

Report Number: DLA04-D016 **Report Date(s):** 27 September 2004

Previous Report Number: D016 **Previous Report Date:** NA

Title: Performance Oriented Packaging Testing of a 30-Gallon, Steel, Open Head Drum, with 1-Gallon Rectangular, Fiberboard & Plastic "Cubitainer" (Qty of 9) for Liquids - Packing Group I (All Modes of Transportation)

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 07-04; TT 10-03; TT 10-02;
9HTNR; AMC 13-88

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 Jan 04

Part 2. Test Results: ___ single X combination ___ composite

Section I. Pre-test Conditions

For initial testing, drums were received in new condition.

The following identification schema designates the packaging specimen used for the test(s) indicated. Each specimen is identified to the sample as received from the container manufacturer with the last four characters of this report no. preceding the specimen.

<u>Specimen</u>	<u>Test</u>
A1	repetitive-shock vibration test
A1	drop test: diagonal bottom chime diagonal bottom chime diagonal top chime at bolt flat top flat side at seam flat bottom
B1,B2,B3	hydrostatic pressure test
C1	stack test

Section II. Summary

A. Drop test - 106.3"	PASS
B. Leakproofness test -	N/A
C. Internal pressure test/Hydrostatic pressure test (liq.) - <small>Internal pressure tested to 100 kPa for air</small>	FAIL
D. Stacking test - 2,000 lbf, 24 hrs.	PASS
E. Vibration standard - 3.0 Hz, 1 hr.	PASS
F. Water resistance test (fiberboard box) -	N/A
G. Compatibility test (liq. in plastics) -	Not tested

Prior to testing, each inner container was filled, unless otherwise noted, with tap water or a 50% solution of propylene glycol and tap water when required for the cold-conditioning of plastic containers. Substitution for the actual hazardous item (material) is permitted by 49 CFR §178.602(c).

Part 2. Test Results (continued)

The decision to use the same container (configuration) for all six drop orientations was based on the relatively minimal damage demonstrated during previous testing of 30 gallon drums with different inner containers or articles. Six 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 circumferential chime per drum). The use of one configuration for multiple tests and drops is DOD policy as stated in DLAD 4145.41/AR 700-143/AFJI 24-210/NAVSUPINST 4030.55B/MCO 4030.40B, Packaging of Hazardous Material. Also per this policy, any failed orientation(s) can be repeated using another configuration.

Section III. Discussion

- A. Drop test:** 49 CFR §178.603 **Test date(s):** 9/24/04
 cold conditioned (0° F, 72 hr)
 ambient conditions (76° F, 56% RH)
 standard conditions (23° C & 50% RH)

No.	Ht.	Orientation	Results
A1	106.3"	Diagonal bottom chime 90° from seam	Pass/No leaks/rupture; entire contents retained
A1	106.3"	Diagonal bottom chime 270° from seam	Pass/No leaks/rupture; entire contents retained
A1	106.3"	Diagonal top chime at bolt	Pass/No leaks/rupture; entire contents retained
A1	106.3"	Flat top	Pass/No leaks/rupture; entire contents retained
A1	106.3"	Flat side at seam	Pass/No leaks/rupture; entire contents retained
A1	106.3"	Flat bottom	Pass/No leaks/rupture; entire contents retained

For each orientation for the drop test, an overhead hoist, equipped with an electronic release, was used. The impact surface was a steel plate.

- B. Leakproofness test:** 49 CFR §178.604
N/A. The leakproofness test of inner packagings is not required.

C. Internal Pressure/Hydrostatic Pressure test: 49 CFR §178.605
 For transportation by air, 49 CFR §173.27, applies.

Test date(s): 8/12/04

No.	Pressure	Duration	Reached & Maintained Marked Pressure?
B1	100 kPa 150 kPa	5 min.	Yes Failed, reached 150kPa, leaked at bolt
B2	100 kPa 150 kPa	5 min.	Yes Failed, reached 150kPa, leaked at bolt
B3	100 kPa 150 kPa	5 min.	Yes Failed, reached 150kPa, leaked at bolt & side seam at ring

The hydrostatic pressure test as a means of demonstrating the ability to maintain an internal pressure differential is conducted on metal drums intended for combination packagings to be transported by air.

Hydrostatic pressure testing was requested to 250 kPa even though the manufacturer certifies the drums to 150 kPa. Three drums do not represent a statistically significant sample which does not support a recommendation for the drums to be used in excess of the manufacturers certification for liquids requiring a test pressure up to 250 kPa. The hydrostatic pressure testing performed on these three specimen containers can be extrapolated to any other configuration which uses these specific drums as the outer container.

D. Stacking test: See 49 CFR §178.606. **Test date(s):** 9/15/04
 standard conditions (23° C & 50% RH)
 ambient conditions (72°F & 62% RH)
 high temperature conditions (104° F)

No.	Length	Type	Force Required	Actual Force Used	Results	Stability Maintained?
C1	24 hr	Static	1,296 lbf	2,000 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 to be applied was greater than the minimum required for one drum based on the outside drum height and the greatest anticipated gross packaged weight based on the highest computed specific gravity. The top load was to simulate a stack of identical packagings that might be stacked on the packaging during transport. The stack test was performed on this one specimen container can be extrapolated to any other configuration which uses these specific drums as the outer container. The container was tested empty to comply with requirements for authorized variations.

E. Vibration test: See 49 CFR §178.608.
ambient conditions (78°F & 55%RH)

Test date(s): 8/5/04

No.	Frequency	Duration	Results
A1	3.0 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. The packed combination packaging was tested using a 2,000-lb vibration table (rotary motion) that had a 1-inch vertical double amplitude (peak-to-peak displacement) such that the combination 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): N/A.
The Cobb Method Test, addressed in (49 CFR §178.516), Standards for Fiberboard Boxes, is a material specification test only for the fiberboard to be used for outer packagings.

G. Compatibility test (plastics packagings only): Not tested.
Compatibility testing (a procedure specified in appendix B to part 173, as required by 49 CFR §173.24(e)(3)(ii)) is only required for plastics packagings intended to contain *liquid* hazardous materials. Compatibility of the particular plastics inner receptacle and the hazardous liquid must be established before use.

Part 3. 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, Charlotte A. Lent, and Timothy L. Reimann.

Part 4. References

A. Title 49 Code of Federal Regulations, Parts 106 and 180, current as of 1 Oct 03

B. International Air Transport Association Dangerous Goods Regulations, 45th edition, 1 Jan. 2004

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

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

Part 4. References (continued)

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, thirteenth revised edition, United Nations, New York, 2003.

H. DLAD 4145.41/AR 700-143/AFJI 24-210/NAVSUPINST 4030.55B/MCO 4030.40B, Packaging of Hazardous Material, 14 Jan 2000

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

Part 5. Equipment

Item	Manufacturer	Serial No.	Calibration Expiration Date
2,000-lb vibration table	L.A.B. Skaneateles, NY	G23605	see note
11,000-lb compression tester	Chant Engr. Co. New Britain, PA	001	4/05
500-lb scale	Ohaus Corporation USA	5097971	4/05
9,000-gram balance	Ohaus Corporation USA	20078	4/05
Release hook	Lansmont Monterey, CA	NA	N/R
Torque wrench (150 ft-lb)	Norbar Torque Tools Banberry, UK	2003/431074	10/05
700 kPa pressure gauge	Cecomp Elect., Inc. Watertown, CT	03125	11/06

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 inner container and drum 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.

Reference to specification materials has been made based either on the information provided by the requester, the manufacturer, or the markings printed on, attached to, or embossed/molded on the packagings. It was not possible to identify the exact composition of the drum construction materials.

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 drum. Packaging paragraphs apply.

*Absorbent **does not meet** the minimum measurement requirements of AFMAN 24-204.

Appendix B

Test Data Sheet

Section I. Test Calculations

DLA COMBINATION PACKAGINGS - INPUTS & CALCULATIONS

Variables		Inputs	Calculations
h	height, drum/box (in.)	29	XXXXXX
n	# packages stacked	XXXXXX	4.1
q1	# inner containers	9	XXXXXX
v1	max. volume, 1 inner container (gal)	XXXXXX	1.16
v2	rated capacity, 1 inner, (gal)	1	1
V	total volume, max (gal)	XXXXXX	10.44
w0	gross wt, packed configuration (lb)	155	155
w1	weight, outer drum/box, empty (lb)	33.3	33.3
w2	weight, bottle or can, empty (lb)	0.50	0.50
w3	weight, ring/pad (lb)	0	0.00
w4	weight, max. liq. + bottle/can (lb)	10.11	10.11
w5	weight, max. inner (1) liq, only	XXXXXX	9.61
w6	weight, filled test wt. inner (lb), qty 1	XXXXXX	9.92
w7	weight, absorbent (inc. bag)	XXXXXX	32
Wp	weight, all packaging mat'ls	XXXXXX	69.80
c	constant	1	XXXXXX
SG	specific gravity	1.8	XXXXXX

NOTE:

A1 = (n - 1) * (Wp + (SG * V * 8.3 * 0.98)) * (c), Packing Group I
 A2 = (n - 1) * (Wp + (SG*1.5 * V * 8.3 * 0.98)) * (c), Packing Group II
 A3 = (n - 1) * (Wp + (SG*2.25 * V * 8.3 * 0.98)) * (c), Packing Group III

SG
 1.8
 2.7
 4.1

where:

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
 Wp = w1 + (w2 * q1) + (w3 * q1) + w7, total weight in pounds
 V = v1 * q1, total volume (max. capacity)
 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)

SG

1.8
 2.7
 4.1

PGs I, II, & III				
A1	Stacking weight, lb - PG I	690.20	rounded to -PG I	691
A2	Stacking weight, lb - PG II	927.20	rounded to - PG II	928
A3	Stacking weight, lb - PG III	1295.70	rounded to - PG III	1296

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

	Specific Gravity (see note 1)	Total Amount per Configuration (see note 2)	Gross Weight (see note 3)	Maximum Gross Mass (see note 4)
water	1.0	86 lb	155 lb	70 kg
PG I	1.8	155 lb	224 lb	102 kg
PG II	2.7	232 lb	301 lb	137 kg
PG III	4.1	344 lb	413 lb	187 kg

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 = 4.1

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

Note 2. Based on 1 gal H₂O = 8.3 lb, or fraction thereof.

Note 3. Gross weight = liquid wt. + packaging (constant).

Note 4. Maximum gross mass is gross weight expressed in kg.

Appendix C

Packaging Data Sheet

Section I. Exterior Shipping Container

Packaging Category: ___ single X combination ___ composite

UN Type: Steel open head drum (49 CFR §178.504)

UN Code: 1A2 Nominal (Rated) Capacity: 30 gal

UN Marking(s) on Packaging:

marked on drum side--  1A2/Y1.8/150/04/USA/GBC1

embossed on drum bottom-- UN/1A2/Y1.8/150/04
1.4-1.1-1.1

Specification Type and No.(s): N/A

Type/Materials: Steel, open head drum

Manufacturer/Distributor: Greif Steel Drum/Myers Container Corp.,
Emeryville, CA 94608 CAGE: 20327

Date(s) of Manufacture: 2004

Nomenclature: Drum, Steel, Shipping and Storage

NSN: 8110-00-366-6809 (drum assembly)

Tare Weight (empty drum): 33.3 lbs.

Dimensions:

- 29 in. OD (drum height, including locking ring)
- 20 in. OD (drum body diameter, outside ring)
- 18³/₈ in. ID (drum body diameter)
- 28 in. ID (drum body height)

Closure (Method/Type): Gasket with bolted locking ring assembly

Closing Instructions: Tap ring while tightening bolt to 60 ft-lbs min. and ring gap min. 1/8" to 5/8" max. per manufacturer's closing instruction.

Appendix C (Continued)**Section II. Inner Packaging/Article**

Quantity of Inner Containers: 1 Capacity: 1 Gallon

Specification Type and No.(s): N/A

Type: "Cubitainer" composite, fiberboard box and a flexible plastic bottle with a screw cap closure

Manufacturer/Distributor: Hedwin/Consolidated Plastics Company P/N: 32113LR

Material(s): 200#, SW, fiberboard/polyethylene

Date of Manufacture: N/A

Tare Weight (empty container): 0.50 lb

Filled Weight: 9.9 lbs.

Dimensions: 7" X 7" X 7"

Closure (Method/Type): Screw cap with liner

Closure Specification Number(s): N/A

Closure Manufacturer: N/A

Closure Dimensions: 1½" diameter X ½" ht.

Secondary Closure: Tape wrapped around cap & neck, twice,
1-inch pressure sensitive, filament-reinforced tape
IAW ASTM 5330, TY II (medium tensile)

Polyethylene Liner Bag: 38" x 50" x .004"

Absorbent Material: HAZMAT PAC A-900 was used, Absorbent GP or fine grain vermiculite can be substituted. Note. Type absorbent used must be capable of absorbing the specific liquid contained.

Absorbent Material Weight: 32 lbs cellulose fiber absorbent
16 lbs fine grain vermiculite

Absorbent Manufacturer: HAZMAT PAC Co., Houston, TX 77023

Appendix C (Continued)

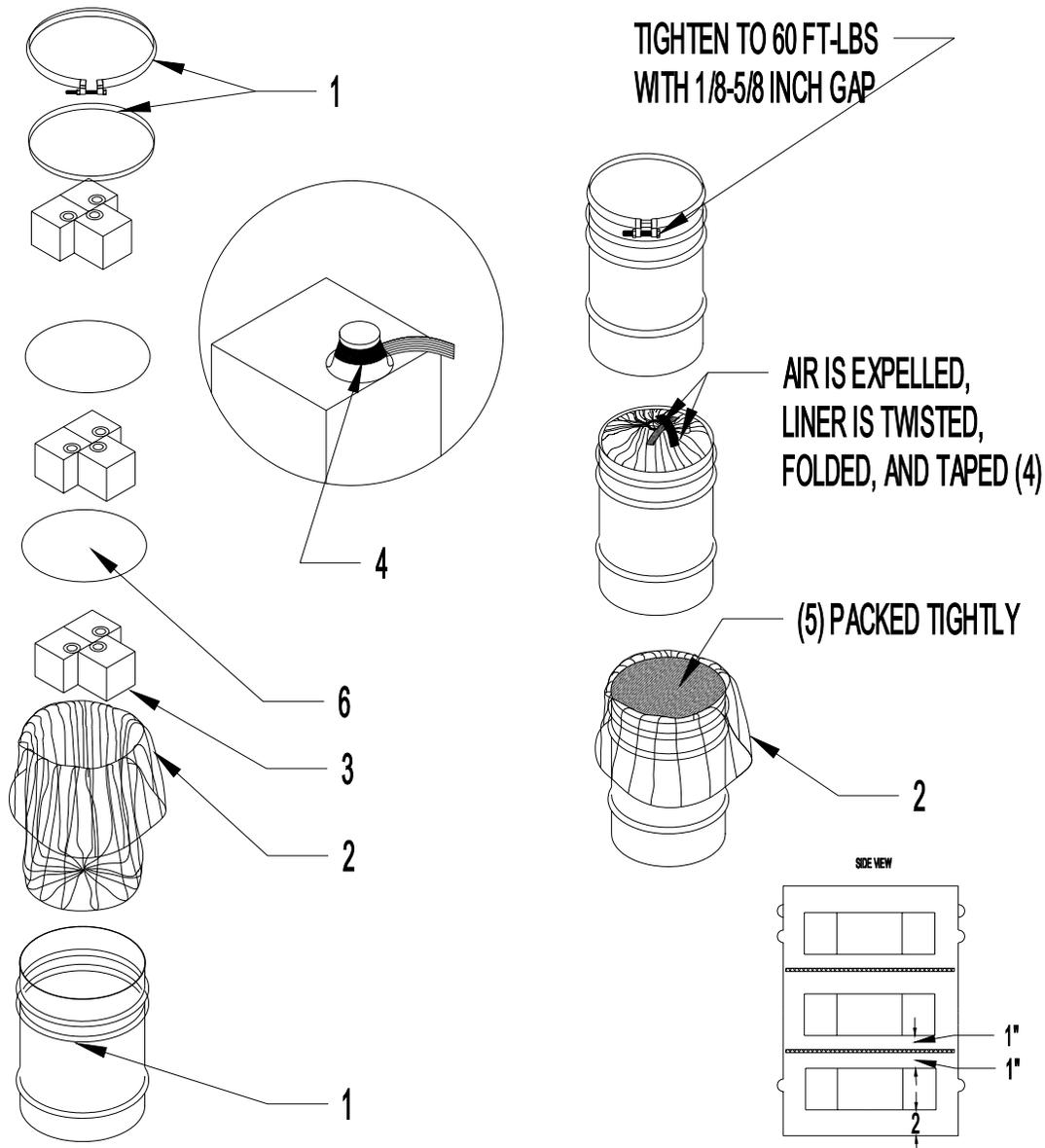
Section II. Inner Packaging/Article (Continued)

Additional Description:

a. A plastic liner, used as an intermediate pack, was first placed into the drum to encapsulate the absorbent and test product.

b. Approximately 2 inches of loose fill absorbent was compressed in the bottom of the drum. Three inner containers were placed on the compressed absorbent cushioning, together in a "T" formation at center with containers touching. Additional loose fill absorbent was then tightly packed around and 1 inch over the inner containers. A fiberboard separator was placed on top of the absorbent and 1 inch of compressed absorbent was added. These steps were repeated for loading the second and third tiers. It is critical that the full amount of absorbent is used and compressed approximately every 4 inches as the drum is being packed. The absorbent must completely fill the drum, up to the rim. The plastic bag is to be twisted and then taped closed(see drawing).

Appendix D
Drawing



ITEM	DESCRIPTION	04D016
1	30 GAL. STEEL OPEN HEAD DRUM, NSN 8110-00-366-6809	
2	PLASTIC LINER, FLAT POLYETHYLENE BAG, 38 X 50 X 0.004 INCHES	
3	1-GAL. "CUBITAINER" FIBERBOARD BOX & PLASTIC BOTTLE (7" x 7" x 7") OD, QTY. 9	
4	1-INCH WIDE, PRESSURE-SENSITIVE TAPE, FILAMENT-REINFORCED, IAW ASTM D 5330, TY II	
5	CELLULOSE FIBER ABSORBENT(32 LB), OR VERMICULITE(16 LB), A-A-52450	
6	FIBERBOARD PAD, 17" DIAMETER, QTY. 2	

Appendix D (Continued)



Inners Placed in Intermediate and Exterior Shipping Container.

Appendix D (Continued)



Inner Shipping Container with Secondary Closure (Tape) and Outer Shipping Container.

Appendix D (Continued)



Intermediate Shipping Container Twisted and Taped.

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Appendix D (Continued)



Outer Container Closed, with Jam Nut Tightened on Untreaded Lug