

Report Number: DLA03D008A **Report Date(s):** 22 Sep 03

Previous Report Number: D003 **Previous Report Date:** 7/1/01

Title: Performance Oriented Packaging Testing of a 30-Gallon,
Forged Lug, Steel, Open Head Drum, With 1-Gallon, "F" Style,
Rectangular, Metal Can with Handle (Quantity of 6) for Liquids -
Packing Group II (All 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 10-02;
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 Dec 02

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

Section I. Pre-test Conditions

The following identification schema designates the packaging specimen used for the test(s) indicated.

<u>Specimen No.</u>	<u>Test</u>
A	stack test
A	repetitive-shock vibration test
A	drop test
B	hydrostatic pressure test

Prior to testing, each can was filled, unless otherwise noted, with tap water. Substitution for the actual hazardous item (material) is permitted by 49 CFR §178.602(c).

Section II. Summary

A. Drop test - 70.87"	PASS
B. Leakproofness test -	N/A
C. Internal pressure test/Hydrostatic pressure test (liq.) - 100 kPa, capable by packing group specification	PASS
D. Stacking test - static load, 1350 lb, 24 hr	PASS
E. Vibration standard - repetitive-shock, rotary motion 3.0 Hz., 1 hr	PASS
F. Water resistance test (fiberboard box) -	N/A
G. Compatibility test (liq. in plastics) -	N/A

Part 2. Test Results (continued)

Section III. Discussion

A. Drop test: 49 CFR §178.603 **Test date(s):** 9/15/03
 ambient conditions (~74°F & 70% RH)

No	Ht.	Orientation	Results
A	70.87"	Bottom diagonal chime at/near seam	Pass/No leaks/rupture; entire contents retained
A	70.87"	Bottom diagonal chime at/near seam	Pass/No leaks/rupture; entire contents retained
A	70.87"	Bottom diagonal chime at/near seam	Pass/No leaks/rupture; entire contents retained
A	70.87"	Top diagonal chime at/near bolt	Pass/No leaks/rupture; entire contents retained
A	70.87"	Flat side at/near seam	Pass/No leaks/rupture; entire contents retained
A	70.87"	Flat side at/near seam	Pass/No leaks/rupture; entire contents retained

For each orientation for the drop test, a quick release hook, fixed to an overhead crane, was used to lift the drum 70.87 inches. The impact surface was a steel plate.

The decision to use one container (Specimen A) for all six drop orientations for Packing Group II was based on the relatively minimal damage demonstrated during previous testing of MS27684 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 24-201/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 of inner packaging is not required.

C. Internal Pressure/Hydrostatic Pressure test: 49 CFR §178.605
 For transportation by air, 49 CFR §173.27, applies.
 ambient conditions (~82°F & 60% RH) **Test date:** 8/22/03

No	Pressure	Duration	Reached & Maintained Marked Pressure?
B1	100 kPa 150 kPa 200 kPa	5 min.	Yes Yes No/Leaked at bolt at 155 kPa
B2	100 kPa 150 kPa	5 min.	Yes No/Leaked at bolt immediately upon reaching 150 kPa
B3	100 kPa 150 kPa 200 kPa	5 min.	Yes Yes No/Leaked at bolt at 155 kPa

Part 2. Test Results: Section III (continued)

The hydrostatic pressure test is not required for combination packagings. This test was conducted at the request of DDC.

D. Stacking test: See 49 CFR §178.606. **Test date:** 9/15/03

- standard conditions (23° C & 50% RH)
- ambient conditions (~74° F & 54% RH)
- high temperature conditions (104° F)

No	Length	Type	Force Required	Peak Force	Results	Stability Maintained?
A	24 hr	Static	1055 lb	1,350 lb	Pass/No leakage or rupture	Yes

A static top load (1,350 lbs.) 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 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:** 9/15/03

- ambient conditions (~74° F & 70% RH)

No.	Frequency	Duration	Results
A	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, using the drum/metal cans combination packaging. The 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.

Part 2. Test Results: Section III (continued)

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

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, Stuart N. Crouse, Timothy L. Reimann, and Karen K. Kimsey

Part 4. References

- A. Title 49 Code of Federal Regulations, Parts 106 and 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

Part 5. Equipment

Item	Manufacturer	Serial No.	Calibration Expiration Date
2,000-lb vibration table	L.A.B. Skaneateles, NY	G23605	see note
5,000-lb compression tester	L.A.B. Skaneateles, NY	1107050	4/04
500-lb scale	Ohaus Corporation USA	5097971	4/04
9,000-gram scale	Ohaus Corporation USA	20078	4/04
release hook	Gaynes Engr. Co. Franklin Park, IL	18211-1	N/R
torque wrench (100 ft.-lb)	Stanley-Proto Covington, GA	WUK50305	7/04

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 cans 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 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.

Appendix B

Test Data Sheet

Section I. Test Product

Physical State: ___ solid X liquid ___ gas ___ aerosol

Amount Per Container:

Item Weight-- 54.6 lbs.
 Tare Weight-- 88.4 lbs.
 Gross Weight-- 143 lbs.

Density/Specific Gravity: 1.0

Stacking Weight Formula, DLA COMBINATION PACKAGINGS

Variables	Inputs		
h height, drum/box	29		
n # stacked containers	XXXXXXXXXX	4.10	
w1 weight, drum/box	31		
w2 weight, bottle/can	9.1		
w3 weight, ring/pad	0		
q1 # inner containers	6		
v1 max. volume, 1 inner container	1		
v total volume	XXXXXXXXXX	6.00	
w4 weight, item (unpacked)	0.00		
W5 weight, absorbent	57		
W gross weight	XXXXXXXXXX	142.60	
C constant	1		
sg specific gravity	1.8		
PG Packing Group	II		

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 = $(n-1) * (w + (4.0 * v * 8.3 * 0.98)) * (c)$, 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 = $w1 + (w2 * q1) * (w3 * q1) * w4$, 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	714.40	715
A2 Stacking weight-PG II	XXXXXXXXXX	850.50	851
A3 Stacking weight-PG III	XXXXXXXXXX	1054.80	1055

Appendix B (Continued)

Section III. Equivalencies of Liquids

	Specific Gravity ¹	Total (Each) Amount per Container	Gross Weight (pounds) (kilograms)	
water*	1.0	49.9 lb	143	64.8
PG I	1.2	59.88 lb	152.9	69.3
PG II	1.8	89.82 lb	182.8	82.9
PG III	2.7	134.73 lb	227.7	103.3

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 = 1.8 m, thus SG = 1.2

PG II: 1.0 m x SG = 1.8 m, thus SG = 1.8

PG III: 0.67 m x SG = 1.8 m, thus SG = 2.7

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

Appendix C (Continued)

Section II. Inner Packaging/Article

Quantity of Inner Containers: 6 Capacity: 1 gallon each

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

Type: Rectangular, 1-gallon "F" Style can with handle; stock # C-672

Manufacturer/Distributor: HAZMATPAC, Houston, TX 77023

Material(s): Metal, tin plate

Markings printed on bottom--  3A1/Y1.8/100/03
USA/M5370

Date of Manufacture: Marked 03

Tare Weight (empty can): 0.81 lb

Filled Weight: 9.1 lbs. (54.6 lbs.)

Dimensions: 6.5 in. x 4 in. X 10 in. high

Closure (Method/Type): Screw cap

Closure Specification Number(s): N/A Closure Manufacturer: N/A

Closure Dimensions: 1.75" diameter x .5" height

Secondary Closure: 1" reinforced tape (see drawing)

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

Bag Manufacturer: Quality Packaging Systems, Warren, MI 48091-5324

Bag Closure: 1-inch pressure sensitive, filament reinforced tape
IAW ASTM 5330, TY II (medium tensile)

Absorbent Material: HAZMAT PAC A-900

Absorbent Material Weight: 57 lbs. of (Absorbent GP, or A-900) or
29 lbs. of vermiculite

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

Plastic Liner Bag: Size 38" x 60" x .004"

Appendix C (Continued)

Section II. Inner Packaging/Article (Continued)

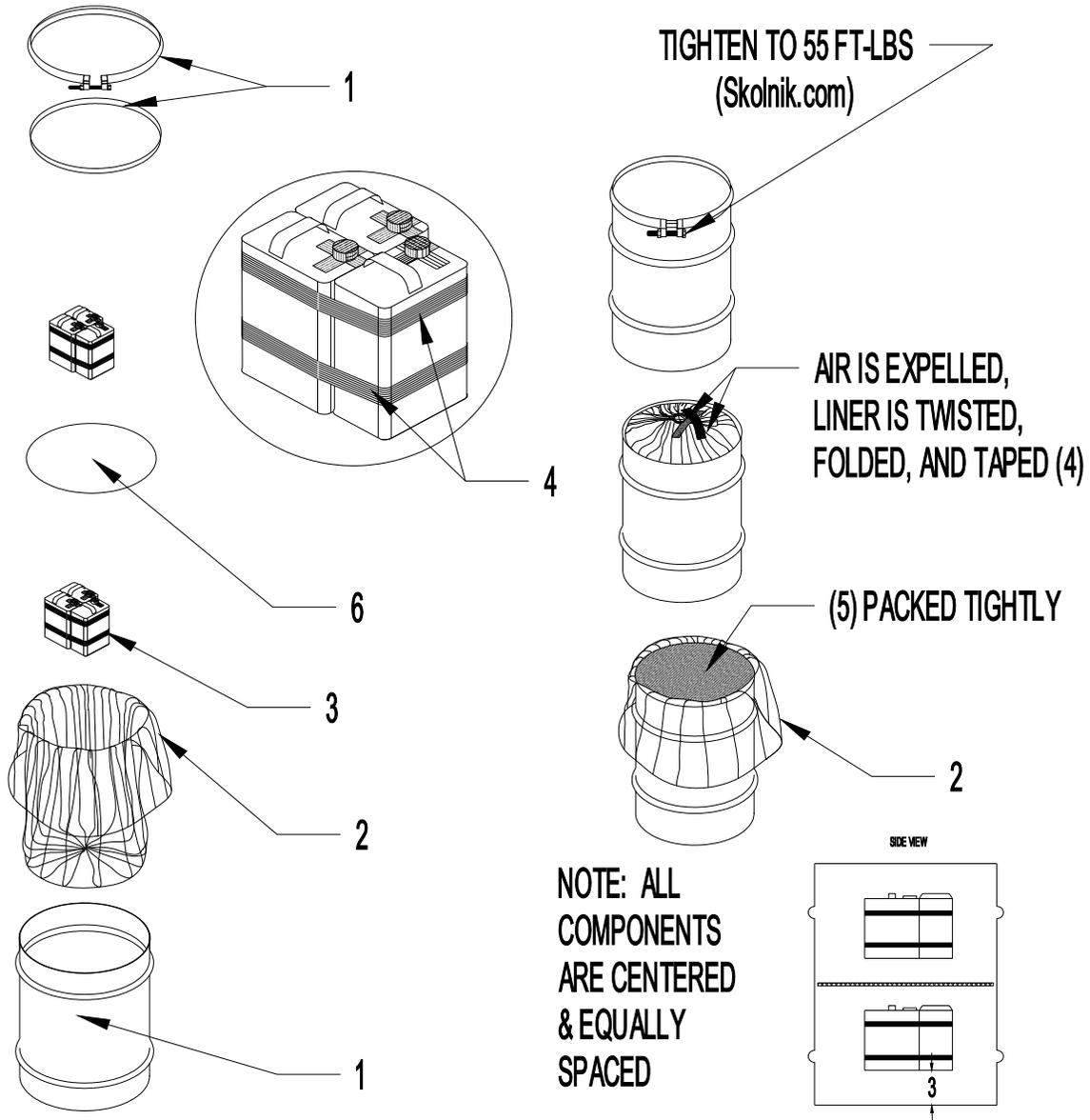
Additional Description:

a. A plastic liner bag, 38" x 50" x .004", was first placed into the drum to encapsulate the absorbent and test product.

b. Approximately 3 inches of absorbent was compressed in the bottom of the drum. Place three cans, taped together (see drawing), on the loose fill absorbent cushioning, separated from the sides of the drum by 2.75". Fill and compress absorbent at 4 inch intervals. Add another 1 inch of absorbent on top of the cans making a firm pack by tamping the absorbent around and on top of the cans. Place a fiberboard separator on top of the absorbent. Add another 2 inches of absorbent on the pad. Place three more cans as described above. Make a firm pack by tamping the absorbent around and on top of the cans and compress the remaining absorbent into the drum. Twist and tape bag to close.

Note: It is critical that the full amount of absorbent material is used.

Appendix D
Drawing



ITEM	DESCRIPTION	DLAD008A
1	30 GAL., 1A2 STEEL OPEN HEAD DRUM	
2	PLASTIC LINER, FLAT POLYETHYLENE BAG, 38 X 50 X 0.004 INCHES	
3	1-GALLON, "F" STYLE, RECTANGULAR, METAL CAN, WITH HANDLE, QTY. 6	
4	1-INCH WIDE, PRESSURE-SENSITIVE TAPE, FILAMENT-REINFORCED, IAW ASTM D 5330, TY II	
5	CELLULOSE FIBER ABSORBENT, OR VERMICULITE, A-A-52450	
6	FIBERBOARD PAD, 17" DIAMETER	

Appendix D (Continued)



View of 1-gal F-Style metal can with handle with secondary closure (tape).

Appendix D (Continued)



View of three inner containers taped together.

Appendix D (Continued)



View showing fiberboard pad in the 30 gallon drum.

Appendix D (Continued)



Three F-Style cans taped together in absorbent.

Appendix D (Continued)



30-gallon exterior shipping container with plastic liner taped and closed.



Exterior shipping container closed.

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Appendix E

Supplemental test data:

A. NSN: 8110-00-866-1728

UN Type: Steel open head drum

UN Code: 1A2

Rated Capacity: 30 gal

UN Marking(s) on Packaging:

label on drum side--



1A2/X235/S/02/USA/SDCC



1A2/Y1.5/100/02/USA/SDCC

embossed on drum bottom--

UN/1A2/X235/S/02

UN/1A2/Y1.5/100/02

Type/Materials: Steel, open head drum, round, standard gasket

Manufacturer/Distributor: Skolnik Industries, Inc.

Internal Pressure/Hydrostatic Pressure test: 49 CFR §178.605

For transportation by air, 49 CFR §173.27, applies.

X ambient conditions (~82°F & 60% RH) **Test date:** 6/17/03

No	Pressure	Duration	Reached & Maintained Marked Pressure?
1	100 kPa	5 min.	No/Leaked at bolt at 90 kPa
2	100 kPa	5 min.	No/Leaked at bolt at 87 kPa
3	100 kPa	5 min.	No/Leaked at bolt at 62 kPa

The hydrostatic pressure test is not required for combination packagings. This test was conducted at the request of DDC.

Packing Group I hydrostatic pressure testing was requested to 250 kPa where as the manufacturer certifies the drums to 100 kPa. Three drums are required to be tested, one failure fails the drums.

B. Commercial drum: Manufacturer/Distributor: Skolnik Industries, Inc./MAXI Container, Inc., 6000 Caniff, Detroit, MI 48212, 800-727-MAXI Stock #CQ3003L

UN Type: Steel open head drum

UN Code: 1A2 Rated Capacity: 30 gal

UN Marking(s) on Packaging:

label on drum side--  1A2/X235/S/03/USA/SDCC
 1A2/Y1.8/150/03/USA/SDCC

embossed on drum bottom-- UN/1A2/X235/S/03
 UN/1A2/Y1.8/150/03
 1.2 - 0.9 - 1.2

Type/Materials: Steel, open head drum, round, standard gasket

Internal Pressure/Hydrostatic Pressure test: 49 CFR §178.605
 For transportation by air, 49 CFR §173.27, applies.
 X ambient conditions (~72°F & 60% RH) **Test date:** 9/18/03

No	Pressure	Duration	Reached & Maintained Marked Pressure?
1	100 kPa 150 kPa	5 min.	Yes No/Leaked at bolt at 150 kPa
2	100 kPa 150 kPa	5 min.	Yes No/Leaked at bolt at 150 kPa
3	100 kPa 150 kPa	5 min.	Yes No/Leaked at bolt at 150 kPa
4	100 kPa 150 kPa	5 min.	Yes No/Leaked at bolt at 150 kPa
5	100 kPa 150 kPa	5 min.	Yes No/Leaked at bolt at 150 kPa
6	100 kPa 150 kPa	5 min.	Yes No/Leaked at bolt at 150 kPa

The hydrostatic pressure test is not required for combination packagings. This supplemental testing was conducted at the request of DDC. These drums did not meet their certification markings.

Packing Group I hydrostatic pressure testing was requested to 250 kPa where as the manufacturer certifies the drums to 150 kPa. Three drums are required to be tested, one failure fails the drums.