The minimum height of the stack, including the test sample, must be 3.0 m …

Problem Statement #4:
Compute the top load required for the stack test using the equivalent values as determined from the package marking

Title 49 CFR §178.601(g)(2)(iv) requires the stacking weight be calculated using the *same combined mass as required for the drop test*. Based on the certification marking, the required mass of a single inner packaging for testing is shown calculated as _____ kg. Therefore, the gross packaging weight to be used in the stacking test formula is as follows:

$E = B + (n)C$

where, E is the gross packaging test weight
B is the mass of all outer and secondary packaging (_____ kg)
C is the maximum gross mass of one bottle filled for testing (_____ kg)
n is the number of inner packagings (__)

E = B + (n) C
E = _____ kg + (__)(_____ kg)
E = _____ kg

Appendix B (continued)

Variables	Inputs	Calculations
h height outer box (cm)	____	XXXX
n	XXXX	_____
E gross packaging weight (kg)	____	XXXX
A Stacking weight (kg)	XXXX	_____ rounded to _____
A1 Stacking weight, dynamic	XXXX	_____ rounded to _____

where, A = (n-1)*E

A = applied load in kilograms
n = (300/h), minimum number of containers that when stacked, reach a height of 3 m
E = gross packaging weight in kg
(from *equivalent test mass* based on certification marking)

§178.606(c)(2)
Periodic retesting. The test sample must be tested in accordance with:
(i) Section 178.606(c)(1) of this subpart; or
(ii) The packaging may be tested using a dynamic compression testing machine. …
The force A to then be applied must be calculated using the formula:
Liquids: A = (n-1)[E + s x v x 8.3 x .98)] x 1.5
Solids: A = (n-1)(m x 1.5)

Where:
A = applied load in [kilograms]
n = minimum number of containers that when stacked, reach a height of 3 m
m = the certified maximum gross mass for the container in kilograms
1.5 is a compensation factor that converts the static load of the stacking test into a load suitable for dynamic compression testing

Thickness Measurements

DETAIL (PROJECT NUMBER)

Sample Location	Sample Number		Measurement (mm) 1	2	3	Sample Average	Grand Average
Top	A	AT1					
	A	AT2					
	B	BT1					
	B	BT2					
	C	CT1					
	C	CT2					
	D	DT1					
	D	DT2					
						Top	
Side	A	AS1					
	A	AS2					
	B	BS1					
	B	BS2					
	C	CS1					
	C	CS2					
	D	DS1					
	D	DS2					
						Side	
Bottom	A	AB1					
	A	AB2					
	B	BB1					
	B	BB2					
	C	CB1					
	C	CB2					
	D	DB1					
	D	DB2					
						Bottom	

Note: First two digits are the container number (replace A, B, C, D).
The letter is T (Top), S (Side), B (Bottom).
The last digit is the cut sequence.

SUMMARY

#	Top#1	Top#2	Side#1	Side#2	Bottom#1	Bottom#2
A						
B						
C						
D						

Appendix D

Hydrostatic Pressure Testing

1. Purpose. The purpose of this appendix is to provide the procedures as followed by USAMC LOGSA PSCC when requested by US DOT PHMSA to perform hydrostatic pressure testing in conjunction with performance oriented packaging.

2. Scope. The hydrostatic pressure test is to be performed on all single and composite packaging designs intended to transport liquids. USAMC LOGSA PSCC conducts hydrostatic pressure testing of performance oriented packaging intended for hazardous materials transportation per 49 CFR 178.605. Inner packagings may be tested as directed by US DOT PHMSA.

3. Preparation for Testing. Upon determination of a test plan, in which a hydrostatic pressure test is to be performed, three test specimens are designated (regardless of construction material). Previously installed closures are verified properly closed, as for transport, per previous test report closing. Any vented closure is rendered inoperable by sealing with epoxy. If space and construction features permitting, three valves are installed into each top head; the first valve is for the water inlet hose; the second valve is for the air release/drain hose; the third valve is for the pressure gauge. For inner packagings to be tested, it may be determined that space is not available for three valves or that the number of valves may weaken the closure and invalidate the test. In that case only 2 valves will be used; one valve for the water inlet hose and one valve for the air release/drain hose. The container pressure will then be measured by the pressure gauge located in-line with the water inlet hose. Water used in testing is drawn from the tap at time of test.

3.1 Placement of Valves. The installation of valves is performed as per the **Fitting Assembly Drawings** below. The placement of valves is performed, to the extent possible, in accordance with the previous test report. If valve placement is not specified in the previous test report, placement of valves for different designs is as described below, to the greatest extent possible (or as directed by US DOT PHMSA):

3.1.1 Glass Bottles – Valves attached to closures of glass bottles are evenly spaced so as to retain closure integrity and minimize possible breakage during testing, which would invalidate the test. In most cases, space for 3 valves is not possible, in which case, only 2 valves (fill, drain) are used along with an inline pressure gauge.

3.1.2 F-Style Cans – Valves attached to top of can are evenly spaced, careful measures being taken to avoid closure, embossments, and other geometries that could possibly compromise the integrity of the vessel and invalidate the test.

3.1.3 Open Head Pails – Placement of valves is greatly simplified if they can be installed before lid is closed. This being the case, the valves are to be as evenly spaced as possible, with respect given to the lid closing tool and its function.

3.1.4 Tight Head Pails – Valves attached to top of can are placed along a 15 cm (6 inch) radius from the bung of the can, and evenly spaced.

3.1.5 Friction Lid Cans – Valve placement is to be along the side of the can, opposite of the manufactured seam, and evenly spaced. Placement of the can (during test) must be on the side, with valves in the vertical position.

3.1.6 Aluminum Bottles - Valve placement is to be along the side of the bottle, and evenly spaced. Placement of the bottle (during test) must be on the side, with valves in the vertical position.

3.1.7 Plastic Bottles – Various designs of plastic bottles/lids provide certain limitations for valve placement. Valves are placed, if at all possible, in the lid closure. However, due to various reasons, such as lid size, geometry, material thickness, construction, etc., it may not be possible to place valves in the lid. In these cases, valves are to be placed in an area with uniform wall thickness, away from lettering, embossments, manufacturers' seams, and other geometries that would not allow the valve to seat properly. Placement of the bottle must be in such a way so that the valves will be in the vertical position during testing.

4 During Testing

4.1 **Pressure Application -** Pressure is to be applied to a container slowly. The rate of pressurization is dependent on the container and its material of construction.

4.1.1 For containers which are less rigid than others, changes in pressure may be noted during both the initial pressurization and during the test duration.

4.1.2 It should be noted that the test requires that the pressure be maintained during the required time. Due to the change in the container's volume, it may be necessary to increase the applied pressure in order to maintain the pressure inside the container.

4.2 **Leakage from Fittings -** If leakage around/from a fitting occurs during the test, and can be attributed to only the test fittings, then the test may be temporarily stopped so that the fittings may be tightened.

4.2.1 In the event tightening is not enough to prevent further leakage from the fittings, a small amount of epoxy may be used to seal around the fitting.

4.2.2 If leakage occurs from only the fittings and cannot be stopped by either tightening the fittings or applying epoxy, the test is to be voided. This may occur if a

significant amount of deformation to the container surface around the fittings occurs. In this case it may be necessary to adjust fittings placement on subsequent samples.

4.3 **Gauge auto shut-off -** The pressure gauges use in testing are equipped with an auto shut-off feature which automatically shuts the gauge off after a 5 minute period of either no change in pressure or inactivity.

4.3.1 The gauge display may shut off during the test, but the test water pressure continues. Pressing the power button on the gauge resumes displaying the pressure.

4.3.2 The gauge will return to the proper pressure after a short (few second) adjustment period. During this period the gauge reading may fluctuate, however this will stop and the reading will stabilize at the correct pressure.

4.4 **Over Pressurization -** In the event the container momentarily ranges over the designated pressurize, the test continues as long as,

4.4.1 There is no leakage which occurred as a direct result of the higher than required pressure.

4.4.2 There is no resulting significant deformation or damage to the container which may lead to leakage (i.e., closure becomes compromised). If there is significant resulting damage, the test is voided.

4.4.3 If the container is over-pressurized, the pressure is slowly released from the container until the required pressure is reached. This should be done at a rate which allows the container to slowly adjust to the new pressure depending on the container and material(s) of construction.

4.5 Rather than develop and follow a proprietary test method, USAMC LOGSA PSCC conducts the hydrostatic pressure test (HMR §178.605) in accordance with Federal Test Method Standard 101C, Method 5009.1, Hydraulic pressure technique with the packaging oriented upright, and subject to the parameters, constraints, and procedures noted above. Note. FTMS 101C is no longer active, having been superseded by MIL-STD-3010B. FTMS 101C method 5009.1 is cited because the Hydraulic pressure technique was not included in MIL-STD-3010B and has not been replaced with an industry standard.

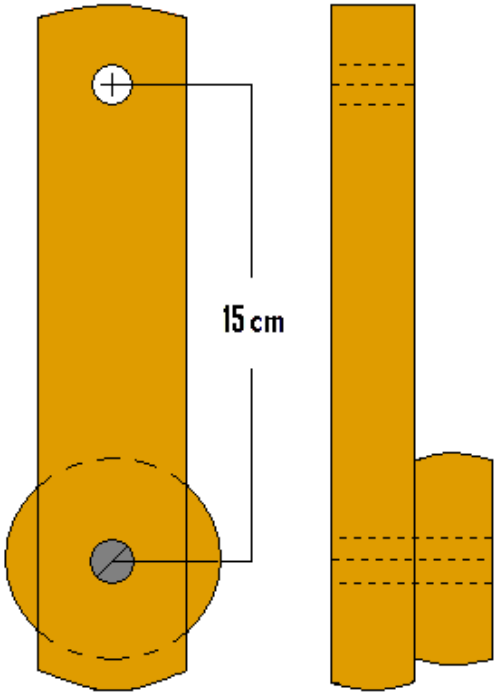

Figure 1. Tool to determine semicircle for fitting placement

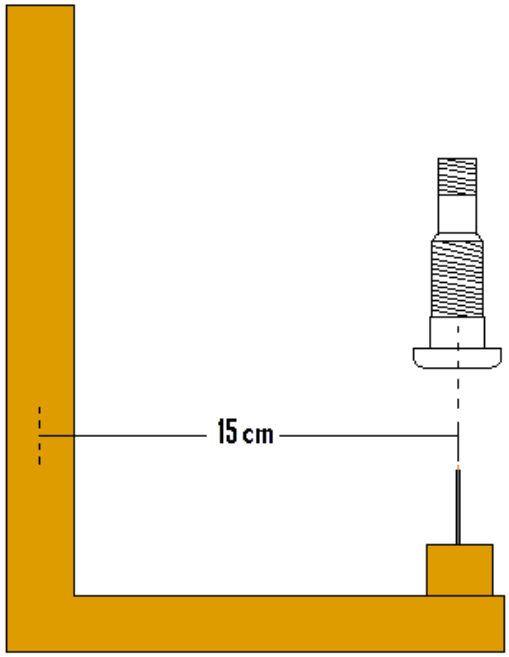

Figure 2. Tool for placing fittings in drilled holes

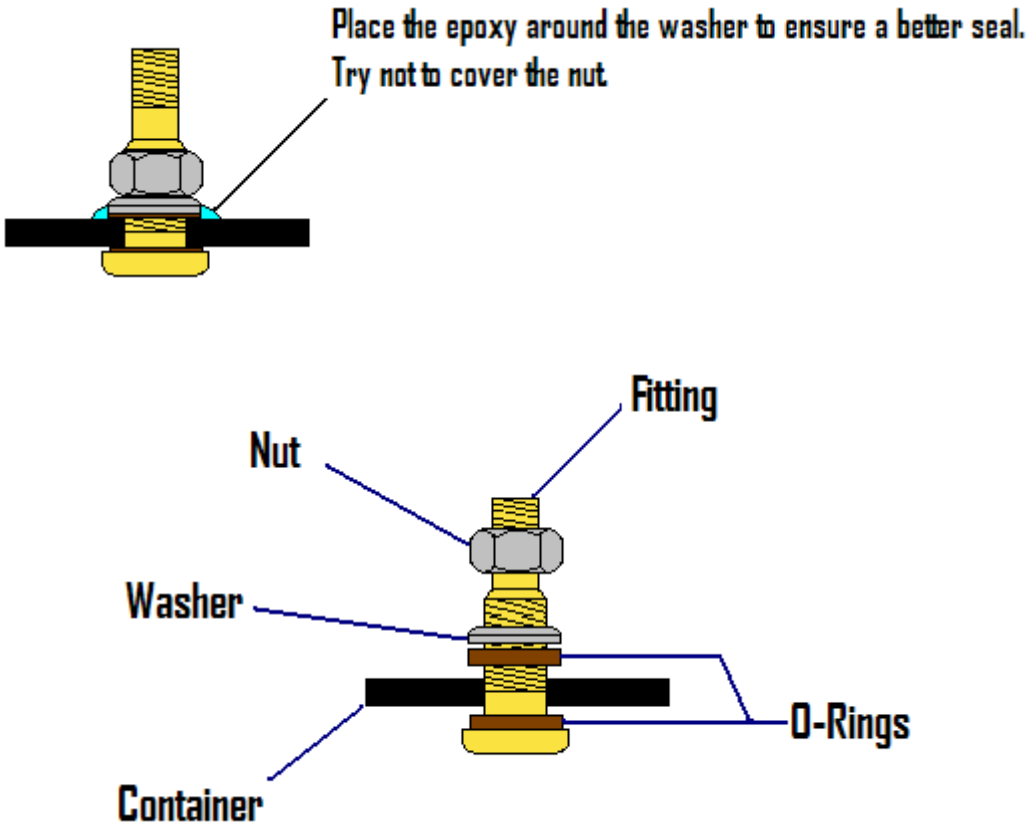

Figure 3. Fitting components and assembly

Appendix E

Intermediate Bulk Container Test Plan

1. Unless otherwise stated below, for IBCs USAMC LOGSA PSCC follows the procedures for test request, acquisition, reporting, file maintenance, record retention, etc. as stated in the body of this document (Policy and Procedures for Performance Oriented Packaging Testing conducted by USAMC LOGSA PSCC).

2. USAMC LOGSA PSCC derives the test parameters (and design-unique tests, e.g., stacking, top lift) from the UN certification marking on the IBC in accordance with the HMR Subpart O. USAMC LOGSA PSCC shall be contact US DOT PHMSA in writing to resolve any deviations in test parameters or tests performed before undertaking any testing.

3. USAMC LOGSA PSCC uses composite specimen No. 6 (untested) for weighing and measurement of component parts, resulting in disassembly of the IBC specimen. USAMC LOGSA PSCC follows a US DOT PHMSA developed systemic approach for referencing measurements. As directed by US DOT PHMAS rotomolded IBCS will not have thickness measured and reported.

4. Test Preparation. For test preparation USAMC LOGSA PSCC follows the closing instructions in the previous test report.

   4.1 When closing instructions are printed/embossed on the IBC and which differ from those in the previous test report, US DOT PHMSA shall be contacted in writing for resolution.

   4.2 Following closure instructions that incorporate non-measurable, variable determinations (e.g., hand-tighten, tighten until contact, etc.) are subject to operator variation and USAMC LOGSA PSCC may not be able to replicate the closing as design tested. Following non-measurable closing instructions in good faith is not cause to void a test.

   4.3 USAMC LOGSA PSCC does not open/close/adjust/torque any service equipment (e.g., valves) intended for filling/draining.

5. Test Lading. USAMC LOGSA PSCC accomplishes the test mass as specified for each test by placing the appropriate mass ***inside*** the IBC (for safety). Except for the drop and vibration tests, the IBC may not be full (98% of maximum volume) once the test mass is achieved. Dry steel grit (CP-80, equivalent to 1 ton in a 55-gal drum) is the test mass used by USAMC LOGSA PSCC except where air, water, or water/antifreeze is specified by the HMR for a particular IBC test (e.g., water for the drop test).

5.1 If the fill level is not stated in the previous test report, for liquid fill of IBCs for vibration testing, USAMC LOGSA PSCC fills the IBC with tap water by weight in kilograms to 98% of maximum (overflow) capacity using the relationship that 1 liter of water/antifreeze is 1 kilogram.

5.2 If the fill level is not stated in the previous test report, for liquid fill of plastic IBCs for drop testing, USAMC LOGSA PSCC fills the IBC with water/antifreeze by weight to 98% of maximum (overflow) capacity using 1 liter of water is 1 kilogram. The antifreeze used is propylene glycol.

5.3 If the fill level is not stated in the previous test report, for liquid fill of non-plastic IBCs for drop testing, USAMC LOGSA PSCC fills the IBC with water by weight to 98% of maximum (overflow) capacity using 1 liter of water is 1 kilogram.

6. Vibration Test (HMR §178.819). Vibration testing is performed in accordance with ASTM D 7387, Standard Test Method for Vibration Testing of IBCs. USAMC LOGSA PSCC uses tap water at ambient conditions as the test load for vibration. The test will be initiated at the lowest frequency possible and brought up slowly until liftoff of at least 2 corners. The motion is vertical linear.

   6.1 If a leak that can be substantiated with the naked eye (e.g., water spray, bottle rupture, etc.) occurs during the 1-hour duration the test is stopped and the results are reported as a failure.

   6.2 If damage occurs such that the container becomes unstable or results in resonance, the test will be stopped, and the results are reported as a failure.

7. Drop Test (HMR §178.810). Antifreeze (propylene glycol 50% solution with tap water) will be the test load for drop testing of plastics IBCs. For non-plastics IBCs tap water will be used when a liquid load is specified for the drop test. Equilibrium of cold-conditioning for plastics IBCs will be determined by fitting a thermocouple wire through a drilled hole in the cap or plug of the IBC before conditioning. The hole will be filled with epoxy. The thermocouple wire is to be cut at the cap surface prior to testing.

8. Leakproofness test (HMR §178.813). USAMC LOGSA PSCC conducts the leakproofness test with cage/frame in place, the cap/plug in place, and using a commercial leak solution over seams method. One air valve to be positioned in the body of the IBC at the highest point in the body if the cap or plug is not the highest point of the design. Otherwise, the fitting is positioned as close to the center of the cap/plug as possible. Regulated compressed air is the pressure medium.

9. Hydrostatic pressure test (HMR §178.814). USAMC LOGSA PSCC conducts the hydrostatic pressure test with a minimum of three valves positioned in the top of the body of the IBC at the highest point if the cap or plug is not the highest point of the design. Otherwise, the fittings are positioned as close to the center of the cap/plug as possible. One valve is for the gauge to be positioned at the top of the IBC. Another valve is for water input and the remaining valves are for air exit. The number and location of additional valves for exit air depends on IBC structure (1 minimum). Water is the pressure medium.

10. Drop Test (HMR §178.810). USAMC LOGSA PSCC conducts the drop test using specimen No. 1. Orientation will be bottom flat unless directed by US DOT PHMSA. (HMR §178.803 footnote 4). Only attached authorized lifting mechanisms that are part of the design will be employed by USAMC LOGSA PSCC to lift the IBC into place for the drop test. Otherwise the IBC will be lifted using slings through the bottom forklift openings ensuring no pressure against the sidewalls that could affect test outcome. A spreader apparatus and/or padding may be employed to minimize pressure.

11. Test Sequence (HMR §178.803). USAMC LOGSA PSCC conducts the tests in sequence (except drop), starting vibration with specimen No. 2. As authorized (HMR §178.803 footnote 4), USAMC LOGSA PSCC conducts the drop test using a separate, untested specimen (No. 1).

    11.1 If an individual test results in a Pass, USAMC LOGSA PSCC continues to the next test in sequence (HMR §178.803) using that specimen container. If an individual test results in a Fail, USAMC LOGSA PSCC continues to the next test in sequence with another (untested) container. For example, if No. 2 passes vibration, conduct bottom lift with No. 2, or if No. 2 fails vibration, conduct bottom lift with No. 3.

    11.2 USAMC LOGSA PSCC continues testing in sequence (HMR §178.803) until every required test for the IBC design type has been tested once in sequence.

    11.3 After the completion of all minimum test requirements (HMR §178.803), USAMC LOGSA PSCC will repeat any failed test only once using available IBCs, unless otherwise directed by US DOT PHMSA.

    11.4 Unless directed by US DOT PHMSA, USAMC LOGSA PSCC does not repeat the sequence (HMR §178.803) for additional tests beyond the required minimum sequence of tests.

    11.5 USAMC LOGSA PSCC does not repeat passed tests unless directed by US DOT PHMSA.

12. Untested IBCs may be stored for later demonstration testing or evaluation.

Appendix F

Test References

A. Title 49 Code of Federal Regulations, Parts 106-180, current as of date testing initiated

B. ASTM D 4919, Standard Guide for Testing of Hazardous Materials Packagings

C. ASTM D 7387, Standard Method for Vibration Testing of Intermediate Bulk Containers (IBCs) Used for Shipping Liquid Hazardous Materials (Dangerous Goods)

D. ASTM D 999, Standard Methods for Vibration Testing of Shipping Containers

E. ASTM D 5276, Standard Test Method for Drop Test of Loaded Containers by Free Fall

F. ASTM D 4332, Standard Practice for Conditioning Containers, Packages, or Packing Components for Testing

G. ASTM E 515, Standard Test Method for Leaks Using Bubble Emission Techniques

H. ISO 535 – Second edition 1991-07-01
Paper and Board – Determination of Water Absorptiveness – Cobb Method

I. ASTM D 1709, Standard Test Method for Impact Resistance of Plastic Film by the Free-Falling Dart Method

J. ASTM D 1922, Standard Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method

K. FTMS 101C, Federal Test Method Standard Test Procedures for Packaging Materials

L. MIL-STD-3010B, Test Procedures for Packaging Materials