Part 1. Report Cover

Report Number: DLA04-F053 **Report Date:** 14 May 04

Previous Report: DLAF053, 13 May 02

Title: Performance Oriented Packaging Testing of a Grade V3c, Fiberboard Box, Style RSC, 12" x 12" x 16" (ID), With a 5.6 Quart Friction Plug (LID), Round Metal Can (Qty 1) with HAZLOC Brand Ring and Containing 1-Liter, Round, Plastic Bottle (Qty 1) for Liquids – Packing Group I (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 07-04; 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 Jan 04

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. All fiberboard containers are conditioned to standard conditions (23°C, 50% RH) prior to testing.

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.

Specimen No.	Test
B	stack test
A	repetitive-shock vibration test
A	flat onto bottom, drop test (3)
	flat onto top, drop test (1)
	flat onto long side, drop test (4)
	flat onto short side, drop test (6)
	bottom corner, drop test (2-3-5)
C	water resistance test

Section II. Summary

A. Drop test – 106.3” **PASS**

B. Leakproofness test N/A

C. Internal pressure test/Hydrostatic pressure test N/A

D. Stacking test – Static load, 550 lbs., 24 hrs. **PASS**

E. Vibration standard – Repetitive-shock, rotary motion 2.5 Hz., 1 hr. **PASS**

F. Water resistance test – V3c, Felt side **PASS**

G. Compatibility test N/A

Note: Unless the friction lid can is equipped with HAZLOC brand locking ring, 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):** 5/03/04
cold conditioned (0° F, 72 hr)

No	Ht.	Orientation	Results
A	106.3″	Flat onto box bottom (3)	Pass/No leaks/rupture; entire contents retained
A	106.3″	Flat onto box top (1)	Pass/No leaks/rupture; entire contents retained
A	106.3″	Flat onto box long side(4)	Pass/No leaks/rupture; entire contents retained
A	106.3″	Flat onto box short side(6)	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

The specimen was a combination packaging consisting of a grade V3c fiberboard box (outer packaging) containing a 5.6-Quart can (intermediate packaging) with a 1-Liter Round plastic bottle (inner packaging) inside. The 1-Liter bottle was filled with 50% water and 50% propylene glycol mixture 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):** 4/14/04
ambient conditions (~70° F & 32% RH)

No.	Length	Type	Load/Force Required	Peak Force	Results	Stability Maintained?
B	24 hrs	Static	188 lb	572 lbf	Pass	Yes

A compression table was used to establish a static top load of 550 lbs for the stack test, because it could hold the load constant for the required 24-hours timeframe. The total top load applied on the empty 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):** 4/29/04
ambient conditions (~72° F & 34% RH)

No.	Frequency	Duration	Results
A	2.5 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 packaging was tested using a 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 specimen "B" cut from one box (DLA 04 - F049). **Test date(s):** 4/09/04

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.

The shipper must take appropriate steps to ensure that the box is correctly constructed with the felt 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 Lynn Hill.

References

A. Title 49 Code of Federal Regulations, Parts 106-180, current as of 1 Oct 2003

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

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

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*
11,000-lb compression tester	Chant Engr. Co. New Britain, PA	001	(new)
500-lb scale	Ohaus Corporation USA	5097971	4/05
3,000-gram balance	Brinkman Instruments Westbury, NY	3103120	4/05
9,000-gram balance	Ohaus Corporation USA	20078	4/05
Release hook	Lansmont Monterey, CA	N/A	N/R
Cobb Sizing Tester	Teledyne Curley Troy, NY	4180-A	N/R

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. Packaging paragraphs apply.

Appendix B

Test Data Sheet

Section I. Test Product

Physical State: ___ solid _X_ liquid ___ gas ___ aerosol

Name: Water

Amount Per Container (Configuration):
1-Liter, rated; 2.20 lbs.; 3.42 lbs, filled

Gross Weight: 23.0 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	Calculations
h	height, drum/box	16.75	
n	# stacked containers	XXXXXXXX	7.00
w1	weight, drum/box	2.27	2.27
w2	weight, bottle/can	3.42	3.42
w3	weight, ring/pad	0	0.00
q1	# inner containers	1	1.00
v1	max. volume, 1 inner container	0.264	0.26
v	total volume	XXXXXXXX	0.26
w4	weight, item (unpacked)	0	0.00
W5	weight, absorbent	17	17.00
W	gross weight	XXXXXXXX	22.69
C	constant	1	XXXXXXXX
Sg	specific gravity	1.8	1.80
PG	packing group	1	XXXXXXXX

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)+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	XXXXXXXX	**159.00**	**159**
A2	Stacking weight-PG II	XXXXXXXX	**170.40**	**171**
A3	Stacking weight-PG III	XXXXXXXX	**187.50**	**188**

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Appendix B (Continued)

Section III. Equivalencies of Liquids

	Specific Gravity[1]	Total (Each) Amount per Packaging	Gross Weight (pounds)	(kilograms)
water*	1.0	2.20 lb	23.00	10.43
PG I	1.8	3.96 lb	24.76	11.23
PG II	2.7	5.94 lb	26.74	12.13
PG III	4.0	8.80 lb	29.60	13.42

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-D5118; CF; V3c; WR; SW; Style RSC; 2.3 lbs.; 12" x 12" x 16"(ID); 12.5" x 12.5" x 16.75"(OD) Bursting Strength-400

Manufacturer: Lynchburg Sheltered Industries, Lynchburg, VA 24501

Date(s) of Manufacture: October 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 36 inch, 4-Mil-polyethylene liner was first placed in the fiberboard box for the purpose of encapsulating the absorbent and the test product. Approximately 2¾ inches of loose-fill absorbent cushioning was firmly packed in the bottom of the fiberboard box. The intermediate can was placed on the absorbent material, and additional loose-fill absorbent material was then packed around and over the can. 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. Close box with 2" tape.
NOTE: It is critical that the full amount of absorbent is used.

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.

c. The quantities of absorbent material do meet the 1-Liter guidelines for absorbent materials as outlined in AFMAN 24-204/TM 38-250/NAVSUP PUB 505/MCO P4030.19F/DLAM 4145.3, Preparing Hazardous Materials for Military Air Shipments.

Absorbent Manufacturer: HAZMATPAC A-900

Appendix C (Continued)

Section II. Intermediate Packaging

Quantity of Intermediate Containers: 1 Capacity: 5.6 Quart

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

Type: 5.6 Quart unlined paint can without metal hand bail; friction plug (lid)

Manufacturer/Distributor: HAZMATPAC
Houston, TX 77023

Manufacturer's/Distributor's Part No(s).: UN116

Tare Weight (empty bottle): .93 lbs

Dimensions: 6¾ in. diameter; 10¾ in. high

Closure Type: Friction plug

Secondary Closure: plastic locking ring

Secondary Closure Specification: HAZLOC Brand

Secondary Closure Manufacturer and Part No.: HAZMATPAC, C-700

Intermediate Packaging: 30 x 36 x .004 in., flat polyethylene bag

Cushioning: Absorbent GP or A900; weight – 18 lbs.
Vermiculite; weight – 9 lbs.

Manufacturer/Distributor: HAZMATPAC A-900, HAZMATPAC Inc.; Absorbent GP, Absorption Corp.; and vermiculite, fine grain, Palmetto Vermiculite Company, Inc.

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

NOTE: This test report can only be cited when a HAZLOC, C-700 ring is applied to the can.

The can is to be closed using a rubber mallet to tap the entire friction lid securely in place. The plastic locking ring is then placed on top of the can. The plastic ring is installed by using a rubber mallet to tap the entire ring over the upper edges of the can. Care must be exercised to avoid denting or creasing the friction-lid can.

Section III. Inner Packaging/Article

Quantity of Inner Containers: 1

Nominal Capacity per Inner Container: 1-Liter

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

Type/Materials: Round, plastic bottle

Manufacturer/Distributor: Freund Can Company
Chicago, IL 60620

Manufacturer's/Distributor's Part No(s).: N/A

Contract and Purchase No(s).: Not marked

Date of Manufacture: N/A

Tare Weight (empty): 0.24 lbs

Dimensions: 3 5/8 in. in diameter x 6 5/8 in. in height (OD)

Closure Type: Plastic screw cap with coated liner (28/410)

Closure Specification Number(s): N/A

Closure Manufacturer/Distributor and Part No(s).: Freund Can Co.

Closure Dimensions: 1¼ in. diameter x 7/8 in. height (OD)

Secondary Closure: Filament-reinforced tape (1 pc)

NOTE: The 1-Liter plastic bottle is to be completely wrapped with enough "bubble wrap" to prevent any movement of the screw-cap can. Additional "bubble wrap" is to be put inside the friction-lid can, as necessary to make a tight pack. The "bubbles" are to be to the outside (i.e., the flat side is to be against the screw-cap can).

Appendix D

Rationale

The equivalent of Packing Group II & III testing was requested for a 12- by 12- by 16-inch corrugated fiberboard box having as the intended contents one 1-Liter, round, plastic bottle, packed inside one 5.6-Quart, friction plug (lid), round, metal can, fitted with a plastic locking ring. The friction-lid can is more commonly known as a paint can. The configuration to be tested is intended to be applicable to a large assortment of liquid products contained in oblong, metal cans, to be packed in friction plug (paint), metal cans for transportation by air. The primary inner packaging (screw-cap cans) can be in volumes of 1-Liter or less. For lesser volumes, variations to testing requirements can be found in *49 CFR §178.601(g)*

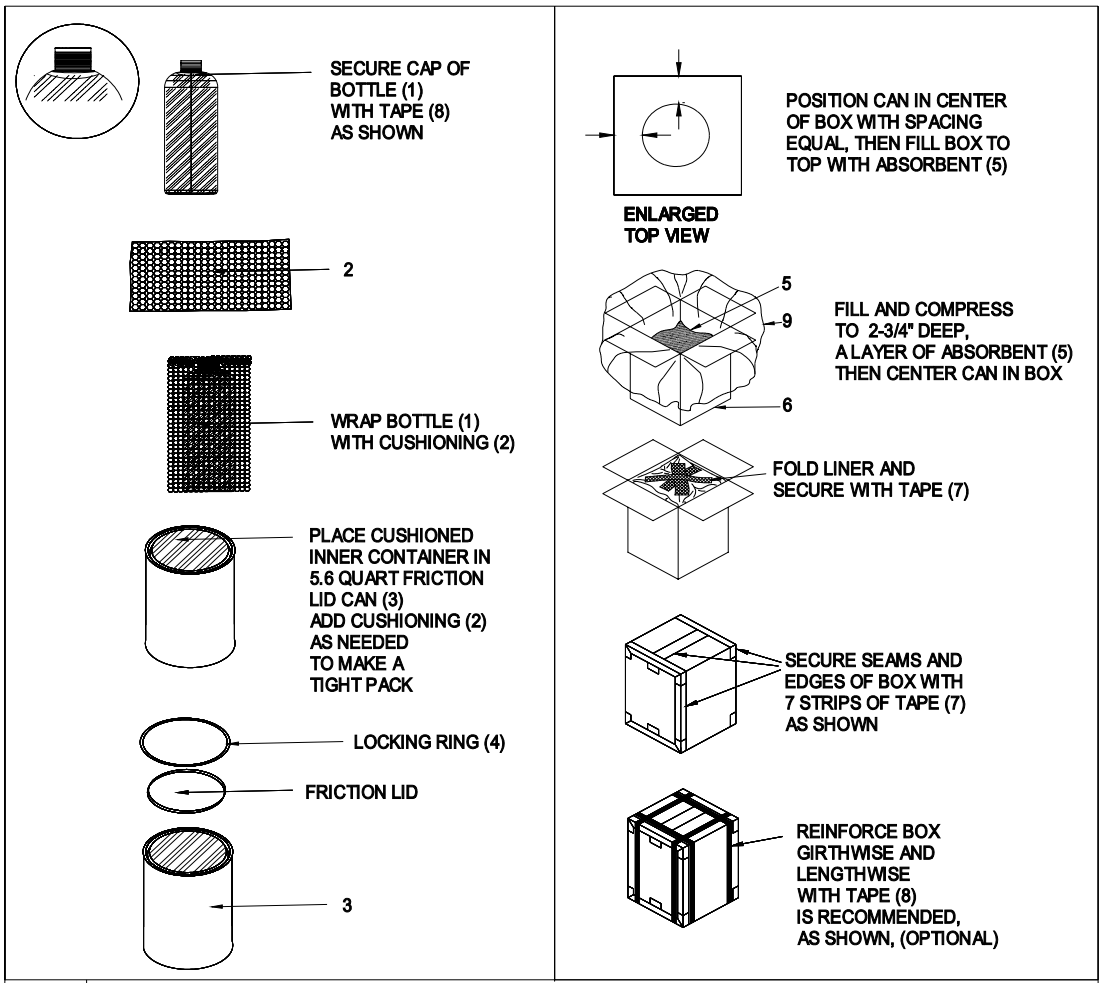
Water was used as the test liquid as permitted by Title 49 Code of Federal Regulations (CFR). Substitution for the actual hazardous lading is permitted by *49 CFR §178.602(c).*

Per the requesting activity, HAZMATPAC A-900 was used as an absorbent material and/or cushioning inside the box. Plastic, closed-cell ("bubble") wrap was used as cushioning/dunnage inside the friction-lid can.

Per the requesting activity, a HAZLOC brand locking ring was used as a secondary closure of the friction-lid can. In accordance with accepted packaging practice, filament-reinforced tape (medium tensile) was used as secondary closure of the screw-cap can.

A rubber mallet was used to tap the friction lid and plastic locking ring securely into place. Care must be exercised to avoid denting or creasing the friction-lid can. Sufficient "bubble" wrap must be used inside the friction-lid can to prevent any movement of the screw-cap can.

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 an empty 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.



ITEM	DESCRIPTION DLA04F053
1	1-LITER, ROUND, PLASTIC BOTTLE WITH 28-410 NECK & SCREW-CAP, QTY. 1
2	BUBBLE WRAP, PPP-C-795, CLASS 1, 5/16"
3	5.6 QUART FRICTION PLUG (LID) ROUND, METAL CAN, QTY. 1
4	LOCKING RING - HAZLOC BRAND (NO SUBSTITUTION), P/N C-700
5	CELLULOSE FIBER ABSORBENT, OR VERMICULITE, A-A-52450
6	FIBERBOARD BOX, ASTM D5118, STYLE RSC, GRADE V3c, NSN: 8115-00-418-4653, 12X12X16 IN.
7	2-INCH WIDE, PRESSURE-SENSITIVE TAPE, IAW ASTM D 5486, TY II, NSN: 7510-00-266-6715
8	1-INCH WIDE, PRESSURE-SENSITIVE TAPE, FILAMENT-REINFORCED, IAW ASTM D5330, TY II
9	4 MIL POLYETHYLENE LINER

Inner and Intermediate containers.

Intermediate Packaging, absorbent and box liner in outer container.

Intermediate Packaging (box liner) closed.

Closed outer container (fiberboard box).