

Part 1. Report Cover

Report Number: DLA03F015

Report Date: 25 August 03

Previous Report Number: F015

Previous Report Date: 8 August 01

Title: Performance Oriented Packaging Testing of a
Grade V3c, Fiberboard Box, Style RSC, 14" x 14" x 14" (ID),
With 1 Quart, Rectangular, Plastic Bottles with Handles (Qty of 4)
for Liquids. All surface modes.

Responsible Individual: Francis S. Flynn

Performing Activity: LOGSA Packaging, Storage,
and Containerization Center
ATTN: AMXLS-AT
11 Hap Arnold Boulevard
Tobyhanna, PA 18466-5097

Performing Activity's Reference(s): TT 10-03; TT 10-02; 9HTNR;
AMC 13-88

DTIC Distribution: N/A

Requesting Organization:

Defense Logistics Agency
Defense Distribution Center
ATTN DDC J-3/J-4-0
2001 Mission Drive
New Cumberland PA 17070-5000

Requesting Organization's Reference(s):

DLA Memo, 23 Dec 02

Test Results: ___ single X combination ___ composite

Section I. Pre-test Conditions

For initial testing, a bundle of boxes were received in new condition. Boxes from the lot from which this box was taken have also been performance tested with a variety of bottles and cans.

The following identification schema designates the packaging specimen used for the test(s) indicated. Assignments were made at random, in no particular order of sequence.

<u>Specimen No.</u>	<u>Test</u>
A	stack test
A	repetitive-shock vibration test
A	flat onto bottom, drop test
	flat onto top, drop test
	flat onto long side, drop test
	flat onto short side, drop test
	bottom corner, drop test
B	water resistance test

Section II. Summary

A. Drop test	PASS
B. Leakproofness test	N/A
C. Internal pressure test/Hydrostatic pressure test	N/A
D. Stacking test	PASS
E. Vibration standard	PASS
F. Water resistance test	PASS
G. Compatibility test	N/A

Note: To be certifiable, the configuration must pass the applicable tests for the type packaging, intended lading, and mode(s) of shipment. This report is not applicable to transportation by air.

Test Results (continued)

Section III. Discussion

A. Drop test: 49 CFR §178.603

Test date(s): 7/29/03

- cold conditioned (0° F, 72 hr)
- ambient conditions (~72° F & 60% RH)
- standard conditions (50% RH & 23° C)

No	Ht.	Orientation	Results
A	106.3"	Flat onto box bottom	Pass/No leaks/rupture; entire contents retained
A	106.3"	Flat onto box top	Pass/No leaks/rupture; entire contents retained
A	106.3"	Flat onto box long side	Pass/No leaks/rupture; entire contents retained
A	106.3"	Flat onto box short side	Pass/No leaks/rupture; entire contents retained
A	106.3"	Diagonally onto bottom corner (2-3-5)	Pass/No leaks/rupture; minor crushing of the 2-3-5 corner; contents retained completely within the box

Specimen A was a combination packaging consisting of a grade V3c fiberboard box (outer packaging) containing an inner packaging (four, 1-qt, plastic bottles with handles). The bottles were filled with 50% propylene glycol and 50% water to 98% of maximum capacity (based on weight).

In conducting the drop test, all five drops (flat bottom, flat top, flat long side, flat short side, and bottom corner) were performed on the same configuration. Five drops per configuration exceeds 49 CFR §178.603 requirements, as well as both UN and ASTM recommendations (i.e., one drop on a side or corner per box). The use of one configuration for multiple tests and drops is DOD policy as stated in DLAD 4145.41/AR 700-143/AFJI 24-201/NAVSUPINST 4030.55A/MCO 4030.40A, Packaging of Hazardous Material. Also per this policy, any failed orientation(s) can be repeated using another configuration.

B. Leakproofness test: 49 CFR §178.604

N/A. The leakproofness test was not conducted on the box, because the packaging is not intended for the containment of liquids.

C. Internal Pressure/Hydrostatic Pressure test: 49 CFR §178.605

N/A. Testing for the maintenance of internal pressure is not required for this configuration.

Test Results: Section III (continued)

D. Stacking test: 49 CFR §178.606

Test date(s): 7/29/03

X ambient conditions (~76°F & 60% RH)

No.	Length	Type	Load/Force Required	Actual Force Used	Results	Stability Maintained?
A	24 hr	Static	480 lbf	511 lbf	Pass	Yes

A static top load compression tester was used for the stack test, because it could hold the load constant for the required 24-hour timeframe. The total top load applied on the full box was greater than the minimum required for one box based on the outside box height and the gross packaged weight. The top load was to simulate a stack of identical packagings that might be stacked on the packaging during transport.

E. Vibration test: See 49 CFR §178.608.

Test date(s): 7/24/03

X ambient conditions (~76°F & 60% RH)

No.	Frequency	Duration	Results
A	3.2 Hz	1 hr	Pass. No leakage, rupture, or damage

To be in compliance with U.S. Department of Transportation standards for packagings bearing the United States mark (USA) as a component of the packaging certification marking (49 CFR §173.24a(a)(5)), the vibration test was performed, as a means to determine capability. The test was conducted as prescribed by ASTM D 999, method A2 (Repetitive Shock Test (Rotary Motion)). The test was run for 1 hour, using the fiberboard box packaging. The packaging was tested using a 1,250-lb vibration table (rotary motion) that had a 1-inch vertical double amplitude (peak-to-peak displacement) such that the packaging was raised from the platform to such a degree that a piece of steel strapping (1.6 mm) could be passed between the bottom of the package and the platform.

F. Water resistance (Cobb Method) test (fiberboard): 49 CFR §178.516

As required by the standards for fiberboard boxes, the Cobb Method Test for water absorptiveness was performed on a specimen cut from one box (DLA03F002). **Test date(s):** 4/04/03

No. specimens felt side (exterior) 10. Average 113 g/m². Highest exterior value was 130 g/m². Lowest exterior value was 107 g/m². All of the samples tested were free of printing.

No. specimens exceeding 155 g/m² 0.

Many factors may affect water absorption by corrugated fiberboard. Among these factors are abrasion, wear, flexure, improper storage, and age. These can greatly decrease the ability of the fiberboard to resist water absorption and result in higher than tested results. In addition, some fiberboard products are only treated on one side of the material, making the box construction method of increased importance. Usually, the water resistant side is the smooth side. The shipper must take appropriate steps to ensure that the box is correctly constructed with the water resistant side on the outside.

Test Results: Section III (continued)

G. Compatibility test (plastics packagings only): N/A.

Test Personnel

The following personnel performed the aforementioned testing, or had a role in the testing, evaluation, and/or documentation, as reported herein-- Richard D. LaFave, Stuart N. Crouse, Timothy L. Reimann, and Karen K. Kimsey

References

A. Title 49 Code of Federal Regulations, Parts 106-180, Winter 2002, current as of 15 Oct 02

B. International Air Transport Association Dangerous Goods Regulations, 40th edition, 1 January 1999

C. ASTM D 4919, Specification for Testing of Hazardous Materials Packagings.

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

E. ASTM D 951, Standard Test Method Water Resistance of Shipping Containers by Spray Method.

F. TAPPI Standard: T 441 Water Absorptiveness of Sized (Non-Bibulous) Paper and Paperboard (Cobb Test).

G. Recommendations on the Transport of Dangerous Goods, tenth revised edition, United Nations, New York, 1999.

H. DLAD 4145.41/AR 700-143/AFJI 24-201/NAVSUPINST 4030.55A/MCO 4030.40A, Packaging of Hazardous Material, 23 Jul 96.

I. AFMAN 24-204/TM 38-250/NAVSUP PUB 505/MCO P4030.19G/DLAI4145.3, Preparing Hazardous Materials for Military Air Shipments, 11 Dec 01.

Test Results: Section III (continued)

Equipment

Item	Manufacturer	Serial No.	Calibration Expiration Date
1,250-lb vibration table	L.A.B Skaneateles, NY	8120179	see note
5,000-lb compression tester	L.A.B Skaneateles, NY	1107050	4/04
500-lb scale	Ohaus Corporation USA	5097971	4/04
3,000-gram balance	Brinkmann Instruments Westbury, NY	3103120	4/04
Release hook	Lansmont Monterey, CA	N/A	N/R
Cobb Sizing Tester	Teledyne Curley Troy, NY	4180-A	N/R
4x4 Versa Tenn V	Tenney Environmental Williamsport, PA	28052	5/05

Note. Equipment is calibrated in accordance with International Safe Transit Association test equipment verification requirements, ANSI/ISO 17025 (General Requirements for the Competence of Testing and Calibration Laboratories) and TB 43180 (Calibration and Repair Requirements for the Maintenance of Army Materiel).

Appendix A

Test Applicability

Pass/fail conclusions were based on the particular fiberboard box specimens, test loads, and the limited quantities submitted for test. Extrapolation to other materials, other manufacturers, other applications, different inner packagings, container sizes, or lesser inner quantities is the responsibility of the packaging design agency or applicable higher headquarters. Extrapolation of test results based on less than the minimum recommended number of test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.

Testing was performed per *Title 49* Code of Federal Regulations.

Performance testing was undertaken and completed at the request of an agency responsible for shipment of the dangerous good(s). The completion of successful required performance tests does not, by itself, authorize the marking and transportation of the dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).

The required performance tests are intended to evaluate the performance of the packaging components. The criteria used to evaluate packaging performance is whether the contents of the packaging are retained within the outer packaging, should damage to the outer packaging occur, and secondly, if any inner packaging of hazardous materials leaks, ruptures, or is damaged so as to affect transportation safety. The successful completion of the required tests does not ensure the undamaged delivery or survivability of the actual commodity/item. Separate testing is necessary to assure the stability of any explosive item.

Before a configuration can be certified by the person(s) authorizing shipment, the appropriate packaging for the particular hazardous materials and mode of transportation must be determined, and the item(s) must be prepared for shipment per applicable regulations. The chosen configuration must have been performance tested in accordance with the size, the shape, and the weight constraints posed by the configuration to be certified. The testing reported herein should not be construed as blanket certification of any configuration that simply uses the performance tested outer fiberboard box.

Appendix B

Test Data Sheet

Section I. Test Product

Physical State: ___ solid X liquid ___ gas ___ aerosol

Name: Water

Amount Per Container (Configuration):
 1 quart (4 qts), rated; (2.08 lb), individual
 (8.23 lb), packed

Gross Weight: 36 lbs

Section II. Test Parameters

Drop Height: Ref: 49 CFR §178.603

- ___ 1.8 m; 71 in. (PG I, II, & III, SG ≤1.2 or solids)
- ___ 1.2 m; 47 in. (PG II & III, SG ≤1.2 or solids)
- ___ 0.8 m; 32 in. (PG III, SG ≤1.2 or solids)

X from-- 106.3 in. **PG I: 1.8 (SG) x 1.5 m x 39.37 in./m**
 _____ PG II: SG x 1.0 m x 39.37 in./m
 _____ PG III: SG x 0.67 m x 26.38 in./m

Stacking Weight Formula- DLA COMBINATION PACKAGINGS

Variables	Inputs		
h height, drum/box	14.75		
n # stacked containers	XXXXXXXXXX	8.00	
w1 weight, drum/box	2.7		
w2 weight, bottle/can, filled	2.23		
w3 weight, ring/pad	0		
q1 # inner containers	4		
v1 max. volume, 1 inner container	0.25		
v total volume	XXXXXXXXXX	1.00	
w4 weight, item (unpacked)	0		
W5 weight, absorbent	24		
W gross weight	XXXXXXXXXX	35.62	
C constant	1		
Sg specific gravity	1.8		
PG packing group	1	XXXXXXXXXX	

NOTE: A1 = (n-1)*(w+(1.8*v*8.3*0.98))*(c), Packing Group I
 A2 = (n-1)*(w+(2.7*v*8.3*0.98))*(c), Packing Group II
 A3 = (n-1)*(w+(4.0*8.3*0.98))*(c), Packing Group III

A1 = stacking weight in pounds, PG I
 A2 = stacking weight in pounds, PG II
 A3 = stacking weight in pounds, PG III
 n = (118/h), minimum number of containers that when stacked, reach a height of 3 m
 w = w1+(w2*q1)*(w3*q1)*w5, total weight in pounds
 v = v1*q1, total volume
 C = either 1.5 (the compensation factor that converts the static load of the stacking test into a load suitable for dynamic compression testing), or 1.0 (static top load)

A1	Stacking weight-PG I	XXXXXXXXXX	351.80	352
A2	Stacking weight-PG II	XXXXXXXXXX	403.10	404
A3	Stacking weight-PG III	XXXXXXXXXX	479.90	480

Appendix B (Continued)**Section III. Equivalencies of Liquids**

	Specific Gravity¹	Total Amount per Packaging	Gross Weight (pounds) (kilograms)	
water*	1.0	8.33	36	16.32
PG I	1.8	14.99	42.66	19.34
PG II	2.7	22.49	50.16	22.74
PG III	4.0	33.32	60.10	27.65

Note 1. Equivalent specific gravity derived from drop height as follows-- PG factor x density (or SG) = drop height, thus

SG = drop height/PG factor (49 CFR §178.603)

PG I: 1.5 m x SG = 2.7 m, thus SG = 1.8

PG II: 1.0 m x SG = 2.7 m, thus SG = 2.7

PG III: 0.67 m x SG = 2.7 m, thus SG = 4.0

Unless otherwise computed for more dense liquids, water (SG = 1) represents a solution having a specific gravity of 1.2 or less.

Appendix C

Packaging Data Sheet

Section I. Exterior Shipping Container

Packaging Category: ___ single X combination ___ composite

UN Type: Fiberboard boxes (49 CFR §178.516) UN Code: 4G

Specification No.: ASTM D 5118; CF; V3c; WR; SW; Style RSC; 2.67
lbs.; 14" x 14" x 14" (ID); 14.5" x 14.5" x 14.75" (OD)

Bursting Strength--400

Manufacturer: Packaging Control Corp., York PA

Date(s) of Manufacture: March 2003

Closure Method: The fiberboard box was sealed (7 strip method) using 2"
A-A-1830 clear tape. (See drawing)

Additional Description:

a. A 30 x 30 inch, .004 inch polyethylene liner was first placed in the fiberboard box for the purpose of encapsulating the absorbent and the test product. Approximately 3.25 inches of loose-fill absorbent cushioning was firmly packed in the bottom of the fiberboard box. The 1-quart plastic bottles were placed on the absorbent material, and additional loose-fill absorbent material was then packed around and over the bottles. The loose fill absorbent material must be firmly compressed in approximately every 4 inches until box top is reached. Void space is not acceptable. Twist and tape plastic bag with 2" plastic tape.

NOTE: This combination packaging configuration does meet the requirements of AFMAN 24-204 for Packing Group I liquids, in 1-quart quantities.

b. For this configuration, either firmly packed, fine grade vermiculite or either of the following, firmly-packed cellulose fiber absorbent products, "HAZMATPAC® Absorbent A-900" or "Absorption Corporation Absorbent GP", can be used without any notable difference in performance. Inner packagings have a tendency to migrate if the loose fill material is not firmly packed, especially along the bottom of the container.

Appendix C (Continued)

Section II. Inner/Intermediate Packaging

Quantity of Inner Packagings: 4

Capacity: 1 quart each (4 quarts)

Specification Type and No(s): N/A

Type: 1-quart, rectangular plastic, bottle with handle (4)

Manufacturer/Distributor: Freund Container, Inc., Chicago, IL 60620

Manufacturer's/Distributor's Part No(s): 31016

Tare Weight (empty bottle): .15 lb

Dimensions: 5.25" x 2.5" x 7.5" (OD)

Closure Type: Plastic screw cap, 33/400

Secondary Closure: Fiber reinforced tape, A-A-1687, 1" width wrapped 1.5 times around and overlapping the base of the cap and the bottle neck.

Intermediate Packaging: 30 x 30 x .004 in., flat, polyethylene barrier bag

Cushioning: Absorbent GP or A900; weight - 24.4 lbs.

Manufacturer/Distributor: Absorbent GP, Absorption Corp.

Closure Type: 2 inch, ASTM D-5486, Type II, NSN: 7510-00-266-6715

Appendix D

Rationale

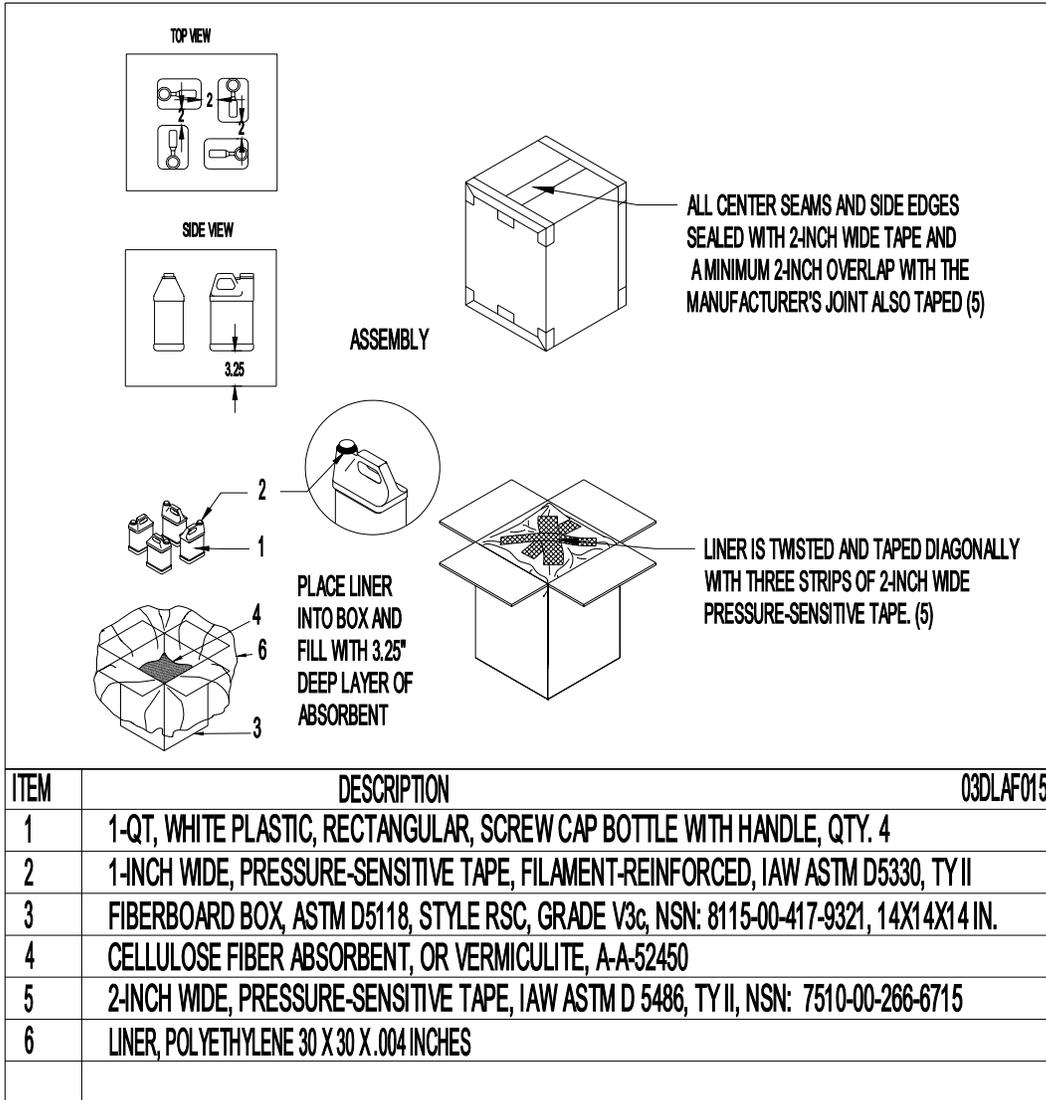
The equivalent of Packing Group I (great danger) testing was requested for a 14- by 14- by 14-inch corrugated fiberboard box having as the intended contents four, 1-quart, rectangular, plastic bottles, with handles. The configuration to be tested is intended to be applicable to a large assortment of liquid products contained in rectangular plastic bottles, in volumes of 1-quart or less. For lesser volumes, variations to testing requirements can be found in 49 CFR §178.601(g).

Water was used as the test liquid for all tests except the drop test as permitted by Title 49 Code of Federal Regulations (CFR). For the drop test a combination of 50% water and 50% propylene glycol was used. Substitution for the actual hazardous lading is permitted by 49 CFR §178.602(c).

An inner closure utilizing filament-reinforced tape around the cap and neck of the bottle was used in accordance with accepted packaging practice.

One combination packaging made to the above described configuration was subjected to drop and vibration testing as prescribed in ASTM D 4919. These tests are designed to simulate the shock and vibration a package (configuration) may encounter when being shipped worldwide by truck, rail, or ocean going transport. The order of testing was vibration, then drop testing. Prior to the rough handling testing of the packed box, static loading was performed on a filled box. This is a U.S. DOT approved method of stack testing, especially when the combination packaging has wide applications. A separate box was used for water absorptiveness testing of the fiberboard.

Appendix D (Continued)



Appendix D (Continued)



Inner Packaging: 1-quart, rectangular, plastic bottle with inner closure (tape)

Appendix D (Continued)



Inner Packaging positioned with Intermediate Packaging (absorbent and box liner) and outer container.

Appendix D (Continued)



Intermediate Packaging Closed.

Appendix D (Continued)



Closed outer container (fiberboard box).