JUN 12 1996

ENGINEERING DATA TRANSMITTAL

Page 1 of 1
1. EDT No 611199

2. To: (Receiving Organization) Below-Listed Distribution		3. From: (Originating Organization) Packaging Operations & Development (84400)		4. Related EDT No.: N/A	
5. Proj./Prog./Dept./Div.: DOT-7A Test Program (YHX01)		6. Cog. Engr.: D. L. Kelly		7. Purchase Order No.: N/A	
8. Originator Remarks: For information and release.		9. Equip./Component No.: N/A		10. System/Bldg./Facility: N/A	
				12. Major Assm. Dwg. No.: N/A	
11. Receiver Remarks:		13. Permit/Permit Application No.: N/A		14. Required Response Date: N/A	

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-TP-RPT-023	N/A	0	Final Evaluation Report for Westinghouse Hanford Company, WRAP-1, 208 Liter Waste Drum, Docket 94-35-7A, Type A Container	N/A	1, 2 3	1	1

16. KEY									
Approval Designator (F)		Reason for Transmittal (G)				Disposition (H) & (I)			
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)		1. Approval		4. Review		1. Approved		4. Reviewed no/comment	
		2. Release		5. Post-Review		2. Approved w/comment		5. Reviewed w/comment	
		3. Information		6. Dist. (Receipt Acknow. Required)		3. Disapproved w/comment		6. Receipt acknowledged	

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)											
(G)	(H)	(J) Name (K) Signature (L) Date (M) MSIN				(J) Name (K) Signature (L) Date (M) MSIN				(G)	(H)
Reason	Disp.									Reason	Disp.
1	1	Cog.Eng.	DL Kelly	6/5/96	G1-12	KJ Leist			T4-02	3	
1	1	Cog. Mgr.	DL McCall	6/5/96	G1-12	RJ Bottenus			T4-02	3	
		QA	N/A			DR Lucas			T4-02	3	
		Safety	N/A			Central Files (orig + 1)			A3-8B	3	
		Env.	N/A			OST-1 (2)			A3-44	3	
1	1	JH O'Brien	6/6/96	G1-12							
3		DOT-7A File	(5)		G1-12						

18. Signature of DOT Originator DL Kelly 6/5/96		19. Authorized Representative Date for Receiving Organization		20. Cognizant Manager Date DL McCall 6/10		21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
--	--	---	--	--	--	--	--

BD-7400-172-2 (04/94) GEF097

BD-7400-172-1

**FINAL EVALUATION REPORT FOR WESTINGHOUSE HANFORD
COMPANY, WRAP-1, 208 LITER WASTE DRUM, DOCKET
94-35-7A, TYPE A PACKAGING**

D. L. Kelly

Westinghouse Hanford Company, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: 611199 UC: 722
Org Code: 84400 Charge Code: YHX01
B&R Code: HA0120000 Total Pages: 251

Key Words: Waste Receiving and Processing Facility, WRAP, WRAP-1 Drum, Bagless Transfer System, Docket 94-35-7A, DOT-7A, Type A, package, packaging, radioactive material.

Abstract: This report documents the U.S. Department of Transportation Specification 7A Type A (DOT-7A) compliance test results of the Westinghouse Hanford Company, Waste Receiving and Processing Facility, Module 1 (WRAP-1) Drum. The WRAP-1 Drum was tested for DOE-HQ in August 1994, by Los Alamos National Laboratory, under docket number 94-35-7A. Additionally, comparison and evaluation of the approved, as-tested packaging configuration was performed by WHC in September 1995. The WRAP-1 Drum was evaluated against the performance of the DOT-17C, 208 l (55-gal) steel drums tested and evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A.

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

Printed in the United States of America. To obtain copies of this document, contact: WHC/BCS Document Control Services, P.O. Box 1970, Mailstop H6-08, Richland WA 99352, Phone (509) 372-2420; Fax (509) 376-4989.

Chris Millington
Release Approval

6-12-96
Date

Approved for Public Release

CONTENTS

1.0	INTRODUCTION	1-1
1.1	BACKGROUND	1-1
1.2	PURPOSE AND SCOPE	1-3
2.0	PACKAGING DESCRIPTION	2-1
2.1	DESIGN	2-1
2.1.1	Materials/Method of Construction	2-3
2.1.2	Authorized Configuration	2-3
2.2	CONTAINMENT SYSTEM	2-4
2.3	AUTHORIZED CONTENTS	2-4
3.0	EVALUATION CRITERIA	3-1
3.1	TEST CRITERIA	3-1
3.2	PASS/FAIL CRITERIA	3-1
4.0	PREPARATION OF SPECIMENS FOR TESTING	4-1
4.1	PRELOADING INSPECTION - 49 CFR 173.462	4-1
4.2	TEST CONTENTS	4-2
4.3	LOADING, ASSEMBLY, AND CLOSURE	4-2
5.0	PACKAGING EVALUATION RESULTS	5-1
5.1	DESIGN EVALUATION	5-2
5.1.1	49 CFR 173.24 - General Requirements for Packages and Packagings	5-2
5.1.2	49 CFR 173.24a - Additional General Requirements for Non-Bulk Packagings and Packages	5-7
5.1.3	49 CFR 173.24b - Additional General Requirements for Bulk Packagings	5-12
5.1.4	49 CFR 173.411 - General Design Requirements	5-14
5.1.5	49 CFR 173.412 - Additional Design Requirements for Type A Packages	5-15
5.1.6	49 CFR 173.442 - Thermal Limitations	5-20
5.1.7	49 CFR 178.3 - Marking of Packagings	5-20
5.2	COMPLIANCE TEST EVALUATION	5-21
5.2.1	49 CFR 173.465 - Type A Packaging Tests	5-21
5.2.2	49 CFR 173.466 - Additional Tests for Type A Packagings Designed for Liquids and Gases	5-28
5.2.3	49 CFR 178.608 - Vibration Standard	5-28
6.0	CONCLUSION	6-1
6.1	RESTRICTIONS/SPECIFICATIONS	6-1
7.0	QUALITY ASSURANCE PROGRAM	7-1
8.0	PRIMARY USER/MANUFACTURER	8-1
9.0	REFERENCES	9-1
10.0	GLOSSARY	GL-1

CONTENTS (cont.)

APPENDIX A	WRAP-1 DRUM PACKAGING CONFIGURATION	A-1
APPENDIX B	WRAP-1 DRUM EVALUATION AND COMPARISON DOCUMENTATION . . .	B-1

LIST OF TABLES

Table 2-1.	Nominal Packaging Dimensions.	2-2
Table 2-2.	Materials/Method of Construction.	2-3
Table 5-1.	1.2 m (4 ft) Drop Test.	5-23

**FINAL EVALUATION REPORT FOR WESTINGHOUSE HANFORD COMPANY,
WRAP-1, 208 LITER WASTE DRUM, DOCKET 94-35-7A
TYPE A CONTAINER**

1.0 INTRODUCTION

1.1 BACKGROUND

This report documents the U.S. Department of Transportation Specification 7A Type A (DOT-7A) compliance test results of the Westinghouse Hanford Company (WHC), Waste Receiving and Processing Facility, Module 1 (WRAP-1) Drum. The WRAP-1 Drum configuration was tested for the U.S. Department of Energy-Headquarters (DOE-HQ) in August 1994 by Los Alamos National Laboratory (LANL) under docket number 94-35-7A. Testing was conducted at DOE-approved test facilities located in Los Alamos, New Mexico, and Richland, Washington. Additionally, comparison and evaluation of the approved, as-tested WRAP-1 Drum configuration with the DOT-17C, 208 liter (55 gal) steel drums tested and evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A was performed by WHC in September 1995.

The WRAP-1 Drum packaging design provides the drum with the capability of mating to the One-Trip Bagless Transfer System. The bagless transfer system allows the loading of the one-trip drum with waste from a glovebox process line without contaminating the exterior of the waste package and while maintaining glovebox confinement. The original WRAP-1 Drum design consisted of a modified UN-1A2, 208-l (55-gal), filtered, galvanized, steel drum. Modifications included the addition of an inner ring (adhered to the inside of the drum), an inner neoprene foam seal, and a filtered inner lid (swaged and secured into place with special equipment). This original design failed the 1.2 m (4 ft) drop test as described later in this section and in Section 5.2.1 of this report.

In early July 1994, five test units were assembled, loaded, and closed per the sponsor's instructions by WHC personnel, at the Hanford Site, located in Richland, Washington. Simulated contents used for testing were sand, soil, and lead bricks. Each drum included a mixture of flour and fluorescein that was added on top of the sand/soil prior to swaging the inner lid into place. The outer lid to each drum was then added, and the drums were closed as for shipment. The gross weight of each drum was approximately 454 kg (1000 lb). These test units were shipped to LANL, located at Los Alamos, New Mexico.

Testing was conducted by LANL, in August 1994, and included the vibration, water spray, compression, penetration bar, and 1.2 m (4 ft) drop tests. Three of the drums underwent the identified testing. Upon completion of testing these drums were opened. It was discovered that the simulated contents and tracer material were slightly damp, and that the flour and fluorescein mixture had clumped together so badly that it was no longer a fine, powdery substance. The inner lid of the fourth test unit was then removed manually by LANL testing staff. It was observed that the flour and fluorescein mixture had absorbed moisture and clumped together. It was determined that the dampness was due to the slight, natural moisture in the sand and soil used for testing. Also, extreme weather temperatures were

encountered during transport of the drums from Washington State to New Mexico. It was determined that the moisture was not the result of water in leakage from the water spray test.

The tracer material was removed from the fourth test unit, and a plastic barrier was placed over the sand, soil, and lead bricks. A new mixture of flour and fluorescein was added on top of the plastic barrier. The special equipment required for proper sealing of the drum was not available, so the inner lid was manually snapped back into place. This test unit underwent a 1.2 m (4 ft) drop test and failed due to indication of tracer material outside the drum under ultraviolet (UV) light.

No test documentation is available for the fifth test unit that was supplied. WHC believes this fifth test drum did not undergo any testing.

Because of the drop test failure, the original design was modified by WHC. Changes were made in the location of the inner ring and inner seal, and included the addition of a neoprene gasket between the inner and outer lids. The location of the inner ring and seal, and the dimension and placement of the inner gasket are critical for proper drum closure. The gasket should lay flat against the inner lid and inner seal. Refer to Section 2.0 of this report for a complete description of the approved, as-tested packaging configuration. The special equipment required for loading and closure of this packaging is defined in WHC-SD-W026-OCD-001, Revision 0, *One-Trip Drum Operating Instruction* (Ruff 1994). Assembly of the approved, as-tested packaging is shown on Hanford Drawing Number H-2-824300, Revision 0. Drums tested were purchased according to Hanford Standard HS-V-P-0010, Revision C.

Because of the special sealing equipment required to close this packaging, three prototypes of the redesigned packaging were tested by LANL at the Hanford Site on August 30, 1994. The redesigned test units were assembled, loaded, and closed according to the sponsor's operating instruction (Ruff 1994). Prior to swaging the inner lid into place, plastic was added on top of the sand, soil, and bricks to keep moisture from inhibiting the tests. A flour and fluorescein mixture was used as a tracer material, and this was added on top of the plastic. The inner lid was swaged into place, and the gasket added between the inner and outer lid. The drum was then closed according to the sponsor's operating instruction. The gross weight of each drum was approximately 454 kg (1000 lb). The three redesigned test units satisfactorily passed the 1.2 m (4 ft) drop tests. Refer to Appendix A, Figure A-1, of this report, for a diagram of the approved, as-tested packaging configuration.

All DOT-7A Type A requirements of 49 CFR are addressed whether the requirement is applicable to the tested package configuration. Type A tests performed included the vibration; water spray; penetration bar drop (1.0 m [3.3 ft]); compression; and 1.2 m [4 ft] drop test. Qualitative information regarding the damage to the drum from the compression, penetration bar, and drop tests was not available in the recorded test data, only photographs. Qualitative information is needed by the shipper to determine changes in radiation levels at the surface of the package due to damage resulting from testing.

Test data indicates that the water spray test was conducted before the vibration and compression tests; however, the qualitative information for the results of the water spray test is not available in the recorded test data. Therefore, an evaluation by comparison with the DOT-17C, 208-l (55-gal) steel drums tested and/or evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A was performed by WHC for the vibration, water spray, compression, penetration bar, and 1.2 m (4 ft) drop tests. Documentation of the evaluation and comparison methodology may be found in Section 5.2 and Appendix B of this document.

Documentation is provided by this report to satisfy the requirements of 49 CFR 173.415(a), "Authorized Type A Packagings," which states:

"U.S. Department of Transportation (DOT) Specification 7A (178.350 of this subchapter) Type A general packaging. Each shipper of a Specification 7A must maintain on file for at least one year after the latest shipment, and shall provide to DOT on request, a complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification. Specification 7A packagings designed in accordance with the requirements of 178.350 in effect on June 30, 1983, and constructed prior to July 1, 1985, may continue to be used. Packagings either designed or constructed after June 30, 1985, must meet the requirements of 178.350 applicable at the time of their design or construction."

This document will serve to meet the above-stated requirements when the packagings are used as prescribed. In addition, a description of the packaging is provided with an illustration and/or drawings to allow the user/shipper to obtain the packaging and verify that the packaging hardware complies with all of the specifications of the tested packaging.

By itself, this document does not ensure total compliance with all documentation necessary for making a shipment of radioactive material. In addition to documentation of tests, the shipper must maintain on file other appropriate documentation such as comparison of the physical properties of the actual contents to be shipped with those of the simulated payload used in testing to demonstrate equivalency. Also, implementation and documentation of a quality control program are required.

1.2 PURPOSE AND SCOPE

Design verification procedures were used by LANL (Guthrie 1995) and WHC (Kelly 1995) to document that the packaging meets the design requirements of 49 CFR 173.24, 173.24a, 173.24b, 173.411, 173.412, and 173.462. Testing was performed by LANL to demonstrate that the approved packaging configuration noted in Section 2.0 of this report meets the requirements for a DOT-7A Type A packaging. Testing was performed in accordance with 49 CFR 173.465 using the LANL, *Packaging Engineering Manual* (Guthrie 1993). Documentation of the testing performed by LANL is described in the draft test report, *WRAP-1 Testing and Evaluation* (Guthrie 1995).

The test data incorporates the Vibration Test Report, TR/VT-94-06 (Guthrie 1995). The test report indicates that a WRAP-1 Drum weighing 468 kg (1032 lb) passed the vibration test. The test report does not qualitatively identify the amount or extent of damage resulting to the drums during the 1.2 m (4 ft) drop test. The drop test data includes photos of the damage. Additionally, the draft test report does not supply qualitative information regarding the water spray, compression, and penetration bar tests. As such, an evaluation and comparison of the WRAP-1 Drum to the DOT-17C, 208-l (55-gal), galvanized steel drums tested and evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A was performed by WHC. Detailed documentation of the evaluation and comparison documentation completed by WHC is described in *Evaluation Documentation for WRAP-1 Drum (Docket 94-35-7A) and Request for Approval for Use* (McCall 1995), and is included as Appendix B to this document.

2.0 PACKAGING DESCRIPTION

2.1 DESIGN

The WRAP-1 Drum packaging design provides the drum with the capability of mating to the One-Trip Bagless Transfer System. The bagless transfer system allows the loading of the one-trip drum with waste from a glovebox process line without contaminating the exterior of the waste package and while maintaining glovebox confinement. The original WRAP-1 Drum design consisted of a modified UN-1A2, 208-l (55-gal), filtered, galvanized, steel drum. Modifications included the addition of an inner ring (adhered to the inside of the drum), an inner neoprene foam seal, and a filtered inner lid (swaged and secured into place with special equipment). This original design failed the 1.2 m (4 ft) drop test as described in Section 1.1 and Section 5.2.1 of this report.

After the 1.2 m (4 ft) drop test failure, the WRAP-1 Drum packaging was redesigned by WHC. Changes were made in the location of the inner ring and inner seal, and included the addition of a neoprene gasket between the inner and outer lids. The location of the inner ring and seal, and the dimension and placement of the inner lid gasket are critical for proper drum closure. The gasket should lay flat against the inner lid and inner seal. A diagram of the approved, as-tested WRAP-1 Drum packaging configuration is shown in Appendix A, Figure A-1, of this report. The special equipment required for loading and closing this packaging is defined in WHC-SD-W026-0CD-001, Revision 0, *One-Trip Drum Operating Instruction* (Ruff 1994). Assembly of the as-tested packaging is per Hanford Drawing Number H-2-824300, Revision 0.

The approved WRAP-1 Drum design consists of an outer packaging that is a modified 208-l (55-gal), UN-1A2, 16 gauge, low carbon steel, galvanized drum built per Hanford Standard HS-V-P-0010, Revision C. The drum head includes a NucFil¹-013, 3/4-in.-14 National Pipe Thread (NPT), carbon-activated, high-efficiency particulate air (HEPA) filter. The filter is installed into the provided flange on the outer drum lid. The flange is located in the center annulus of the outer lid at least 7.62 cm (3 in.) from the center. The filter is torqued to 33.9 Nm (25 [±1] lbf.ft). No sealant or tape is added to enhance this seal. The inner packaging consists of a 16 gauge low carbon steel inner ring (adhered to the inside of the drum), an adhesive-backed inner neoprene foam seal, an inner drum lid that is fitted with a NucFil-013 filter and locking nut, and an inner neoprene rubber gasket that is 0.3175-cm (0.125-in.) thick.

Installation of the inner ring to the drum requires special mechanical equipment and requires two applications of E-6000² black adhesive. The first application of adhesive must be allowed to dry for 24 hours. A second application of adhesive occurs above and below the inner ring to ensure that

¹NucFil is a trademark of Nuclear Filter Technology Corporation, Lakewood, Colorado.

²E-6000 is a trademark of Eclectic Products Incorporated, Carson, California.

an air tight seal between the inner ring and drum body is achieved. This second application of adhesive must be allowed to dry for 24 hours.

NOTE: The location of the inner ring is critical.

The adhesive back of the inner seal is removed and the inner seal is pressed into place on the top surface of the inner ring. The seal fits tightly against the inner surface of the drum body. A 2.54-cm (1-in.) diameter hole is punched into the center of the inner lid. The Nucfil-013 filter is threaded through the hole. A locking nut is tightened onto the back side of the HEPA filter and torqued to 33.9 Nm (25 [$\pm$ 1] lbf.ft). The inner lid is then placed into the drum, and rests on the inner seal. The One-Trip System is then used to permanently compress the inner lid against the inner seal. The inner lid is swaged into the inner ring in four locations via 34,475 kPa (5000 psi) of hydraulic pressure from the One-Trip System. The consistency of the swage depth is controlled by tight tolerances on the swaging head locations and the inner lid and inner ring dimensions in conjunction with limit switches on each swaging head that verify that end of stroke was attained. The swages are approximately 0.3175-cm by 0.9525-cm by 0.47625-cm deep (1/8-in. by 3/8-in. by 3/16-in. deep).

The drum is then separated from the One-Trip System. The inner gasket is then laid into place on top of the inner lid. The gasket must lay flat against the inner lid and inner seal. The outer drum lid and clamp band are placed on the drum. The clamp band is placed over the outer lid and the drum false wire. The clamp bolt is then threaded through the clamp band. The clamp band is lightly impacted around its circumference while the clamp bolt is tightened. This process is repeated until the clamp band will no longer move when impacted and tightened. A torque wrench is used to tighten the clamp bolt to a torque of 54.24 Nm (40 [$\pm$ 1] lbf.ft). The jam nut on the clamp bolt is then tightened against the threaded portion of the clamp band to a torque of 54.24 Nm (40 [$\pm$ 1] lbf.ft).

The packagings were tested with a maximum gross weight of 454 kg (1000 lb) for solids of any particulate size, and included Material Form Nos. 1, 2, and 3 as described in Section 2.3 of this report. Test units were loaded with simulated contents consisting of soil, sand, and lead bricks. A mixture of flour and fluorescein was added as a tracer material and to simulate Form No. 1 materials. Simulated contents were added prior to adding the inner lid assembly.

Nominal packaging dimensions can be found in Table 2-1. Design measurements noted for this packaging are provided in English units and converted to metric units. Measurements are nominal (1 in = 2.54 cm). Full details regarding the materials and method of construction are provided in Table 2-2.

Table 2-1. Nominal Packaging Dimensions.

WRAP-1 Drum	Diameter cm (in)	Height cm (in)
Interior	57.15 (22.5)	83.421 (32.843)
Exterior	60.96 (24.0)	88.417 (34.81)

2.1.1 Materials/Method of Construction

Refer to Table 2-2 for the WRAP-1 Drum packaging materials/method of construction information. The packaging configuration was tested as described in Section 1.1 and Section 5.2.1 of this report.

Table 2-2. Materials/Method of Construction.

Item	Description
Drum body*	208-1 (55-gal), UN-1A2 full removable head, 16 ga low carbon steel, galvanized.
Drum head and gasket*	Drum head is 16 ga low carbon steel, galvanized. NucFil-013, 3/4-in - 14 NPT, carbon-activated, HEPA filter. Gasket is FKM or EPDM type, both materials are acceptable. Tubular gaskets are not acceptable.
Bolt ring, nut, and bolt*	Bolt ring is 12 ga (ASTM A109), low carbon steel. Bolt: 5/8-in - 11 threads/in x 4 UNC-2A, hex bolt, steel, zinc plated (ANSI B18.2.1) with corresponding locking nut.
Inner drum lid and filter	Inner drum lid is 16 ga low carbon steel. Lid is fitted with NucFil-013 filter and locking nut.
Inner ring	16 ga low carbon steel. The inner ring shall be adhered and sealed around its circumference at its interface with the drum body with E-6000 [†] black adhesive.
Inner seal	22 7/16-in OD x 20 1/2-in ID x 5/16-in thick Neoprene/sbr foam, adhesive backed and satin finish, density 3.5 - 5.0 lb/cu ft, 25% compression resistance: 2.0 - 5.0 psi.
Inner gasket	1/8-in thick sheet, Neoprene/sbr rubber, 35-45 durometer shore A.

* Per Hanford Standard HS-V-P-0010, Rev. C

[†] NucFil is a trademark of Nuclear Filter Technology Corporation, Lakewood, Colorado

[‡] E-6000 is a trademark of Eclectic Products Incorporated, Carson, California

ANSI = American National Standards Institute

ASTM = American Society for Testing and Materials

EPDM = Ethylene/Propylene/Diene

FKM = Fluorocarbon Rubber

HEPA = high-efficiency particulate air

NPT = National Pipe Thread

PSI = pounds per square inch

2.1.2 Authorized Configuration

The authorized configuration consists of a modified UN-1A2, 208-1 (55-gal), filtered, galvanized steel drum. Drums were purchased according to Hanford Standard HS-V-P-0010, Revision C. Modifications consist of the

addition of an inner ring (adhered to the inside of the drum), inner neoprene foam seal, a filtered inner lid (swaged and secured into place with special equipment), and an inner rubber gasket. The assembly of the as-tested packaging is per Hanford Drawing Number H-2-824300, Revision 0.

The packagings were tested with a maximum gross weight of 454 kg (1000 lb) for solids of any particulate size, and included Material Form Nos. 1, 2, and 3 as described in Section 2.3 of this report. Prior to the installation of the inner lid assembly, the test units were loaded with soil, sand, and lead bricks. A mixture of flour and fluorescein was added as a tracer material and to simulate Form No. 1 materials.

2.2 CONTAINMENT SYSTEM

The WRAP-1 Drum consists of an inner packaging that provides containment via the use of an inner lid assembly. The inner lid assembly consists of an inner ring, neoprene foam seal, inner lid that includes a NucFil-013 filter and locking nut, and inner rubber gasket. The outer packaging consists of a 208-l (55-gal), UN-1A2 drum, drum head and gasket, NucFil-013 filter, bolted ring, and nut.

2.3 AUTHORIZED CONTENTS

The approved packaging system described in this report is designed to ship Type A quantities of solid radioactive materials, normal form.

The packaging described in this report is designed for transporting Form Numbers 1, 2, and 3 radioactive contaminated solid materials (Cruse, 1992). A description of each form is provided below.

- Form No. 1 - Solids of any particulate size.

A packaging certified for these contents is expected to contain radioactive contents of any representative particulate form.

- Form No. 2 - Solids of large particulate size only (cement grade sand or larger).

Contents of a corresponding particulate size, such as soil or construction debris. (Glass or plastic labware having fine particulate available for dispersion would not fit this category and would require a packaging certified for fine particulate, Form No. 1.)

- Form No. 3 - Solid material with no removable or dispersible contamination. (For definition, see 49 CFR 173.443, "Contamination Control.")

1. Metals with activation products;
2. Forms of metals/alloys/compounds of uranium, thorium;

3. Solid materials with the radioactive material firmly fixed in place, possibly by the application of a fixing media (paint, etc.);
4. Solidified material.

NOTE: This is an example only and each form must be analyzed for compliance with the "no removable or dispersible contamination" criterion found in 40 CFR 173.443. Additional restrictions on contents can be found in Section 6.1 of this report.

The simulated payload used during testing was soil, sand, and lead bricks. A mixture of flour and fluorescein was added as a tracer material and to simulate Form No. 1 materials. The maximum gross weight of the approved packaging configuration is 454 kg (1000 lb).

This page intentionally left blank.

3.0 EVALUATION CRITERIA

3.1 TEST CRITERIA

When subjected to the tests specified in 49 CFR 173.465, the packaging will prevent the following:

- Loss or dispersal of the radioactive contents
- Any significant increase in the radiation levels recorded or calculated at the external surfaces as compared to the condition before the test.

3.2 PASS/FAIL CRITERIA

For all tests, except where otherwise indicated, the packages tested were considered to fail if there was significant damage to the packaging and/or loss of the simulated load. Rupture or leakage from any of the packages constitutes failure.

This page intentionally left blank.

4.0 PREPARATION OF SPECIMENS FOR TESTING

NOTE: The bold text identifies the applicable Type A regulations outlined in 49 CFR.

4.1 PRELOADING INSPECTION - 49 CFR 173.462

- a. Each packaging was examined before testing to identify and record any faults or damage, including:

1. Divergence from the specifications or drawings.

The original design of the WRAP-1 Drum failed the 1.2 m (4 ft) drop test as described in Section 1.1 and Section 5.2.1 of this report. The WRAP-1 drum was redesigned. Changes were made to the location of the inner ring and seal, and in the addition of a neoprene gasket between the inner and outer lids. The approved, as-tested configuration differs from the original design. The approved, as-tested configuration is assembled according to Hanford Drawing Number H-2-824300, Revision 0, and there was no divergence from the specifications or drawings for the approved, as-tested configuration. Refer to Section 2.0 of this report for a complete description of the approved, as-tested packaging configuration.

2. Defects in construction.

No defects in construction were found on any test units.

3. Corrosion or other deterioration.

No corrosion or other deterioration was found.

4. Distortion of features.

There were no observable distortions of features.

- b. Any deviation found under paragraph (a) of this section from the specified design shall be corrected or suitably taken into account in the subsequent evaluation.

As stated in paragraph (a) of this section, the original design of the WRAP-1 Drum failed the 1.2 m (4 ft) drop test as described in Section 1.1 and Section 5.2.1 of this report. The WRAP-1 drum was redesigned. Changes were made to the location of the inner ring and seal, and in the addition of a neoprene gasket between the inner and outer lids. The approved, as-tested configuration differs from the original design. The approved, as-tested configuration is assembled according to Hanford Drawing Number H-2-824300, Revision 0, and there was no deviation from the specifications or drawings for the approved, as-tested configuration. Refer to Section 2.0 of this

report for a complete description of the approved, as-tested packaging configuration.

Although the WRAP-1 Drum was redesigned, there was no deviation from the specified design to take into account during testing and evaluation.

- c. The containment system of the packaging shall be clearly specified.

This requirement is met. The WRAP-1 Drum consists of an inner packaging that provides containment via the use of an inner lid assembly. The inner lid assembly consists of an inner ring, neoprene foam seal, inner lid that includes a NucFil-013 filter and locking nut, and inner rubber gasket. The outer packaging consists of a 208-l (55-gal), UN-1A2 drum, drum head and gasket, NucFil-013 filter, bolted ring, and nut.

- d. The external features of the packaging shall be clearly identified so that reference may be made to any part of it.

The external features of the packaging are clearly identifiable.

4.2 TEST CONTENTS

The approved packagings were tested with a maximum gross weight of 454 kg (1000 lb) for solids of any particulate size, and included Material Form Nos. 1, 2, and 3 as described in Section 2.3 of this report. Prior to the installation of the inner lid assembly, the test units were loaded with soil, sand, and lead bricks. A plastic barrier was placed over these contents to prevent natural moisture from inhibiting the tests. A mixture of flour and fluorescein was added as a tracer material and to simulate Form No. 1 materials.

4.3 LOADING, ASSEMBLY, AND CLOSURE

A diagram of the approved, as-tested packaging configuration is provided in Appendix A, Figure A-1, of this report. The packagings were assembled, loaded, and closed in accordance with the sponsor's operating instructions (Ruff 1994).

5.0 PACKAGING EVALUATION RESULTS

The following list shows the primary sections of 49 CFR applicable to Type A packaging:

NOTE: This list highlights the performance requirements and is not intended to present an all-encompassing list.

- 173.24 General Requirements for Packagings and Packages
- 173.24a Additional General Requirements for Non-Bulk Packagings and Packages
- 173.24b Additional General Requirements for Bulk Packagings
- 173.411 General Design Requirements
- 173.412 Additional Design Requirements for Type A Packages
- 173.415(a) Authorized Type A Packages
- 173.442 Thermal Limitations
- 173.461 Demonstration of Compliance with Tests
- 173.462 Preparations of Specimens for Testing
- 173.463 Packaging and Shielding - Testing for Integrity
- 173.465 Type A Packaging Tests
- 173.474 Quality Control for Construction of Packaging
- 173.475 Quality Control Requirements Prior to Each Shipment of Radioactive Material
- 178.3 Marking of Packagings
- 178.350 Specification 7A; General Packaging, Type A
- 178.608 Vibration Standard

5.1 DESIGN EVALUATION

NOTE: The bold text identifies the applicable Type A regulations outlined in 49 CFR.

Following is an evaluation of the ability of the approved packaging configuration to meet performance-related regulations. Compliance with all the indicated regulations will signify that the packagings have met the design and performance testing requirements for a DOT-7A Type A packaging.

5.1.1 49 CFR 173.24 - General Requirements for Packages and Packagings

- a. **Applicability.** Except as otherwise provided in this subchapter, the provisions of this section apply to--

- (1) Bulk and non-bulk packagings;
- (2) New packagings and packagings which are reused; and
- (3) Specification and non-specification packagings.

The approved packaging configuration meets DOT-7A Type A packaging criteria. The approved packaging configuration has been tested and evaluated by LANL. Additionally, comparison and evaluation of the approved, as-tested WRAP-1 Drum configuration with the DOT-17C, 208 l (55 gal) steel drums tested and evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A was performed by WHC (McCall 1995).

- b. Each package used for shipment of hazardous materials under this subchapter shall be designed, constructed, maintained, filled, its contents so limited, and closed so that under conditions normally incident to transportation--

- (1) Except as otherwise provided in this subchapter, there will be no identifiable (without the use of instruments) release of hazardous materials to the environment;

The approved packaging configuration meets the intent of this requirement as demonstrated by meeting the more severe Type A packaging requirements of 49 CFR 173.411, .412, and .465 as demonstrated in this report.

- (2) The effectiveness of the package will not be substantially reduced; for example, impact resistance, strength, packaging compatibility, etc. must be maintained for the minimum and maximum temperatures encountered during transportation;

The approved packaging configuration meets the intent of this requirement as demonstrated by meeting the more severe Type A packaging requirements of 49 CFR 173.411, .412, and .465 as demonstrated in this report.

- (3) There will be no mixture of gases or vapors in the package which could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging.

The packaging is constructed of stable and durable materials that will provide good protection for the payload. It is the responsibility of the shipper to ensure that the payload will remain stable during transport.

- c. Authorized packagings. A packaging is authorized for a hazardous material only if--

- (1) The packaging is prescribed or permitted for the hazardous material in a packaging section specified for that material in Column 8 of the section 172.101 Table and conforms to applicable requirements in the special provisions of Column 7 of the section 172.101 Table and, for specification packagings (including U.N. standard packagings), the specification requirements in parts 178 and 179 of this subchapter; or
- (2) The packaging is permitted under, and conforms to, provisions contained in sections 171.11, 171.12, 171.12a, 173.3, 173.4, 173.5, 173.7, 173.27, or 176.11 of this subchapter.

The approved packaging configuration, as documented herein, has been qualified to meet Specification 7A packaging requirements in accordance with 49 CFR 178.350. It is the responsibility of the shipper to ensure that the packagings used are in compliance with the design discussed in this report.

- d. DOT specification and U.N. standard packagings. For DOT specification packagings (including U.N. standard packagings), conformance to the applicable specifications in parts 178 and 179 of this subchapter is required in all details. For performance-oriented packagings covered by subpart L of part 178 of this subchapter, each packaging must be capable of meeting the performance test requirements specified in subpart M of part 178 of this subchapter for the applicable packing group shown in Column 5 of the section 172.101 Table.

The approved packaging configuration, as documented herein, has been qualified to meet Specification 7A packaging requirements in accordance with 49 CFR 178.350. It is the responsibility of the shipper to ensure that the packagings used are in compliance with the design discussed in this report.

- e. Compatibility.

- (1) Even though certain packagings are specified in this part, it is, nevertheless, the responsibility of the person offering a hazardous material for transportation to ensure that such packagings are compatible with their lading. This particularly

applies to corrosivity, permeability, softening, premature aging and embrittlement.

It is the responsibility of the shipper to ensure that these design requirements have been properly addressed by the designer and fabricator. The approved packaging configuration tested and/or evaluated meets this requirement.

Drums are galvanized steel, 16 gauge. It is the shipper's responsibility to ensure that welding and brazing are performed in a workmanlike manner using suitable and appropriate techniques, materials, and equipment.

- (2) Packaging materials and contents must be such that there will be no significant chemical or galvanic reaction between the materials and contents of the package.

The packaging materials and the arrangement of these materials are such that this requirement is met. It is the responsibility of the shipper to ensure that the contents will not react adversely with the packaging.

- (3) Plastic packagings and receptacles.

(i) Plastic used in packagings and receptacles must be of a type compatible with the lading and may not be permeable to an extent that a hazardous condition is likely to occur during transportation, handling or refilling.

(ii) Each plastic packaging or receptacle which is used for liquid hazardous materials must be capable of withstanding without failure the procedure specified in Appendix B of this part ("Procedure for Testing Chemical Compatibility and Rate of Permeation in Plastic Packagings and Receptacles"). The procedure specified in Appendix B of this part must be performed on each plastic packaging or receptacle used for Packing Group I materials. The maximum rate of permeation of hazardous lading through or into the plastic packaging or receptacles may not exceed 0.5 percent for materials meeting the definition of a Division 6.1 material according to section 173.132 and 2.0 percent for other hazardous materials, when subjected to temperatures no lower than--

- (A) 18 °C (64 °F) for 180 days in accordance with Test Method 1 in Appendix B of this part;
- (B) 50 °C (122 °F) for 28 days in accordance with Test Method 2 in Appendix B of this part; or
- (C) 60 °C (140 °F) for 14 days in accordance with Test Method 3 in Appendix B of this part.

- (iii) Alternative procedures or rates of permeation are permitted if they yield a level of safety equivalent to or greater than that provided by paragraph (e)(3)(ii) of this section and are specifically approved by the Associate Administrator for Hazardous Materials Safety.

The approved packaging configuration described does not consist of plastic components and is authorized for transportation of solids. It is the responsibility of the shipper to ensure that the contents will not react adversely with the container.

- (4) Mixed contents. Hazardous materials may not be packed or mixed together in the same outer packaging with other hazardous or nonhazardous materials if such materials are capable of reacting dangerously with each other and causing--

- (i) Combustion or dangerous evolution of heat;

- (ii) Evolution of flammable or poisonous gases; or

- (iii) Formation of unstable or corrosive materials.

Hazardous and/or nonhazardous materials will not be packed or mixed together so as to cause a reaction. The approved packaging configuration, as documented herein, has been qualified to meet Specification 7A packaging requirements in accordance with 49 CFR 178.350. It is the responsibility of the shipper to ensure that materials will not be combined so as to cause a reaction.

- (5) Packagings used for solids, which may become liquid at temperatures likely to be encountered during transportation, must be capable of containing the hazardous material in the liquid state.

The approved packaging configuration described in this report is not authorized for liquids. It is the responsibility of the shipper to ensure that the packagings used are in compliance with the approved design discussed in this report.

f. Closures.

- (1) Closures on packagings shall be so designed and closed that under conditions (including the effects of temperature and vibration) normally incident to transportation--

- (i) Except as provided in paragraph (g) of this section, there is no identifiable release of hazardous materials to the environment from the opening to which the closure is applied; and

- (ii) The closure is secure and leakproof.

- (2) Except as otherwise provided in this subchapter, a closure (including gaskets or other closure components, if any) used on a specification packaging must conform to all applicable requirements of the specification.

Testing and/or evaluation of the approved packaging design indicates the above requirements to be satisfied. The bolted ring on the outer packaging (i.e., the drum) is provided with a jam nut that is used to prevent loosening due to acceleration, vibration, or vibration resonance resulting from normal conditions of transportation. The jam nut on the clamp bolt is tightened against the threaded portion of the clamp band to 54.24 Nm (40 [$\pm$ 1] lbf.ft).

Containment is also provided via the inner packaging system that consists of the inner lid, ring, seal, and gasket. The inner lid is fitted with a NucFil-013 filter and locking nut. The inner seal is compressed when the inner lid is swaged into place against the inner ring. The inner gasket is then laid into place on top of the inner lid. The gasket must lay flat against the inner lid and inner seal. The lid to the outer packaging is then installed as noted above.

Vibration testing was conducted as described in Section 5.2.3 of this report. There was no observed damage to the drum, no indication of distortion of the sealing area, and no release of contents under visual and UV light inspection. In comparison, three drums tested under docket 94-37-7A and filled with actual simulated contents underwent vibration testing for 1 hour with no release of contents when observed under visual and UV light inspection.

- g. Venting. Venting of packagings, to reduce internal pressure which may develop by the evolution of gas from the contents, is permitted only when--
 - (1) Transportation by aircraft is not involved;
 - (2) Except as otherwise provided in this subchapter, the evolved gases are not poisonous, likely to create a flammable mixture with air or be an asphyxiant under normal conditions of transportation;
 - (3) The packaging is designed so as to preclude an unintentional release of hazardous materials from the receptacle; and
 - (4) For shipments in bulk packagings, venting is authorized for the specific hazardous material by a special provision in the section 172.101 Table or by the applicable bulk packaging specification in part 178 of this subchapter.

The approved packaging configuration described and tested and/or evaluated is not authorized for transportation by aircraft, and utilizes a NucFil-013 filter as a pressure relief device for both the inner and outer packaging. Venting is authorized by the packaging specification. The gases that are vented will not, under

conditions normal to transportation, result in a flammable mixture with air, or be an asphyxiant.

h. Outage and filling limits--

- (1) *General*. When filling packagings and receptacles for liquids, sufficient ullage (outage) must be left to ensure that neither leakage nor permanent distortion of the packaging or receptacle will occur as a result of an expansion of the liquid caused by temperatures likely to be encountered during transportation. Requirements for outage and filling limits for non-bulk and bulk packaging are specified in section 173.24a(d) and 173.24b(a), respectively.
- (2) *Compressed gases and cryogenic liquids*. Filling limits for compressed gases and cryogenic liquids are specified in sections 173.301 through 173.306 for cylinders and sections 173.314 through 173.319 for bulk packagings.

The approved packaging configuration described and tested and/or evaluated is not authorized for transportation of liquids. The approved packaging configuration described and tested and/or evaluated will not transport compressed gasses or cryogenic liquids.

- i. *Air transportation*. Packages offered or intended for transportation by aircraft must conform to the general requirements for transportation by aircraft in 173.27, except as provided in 171.11 of this subchapter.

The approved packaging configuration described and tested and/or evaluated is not authorized for transportation by aircraft.

5.1.2 49 CFR 173.24a - Additional General Requirements for
Non-Bulk Packagings and Packages

NOTE: This section is not applicable to the approved WRAP-1 Drum packaging (gross weight exceeds 400 kg [882 lb]). However, specific areas have been addressed for reporting purposes to provide as much information as possible on the approved packaging configuration tested and/or evaluated.

- a. *Packaging design*. Except as provided in section 172.312 of this subchapter:

- (1) *Inner packaging closures*. A combination packaging containing liquid hazardous materials must be packed so that closures on inner packagings are upright.

Liquids are not authorized for transport in the approved packaging configuration tested and/or evaluated.

- (2) *Friction.* The nature and thickness of the outer packaging must be such that friction during transportation is not likely to generate an amount of heat sufficient to alter dangerously the chemical stability of the contents.

The nature and thickness of the approved packaging configuration is such that friction during transport will not generate any heating that would adversely affect the contents.

- (3) *Securing and cushioning.* Inner packagings of combination packagings must be so packed, secured and cushioned to prevent their breakage or leakage and to control their movement within the outer packaging under conditions normally incident to transportation. Cushioning material must not be capable of reacting dangerously with the contents of the inner packagings.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/position within the package.

The shipper is responsible to ensure that the internal contents do not shift such that an increase in radiation of 20 percent or more is encountered (IAEA 1985). It is the responsibility of the shipper to ensure that cushioning material is compatible with contents.

- (4) *Metallic devices.* Nails, staples and other metallic devices shall not protrude into the interior of the outer packaging in such a manner as to be likely to damage inner packagings or receptacles.

There are no metallic devices or protrusions that could cause failures.

- (5) *Vibration.* Each non-bulk package must be capable of withstanding, without rupture or leakage, the vibration test procedure specified in section 178.608 of this subchapter.

The approved packaging configuration passed this requirement. Type A packagings are required "to withstand the effects of any acceleration, vibration, or vibration resonance that may arise during normal transportation" [see 49 CFR 173.412 (e)]. The test identified in this section was applied to support the ability of the packaging to meet the requirement.

Vibration testing was conducted as described in Section 5.2.3 of this report. There was no observed damage to the drum, no indication of distortion of the sealing area, and no release of contents under visual and UV light inspection. In comparison, three drums tested under docket 94-37-7A and filled with actual simulated contents underwent vibration testing for 1 hour with

no release of contents when observed under visual and UV light inspection.

Containment is provided via the inner packaging system that consists of the inner lid, ring, seal, and gasket. The inner lid is fitted with a NucFil-013 filter and locking nut. The inner seal is compressed when the inner lid is swaged into place against the inner ring. The inner gasket is then laid into place on top of the inner lid. The gasket must lay flat against the inner lid and inner seal. Containment is also provided via the outer packaging system that consists of the filtered outer drum lid, clamp band, bolt, and jam nut. The outer drum lid and clamp band are placed on the drum. The clamp band is placed over the outer lid and the drum false wire. The clamp bolt is then threaded through the clamp band. The clamp band is lightly impacted around its circumference while the clamp bolt is tightened. This process is repeated until the clamp band will no longer move when impacted and tightened. A torque wrench is used to tighten the clamp bolt to a torque of 54.24 Nm (40 [±1] lbf.ft). The jam nut on the clamp bolt is then tightened against the threaded portion of the clamp band to a torque of 54.24 Nm (40 [±1] lbf.ft).

b. Non-bulk packaging filling limits.

- (1) A single or composite non-bulk packaging may be filled with a liquid hazardous material only when the specific gravity of the material does not exceed that marked on the packaging, or a specific gravity of 1.2 if not marked, except as follows:
 - (i) A Packing Group I packaging may be used for a Packing Group II material with a specific gravity not exceeding the greater of 1.8, or 1.5 times the specific gravity marked on the packaging, provided all the performance criteria can still be met with the higher specific gravity material;
 - (ii) A Packing Group I packaging may be used for a Packing Group III material with a specific gravity not exceeding the greater of 2.7, or 2.25 times the specific gravity marked on the packaging, provided all the performance criteria can still be met with the higher specific gravity material; and
 - (iii) A Packing Group II packaging may be used for a Packing Group III material with a specific gravity not exceeding the greater of 1.8, or 1.5 times the specific gravity marked on the packaging, provided all the performance criteria can still be met with the higher specific gravity material.

This is not applicable to a Type A packaging as Type A packaging does not incorporate packing groups. Liquids are not authorized for transport in the approved packaging

configuration. The solid materials intended for shipment are limited in weight, to the as-tested weights identified during testing 454 kg (1000 lb).

- (2) Except as otherwise provided in this section, a single or composite non-bulk packaging may not be filled with a solid hazardous material to a gross mass greater than the maximum gross mass marked on the packaging.

This is not applicable to a Type A packaging as the gross mass is not required to be marked on the packaging by the manufacturer. Packagings were tested for solids; Form Nos. 1, 2, and 3, as described in Section 2.3 of this report. The gross weight of the approved as-tested packaging is 454 kg (1000 lb).

- (3) A single or composite non-bulk packaging which is tested and marked for liquid hazardous materials may be filled with a solid hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked. In addition:

- (i) A single or composite non-bulk packaging which is tested and marked for Packing Group I liquid hazardous materials may be filled with a solid Packing Group II hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by 1.5, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked.
- (ii) A single or composite non-bulk packaging which is tested and marked for Packing Group I liquid hazardous materials may be filled with a solid Packing Group III hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by 2.25, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked.
- (iii) A single or composite non-bulk packaging which is tested and marked for Packing Group II liquid hazardous materials may be filled with a solid Packing Group III hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by 1.5, multiplied by the specific gravity marked on the packaging, of 1.2 if not marked.

This is not applicable to a Type A packaging as Type A packaging does not incorporate packing groups. Packagings were tested for solids; Form Nos. 1, 2, and 3, as described in Section 2.3 of this report. The gross weight of the approved as-tested packaging is 454 kg (1000 lb). Liquids are not authorized for transportation.

- (4) Packagings tested as prescribed in section 178.605 of this subchapter and marked with the hydrostatic test pressure as prescribed in section 178.503(a)(5) of this subchapter may be used for liquids only when the vapor pressure of the liquid conforms to one of the following:
- (i) The vapor pressure must be such that the total pressure in the packaging [i.e., the vapor pressure of the liquid plus the partial pressure of air or other inert gases, less 100 kPa (15 psi) at 55 °C (131 °F)], determined on the basis of a maximum degree of filling in accordance with paragraph (b)(1) of this section and a filling temperature of 15 °C (59 °F)], will not exceed two-thirds of the marked test pressure;
 - (ii) The vapor pressure at 50 °C (122 °F) must be less than four-sevenths of the sum of the marked test pressure plus 100 kPa (15 psi); or
 - (iii) The vapor pressure at 55 °C (131 °F) must be less than two-thirds of the sum of the marked test pressure plus 100 kPa (15 psi).

This is not applicable to Type A packaging as Section 178.605 does not pertain to specification packagings. The approved packaging configuration described and tested and/or evaluated is authorized for transportation of radioactive solid materials. Liquids are not authorized for transportation in the approved packaging configuration.

- (5) No hazardous material may remain on the outside of a package after filling.

The amount of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for shipment shall be kept as low as practicable (49 CFR 173.443). It is the responsibility of the shipper to ensure compliance with this requirement.

c. Mixed contents.

- (1) An outer non-bulk packaging may contain more than one hazardous material only when--
- (i) The inner and outer packagings used for each hazardous material conform to the relevant packaging sections of this part applicable to that hazardous material;
 - (ii) The package as prepared for shipment meets the performance tests prescribed in part 178 of this subchapter for the packing group indicating the highest order of hazard for the hazardous materials contained in the package;

- (iii) Corrosive materials (except ORM-D) in bottles are further packed in securely closed inner receptacles before packing in outer packagings; and
 - (iv) For transportation by aircraft, the total net quantity does not exceed the lowest permitted maximum net quantity per package as shown in Column 9a or 9b, as appropriate, of the section 172.101 Table. The permitted maximum net quantity must be calculated in kilograms if a package contains both a liquid and a solid.
- (2) A packaging containing inner packagings of Division 6.2 materials may not contain other hazardous materials, except dry ice.

The approved packaging is designed and tested for Type A radioactive material shipments. It is the responsibility of the shipper to ensure that reactive hazardous components are not shipped together in a packaging, and that the package is in compliance with the above requirements. This packaging will not be transported by aircraft.

- d. Liquids must not completely fill a receptacle at a temperature of 55 °C (131 °F) or less.

Liquids are not authorized for transport in the approved packaging configuration described in this report.

5.1.3 49 CFR 173.24b - Additional General Requirements
for Bulk Packagings

NOTE: This section is not applicable for the approved WRAP-1 Drum packaging. Although the gross weight exceeds 400 kg (882 lb), the package does not have a maximum capacity greater than 450 l (119 gal) as a receptacle for a solid. This package consists of a 208 l (55-gal) drum. However, specific areas have been addressed for reporting purposes to provide as much information as possible on the approved packaging configuration tested and/or evaluated.

a. *Outage and filling limits.*

- (1) Liquids and liquefied gases must be so loaded that the outage is at least one percent of the total capacity of a cargo or portable tank, or compartment thereof, or at least one percent of the total capacity of the tank and dome for tank car and multi-unit tank car tanks at the reference temperature of 46 °C (115 °F) for uninsulated tanks and 41 °C (105 °F) for insulated tanks.
- (2) Hazardous materials may not be loaded into the dome of a tank car. If the dome of the tank car does not provide sufficient

outage, vacant space must be left in the shell to provide the required outage.

- (3) Bulk packagings for materials poisonous by inhalation. For a material which meets the definition of poisonous by inhalation (see section 171.8 of this subchapter), the outage in a bulk packaging must be at least five percent of the total capacity of the tank or compartment at the reference temperature of 46 °C (115 °F) for uninsulated tanks and 41 °C (105 °F) for insulated tanks.

The above items do not apply as liquids and gases are not authorized contents.

- b. *Equivalent steel.* For the purposes of this section, stainless steel is steel with a guaranteed minimum tensile strength of 51.7 deka newtons per square millimeter (75,000 psi) and a guaranteed elongation of 40 percent or greater. Where the regulations permit steel other than stainless steel to be used in place of a specified stainless steel (for example, as in section 172.102 of this subchapter, special provision B30), the minimum thickness for the steel must be obtained from one of the following formulas, as appropriate:

Formula for metric units:

$$e_1 = (12.74e_0) / (Rm_1A_1)^{1/3}$$

Formula for non-metric units:

$$e_1 = (144.2e_0) / (Rm_1A_1)^{1/3}$$

Where:

e_0 = Required thickness of the reference stainless steel in millimeters or inches respectively;
 e_1 = Equivalent thickness of the steel used in millimeters or inches respectively;
 Rm_1 = Specified minimum tensile strength of the steel used in deka newtons per square millimeter or pounds per square inch respectively; and
 A_1 = Specified minimum percentage elongation of the steel used multiplied by 100 (for example, 20 percent times 100 equals 20). Elongation values used must be determined from a 50 mm or 2 inch test specimen.

This requirement is not applicable. Specification 49 CFR 178.350 does not require the use of stainless steel or its equivalent.

- c. Air pressure in excess of ambient atmospheric pressure may not be used to load or unload any lading which may create an air-enriched mixture within the flammability range of the lading in the vapor space of the tank.

This requirement is not applicable as air pressure is not used in the loading and unloading process.

- d. A bulk packaging may not be loaded with a hazardous material that:
- (1) Is at a temperature outside of the packaging's design temperature range; or
 - (2) Exceeds the maximum weight of lading marked on the specification plate.

This requirement is not applicable as this is not a bulk packaging. Also, it is the shipper's responsibility to ensure compliance with this requirement.

5.1.4 49 CFR 173.411 - General Design Requirements

Except for a package that contains a limited quantity or excepted instrument or article under Paragraphs 173.421 through 173.424, each package used for shipment of radioactive materials shall be designed so that:

- a. The package can be easily handled and properly secured in or on a conveyance during transport;
- The WRAP-1 Drum is handled the same way any other standard 208-1 (55-gal) drum is handled. Test units were moved using a fork lift truck with a drum lifting attachment and with nylon straps and a hoist. The shipper should avoid loading a top-heavy package and should be aware of the need for tie-downs.
- b. A package with a gross weight exceeding 10 kilograms (22 pounds) and up to 50 kilograms (110 pounds) has a means for manual handling;

The authorized gross weight for this packaging exceeds 50 kg (110 lb); therefore, this requirement is not applicable.

- c. A package with a gross weight of 50 kilograms (110 pounds) or more can be safely handled by mechanical means;

This requirement is met as the approved packaging configuration tested has a gross weight of more than 50 kg (110 lb). The WRAP-1 Drum can be safely handled mechanically the same way any other standard 208-1 (55-gal) drum is handled. This packaging configuration may be easily lifted and handled via the use of a forklift truck with a drum lifting attachment or with nylon straps and a hoist.

- d. Each lifting attachment on the package, when used in the intended manner, with a minimum safety factor of three, does not impose an unsafe stress on the structure of the package. In addition, the lifting attachment shall be so designed that failure under excessive load would not impair the ability of the package to meet all other requirements of this subpart. Each attachment or other feature on the outer surface of the packaging that could be used to lift the package must be removable or otherwise capable of being made

inoperable for transport, or shall be designed with strength equivalent to that required for lifting attachments;

There are no lifting attachments; therefore, this requirement is not applicable.

- e. The external surface, as far as practicable, may be easily decontaminated;

The approved packaging configuration tested and/or evaluated meets the intent of this requirement. The exterior surface of the WRAP-1 Drum is smooth. There is a minimum of cracks and crevices where surface contamination could reside.

- f. The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect; and

All packages tested and/or evaluated met the intent of this requirement. There were no pockets or crevices where water might collect. Water collecting on the lid during transport will have no adverse effects on the package.

- g. Each feature that is added to the package at the time of transport, and that is not a part of the package, will not reduce the safety of the package.

No additional features are to be added at the time of transport. It is the shipper's responsibility to ensure this requirement is met since the regulation addresses items added to the packaging at the time of transport.

5.1.5 49 CFR 173.412 - Additional Design Requirements for Type A Packages

In addition to meeting the general design requirements prescribed in Paragraph 173.411, each Type A packaging shall be designed so that:

- a. The smallest overall external dimension of the package is not less than 10 centimeters (4 inches);

The external dimensions of the packaging exceed the minimum dimensional requirement.

- b. The outside of the packaging incorporates a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in exclusive use closed transport vehicles, the cargo compartment may be sealed instead of the individual packages;

It is the responsibility of the shipper to ensure that appropriate precautions are taken to seal the package in a manner that will provide evidence that the package has not been opened. Tamper

indication will be provided by wiring and tagging the clamp bolt upon final closure of the WRAP-1 Drum.

- c. As far as practicable, the external surfaces are free from protrusions and are designed and finished so that they can be easily decontaminated;

The approved packaging configuration tested and/or evaluated meets this requirement. The package surface is smooth and free from protrusions, and can easily be decontaminated.

- d. Containment and shielding would be maintained during transportation and storage in a temperature range of -40 °C (-40 °F) to 70 °C (158 °F) with account being taken of the possibility of brittle fracture;

No shielding is used for the approved packaging configuration. Containment is provided by the use of an inner lid assembly and an outer lid that seals the drum. The thickness of the metal used in the packaging is such to alleviate brittle fracture concerns at -40°C (-40°F). The gaskets and inner seal are effective over the stated temperature range. The glue used for attachment of the inner ring to the inside of the drum is effective over a range from -84°C (-119.2°F) to 99°C (210.2°F).

- e. It is able to withstand the effects of any acceleration, vibration, or vibration resonance that may arise during normal transportation, without any deterioration of the effectiveness of closing devices or of the integrity of the package as a whole and without loosening or unintentional release of nuts, bolts, or other securing devices even after repeated use;

The approved packaging configuration passed this requirement. The test identified in 49 CFR 178.608 was applied to support the ability of the packaging to meet the requirement. Vibration testing was conducted as described in Section 5.2.3 of this report. There was no observed damage to the drum, no indication of distortion of the sealing area, and no release of contents under visual and UV light inspection. In comparison, three drums tested under docket 94-37-7A and filled with actual simulated contents underwent vibration testing for 1 hour with no release of contents when observed under visual and UV light inspection.

Containment is provided via the inner packaging system that consists of the inner lid, ring, seal, and gasket. The inner lid is fitted with a NucFil-013 filter and locking nut. The inner seal is compressed when the inner lid is swaged into place against the inner ring. The inner gasket is then laid into place on top of the inner lid. The gasket must lay flat against the inner lid and inner seal. Containment is also provided via the outer packaging system that consists of the filtered outer drum lid, clamp band, bolt, and jam nut. The outer drum lid and clamp band are placed on the drum. The clamp band is placed over the outer lid and the drum false wire. The clamp bolt is then threaded through the clamp band. The clamp

band is lightly impacted around its circumference while the clamp bolt is tightened. This process is repeated until the clamp band will no longer move when impacted and tightened. A torque wrench is used to tighten the clamp bolt to a torque of 54.24 Nm (40 [$\pm$] lbf-ft). The jam nut on the clamp bolt is then tightened against the threaded portion of the clamp band to a torque of 54.24 Nm (40 [$\pm$] lbf-ft).

- f. It includes a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form, as demonstrated in accordance with Paragraph 173.469 may be considered as a component of the containment system;

The WRAP-1 Drum consists of an inner packaging that provides containment via the use of an inner lid assembly. The inner lid assembly consists of an inner ring, neoprene foam seal, inner lid that includes a NucFil-013 filter and locking nut, and inner rubber gasket. The gasket is laid over the top of the inner lid prior to placing the outer drum lid onto the drum. The gasket must lay flat against the inner lid and inner seal. The outer filtered drum lid, clamp band, bolt, and jam nut are installed on the outer drum. The outer drum lid and clamp band are placed on the drum. The clamp band is placed over the outer lid and the drum false wire. The clamp bolt is then threaded through the clamp band. The clamp band is lightly impacted around its circumference while the clamp bolt is tightened. This process is repeated until the clamp band will no longer move when impacted and tightened. A torque wrench is used to tighten the clamp bolt to a torque of 54.24 Nm (40 [$\pm$] lbf-ft). The jam nut on the clamp bolt is then tightened against the threaded portion of the clamp band to a torque of 54.24 Nm (40 [$\pm$] lbf-ft).

- g. The materials of the packaging and any components or structures are physically and chemically compatible with each other and with the contents, taking into account the behavior of each under irradiation;

The materials of the approved packaging configuration are physically and chemically compatible with each other. It is the responsibility of the shipper to ensure that the contents are compatible with the packaging.

- h. For each component of the containment system account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis;

It is the responsibility of the shipper to ensure that the effects of radiation from the payload will not degrade the performance of the packaging through gas generation, chemical reaction, or radiolysis.

- i. The containment system will retain its radioactive contents under the reduction of ambient pressure to .25 kilograms per square centimeter (3.5 pounds per square inch);

The reduced ambient pressure testing for this docket was not conducted. The packaging is judged to pass this requirement based on previous tests on filtered drums that are comparable to the WRAP-1 Drum design (McCall 1995).

Reduced ambient pressure testing of DOT-17C, 208-1 (55-gal) filtered drums was performed previously by Mound with successful results (Cruse 1992; Table C-1). Pressure differentials due to reduction of ambient pressure will not occur in the drum due to the presence of the Nucfil filter on the inner and outer drum lids.

- j. Each valve through which the radioactive contents could otherwise escape is protected against damage and unauthorized operation and, except for a pressure relief device, has an enclosure to retain any leakage;

There are no valves used in the approved packaging configuration; therefore, this requirement is not applicable.

- k. Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield;

Shielding is not a component of this packaging system; therefore, this requirement is not applicable.

- l. Failure of any tie down attachment of the packaging under excessive load will not impair the ability of the package to meet other requirements of this subpart;

There are no tie-down attachments on the packagings; therefore, this requirement is not applicable.

- m. When subjected to the tests specified in Paragraph 173.465 or evaluated against these tests by any of the methods authorized by Paragraph 173.461(a), the packaging will prevent:

- (1) Loss or dispersal of the radioactive contents; and
- (2) Any significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test.

Packagings tested and/or evaluated under this docket meet the requirements of this paragraph. Refer to Section 5.2.1 of this report for specific damage received to the packagings during the drop test, penetration bar drop, and compression test. Information stated in this report was either tested under docket 94-35-7A (WRAP-1 Drum) and/or evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A.

For specific damage received to the packagings during the vibration test, refer to Section 5.2.3 of this report. In comparison, three drums tested under docket 94-37-7A and filled with actual simulated

contents underwent vibration testing for 1 hour with no release of contents when observed under visual and UV light inspection.

The shipper must ensure that the amount of radiation at any surface of the packaging would not increase by more than 20% as a result of the decrease in distance to the center of the package load (IAEA 1985). Consideration of the internal load and shifting of contents needs to be taken into account during transport.

n. Each packaging designed for liquids will:

- (1) Meet the conditions prescribed in paragraph (m) of this section when subjected to the tests specified in Paragraph 173.466 or evaluated against these tests by any of the methods authorized by Paragraph 173.461(a);
- (2) For any package with a liquid volume not exceeding 50 cubic centimeters (1.7 fluid ounces), have sufficient suitable absorbent material to absorb twice the volume of the liquid contents. The absorbent material shall be compatible with the package contents and suitably positioned to contact the liquid in the event of leakage; and
- (3) For any package with a liquid volume exceeding 50 cubic centimeters (1.7 fluid ounces), either:
 - (i) Have sufficient absorbent material as prescribed in paragraph (n) (2) of this section; or
 - (ii) Have a containment system composed of primary inner and secondary outer containment components designed to assure retention of the liquid contents within the secondary outer components in the event that the primary inner components leak; and

Liquids are not authorized for use in the approved packaging configuration; therefore, this requirement is not applicable.

o. Each package designed for compressed or uncompressed gases other than tritium or argon-37 not exceeding 200 curies will be able to prevent loss of contents when the package is subjected to the tests prescribed in 173.466 or evaluated against these tests by any of the methods authorized by Paragraph 173.461(a).

Compressed or uncompressed gases are not authorized for use in the approved packaging configuration; therefore, this requirement is not applicable.

5.1.6 49 CFR 173.442 - Thermal Limitations

Each package of radioactive material shall be designed, constructed, and loaded so that:

- a. The heat generated within the package because of the radioactive contents will not, at any time during transportation, affect the integrity of the package under conditions normally incident to transportation; and
- b. The temperature of the accessible external surfaces of the loaded package will not, assuming still air in the shade at an ambient temperature of 38 °C (100 °F), exceed either:
 - (1) 50 °C (122 °F) in other than an exclusive use shipment; or
 - (2) 82 °C (180 °F) in an exclusive use shipment.

It is the responsibility of the shipper to ensure that the design and construction capabilities have been properly addressed by the designer and fabricator. The shipper is responsible to ensure that the contents of the package are properly loaded within the thermal design limitations.

5.1.7 49 CFR 178.3 - Marking of Packagings

- a. Each packaging manufactured to a DOT specification or a UN standard shall be marked as follows:
 - (1) In an unobstructed area with letters and numerals identifying the standards or specification (e.g., UN 1A1, DOT 4B240ET, etc.).
 - (2) Unless otherwise specified in this part, with the name and address or symbol of the manufacturer, or, for a UN standard packaging, the approval agency certifying compliance with the UN standard. Symbols, if used, must be registered with the Associate Administrator for Hazardous Materials Safety. Duplicate symbols are not authorized.
 - (3) The markings must be stamped, embossed, burned, printed or otherwise marked on the packaging, to provide adequate accessibility, permanency, contrast, and legibility so as to be readily apparent and understood.
 - (4) Unless otherwise specified, letters and numerals must be at least 12.0 mm (0.47 inches) in height except that for packagings of less than or equal to 30 L (7.9 gallons) capacity for liquids or 30 kg (66 pounds) capacity for solids, the height must be at least 6.0 mm (0.2 inches).
- b. Packagings may be marked with the United Nations symbol and packaging identification code as provided in this subchapter, in the ICAO Technical Instructions or in Annex 1 to the IMDG Code, provided

the person applying these marks has established that the packaging conforms to the applicable provisions of this subchapter, the ICAO Technical Instructions or Annex 1 to the IMDG Code, respectively.

- (1) If an indication of the State in whose territory the specified tests are carried out, or of the State authorizing the allocation of the mark, is required by this part (see paragraph 178.503 of this part), the letters "USA" shall be used if the manufacturing and testing occurs in the United States.
 - (2) If an indication of the name of the manufacturer or other identification of the packaging as specified by the competent authority is required, the name and address or symbol of the person making the mark shall be entered. Symbols, if used, must be registered with the Associate Administrator for Hazardous Material Safety. Duplicate symbols are not authorized.
 - (3) Packagings manufactured to UN standards in accordance with this subchapter shall be marked as prescribed in paragraph 178.503 of this part.
- c. Where a packaging conforms to more than one UN standard or DOT specification, the packaging may bear more than one marking, provided the packaging meets all the requirements of each standard or specification. Where more than one marking appears on a packaging, each marking must appear in its entirety.

It is the responsibility of the shipper to ensure that the above requirements have been properly addressed by providing assurance that the packagings have been correctly marked as a Type A packaging, including identification of the manufacturer.

5.2 COMPLIANCE TEST EVALUATION

5.2.1 49 CFR 173.465 - Type A Packaging Tests

- a. The proposed packaging with proposed contents must be capable of withstanding the tests prescribed in this section. One prototype may be used for all tests if the requirements of paragraph (b) of this section are complied with.
- b. **Water Spray Test.** The water spray test must precede each test or test sequence prescribed in this section. The water spray test shall simulate exposure to rainfall of approximately 5 centimeters (2 inches) per hour for at least one hour. The time interval between the end of the water spray test and the beginning of the next test shall be such that the water has soaked-in to the maximum extent without appreciable drying of the exterior of the specimen. In the absence of evidence to the contrary, this interval may be assumed to be two hours if the water spray is applied from four different directions simultaneously. However, no time interval may

elapse if the water spray is applied from each of the four directions consecutively.

Test data indicates that the water spray test was conducted before the vibration and compression tests (Guthrie 1995); however, the qualitative information for the results of the water spray test is not available in the recorded test data. To supply the information required to support the WRAP-1 Drum as meeting all Type A packaging design and test requirements, a comparison was made to the testing and evaluation conducted on the same basic packaging component, a 208-l (55-gal), galvanized, filtered, DOT-17C drum (McCall 1995). The main difference, between the WRAP-1 Drum design and the DOT-17C drum tested and/or evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A, is in the inner packaging.

The inner packaging on the WRAP-1 Drum consists of an inner ring, seal, filtered lid, and gasket. The drums tested and/or evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A use either a heavy wall plastic drum liner or a plastic bag as the inner packaging. The inner packaging will not have any effect upon the performance of the WRAP-1 Drum packaging design to pass the water spray test. The water spray would be resisted by the primary packaging alone.

In all instances, primary containment is provided by the outer drum, lid, gasket, ring, bolt and jam nut. All of the noted drums are filtered. Because the WRAP-1 drum and the other drums tested and/or evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A are all DOT-17C or equivalent, the WRAP-1 drum is judged by comparison to meet the Type A packaging water spray test requirements. Refer to Appendix B of this report for evaluation information.

- c. Free Drop Test. The free drop test consists of a fall onto the target in a manner that causes maximum damage to the safety features being tested, and:
 1. For packages weighing 5,000 kilograms (11,000 pounds) or less, the distance of the fall measured from the lowest point of the packaging to the upper surface of the target shall not be less than 1.2 meters (4 feet).
 2. For packages weighing more than 5,000 kilograms (11,000 pounds), the distance of the fall shall not be less than the distance specified in Table 11, for the applicable packaging weight:

TABLE 11:
FREE-FALL DISTANCE FOR PACKAGING WEIGHING MORE THAN 5,000 KILOGRAMS.

PACKAGING WEIGHT		FREE-FALL DISTANCE	
KILOGRAMS	POUNDS	FEET	METERS
>5,000 TO 10,000...	>11,000 TO 22,000...	3	0.9

WHC-SD-TP-RPT-023
Revision 0

>10,000 TO 15,000...	>22,000 TO 33,000...	2	0.6
More than 15,000...	More than 33,000...	1	0.3

The original packaging design failed the 1.2 m (4 ft) drop test as described in Section 1.1 of this report. The WRAP-1 Drum was redesigned, as described in Section 2.0. Because of the special sealing equipment required to close this packaging, three prototypes of the redesigned packaging were tested by LANL at the Hanford Site on August 30, 1994.

The redesigned test units were assembled, loaded, and closed according to the sponsor's operating instruction (Ruff 1994). Prior to swaging the inner lid into place, plastic was added on top of the sand, soil, and bricks to keep moisture from inhibiting the tests. A flour and fluorescein mixture was used as a tracer material, and this was added on top of the plastic. The inner lid was swaged into place, and the gasket added between the inner and outer lid. The drum was then closed according to the sponsor's instructions.

The gross weight of each drum was approximately 454 kg (1000 lb). The three redesigned test units satisfactorily passed the 1.2 m (4 ft) drop tests with no detectable loss of material under visual and UV light inspection. Refer to Table 5-1 for drop test information. Refer to Appendix A, Figure A-1, of this report, for a diagram of the approved, as-tested packaging configuration.

Table 5-1. 1.2 m (4 ft) Drop Test.

Sample No.	Weight kg (lb)	Orientation	Results
#3	464 (1024)	Center-of-gravity (CG) over the top corner to impact the locking ring bolt.	Pass
#4	464 (1024)	CG over the top corner to impact the locking ring bolt.	Pass
#5	461 (1018)	Flat onto the side of the packaging to impact the locking ring bolt.	Pass

The draft test report does not qualitatively identify the amount or extent of damage resulting to the drums. The drop test report includes photographs of the damage. Qualitative information is needed by the shipper to determine changes in radiation levels at the surface of the package due to damage resulting from testing.

To supply the qualitative information, an evaluation by comparison was made by WHC on the drop testing conducted on the same basic packaging component under docket 89-13-7A/90-18-7A and 94-37-7A

(McCall 1995). The outer packaging consists of a filtered (NucFil-013) DOT-17C or equivalent, 208-l (55-gal) galvanized steel drum, lid, ring, bolt and jam nut. The primary difference between the WRAP-1 drums and the other tested drums is in the inner packaging. The WRAP-1 drum uses an inner packaging assembly consisting of an inner ring, seal, filtered lid, and gasket. The other drums use either a heavy wall plastic drum liner or a plastic bag as the inner packaging. In both cases, this inner packaging is required to prevent loss of material.

The photographs in the recorded test data show damage similar to the drums of the same approximate gross weight tested under dockets 89-13-7A/90-18-7A and 94-37-7A (454 kg [1000 lb]). Also, the photographs show no distortion of the drum due to the inner lid assembly. The test contents in all the tests are the same; sand/soil, lead bricks, flour, and fluorescein.

Based on the photo evidence, the damage to the WRAP-1 drum is qualitatively the same as the damage observed under dockets 89-13-7A/90-18-7A and 94-37-7A. As the basic packaging component is the same in all the tests and as the evidence does not show the inner packaging adding to the damage, it is judged that the qualitative damage of the WRAP-1 Drums should be equivalent to that observed during the testing conducted under dockets 89-13-7A/90-18-7A and 94-37-7A. Therefore, the damage reported for the packagings tested under dockets 89-13-7A/90-18-7A and 94-37-7A will be used to determine changes in radiation levels for the WRAP-1 Drum.

Under docket 89-13-7A/90-18-7A, a drum weighing 465 kg (1025 lb) was dropped twice. The CG drop over the bolt closure caused the side of the drum to crush down to the first hoop (approximately 6.35 cm [2.5 in.]). The drum head, side, and ring were deformed. There was a slight bulging of the drum head. No loss of contents was detected when inspected by UV light. No damage or loss of contents was detected when the package was dropped flat onto the bottom. The drum lid and bolted ring remained in place after each drop.

Also under docket 89-13-7A/90-18-7A, a second drum weighing 476.7 kg (1050 lb) was dropped three times. When dropped horizontally onto the bolted side, damage consisted of a flattening of the side by approximately 1.3 cm (0.5 in.). The bolt was bent down against the side of the drum and twisted the ring. No loss of contents was detected. When this drum was dropped CG over the bottom rim, the bottom of the drum bulged outward and the rim crushed approximately 5.08 cm (2 in.). No loss of contents was detected under UV light. No further damage was visible when the drum was dropped flat onto the top. No loss of contents was detected. The drum lid and bolted ring remained in place after each drop.

Under docket 94-37-7A, a drum weighing 465 kg (1025 lb) was dropped onto its side, flat at the bolt location. Damage to the drum consisted of a flattening of the side by approximately 1.3 cm

(0.5 in). The bolt bend down against the side of the drum. The closure ring bolt and side of drum pushed in slightly, and were deformed. No loss of contents was detected. The drum lid and bolted ring remained in place after the drop.

Also under docket 94-37-7A, a drum weighing 459 kg (1011 lb) was dropped onto the top at the bolt location, CG over the impact point. The closure ring crushed down and inward at the bolt location. The contents of the package pushed the lid outward. The drum head, side, and ring were deformed. The drum lid and bolted ring remained in place after the drop. No loss of contents was detected.

On the basis of the reported evidence and the comparison with other drum type packagings that have passed the Type A packaging requirements, the WRAP-1 Drum is evaluated as passing the Type A packaging drop test requirements. Refer to Appendix B of this report for evaluation information.

3. For Fissile Class II packagings, the free drop specified in subparagraph (1) or (2) of this paragraph shall be preceded by a drop from a height of 0.3 meter (1 foot) on each corner. For cylindrical packagings, the 0.3 meter (1 foot) drop shall be onto each of the quarters of each rim.

The approved packaging configuration will not be authorized for Fissile Class II materials; therefore, this requirement is not applicable.

4. For fiberboard or wood rectangular packages not exceeding 50 kilograms (110 pounds) in weight, a separate specimen of the proposed packaging shall be subjected to a free drop onto each corner from a height of 0.3 meter (1 foot).

The drums are made of metal; therefore, this requirement is not applicable.

5. For fiberboard cylindrical packages weighing not more than 100 kilograms (220 pounds) a separate specimen of the proposed packaging shall be subjected to a free drop onto each of the quarters of each rim from a height of 0.3 meter (1 foot).

The drums are made of metal; therefore, this requirement is not applicable.

6. The target shall have a flat, horizontal surface of such mass and rigidity that any increase in its resistance to displacement or deformation upon impact by the specimen would not significantly increase the damage to the specimen.

The approved WRAP-1 Drum packaging design was drop tested at the DOE-approved test facility, located at the Hanford site. The test pad used meets this requirement.

The DOE-approved test facility, located at the Hanford site, utilizes a test pad that is located in the 305 Building. This pad is an 11,868-kg (26,165-lb), 2.1-m (84-in) square, indoor test pad consisting of a 5-cm (2-in) thick steel top plate, a 10-cm (4-in) thick steel intermediate plate, and a 61-cm (2-ft) thick reinforced concrete base. The pad is located in a 4.6-m (15-ft) deep pit with a 3.0 by 3.7-m (10 by 12-ft) opening.

- d. **Compression Test.** The compression test shall last for a period of at least 24 hours and consists of a compressive load equivalent to the greater of the following:
1. Five times the weight of the actual package; or
 2. 1300 kilograms per square meter (265 pounds per square foot) multiplied by the vertically projected area of the package. The compressive load shall be applied uniformly to two opposite sides of the packaging specimen, one of which must be the base on which the package would normally stand.

Test data indicates that the compression test was conducted (Guthrie 1995); however, the qualitative information for the results of the compression test is not available in the recorded test data. To supply the information required to support the WRAP-1 Drum as meeting all Type A packaging design and test requirements, a comparison was made to the testing and evaluation conducted on the same basic packaging component, a 208-l (55-gal), galvanized, filtered, DOT-17C drum (McCall 1995). The main difference, between the WRAP-1 Drum design and the DOT-17C drum tested and/or evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A, is in the inner packaging.

The inner packaging on the WRAP-1 Drum consists of an inner ring, seal, filtered lid, and gasket. The drums tested and/or evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A use either a heavy wall plastic drum liner or a plastic bag as the inner packaging. The inner packaging will not have any effect upon the performance of the WRAP-1 Drum packaging design to pass the compression test. The compression would be resisted by the primary packaging alone.

In all instances, primary containment is provided by the outer drum, lid, gasket, ring, bolt and jam nut. All of the noted drums are filtered. Because the WRAP-1 drum and the other drums tested and/or evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A are all DOT-17C or equivalent, the WRAP-1 drum is judged by comparison to meet the Type A packaging compression test requirements. A compression test was conducted under docket 89-13-7A with a load of 2506 kg (5525 lb) for a 24-hour period with no evidence of damage or loss of contents detected. Refer to Appendix B of this report for evaluation information.

- e. **Penetration Test.** For the penetration test the packaging specimen shall be placed on a rigid, flat, horizontal surface that will not move while the test is being performed. The test shall consist of:

1. A bar of 3.2 centimeters (1.25 inches) in diameter with a hemispherical end weighing 6 kilograms (13.2 pounds) being dropped with its longitudinal axis vertical, onto the center of the weakest part of the packaging specimen, so that, if it penetrates far enough, it will hit the containment system. The bar must not be deformed by the test; and
2. The distance of the fall of the bar measured from its lower end to the upper surface of the packaging specimen shall not be less than 1 meter (3.3 feet).

Test data indicates that the penetration bar drop test was conducted (Guthrie 1995); however, the qualitative information for the results of this test is not available in the recorded test data. To supply the information required to support the WRAP-1 Drum as meeting all Type A packaging design and test requirements, a comparison was made to the testing and evaluation conducted on the same basic packaging component, a 208-l (55-gal), galvanized, filtered, DOT-17C drum (McCall 1995). The main difference, between the WRAP-1 Drum design and the DOT-17C drum tested and/or evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A, is in the inner packaging.

The inner packaging on the WRAP-1 Drum consists of an inner ring, seal, filtered lid, and gasket. The drums tested and/or evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A use either a heavy wall plastic drum liner or a plastic bag as the inner packaging. The inner packaging will not have any effect upon the performance of the WRAP-1 Drum packaging design to pass the penetration test. The impact of the penetration bar would be resisted by the primary packaging alone.

In all instances, primary containment is provided by the outer drum, lid, gasket, ring, bolt and jam nut. All of the noted drums are filtered. Because the WRAP-1 drum and the other drums tested and/or evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A are all DOT-17C or equivalent, the WRAP-1 drum is judged by comparison to meet the Type A packaging penetration test requirements. Under docket 89-13-7A, the prescribed bar was dropped from 101.6 cm (40 in.) onto the drum top center, side, bottom, and directly onto the filter. No damage was observed other than a slight impression. There was no loss of contents or adverse effect to the filter. Further, the NucFil filters have been previously tested and found to function properly after being struck by the penetration test bar (Cruse 1992). Refer to Appendix B of this report for evaluation information.

5.2.2 49 CFR 173.466 - Additional Tests for Type A Packagings Designed for Liquids and Gases

In addition to the tests prescribed in 173.465, Type A packaging designed for liquids and gases shall be capable of withstanding the following tests:

1. Free Drop Test. The packaging specimen shall fall onto the target in a manner which will cause it to suffer the maximum damage to its containment. The distance of the fall measured from the lowest part of the packaging specimen shall not be less than 9 meters (30 feet).

This packaging is not authorized for transport of liquids and/or gases; therefore, this test is not required.

2. Penetration Test. The specimen must be subjected to the test specified in 173.465(e) except that the distance of the fall shall be 1.7 meters (5.5 feet).

This packaging is not authorized for transport of liquids and/or gases; therefore, this test is not required.

5.2.3 49 CFR 178.608 - Vibration Standard

- a. Each packaging must be capable of withstanding, without rupture or leakage, the vibration test procedure outlined in this section.
- b. Test method.
 - (1) Three sample packagings must be filled and closed as for shipment.
 - (2) The three samples must be placed on a vibrating platform that has a vertical or rotary double-amplitude (peak-to-peak displacement) of one inch. The packages should be constrained horizontally to prevent them from falling off the platform, but must be left free to move vertically, bounce, and rotate.
 - (3) The test must be performed for one hour at a frequency that causes the package to be raised from the vibrating platform to such a degree that a piece of material of approximately 1.6 mm (0.063 inch [1/16 inch]) thickness (such as steel strapping or paperboard) can be passed between the bottom of any package and the platform.
 - (4) Immediately following the period of vibration, each package must be removed from the platform, turned on its side, and observed for any evidence of leakage.
 - (5) Other methods, at least equally effective, may be used, if approved by the Associate Administrator for Hazardous Material Safety.

- c. Criteria for passing the test. A packaging passes the vibration test if there is no rupture or leakage from any of the packages. No test sample should show any deterioration which could adversely affect transportation safety or any distortion liable to reduce packaging strength.

The approved packaging configuration passed this requirement. Type A packagings are required "to withstand the effects of any acceleration, vibration, or vibration resonance that may arise during normal transportation" [see 49 CFR 173.412 (e)]. The test identified in this section was applied to support the ability of the packaging to meet the requirement.

The test data incorporates the Vibration Test Report, TR/VT-94-06 (Guthrie 1995). The test report indicates that a WRAP-1 Drum weighing 468 kg (1032 lb) passed the vibration test. The test report indicates no observed damage to the packaging, no distortion of the sealing area, and no release of contents under visual and UV light inspection. The examination showed no loss of flour or fluorescein. The flour and fluorescein materials were placed into the package to serve as markers for loss of containment. In comparison, three drums tested under docket 94-37-7A and filled with actual simulated contents underwent vibration testing for 1 hour with no release of contents when observed under visual and UV light inspection.

Containment is provided via the inner packaging system that consists of the inner lid, ring, seal, and gasket. The inner lid is fitted with a NucFil-013 filter and locking nut. The inner seal is compressed when the inner lid is swaged into place against the inner ring. The inner gasket is then laid into place on top of the inner lid. The gasket must lay flat against the inner lid and inner seal. Containment is also provided via the outer packaging system that consists of the filtered outer drum lid, clamp band, bolt, and jam nut. The outer drum lid and clamp band are placed on the drum. The clamp band is placed over the outer lid and the drum false wire. The clamp bolt is then threaded through the clamp band. The clamp band is lightly impacted around its circumference while the clamp bolt is tightened. This process is repeated until the clamp band will no longer move when impacted and tightened. A torque wrench is used to tighten the clamp bolt to a torque of 54.24 Nm (40 [$\pm$] 1 lbf-ft). The jam nut on the clamp bolt is then tightened against the threaded portion of the clamp band to a torque of 54.24 Nm (40 [$\pm$] 1 lbf-ft).

This page intentionally left blank.

6.0 CONCLUSION

The evaluation and testing indicates that the approved packaging configuration identified meets applicable DOT-7A Type A design and compliance test requirements. Deviations from the approved, tested packaging system configuration will require retesting or approval by the U.S. Department of Energy.

6.1 RESTRICTIONS/SPECIFICATIONS

The following restrictions/specifications shall be observed:

1. The special equipment required for loading and closure of this packaging is defined in WHC-SD-W026-0CD-001, Revision 0, *One-Trip Drum Operating Instruction*. Assembly of the as-tested packaging is shown on Hanford Drawing Number H-2-824300, Revision 0. Drums tested were purchased according to Hanford Standard HS-V-P-0010, Revision C. Sizes and tolerances per Hanford Drawing H-2-824300, Revision 0, must be strictly adhered to and followed.
2. The inner lid must be fitted with a NucFil-013, 3/4-in - 14 NPT, carbon-activated filter. A 2.54-cm (1-in.) diameter hole is punched into the center of the inner drum lid. The NucFil-013 filter is threaded through the hole and a locking nut is tightened onto the back side of the filter and torqued to 33.9 Nm (25 [$\pm$ 1] lbf.ft).
3. The inner ring shall be adhered and sealed (top and bottom) around its circumference to the drum body with E-6000 black adhesive. This first application of adhesive is allowed to cure for 24 hours. A second application of adhesive occurs above and below the inner ring. Remove any excess adhesive from the top and bottom surface of the ring. Allow second application to cure for 24 hours.
4. The inner seal shall meet the following specifications:
 - Neoprene/sbr foam
 - Adhesive backed and satin finish
 - Density: 3.5 - 5.0 lb/cu ft.
 - 25% compression resist: 2.0 - 5.0 psi
5. Dimension and placement of inner lid gasket is critical for proper drum closure per DOT-7A testing. The gasket should lay flat against the inner lid and inner seal.
6. A NucFil-013 filter is installed into the provided flange on the outer drum lid. The flange is located in the center annulus of the outer lid at least 7.62 cm (3 in.) from the center to avoid interference with the filter in the inner lid. The outer lid filter is torqued to 33.9 Nm (25 [$\pm$ 1] lbf.ft). No sealant or tape is added to enhance this seal.

7. The lid locking ring bolt shall be tightened to 54.24 Nm (40 lbf.ft) torque with tapping of the ring followed by tightening. A jam nut shall also be used to prevent unintentional loosening during transport. The location of the jam nut shall be between the lugs, and the jam nut shall be tightened against the threaded lug.
8. The drum gasket material, the neoprene inner gasket, and the neoprene inner seal shall have an operating range of -40°C to +70°C (-40°F to +158°F).
9. For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment/materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package. This loading must be evaluated to assure that the packaging, if tested, would not fail.

The shipper is the organization that actually uses the packagings and therefore is responsible to make sure they are used in accordance with their designs. The shipper shall ensure that the design is suitable in all respects for the contents to be shipped. If it is not suitable, testing/analysis must be conducted and documented to demonstrate Specification 7A compliance with the actual contents. The design will dictate many of the limits placed on the contents, such as mass and physical form.

The manufacturer(s) of the packaging described herein is responsible for using materials, processes, and controls in the packaging fabrication that are equivalent to those used in the fabrication of the test unit packagings.

7.0 QUALITY ASSURANCE PROGRAM

The quality assurance program implemented by the shipper's organization must implement actions to provide adequate confidence that the shipment will comply with the regulations. The following regulatory requirements address quality control applicable to Type A packaging.

Paragraphs 173.474 and 173.475 that are restated below provide the quality control elements prescribed in 49 CFR. These requirements must be met for all shipments.

173.474. Quality Control for Construction of Packaging

- a. Prior to the first use of any packaging for the shipment of radioactive material, the shipper shall determine that:
 - 1. The packaging meets the quality of design and construction requirements as specified in this subchapter; and
 - 2. The effectiveness of the shielding, containment, and, when required heat transfer characteristics of the package, are within the limits specified for the package design.

173.475. Quality Control Requirements Prior to Each Shipment of Radioactive Materials

Before each shipment of any radioactive materials package, the shipper shall ensure by examination or appropriate tests, that:

- a. The packaging is proper for the contents to be shipped;
- b. The packaging is in unimpaired physical condition, except for superficial marks;
- c. Each closure device of the packaging, including any required gasket, is properly installed, secured, and free of defects;
- d. For fissile material, each moderator and neutron absorber, if required, is present and in proper condition;
- e. Each special instruction for filling, closing, and preparation of the packaging for shipment has been followed;
- f. Each closure, valve, or other opening of the containment system through which the radioactive content might escape is properly closed and sealed;
- g. Each packaging containing liquid in excess of an A₂ quantity and intended for air shipment has been tested to show that it will not leak under an ambient atmospheric pressure of not more than 0.25 atmosphere, absolute, (0.25 kilograms per square centimeter or 3.6 pisa). The test must be conducted on the entire containment

system, or on any receptacle or vessel within the containment system, to determine compliance with this requirement.

- h. The internal pressure of the containment system will not exceed the design pressure during transportation; and
- i. External radiation and contamination levels are within the allowable limits specified in this subchapter.

It is critical that controls are in place to ensure that the packaging hardware to be used complies with the specifications given for the packaging hardware tested, described, and evaluated in this document. Each shipper must have a documented program that describes how this is achieved, and the degree of certainty, in addition to documentation (audit trail) that demonstrates compliance. The quality assurance program is mandated in DOE Order 5480.3, *Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes* (DOE 1985).

8.0 PRIMARY USER/MANUFACTURER

Site/Contact/Phone

Hanford Site
K. Leist
(509) 376-0325
D. R. Lucas
(509) 376-0060

Address

Westinghouse Hanford Company
P.O. Box 1970
Richland, Washington 99352

This page intentionally left blank.

9.0 REFERENCES

- 49 CFR, "Transportation," Parts 100 to 177 and Parts 178 to 199, *Code of Federal Regulations*, as amended.
- Cruse, J. M., 1992, *Test and Evaluation Document for DOT Specification 7A Type A Packaging*, WHC-EP-0558, Rev. 3, Westinghouse Hanford Company, Richland, Washington.
- DOE, 1985, *Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes*, DOE Order 5480.3, U.S. Department of Energy, Washington, D.C.
- Guthrie, A., 1993, *Packaging Engineering Manual*, LAUR-93-3224, Rev. 0, Dated February 17, 1993, Los Alamos National Laboratory, Los Alamos, New Mexico.
- Guthrie, A., 1995, *WRAP-1 Testing and Evaluation*, TR-94-06, Draft, Los Alamos National Laboratory, Los Alamos, New Mexico.
- IAEA, 1985, *IAEA Safety Standards, Safety Series No. 6*, 1985 edition, Regulations for the Safe Transport of Radioactive Material, International Atomic Energy Agency, Vienna, Austria.
- Kelly, D. L., 1995, *DOT-7A Type A Packaging Design Guide*, WHC-SD-TP-RPT-017, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- McCall, D. L., 1995, *Evaluation Documentation for WRAP-1 Drum (Docket 94-35-7A) and Request for Approval for Use*, (external letter 9554842 to M. E. Wangler, U.S. Department of Energy [EH-32], September 12, 1995), Westinghouse Hanford Company, Richland, Washington.
- Ruff, D. T., 1994, *One-Trip Drum Operating Instruction*, WHC-SD-W026-OCD-001, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

This page intentionally left blank.

10.0 GLOSSARY

ABBREVIATIONS AND ACRONYMS

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CG	center of gravity
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DOT-7A	U.S. Department of Transportation Specification 7A Type A
EPDM	ethylene/propylene/diene
FKM	fluorocarbon rubber
HEPA	high-efficiency particulate air
LANL	Los Alamos National Laboratory
NPT	national pipe thread
PSI	pounds per square inch
UV	ultraviolet
WHC	Westinghouse Hanford Company
WRAP-1	Waste Receiving and Processing Facility, Module 1

This page intentionally left blank.

APPENDIX A

WRAP-1 DRUM PACKAGING CONFIGURATION

This page intentionally left blank.

Figure A-1. Tested WRAP-1, 55-Gallon Waste Drum.

*NucFil is a trademark of Nuclear Filter Technology, Incorporated.

S9505049.2

This page intentionally left blank.

Figure A-2. WRAP-1, 55-Gallon Waste Drum - Sealing Detail.

This page intentionally left blank.

APPENDIX B

WRAP-1 DRUM EVALUATION AND COMPARISON DOCUMENTATION

NOTE: This appendix consists of the referenced document, McCall, D. L., 1995, *Evaluation Documentation for WRAP-1 Drum (Docket 94-35-7A) and Request for Approval for Use*, (external letter 9554842 to M. E. Wangler, U.S. Department of Energy [EH-32], September 12, 1995), Westinghouse Hanford Company, Richland, Washington. This appendix also includes the DOE-HQ (EH-32) letter that approves the WRAP-1 Drum for interim use as a Type A container until the formal test report is completed and approved.

This page intentionally left blank.

United States Government

Department of Energy

memorandum

DATE: OCT 1 - 1995

REPLY TO
ATTN OF: Office of Facility Safety Analysis:Wangler:3-5078

SUBJECT: APPROVAL OF EVALUATION AND COMPARISON DOCUMENTATION FOR WRAP-1 DRUM, DOCKET 94-35-7A

TO: T. K. Teynor, Director, Waste Programs Division, Richland Operations Office

We have reviewed the evaluation and comparison documentation for the Westinghouse Hanford Company Waste Receiving and Processing Facility, Module 1 (WRAP-1) Drum (docket 94-35-7A). We hereby approve the WRAP-1 Drum for interim use as a Department of Transportation Specification 7A Type A container. Interim approval will remain valid until the formal test report is completed and approved. Our review of the evaluation and comparison documentation concluded that this packaging meets Specification 7A performance requirements.

If you need additional information, please contact Michael E. Wangler (301-903-5078) or Ashok Kapoor (301-903-6838) of my staff.

Sarbes Acharya, Director
Office of Facility Safety Analysis, EH-32

cc:
D. McCall, WHC
O. Pearson, EH-3
T. O'Toole, EH-1
P. Brush, EH-1
M. Williams, EH-3
R. Christopher, EH-3
R. Black, EH-31
T. Rollow, EH-33
G. Podonsky, EH-2
R. Berube, EH-4
J. Fitzgerald, EH-5
C. Beers, DP-20
D. Knuth, DP-30
R. Scott, EM-20
J. Lytle, EM-30
W. Bixby, EM-60
D. Pearman, FM-1
N. Haberman, NE-30
R. Hunter, NE-40
G. McFadden, NN-50
J. Brodman, PO-71
J. Baublitz, EM-40
S. Roussio, RW-40

B-3

P.O. Box 1970 Richland, WA 99352

September 12, 1995

9554842

Mr. M. E. Wangler, Program Manager
Office of Facility Safety Analysis
U.S. Department of Energy, EH-32
19901 Germantown Road
Germantown, Maryland 20874

Dear Mr. Wangler:

EVALUATION DOCUMENTATION FOR WRAP-1 DRUM (DOCKET 94-35-7A) AND
REQUEST FOR APPROVAL OF USE

Reference: Letter, W. F. Irvine, WHC, to T. K. Teynor, RL, "Review and
Comment of Draft Test Report and Information Pages for Docket
94-35-7A (WRAP-1 Drum)," dated June 1, 1995.

Westinghouse Hanford Company (WHC) needs approval to ship the packaging configuration tested in August 1994 by Los Alamos National Laboratories (LANL). The above-referenced correspondence outlined milestone commitments associated with Hanford's Waste Receiving and Processing Facility, Module 1 (WRAP-1). Comment resolution had also been requested no later than July 30, 1995, so that WHC should develop the Blue Book Information pages and request approval for packaging use. Approval for packaging use is needed by no later than September 30, 1995, to meet facility construction and Tri-Party Agreement milestones.

WHC requests that the U.S. Department of Energy, Office of Facility Safety Analysis (EH-32), issue an interim approval for use of the WRAP-1 drum as a U.S. Department of Transportation Specification 7A (DOT-7A) Type A packaging. This request is made because the test facility has not completed the formal test documentation that EH-32 would normally base its decision to issue approved test and evaluation documentation. The documentation normally issued states that the packaging meet DOT-7A general packaging Type A test and evaluation requirements (Type A) when loaded as tested.

The attached documentation identifies the packaging and the results of drop testing, and compares the packaging to other drum type packaging to complete the documentation requirements identified in 49 CFR 173.415(a). The attached documentation consists of:

1. An evaluation document, that through evaluation and comparison, demonstrates that the WRAP-1 drums passes the Type A packaging test and evaluation requirements.
2. The packaging qualification checklist submitted for the WRAP-1 drum.

Mr. M. E. Wangler
Page 2
September 12, 1995

9554842

3. The draft test report, TR-94-06, that shows the drum retains containment when subjected to the required drop tests.
4. The approved, final test reports for Dockets 89-13-7A/90-18-7A and 94-37-7A, that show the ability of a DOT-17C drum, when loaded as described in the test reports, to pass the Type A packaging test and evaluation requirements.

It is the opinion of the Type A packaging personnel of WHC's Packaging Operations and Development organization, that the packaging, when loaded as tested, combined with the attached documentation, meets all of the Type A packaging test and evaluation requirements.

Your immediate attention to this matter is much appreciated. Any further delays beyond September 30, 1995, increase the risk of affecting milestone compliance associated with this project. If you have any questions, please contact Donna Kelly at (509) 372-2276.

Very truly yours,

D. L. McCall, Manager
Packaging Operations and Development
Projects and Site Services

acp

Attachments (4)

RL - D. W. Claussen (w/o attachments)
A. H. Wirkkala (w/o attachments)

ERG - S. J. Primeau

EVALUATION DOCUMENTATION FOR WRAP-1 DRUM

1.0 INTRODUCTION

This documentation has been assembled to demonstrate that the WRAP-1 drum, when loaded and assembled as described in the draft test report, "Los Alamos, TR-94-06, "WRAP-1 Testing and Evaluation," meets the test and evaluation requirements for U.S. Department of Transportation Specification 7A (DOT-7A) general packaging Type A (Type A). Supporting documentation consists of:

1. This evaluation document, that through evaluation and comparison, demonstrates that the WRAP-1 drums passes the Type A packaging test and evaluation requirements.
2. The packaging qualification checklist submitted for the WRAP-1 drum.
3. The draft test report, TR-94-06, that shows the drum retains containment when subjected to the required drop tests.
4. The approved, final test reports for Dockets 89-13-7A/90-18-7A and 94-37-7A, that show the ability of a DOT-17C drum, when loaded as described in the test reports, to pass the Type A packaging test and evaluation requirements.

2.0 EVALUATION

2.1 Drop Test

The draft test report, (see Pages 1 through 7 of TR-94-06), identifies the tested packaging configuration. The primary packaging component is a 55-gallon drum built to the DOT-17C drum specification. Sketches are provided that show a general description of the WRAP-1 packaging tested.

The draft test report incorporates the Drop Test Report, TR/DT-94-06. The drop test report states that the described packaging configuration retain containment when subjected to the 4-ft drop test required for Type A packaging. Three packagings were dropped. Two were dropped center of gravity over the drum body lid interface to impact at the bolt location on the closure ring. The third was dropped flat on its side with the bolt location on the closure ring down so as to be in the impact zone. The no loss of material was determined by visual examination using ultra violet light. The examination showed no loss of flour or fluorescein. The flour and fluorescein materials were placed into the package to serve as markers for loss of containment. One test drum had a gross weight of 1018 pounds. The other two test drums both had a gross weight of 1024 pounds.

The draft test report does not qualitatively identify the amount or extent of damage resulting to the drums. The drop test report includes photos of the damage. Qualitative information is needed by the shipper to determine changes in radiation levels at the surface of the package due to damage resulting from testing.

To supply the qualitative information, a comparison is made to the drop testing conducted on the same basic packaging component under dockets 89-13-7A/90-18-7A and 94-37-7. The primary difference between the WRAP-1 drums and the other tested drums is in the secondary packaging. The WRAP-1 drum uses an inner lid and gaskets as inner packaging. The other drums use either a heavy wall plastic drum liner or a plastic bag as secondary packaging. In both cases the secondary packaging is required to prevent loss of material.

The photos in the draft test report show damage similar to the drums of the same approximate gross weight tested under dockets 89-13-7A/90-18-7A and 94-37-7A. Also, the photos show no distortion of the drum to the inner lid assembly. The test contents in all the tests are the same; sand, flour, fluorescein, and lead bricks.

Based on the photo evidence, the damage to the WRAP-1 drum is qualitatively the same as the damage observed under dockets 89-13-7A/90-18-7A and 94-37-7A. As the basic packaging component is the same in all the tests and as the evidence does not show the secondary packaging adding to the damage, it is judged that the qualitative damage of the WRAP-1 drums should be equivalent to that observed during the testing conducted under dockets 89-13-7A/90-18-7A and 94-37-7A. Therefore, the damage reported for the packagings tested under dockets 89-13-7A/90-18-7A and 94-37-7A will be used to determine changes in radiation levels for the WRAP-1 drums.

On the basis of the reported evidence and the comparison with other drum type packagings that have passed the Type A packaging requirements, the WRAP-1 drum is evaluated as passing the Type A packaging drop test requirements.

2.2 Vibration Test

The draft test report incorporates the Vibration Test Report, TR/VT-94-06. The test report indicates that a WRAP-1 drum weighing 1032 pounds passed the vibration test. The test conducted was that described in *Title 49, Code of Federal Regulations, Paragraph 178.608 (49 CFR 178.608), "Vibration Standard."* The test report indicates no damage to the packaging or loss of materials. The no loss of material was determined by visual examination using ultra violet light. The examination showed no loss of flour or fluorescein. The flour and fluorescein materials were placed into the package to serve as markers for loss of containment.

Based on this vibration testing, the packaging is determined to meet the Type A packaging requirements for vibration identified in *49 CFR 173.24a and 173.412(e)*.

2.3 All Other Type A Packaging Design and Test Requirements

To supply the information required to support the WRAP-1 drum as meeting all of the other Type A packaging design and test requirements, a comparison is made to the testing and evaluation conducted on the same basic packaging component, a 55-gallon, galvanized, DOT-17C or equivalent drum. The primary difference, between the WRAP-1 drums and the DOT-17C or equivalent drum tested under dockets 89-13-7A/90-18-7A and 94-37-7A, is in the secondary packaging.

The WRAP-1 drum uses an inner lid and gaskets as inner packaging. The other drums use either a heavy wall plastic drum liner or a plastic bag as secondary packaging. In both cases the secondary packaging is required to prevent loss of material during drop testing. The test contents in all the tests are the same; sand, flour, fluorescein, and lead bricks. The test weight in all tests were slightly greater than 1000 pounds.

The inner lid and gasketing of the WRAP-1 drums are made of the same basic materials as those in the other drums tested. Therefore, the only materials of construction that differ between the packagings are the epoxy used to install the inner lid in the WRAP-1 drum and the lack of plastic material. The packaging qualification checklist states that the epoxy meets the performance requirements identified for Type A packaging. The epoxy performs over the required temperature range and is compatible with the other materials used for construction. The epoxy is also not adversely impacted by the radiation dose resulting from the planned loading.

The other drum type packagings evaluated under dockets 89-13-7A/90-18-7A and 94-37-7A meet the Type A packaging design requirements because of the primary packaging. The WRAP-1 drum uses the same primary packaging. The WRAP-1 drum, by the above evaluation and comparison, is judged as meeting the Type A packaging design requirements.

Other than the drop test, the WRAP-1 drum needs to meet the water spray, compression, and penetration tests. The differences between the WRAP-1 and the other drums tested do not impact the ability of the basic packaging to pass these tests. The compression load, penetration, and water spray are all resisted by the primary packaging alone. Because the WRAP-1 drum and the other drums tested under dockets 89-13-7A/90-18-7A and 94-37-7A are all DOT-17C or equivalent, the WRAP-1 drum is judged by comparison to meet the Type A packaging compression load, penetration, and water spray test requirements.

3.0 Conclusion

The WRAP-1 drum is judged to meet all of the Type A packaging evaluation and test requirements when loaded as described for testing. A mixture of flour and fluorescein was added to the WRAP-1 test units as tracer material and to simulate Material Form Number 1 contents, solids, any particle size, as described in WHC-EP-0558, "Test and Evaluation Document for DOT Specification 7A Type A Packaging." As with the drums tested under dockets 89-13-7A/90-18-7A and 94-37-7A, the shipper is responsible for assuring compliance with

all regulatory requirements for shipment of a Type A package. The test reports prepared for dockets 89-13-7A/90-18-7A and 94-37-7A contain identification of requirements that the shipper must check for compliance. When using the WRAP-1 drum, the shipper must also assure compliance with those regulatory requirements.

The test reports for dockets 89-13-7A/90-18-7A and 84-37-7A contain restrictions/specifications that must be followed when preparing the drum type packagings for shipment. The restrictions/specifications that are specific to the drums tested under dockets 89-13-7A/90-18-7A and 84-37-7A do not apply to the WRAP-1 drum. In this evaluation documentation, Section 4.0, "Restrictions/Specifications," contains a set of restrictions applying to use of the WRAP-1 drum as a Type A packaging. Use of the WRAP-1 drum also requires following the quality assurance conditions presented in this evaluation documentation under Section 5.0, "Quality Assurance."

4.0 Restrictions/Specifications

The packagings should be loaded, assembled, and closed as described in Los Alamos' document TR-94-06. Deviations from the tested packaging system configuration will require retesting or approval by the DOE. The following restrictions/specifications shall be observed for the WRAP-1 drum:

1. The special equipment required for loading and closure of this packaging is defined in WHC-SD-W026-OCD-001, Revision 0, "One-Trip Drum Operating Instruction." Assembly of the as-tested packaging is shown on Hanford Drawing Number H-2-824300, Revision 0. Drums tested were purchased according to Hanford Standard HS-V-P-0010, Revision C. Sizes and tolerances per Hanford Drawing Number H-2-824300, Revision 0, must be strictly adhered to and followed.
2. The inner lid must be fitted with a NucFil-013, 3/4-in - 14 NPT, carbon-activated filter. A 1-in diameter hole is punched into the center of the inner drum lid. The NucFil-013 filter is threaded through the hole and a locking nut is tightened onto the back side of the filter and torqued to 34 N-m (25 (±1) ft-lb).
3. The inner ring shall be adhered and sealed (top and bottom) around its circumference to the drum body with E-6000 black adhesive. This first application of adhesive is allowed to cure for 24 hours. A second application of adhesive occurs above and below the inner ring. Remove any excess adhesive from the top and bottom surface of the ring. Allow second application to cure for 24 hours.
4. The inner seal shall meet the following specifications:

Neoprene/sbr foam
Adhesive backed and satin finish
Density: 3.5 - 5.0 lb/cu ft.
25% compression resist: 2.0 - 5.0 psi

5. Dimension and placement of inner lid gasket is critical for proper drum closure per DOT-7A testing. The gasket should lay flat against the inner lid and inner seal.
6. A NucFil-013 filter is installed into the provided flange on the outer drum lid. The flange is located in the center annulus of the outer lid at least 3-in from the center to avoid interference with the filter in the inner lid. The outer lid filter is torqued to 34 N-m (25 (±1) ft-lb). No sealant or tape is added to enhance this seal.
7. The lid locking ring bolt shall be tightened to 54.2 N-m (40 ft-lb) torque with tapping of the ring followed by tightening. A jam nut shall also be used to prevent unintentional loosening during transport. The location of the jam nut shall be between the lugs, and the jam nut shall be tightened against the threaded lug.
8. The drum gasket material, the neoprene inner gasket, and the neoprene inner seal shall have an operating range of -40°C to +70°C (-40°F to +158°F).
9. The damage reported for the packagings tested under dockets 89-13-7A/90-18-7A and 94-37-7A will be used to determine changes in radiation levels for the WRAP-1 drums.
10. For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment/materials with sharp corners or protrusions, or material/containment geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package. This loading must be evaluated to assure that the packaging, if tested, would not fail.

5.0 Quality Assurance

The quality assurance program implemented by the shipper's organization must implement actions to provide adequate confidence that the shipment will comply with the regulations. Quality control elements prescribed in 49 CFR 173.474 and 173.475 must be met for all shipments. Following is the packaging acceptance and packaging use criteria established for the WRAP-1 drum.

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Outer lid/body and inner lid/ring interface and sealing surface	Vendor qualification and experience	Functional: <ul style="list-style-type: none"> Ease of lid/closure ring application Bolt closure ring--bolt size Gaskets, seal, and adhesive, as specified Geometry, as specified Acceptable Conditions: <ul style="list-style-type: none"> Lack of dents, no deformation of sealing surfaces Size, material, and geometry as specified Continuous welds, no sharp edges
Inner seal and inner lid gasket		
Weld areas		
Body and chime	Metal thickness	Lot tests by shipper, as appropriate
	Protective coating application	Visual: <ul style="list-style-type: none"> Surface/coating as specified Lack of imperfections in application Lack of rust, dents, nicks
Air leak tests	Bolt size	Vendor Data and/or Certification: <ul style="list-style-type: none"> Marking Test data Type A document provided as appropriate Air leak tests
Filter outer drum lid inner lid		Acceptable: <ul style="list-style-type: none"> Type, location, and installation as specified

*These criteria apply to first-time use and to reuse as a DOT-7A Type A packaging.

DOT 7A Type A 49 CFR 178.350

*NucFil is a trademark of Nuclear Filter Technology, Incorporated.

S9505049.2

DOT 7A Type A
49 CFR 178.350

S9505049.1

9554842

ATTACHMENT 2

Packaging Qualification Checklist
(includes Operating Instructions)

Consisting of 39 pages,
including coversheet

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

When subjected to the tests specified in 49 CFR 173.465 or evaluated against these tests by any of the methods authorized by 49 CFR 173.461(a), the packaging will prevent:

- (1) Loss or dispersal of the radioactive contents; and
- (2) Any significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test.

1.0 Characterization of Contents

Radiological

Limited to Type A Quantity of Radionuclides

Isotopic Inventory:

RADIONUCLIDES	QUANTITY (per package)			DECAY HEAT
	Curies	Grams	Grams Fissile	Watts/gram
Various Isotopes not exceeding the normal limit for Type A packaging as outlined in 49 CFR 173.431.				

(Use extra sheets if needed.)

Fissile Class: ☒ -Exempt ☐ -I ☐ -II ☐ -III

Physical

Form Category: ☒ Normal ☐ Special (see 49 CFR 173.469)

Physical Form: ☒ Solid ☒ Form 1 ☒ Form 2 ☒ Form 3

Density: Varies (kg/m³)

☐ Liquid

Specific gravity: N/A

☐ Gas

Volume: N/A (cm³ at STP)

Thermal

Total wattage of contents: _____ (watts/package)

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

2.0 49 CFR 173.24 General requirements for packagings and packages.

173.24 (a) Applicability.

Except as otherwise provided in this subchapter, the provisions of this section apply to--

- (1) Bulk and non-bulk packagings;
- (2) New packagings and packagings which are reused; and
- (3) Specification and non-specification packagings.

This requirement applies. Please indicate the following.

Addressed in:	☒ Drawing	☐ Operating Instruction
	☐ Specification	☐ Manufacturer Supplied Data
	☐ Analysis Report	☒ Similarity or Documented Record

Specify: The one-trip drum falls under the requirements of this section as specified by the drum drawing, and the operating instruction. Package will be a 7A Type A packaging.

173.24 (b) Containment.

Each package used for the shipment of hazardous materials under this subchapter shall be designed, constructed, maintained, filled, its contents so limited, and closed, so that under conditions normally incident to transportation--

- (1) Except as otherwise provided in this subchapter, there will be no identifiable (without the use of instruments) release of hazardous materials to the environment;
- (2) The effectiveness of the package will not be substantially reduced; for example, impact resistance, strength, packaging compatibility, etc. must be maintained for the minimum and maximum temperatures encountered during transportation;
- (3) There will be no mixture of gases or vapors in the package which could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging.

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in:	☒ Drawing	☒ Operating Instruction
	☒ Specification	☐ Manufacturer Supplied Data
	☐ Analysis Report	☒ Similarity or Documented Record

Specify: Containment is provided by the use of an inner lid assembly (for bagless transfer function at the WRAP facility), and an outer lid which seals the drum.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

173.24 (c) Authorized Packagings.

A packaging is authorized for a hazardous material only if--

- (1) The packaging is prescribed or permitted for the hazardous material in a packaging section specified for that material in Column 8 of the section 172.101 Table and conforms to applicable requirements in the special provisions of Column 7 of the section 172.101 Table and, for specification packagings (including U.N. standard packagings), the specification requirements in parts 178 and 179 of this subchapter; or
- (2) The packaging is permitted under, and conforms to, provisions contained in sections 171.11, 171.12, 171.12a, 173.3, 173.4, 173.5, 173.7, 173.27 or 176.11 of this subchapter.

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☐ Drawing ☐ Operating Instruction
☒ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☒ Similarity or Documented Record

Specify: (1) A UN standard drum is the base component of the one-trip drum. The UN specification portion of the packaging will be fabricated to meet the parts listed. The entire package will be tested to conform with DOT 7A requirements. (2) Not Applicable.

173.24 (d) DOT Specification and U.N. Standard Packagings.

DOT specification and U.N. standard packagings. For DOT specification packagings (including U.N. standard packagings), conformance to the applicable specifications in parts 178 and 179 of this subchapter is required in all details. For performance-oriented packagings covered by subpart L of part 178 of this subchapter, each packaging must be capable of meeting the performance test requirements specified in subpart M of part 178 of this subchapter for the applicable packing group shown in Column 5 of the section 172.101 Table.

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☐ Drawing ☐ Operating Instruction
☒ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: A UN standard drum is the base component of the one-trip drum. The UN specification portion of the packaging will be fabricated to meet the parts listed. The entire package will be tested to conform with DOT 7A requirements.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

173.24 (e) Compatibility.

- (1) Even though certain packagings are specified in this part, it is, nevertheless, the responsibility of the person offering a hazardous material for transportation to ensure that such packagings are compatible with their lading. This particularly applies to corrosivity, permeability, softening, premature aging and embrittlement.
(2) Packaging materials and contents must be such that there will be no significant chemical or galvanic reaction between the materials and contents of the package.

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☒ Drawing ☒ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☒ Similarity or Documented Record

Specify: The operating instruction for the one-trip drum contains information describing the steps taken to separate incompatible items. The adhesive that is part of the waste package has excellent resistance to all materials that will be loaded into the drum. The exterior of the one-trip drum is a standard UN-1A2 galvanized drum and has been designed for the types of loadings that are intended.

(3) Plastic packagings and receptacles.

- (i) Plastic used in packagings and receptacles must be of a type compatible with the lading and may not be permeable to an extent that a hazardous condition is likely to occur during transportation, handling or refilling.
(ii) Each plastic packaging or receptacle which is used for liquid hazardous materials must be capable of withstanding without failure the procedure specified in appendix B of this part ("Procedure for Testing Chemical Compatibility and Rate Permeation in Plastic Packagings and Receptacles")...

This requirement: ☒ Does not apply. ☐ Applies; indicate the following.

Addressed in: ☐ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: The one-trip drum does not consist of plastic components.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

173.24 (e) Compatibility. (Continued)

- ... (4) Mixed contents. Hazardous materials may not be packed or mixed together in the same outer packaging with other hazardous or nonhazardous materials if such materials are capable of reacting dangerously with each other and causing--
(i) Combustion or dangerous evolution of heat;
(ii) Evolution of flammable or poisonous gases; or
(iii) Formation of unstable or corrosive materials.
(5) Packagings used for solids, which may become liquid at temperatures likely to be encountered during transportation, must be capable of containing the hazardous material in the liquid state.

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☐ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: (4) All materials loaded into the drum will be stable (non-reactive), eliminating concerns for incompatibility. (5) No liquids will be present in the one-trip drum within the designed temperature limits of -40°C to 70°C.

173.24 (f) Closures.

- (1) Closures on packagings shall be so designed and closed that under conditions (including the effects of temperature and vibration) normally incident to transportation--
(i) Except as provided in paragraph (g) of this section, there is no identifiable release of hazardous materials to the environment from the opening to which the closure is applied; and
(ii) The closure is secure and leakproof.
(2) Except as otherwise provided in this subchapter, a closure (including gaskets or other closure components, if any) used on a specification packaging must conform to all applicable requirements of the specification.

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☒ Drawing ☒ Operating Instruction
☒ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☒ Similarity or Documented Record

Specify: (1) The one-trip drum drawing and specification HS-V-P-0010 Rev C depict and describe the fabrication of the closure device and seal for the outer lid of the drum. Containment is also provided by the inner lid. The inner lid is fitted with a NucFil filter. The inner seal is compressed when swaged into place against the inner ring. The operating instruction contains the description of how the closure occurs. (2) The closure components for the one-trip drum conforms to the requirements for the specification for UN-1A2 packaging and Specification 7A Type A packaging.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST173.24 (g) Venting.

Venting of packagings, to reduce internal pressure which may develop by the evolution of gas from the contents, is permitted only when--

- (1) Transportation by aircraft is not involved;
- (2) Except as otherwise provided in this subchapter, the evolved gases are not poisonous, likely to create a flammable mixture with air or be an asphyxiant under normal conditions of transportation;
- (3) The packaging is designed so as to preclude an unintentional release of hazardous materials from the receptacle; and
- (4) For shipments in bulk packagings, venting is authorized for the specific hazardous material by a special provision in the section 172.101 Table or by the applicable bulk packaging specification in part 178 of this subchapter.

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☒ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☒ Similarity or Documented Record

Specify: The one-trip drum meets criteria 1 through 4. The drum is not intended for air transport. The evolved gases will not be poisonous, create a flammable mixture, or be an asphyxiant. The package is designed to preclude the unintentional release of materials. The containment of the package meets the packaging specification for Type A packages and is authorized to be vented.

173.24 (h) Outage and Filling Limits.

- (1) General. When filling packagings and receptacles for liquids, sufficient ullage (outage) must be left to ensure that neither leakage nor permanent distortion of the packaging or receptacle will occur as a result of an expansion of the liquid caused by temperatures likely to be encountered during transportation. Requirements for outage and filling limits for non-bulk and bulk packagings are specified in sections 173.24a(d) and 173.24b(a), respectively.
- (2) Compressed gases and cryogenic liquids. Filling limits for compressed gases and cryogenic liquids are specified in sections 173.301 through 173.306 for cylinders and sections 173.314 through 173.319 for bulk packagings.

This requirement: ☒ Does not apply. ☐ Applies; indicate the following.

Addressed in: ☐ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: The one-trip drum will not be loaded with liquids or compressed gases.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

173.24 (i) Air Transportation.

Packages offered or intended for transportation by aircraft must conform to the general requirements for transportation by aircraft in section 173.27 except as provided in section 171.11 of this subchapter.

This requirement: ☒ Does not apply. ☐ Applies; indicate the following.

Addressed in: ☐ Drawing ☐ Operating Instruction
 ☐ Specification ☐ Manufacturer Supplied Data
 ☐ Analysis Report ☐ Similarity or Documented Record

Specify: The one-trip drum will not be transported by air.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

3.0 49 CFR 173.24a Additional general requirements for non-bulk packagings and packages.

173.24a (a) Packaging Design.

Except as provided in section 172.312 of this subchapter:

- (1) Inner packaging closures. A combination packaging containing liquid hazardous materials must be packed so that closures on inner packagings are upright.
- (2) Friction. The nature and thickness of the outer packaging must be such that friction during transportation is not likely to generate an amount of heat sufficient to alter dangerously the chemical stability of the contents.
- (3) Securing and cushioning. Inner packagings of combination packagings must be so packed, secured and cushioned to prevent their breakage or leakage and to control their movement within the outer packaging under conditions normally incident to transportation. Cushioning material must not be capable of reacting dangerously with the contents of the inner packagings.
- (4) Metallic devices. Nails, staples and other metallic devices shall not protrude into the interior of the outer packaging in such a manner as to be likely to damage inner packagings or receptacles.

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in:	☐ Drawing	☒ Operating Instruction
	☐ Specification	☐ Manufacturer Supplied Data
	☐ Analysis Report	☒ Similarity or Documented Record

Specify: (1) Liquids will not be loaded into the one-trip drums. (2) The nature and thickness of the galvanized steel outer packaging will not generate enough heat due to friction to affect the contents in any way. (3) The operating instruction describes how dunnage and cushioning will be applied to any large or sharp objects to preclude breakage or leakage of the package. Materials used for dunnage will be similar to the waste stream or will be items from the waste stream itself. (4) No metallic devices will protrude through the outer packaging.

173.24a (a) Packaging Design. (Continued)

- (5) Vibration. Each non-bulk package must be capable of withstanding, without rupture or leakage, the vibration test procedure specified in section 178.608 of this subchapter.

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in:	☒ Drawing	☒ Operating Instruction
	☐ Specification	☐ Manufacturer Supplied Data
	☐ Analysis Report	☒ Similarity or Documented Record

Specify: The drawing and the operating instruction depict the drum closure mechanism and procedure. The closure is the same as that for UN-1A2 specification packagings and is designed to withstand vibration incident to transportation. The drum's inner lid is attached with sufficient metal engagement that vibration will not cause detachment. The outer and inner lid vents are also installed with such vibrations in mind and use similar installations as previous packagings.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST173.24a (b) Non-bulk Packaging Filling Limits.

- (1) A single or composite non-bulk packaging may be filled with a liquid hazardous material only when the specific gravity of the material does not exceed that marked on the packaging, or a specific gravity of 1.2 if not marked...
- ... (2) Except as otherwise provided in this section, a single or composite non-bulk packaging may not be filled with a solid hazardous material to a gross mass greater than the maximum gross mass marked on the packaging.
- (3) A single or composite non-bulk packaging which is tested or marked for liquid hazardous materials may be filled with a solid hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked...
- ... (5) No hazardous material may remain on the outside of a package after filling.
- NOTE: Type A limits are identified in 49 CFR 173.443.

This requirement: ☒ Does not apply. ☐ Applies; indicate the following.

Addressed in: ☐ Drawing ☒ Operating Instruction
 ☐ Specification ☐ Manufacturer Supplied Data
 ☐ Analysis Report ☐ Similarity or Documented Record

Specify: This is not applicable as this is a bulk packaging (max. wt. exceeds 882 lbs). (1)(3)(4) The one-trip drum will not be filled with any liquids, hazardous or otherwise. (2) The operating instruction provides the maximum mass that may be loaded into the one-trip drum (1000 lbs). The maximum mass will be marked on the package. (5) The one-trip drum is surveyed after loading and closure to ensure that no radioactive materials are present on the outside of the container.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST173.24a (c) Mixed Contents.

- (1) An outer non-bulk packaging may contain more than one hazardous material only when--
(i) The inner and outer packagings used for each hazardous material conform to the relevant packaging sections of this part applicable to that hazardous material;
(ii) The package as prepared for shipment meets the performance tests prescribed in part 178 of this subchapter for the packing group indicating the highest order of hazard for the hazardous materials contained in the package.
(iii) Corrosive materials (except ORM-D) in bottles are further packed in securely closed inner receptacles before packing in outer packagings; and
(iv) For transportation by aircraft, the total net quantity does not exceed the lowest permitted maximum net quantity per package as shown in Column 9a or 9b, as appropriate, of the section 172.101 Table. The permitted maximum net quantity must be calculated in kilograms if a package contains both a liquid and a solid.
- (2) A packaging containing inner packagings of Division 6.2 materials may not contain other hazardous materials, except dry ice.

This requirement: ☒ Does not apply. ☐ Applies; indicate the following.

Addressed in:	☐ Drawing	☒ Operating Instruction
	☐ Specification	☐ Manufacturer Supplied Data
	☐ Analysis Report	☐ Similarity or Documented Record

Specify: This is not applicable as this is a bulk packaging (exceeds 882 lbs maximum weight). The operating instruction for the one-trip drum indicates that reactive hazardous components will be separated, characterized, stabilized, and immobilized before loading into the drum. The waste package will not be transported by aircraft.

173.24a (d) Liquid Fill Level.

Liquids must not completely fill a receptacle at a temperature of 55 °C (131 °F) or less.

This requirement: ☒ Does not apply. ☐ Applies; indicate the following.

Addressed in:	☐ Drawing	☐ Operating Instruction
	☐ Specification	☐ Manufacturer Supplied Data
	☐ Analysis Report	☐ Similarity or Documented Record

Specify: Liquids will not be loaded into the one-trip drum.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST173.24a (c) Mixed Contents.

- (1) An outer non-bulk packaging may contain more than one hazardous material only when--
(i) The inner and outer packagings used for each hazardous material conform to the relevant packaging sections of this part applicable to that hazardous material;
(ii) The package as prepared for shipment meets the performance tests prescribed in part 178 of this subchapter for the packing group indicating the highest order of hazard for the hazardous materials contained in the package;
(iii) Corrosive materials (except ORM-D) in bottles are further packed in securely closed inner receptacles before packing in outer packagings; and
(iv) For transportation by aircraft, the total net quantity does not exceed the lowest permitted maximum net quantity per package as shown in Column 9a or 9b, as appropriate, of the section 172.101 Table. The permitted maximum net quantity must be calculated in kilograms if a package contains both a liquid and a solid.
- (2) A packaging containing inner packagings of Division 6.2 materials may not contain other hazardous materials, except dry ice.

This requirement: ☒ Does not apply. ☐ Applies; indicate the following.

Addressed in: ☐ Drawing ☒ Operating Instruction
 ☐ Specification ☐ Manufacturer Supplied Data
 ☐ Analysis Report ☐ Similarity or Documented Record

Specify: This is not applicable as this is a bulk packaging (exceeds 882 lbs maximum weight). The operating instruction for the one-trip drum indicates that reactive hazardous components will be separated, characterized, stabilized, and immobilized before loading into the drum. The waste package will not be transported by aircraft.

173.24a (d) Liquid Fill Level.

Liquids must not completely fill a receptacle at a temperature of 55 °C (131 °F) or less.

This requirement: ☒ Does not apply. ☐ Applies; indicate the following.

Addressed in: ☐ Drawing ☐ Operating Instruction
 ☐ Specification ☐ Manufacturer Supplied Data
 ☐ Analysis Report ☐ Similarity or Documented Record

Specify: Liquids will not be loaded into the one-trip drum.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

4.0 49 CFR 173.24b Additional general requirements for bulk packagings.

173.24b (a) Outage and Filling Limits.

(1) Liquids and liquified gases must be so loaded that the outage is at least one percent of the total capacity of a cargo or portable tank, or compartment thereof, or at least one percent of the total capacity of the tank and dome for tank car and multi-unit tank car tanks at the reference temperature of 46 °C (115 °F) for uninsulated tanks and 41 °C (105 °F) for insulated tanks.

(2) Hazardous materials may not be loaded into the dome of a tank car. If the dome of a tank car does not provide sufficient outage, vacant space must be left in the shell to provide the required outage.

(3) Bulk packagings for materials poisonous by inhalation. For a material which meets the definition of poisonous by inhalation (see section 171.8 of this subchapter), the outage in a bulk packaging must be at least five percent of the total capacity of the tank or compartment at the reference temperature of 46 °C (115 °F) for uninsulated tanks and 41 °F (105 °F) for insulated tanks.

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☐ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: This is a bulk packaging; however, no materials will be filled into a tank car, nor does it contain any poisonous materials. (1) (2) and (3) are all not applicable.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST173.24b (b) Stainless Steel Substitution.

Equivalent steel. For the purposes of this section, stainless steel is steel with a guaranteed minimum tensile strength of 51.7 deka newtons per square millimeter (75,000 psi) and a guaranteed elongation of 40 percent or greater. Where the regulations permit steel other than stainless steel to be used in place of a specified stainless steel (for example, as in section 172.102 of this subchapter, special provision B30), the minimum thickness for the steel must be obtained from one of the following formulas, as appropriate:

Formula for metric units:

$$e_1 = (12.74e_0) / (Rm_1A_1)^{1/3}$$

Formula for non-metric units:

$$e_1 = (144.2e_0) / (Rm_1A_1)^{1/3}$$

Where:

e_0 = Required thickness of the reference stainless steel in millimeters or inches respectively;

e_1 = Equivalent thickness of the steel used in millimeters or inches respectively;

Rm_1 = Specified minimum tensile strength of the steel used in deka newtons per square millimeter or pounds per square inch respectively; and

A_1 = Specified minimum percentage elongation of the steel used multiplied by 100 (for example, 20 percent times 100 equals 20). Elongation values used must be determined from a 50 mm or 2 inch test specimen.

This requirement: ☒ Does not apply. ☐ Applies; indicate the following.

Addressed in: ☐ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: No substitutions are made. Stainless steel is not specified as part of this package except for the vents. The NucFil HEPA filters are specified as stainless steel. Structural portions of the waste package will not be replaced with any other metal then that specified. The NucFil HEPA filter material, if changed, would not be subject to this section.

173.24b (c) Pressurized Loading:

Air pressure in excess of ambient atmospheric pressure may not be used to load or unload any lading which may create an air-enriched mixture within the flammability range of the lading in the vapor space of the tank.

This requirement: ☒ Does not apply. ☐ Applies; indicate the following.

Addressed in: ☐ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: Air pressure is not used in the loading and unloading process.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

5.0 49 CFR 173.411 General design requirements.

173.411 (a) Handling and Securing.

Except for a package that contains a limited quantity or excepted instrument or article under sections 173.421 through 173.424, each package used for shipment of radioactive materials shall be designed so that:

- (a) The package can be easily handled and properly secured in or on a conveyance during transport;

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in:	☐ Drawing	☒ Operating Instruction
	☐ Specification	☐ Manufacturer Supplied Data
	☐ Analysis Report	☐ Similarity or Documented Record

Specify: The operating instruction explains that the one-trip drum will be handled according to standard drum handling practices for 55 gallon drums.

173.411 (b) Manual Handling.

A package with a gross weight exceeding 10 kilograms (22 pounds) and up to 50 kilograms (110 pounds) has a means for manual handling;

This requirement: ☐ Does not apply. ☐ Applies; indicate the following.

Addressed in:	☒ Drawing	☐ Operating Instruction
	☐ Specification	☐ Manufacturer Supplied Data
	☐ Analysis Report	☒ Similarity or Documented Record

Specify: The one trip drum can be handled manually the same way any other standard 55 gallon drum can be.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

173.411 (c) Mechanical Handling.

A package with a gross weight of 50 kilograms (110 pounds) or more can be safely handled by mechanical means;

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☒ Drawing ☒ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: The one trip drum can be handled mechanically the same way any other standard 55 gallon drum can be. The one trip drum will be handled exclusively in this manner inside the WRAP 1 plant, including preparation for transport.

173.411 (d) Lifting Attachments.

Each lifting attachment on the package, when used in the intended manner, with a minimum safety factor of three, does not impose an unsafe stress on the structure of the package. In addition, the lifting attachment shall be so designed that failure under excessive load would not impair the ability of the package to meet all other requirements of this subpart. Each attachment or other feature on the outer surface of the packaging that could be used to lift the package must be removable or otherwise capable of being made inoperable for transport, or shall be designed with strength equivalent to that required for lifting attachments;

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☐ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☒ Similarity or Documented Record

Specify: This issue is addressed by the use of a standard 55 gallon drum as the base component of the one-trip drum design. No additional lifting attachments will be added to the package at the time of transport. The lifting features of the drum being used have a previous history in meeting these requirements (i.e., rolling hoops, false wire.)

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

173.411 (e) External Surface Decontamination.

The external surface, as far as practicable, may be easily decontaminated;

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☒ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☒ Similarity or Documented Record

Specify: The galvanized surface of the one-trip drum meets the specification for Type A packagings. This type of drum has a previous history of the surface being easily decontaminated.

173.411 (f) Outer Layer - Pockets, Crevices (Water Collection).

The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect; and

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☒ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☒ Similarity or Documented Record

Specify: The outer layer of the one-trip drum meets the specification for the UN-1A2 standard packaging. The historic use of this drum demonstrates its ability to withstand water collection.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

173.411 (g) Features Added at Time of Transport.

Each feature that is added to the package at the time of transport, and that is not a part of the package, will not reduce the safety of the package.

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in:	☐ Drawing	☒ Operating Instruction
	☐ Specification	☐ Manufacturer Supplied Data
	☐ Analysis Report	☐ Similarity or Documented Record

Specify: No additional feature will be added to the package at the time of transport.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

6.0 49 CFR 173.412 Additional design requirements for Type A packages.

173.412 Smallest External Dimension.

In addition to meeting the general design requirements prescribed in section 173.411, each Type A packaging shall be designed so that:

- (a) The smallest overall external dimension of the package is not less than 10 centimeters (4 inches);

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☒ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: The drawing specifies clearly that this criteria has been met.

173.412 (b) Tamper Indication.

The outside of the packaging incorporates a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in exclusive use closed transport vehicles, the cargo compartment may be sealed instead of the individual packages;

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☐ Drawing ☒ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: Tamper indication will be provided by wiring and tagging the clamp bolt upon final closure of the waste drum.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST173.412 (c) External Surface Protrusions, Decontamination.

As far as practicable, the external surfaces are free from protrusions and are designed and finished so that they can be easily decontaminated;

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in:	☒ Drawing	☐ Operating Instruction
	☐ Specification	☐ Manufacturer Supplied Data
	☐ Analysis Report	☒ Similarity or Documented Record

Specify: This criteria has been met by similarity with standard 55 gallon drum designs.

173.412 (d) Containment and Shielding.

Containment and shielding would be maintained during transportation and storage in a temperature range of -40 °C (-40 °F) to 70 °C (158 °F) with account being taken of the possibility of brittle fracture;

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in:	☒ Drawing	☐ Operating Instruction
	☒ Specification	☒ Manufacturer Supplied Data
	☐ Analysis Report	☐ Similarity or Documented Record

Specify: Containment is provided by the use of an inner lid assembly (for bagless transfer function at the WRAP facility), and an outer lid which seals the drum. The one-trip drum drawing and the specification used to purchase the 55 gallon drums (HS-V-P-0010 Rev C) specifies materials that provide effective containment over this temperature range. The inner seal is effective over this range also. The glue used for attachment of the inner ring to the one-trip drum is effective over a range from -84°C to 99°C. During transport, the thermal heat generation of the contents will not degrade the packaging.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

173.412 (e) Acceleration, Vibration.

It is able to withstand the effects of any acceleration, vibration, or vibration resonance that may arise during normal transportation, without any deterioration of the effectiveness of closing devices or of the integrity of the package as a whole and without loosening or unintentional release of nuts, bolts, or other securing devices even after repeated use;

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☒ Drawing ☒ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☒ Similarity or Documented Record

Specify: The final closure of the one-trip drum is identical to the closure of any standard 55 gallon drum. The proper closure of the drum precludes loosening of nuts, bolts, or other securing devices. The HEPA filters are locked into place by Loctite, mounting bung, or by a locking nut. The inner lid is swaged into place with sufficient metal engagement to preclude it from disengaging due to vibration.

173.412 (f) Secure Containment System.

It includes a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form, as demonstrated in accordance with section 173.469 may be considered as a component of the containment system;

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☒ Drawing ☐ Operating Instruction
☒ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☒ Similarity or Documented Record

Specify: Containment is provided by the use of an inner lid assembly (for bagless transfer function at the WRAP facility), and an outer lid which seals the drum. The one-trip drum drawing and specification HS-V-P-0010 Rev C depict and describe the fabrication of the closure device and seal for the outer lid of the drum. The inner lid is fitted with a Nucfil filter. The inner seal is compressed when swaged into place against the inner ring. The operating instruction contains the description of how the closure occurs. The closure components for the one-trip drum conforms to the requirements for the specification for UN-1A2 packaging and Specification 7A Type A packaging. The external drum closure is identical to standard 55 gallon drum and standard bandclamp.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

173.412 (g) Physical/Chemical Compatibility, Irradiation.

The materials of the packaging and any components or structures are physically and chemically compatible with each other and with the contents, taking into account the behavior of each under irradiation;

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☒ Drawing ☒ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: The components of the package have all been verified to be compatible with each other (i.e. steel, seals, glue). The waste loaded into the one-trip drum will be processed to assure that the containment of the waste container is not compromised by the addition of any item (i.e. corrosives eliminated, liquids eliminated, and fines stabilized).

173.412 (h) Radiolytic Decomposition, Chemical Reaction, Radiolysis.

For each component of the containment system account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis;

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☒ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: Containment is provided by the use of an inner lid assembly (for bagless transfer function at the WRAP facility), and an outer lid which seals the drum. This container has been designed for the intended loading and therefore any degradation by radiolytic action will not compromise the containment of the package.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

173.412 (i) Reduction of Ambient Pressure.

The containment system will retain its radioactive contents under the reduction of ambient pressure to .25 kilograms per square centimeter (3.5 pounds per square inch);

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in: ☒ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: The HEPA filters installed into both lids of the one-trip drum will allow the drum to "breathe" during fluctuations in ambient pressure and therefore will equalize. The radioactive contents remain contained.

173.412 (j) Valve - Protection, Enclosure.

Each valve through which the radioactive contents could otherwise escape is protected against damage and unauthorized operation and, except for a pressure relief device, has an enclosure to retain any leakage;

This requirement: ☒ Does not apply. ☐ Applies; indicate the following.

Addressed in: ☐ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: The one-trip drum does not contain any valves.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

173.412 (k) Shielding (Enclosure).

Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield;

This requirement: ☒ Does not apply. ☐ Applies; indicate the following.

Addressed in: ☐ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: The one-trip drum does not consist of any shielding.

173.412 (l) Tiedown (Failure).

Failure of any tiedown attachment on the packaging under excessive load will not impair the ability of the package to meet other requirements of this subpart;

This requirement: ☒ Does not apply. ☐ Applies; indicate the following.

Addressed in: ☐ Drawing ☐ Operating Instruction
☐ Specification ☐ Manufacturer Supplied Data
☐ Analysis Report ☐ Similarity or Documented Record

Specify: The one-trip drum does not consist of any tiedown attachments.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

173.412 (m) Evaluation and Testing.

When subjected to the tests specified in section 173.465 or evaluated against these tests by any of the methods authorized by section 173.461(a), the packaging will prevent:

- (1) Loss or dispersal of the radioactive contents; and
- (2) Any significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test;

This requirement will be addressed by the test facility.

173.412 (n) Evaluation and Testing of Liquid Packagings.

Each packaging designed for liquids will:

- (1) Meet the conditions prescribed in paragraph (m) of this section when subjected to the tests specified in section 173.466 or evaluated against these tests by any of the methods authorized by section 173.461(a);
- (2) For any package with a liquid volume not exceeding 50 cubic centimeters (1.7 fluid ounces), have sufficient suitable absorbent material to absorb twice the volume of the liquid contents. The absorbent material shall be compatible with the package contents and suitably positioned to contact the liquid in the event of leakage; and
- (3) For any package with a liquid volume exceeding 50 cubic centimeters (1.7 fluid ounces), either:
 - (i) Have sufficient absorbent material as prescribed in paragraph (n)(2) of this section; or
 - (ii) Have a containment system composed of primary inner and secondary outer containment components designed to assure retention of the liquid contents within the secondary outer components in the event that the primary inner components leak; and

This requirement will be addressed by the test facility.

173.412 (o) Evaluation and Testing of Gas Packagings.

Each package designed for compressed or uncompressed gases other than tritium or argon-37 not exceeding 200 curies will be able to prevent loss of contents when the package is subjected to the tests prescribed in section 173.466 or evaluated against these tests by any of the methods authorized by section 173.461(a).

This requirement will be addressed by the test facility.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

7.0 49 CFR 178.3 Marking of Packagings

178.3 (a) What and How to Mark.

Each packaging manufactured to a DOT specification or a UN Standard shall be marked as follows:

- (1) In an unobstructed area, with letters, and numerals identifying the standards or specification (e.g., UN 1A1, DOT 4B240ET, etc.).
- (2) Unless otherwise specified in this part, with the name and address or symbol of the manufacturer, or, for a UN standard packaging, the approval agency certifying compliance with the UN standard. Symbols, if used, must be registered with the Associate Administrator for Hazardous Materials Safety. Duplicative symbols are not authorized.
- (3) The markings must be stamped, embossed, burned, printed or otherwise marked on the packaging to provide adequate accessibility, permanency, contrast, and legibility so as to be readily apparent and understood.
- (4) Unless otherwise specified, letters and numerals must be at least 12.0 mm (0.47 inches) in height except that for packagings of less than or equal to 30 L (7.9 gallons) capacity for liquids or 30 kg (66 pounds) capacity for solids the height must be at least 6.0 mm (0.2 inches).

This requirement: ☐ Does not apply. ☒ Applies; indicate the following.

Addressed in:	☒ Drawing	☒ Operating Instruction
	☒ Specification	☐ Manufacturer Supplied Data
	☐ Analysis Report	☐ Similarity or Documented Record

Specify: The one-trip drum will be marked with the appropriate markings according to this subpart.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

178.3 (b) Marking.

Packagings may be marked with the United Nations symbol and packaging identification code as provided in this subchapter, in the ICAO Technical Instructions or in Annex 1 to the IMDG Code, provided the person applying these marks has established that the packaging conforms to the applicable provisions of this subchapter, the ICAO Technical Instructions or Annex 1 to the IMDG Code, respectively.

(1) If an indication of the State in whose territory the specified tests are carried out, or of the State authorizing the allocation of the mark, is required by this part (see section 178.503 of this part), the letters "USA" shall be used if the manufacturing and testing occurs in the United States.

(2) If an indication of the name of the manufacturer or other identification of the packaging as specified by the competent authority is required, the name and address or symbol of the person making the mark shall be entered. Symbols, if used, must be registered with the Associate Administrator for hazardous Materials Safety. Duplicate symbols are not authorized.

(3) Packagings manufactured to UN standards in accordance with this subchapter shall be marked as prescribed in section 178.503 of this part.

This requirement: [] Does not apply. [X] Applies; indicate the following.

Addressed in:	[X] Drawing	[X] Operating Instruction
	[X] Specification	[] Manufacturer Supplied Data
	[] Analysis Report	[] Similarity or Documented Record

Specify: The one-trip drum will be marked with the appropriate markings according to this subpart.

178.3 (c) Multiple Markings.

Where a packaging conforms to more than one UN standard or DOT specification, the packaging may bear more than one marking, provided the packaging meets all the requirements of each standard or specification. Where more than one marking appears on a packaging, each marking must appear in its entirety.

This requirement: [] Does not apply. [X] Applies; indicate the following.

Addressed in:	[X] Drawing	[X] Operating Instruction
	[X] Specification	[] Manufacturer Supplied Data
	[] Analysis Report	[] Similarity or Documented Record

Specify: The one-trip drum will be marked with the appropriate markings according to this subpart.

DOT-7A TYPE A
PACKAGING QUALIFICATION CHECKLIST

8.0 Other Items

Enclose a copy of the following documents with this completed checklist and forward to the DOE/HQ-approved test facility. The name and address of the test facility are provided when a docket is opened as discussed in Section 5.0:

- Packaging drawing
- Packaging specification (if developed)
- Analysis report (N/A)
- Operating instruction.

Completion

Applicant:

David T. Ruff
Signature

5/16/94
Date

Name (print)/
Company/
Address

David T. Ruff

Westinghouse Hanford Company

P.O. Box 1979 (MSIN: G6-46)

Richland, Washington 99352

Phone:

(509) 372-0238

Test Facility Use Only

Document review:

Test engineer
(sign/date)

Reviewed by:
(sign/date)

Packaging drawing

Packaging specification

Analysis report

Operating instruction

Packaging Qualification Checklist

35 Station 21

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

601100

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) WRAP Mechanical Engineering W7FD60	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: W-026, WRAP-1	6. Cog. Engr.: D. T. Ruff	7. Purchase Order No.: N/A
8. Originator Remarks: APPROVAL/RELEASE		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: WRAP 1 Facility
11. Receiver Remarks:		12. Major Assm. Dwg. No.: H-2-132048 Rev 1
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: N/A

DATA TRANSMITTED						(F)	(G)	(H)	(I)		
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Impact Level	Reason for Transmittal	Originator Disposition	Receiver Disposition			
1	WHC-SD-W026-OCD-001		0	One-Trip Drum Operating Instruction	N/A	1					
16. KEY											
Impact Level (F)		Reason for Transmittal (G)			Disposition (H) & (I)						
1. 2, 3, or 4 (see MRP 5.43)		1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)			1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged						
SIGNATURE/DISTRIBUTION (See Impact Level for required signatures)											
(G)	(H)								(G)	(H)	
Reason	Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	Reason	Disp.
1	/	Cog. Eng. DT Ruff	[Signature]	9/28/94	G3-15	Central Files (Original)		L8-04		3	
1	/	Cog. Mgr. DE Ball	[Signature]	9/28/94	G6-46	WRAP/DMC(3)		G3-15		3	
1	/	QA JR McGee	[Signature]	9/9/94	G3-15	JH OBrien		G2-02		3	
		Safety									
		Env.									
1	/	BA Mayancsik	[Signature]	9-13-94	-92						
18.		19.			20.		21. DOE APPROVAL (if required)				
DT Ruff [Signature] 9/24/94 Signature of EDT Originator		Authorized Representative Date for Receiving Organization			DE Ball [Signature] 9/24/94 Cognizant/Project Engineer's Manager		Date ☐ Approved ☐ Approved w/comments ☒ Disapproved w/comments				

RELEASE AUTHORIZATION

Document Number: WHC-SD-W026-OCD-001, Revision 0

Document Title: One-Trip Drum Operating Instruction

Release Date: 9/29/94

* * * * *

This document was reviewed following the
procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

* * * * *

WHC Information Release Administration Specialist:

Christine Willingham

C. Willingham

(Signature)

9/29/94

(Date)

SUPPORTING DOCUMENT		1. Total Pages 8
2. Title One-Trip Drum Operating Instruction	3. Number WHC-SD-W026-0CD-001	4. Rev No. 0
5. Key Words WRAP, Drums, Heads, Lids, Bagless Transfer, Drop Test.	6. Author Name: D. T. Ruff <i>D. T. Ruff</i> 9/9/94 Signature Organization/Charge Code W7FD60/A451A	
7. Abstract The one trip system is a bagless transfer system for egress of waste from gloveboxes into 55 gallon one-trip drums. The contents of this document give an overview of the assembly, loading, and handling of the one-trip drum for use in the WRAP-1 plant.		
8. PURPOSE AND USE OF DOCUMENT - This document was prepared for use within the U.S. Department of Energy and its contractors. It is to be used only to perform, direct, or integrate work under U.S. Department of Energy contracts. This document is not approved for public release until reviewed. PATENT STATUS - This document is not to be transmitted in advance of patent clearance. It is made available in confidence solely for use in performance of work under contracts with the U.S. Department of Energy. This document is not to be published nor its contents otherwise disseminated or used for purposes other than specified above before patent approval for such release or has been secured, upon request, from the Patent Counsel, U.S. Department of Energy Field Office, Richland, WA. DISCLAIMER - This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.		10. RELEASE STAMP OFFICIAL RELEASE BY WHC DATE SEP 30 1994 35 Station 21
9. Impact Level N/A		

**APPROVED FOR
PUBLIC RELEASE**
WJ
9-29-94

WHC-SD-TP-RPT-023
Revision 0

Project W-026
Waste Receiving and Processing Facility Module 1
(WRAP 1)

One-Trip Drum Operating Instruction
Operating Criteria Document

WHC-SD-W026-OCD-001
Revision 0

D. T. Ruff
Westinghouse Hanford Company

TABLE OF CONTENTS

	<u>Page</u>
1.0 SCOPE.	1
2.0 GENERAL DESCRIPTION	1
3.0 REFERENCE DOCUMENTS	1
4.0 PACKAGE CONSTRUCTION	2
4.1 Components	2
4.2 Assembly	2
5.0 PACKAGE LOADING AND CLOSURE	3
6.0 PACKAGE HANDLING	5

ONE-TRIP DRUM OPERATING INSTRUCTION

1.0 SCOPE

The purpose of this operating instruction is to convey the necessary information for proper handling of the one-trip drum for WRAP-1.

2.0 GENERAL DESCRIPTION

The one-trip drum is a modified UN-1A2 galvanized 55 gallon drum. The modifications to the drum consist of the addition of: an inner lid, inner seal, inner ring (adhered to the inside of the drum), and inner gasket. The modifications to the drum provide it with the capability of mating to the British Nuclear Fuels Limited (BNFL) One-Trip bagless transfer system as modified by WHC testing (Reference 1 of Section 3.0). The bagless transfer system allows the loading of the one-trip drum with waste from a glovebox process line without contaminating the exterior of the waste package and while maintaining glovebox confinement.

The gross weight of the one-trip drum is not to exceed 1,000 pounds. If necessary, the contents of the waste package will be packed with sufficient dunnage as to prevent damage to the one-trip drum during transport. It has been designed for the following payloads:

- Material Form No. 1: Solids - Any particle size
- Material Form No. 2: Solids - Large particle size only (i.e., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids - Objects with no significant dispersible or removable contamination (see 49 CFR 173.443)

3.0 REFERENCE DOCUMENTS

The following documents contain information that will be referred to instead of repeated in this operating instruction:

1. Test Report, WHC-SD-W026-TRP-014 Rev 1, "One-Trip Bagless Transfer System Test Report."
2. Document, WHC-SD-W026-SDRD-001 Rev 3, "Supplemental Design Requirements Document, Revision 3, Project W026."
3. Drawing, Hanford Drawing H-2-824300, 55 Gallon One-Trip Drum Arrangement and Details.
4. Specification, HS-V-P-0010 Rev C, Hanford Drum Purchasing Spec.

4.0 PACKAGE CONSTRUCTION

The one-trip drum consists of the following listed components assembled in the following manner (see One-Trip Drum Drawing).

4.1 Components

- A. DOT UN-1A2 galvanized 55 gallon drum built to Hanford Standard HS-V-P-0010 Rev C.
 - 1. Drum Body
 - 2. Drum Head
 - 3. NucFil²-013 HEPA filter on head
 - 4. Clamp band and bolt
- B. Inner ring, low carbon steel, adhered to the inside of the 55 gallon drum with E-6000¹ adhesive.
- C. Inner seal, Neoprene/sbr foam, adhesive backed and adhered to top of inner ring.
- D. Inner lid, low carbon steel, fitted with NucFil²-013 filter and locking nut, compresses inner seal when swaged into place against the inner ring.
- E. Inner gasket, Buna-N rubber sheet, sandwiches inner lid against inner seal upon final closure of the drum.

4.2 Assembly

4.2.1 Inner Ring Installation

The inner ring is mechanically held inside of the drum body below the height of final adhesion. E-6000 adhesive is then liberally applied around the circumference of the drum body above the inner ring and at the proper height for final placement of the inner ring. The inner ring is then drawn up into place ($\approx 7/8$ " from the top of the drum false wire) over the applied adhesive. Once oriented to the proper height around its circumference, the inner ring is mechanically clamped into place to allow the adhesive to cure. This first application of adhesive is allowed to cure for 24 hours and provides sufficient adherent strength, but another application is necessary to provide an air tight seal between the inner ring and drum body. The second application occurs above and below the inner ring and is pressed into place. Any excess adhesive must be removed from the top surface of the inner ring for proper installation of the inner seal. The second application of adhesive is allowed to cure for 24 hours.

¹E-6000 is a trademark of Eclectic Products Incorporated, Carson, California.

²NucFil is a trademark of Nuclear Filter Technology Corporation, Lakewood, Colorado.

4.2.2 Inner Seal Installation

The adhesive back of the inner seal is removed while the inner seal is pressed into place on the top surface of the inner ring. The seal fits tightly against the inner surface of the drum body.

4.2.3 Inner Lid Installation

The inner lid must be fitted with a Nucfil-013 HEPA filter. A one inch diameter hole is punched into the center of the inner lid. A NucFil-013 filter is threaded through the hole and a locking nut is tightened onto the back side of the HEPA filter and torqued to 25 ($\pm$ 1) ft-lbs. This torque on the filter provides a tight seal by compressing the filter gasket between the filter and the lid. The inner lid is then placed into the drum and rests on the inner seal. The inner lid will be permanently mated to the inner ring by the BNFL One-Trip system.

4.2.4 Inner Gasket

The inner gasket is laid into place on top of the inner lid. The gasket should lay flat against the inner lid and inner seal. The outer lid is placed over the top of the inner gasket compressing the gasket against the inner lid.

4.2.5 Outer Lid Filter

A NucFil-013 filter is installed into the provided flange on the outer drum lid. The flange is located in the center annulus of the outer lid at least three inches from the center to avoid interference with the filter in the inner lid. The filter is torqued to 25 ($\pm$ 1) ft-lbs to provide a proper seal between the filter and the outer lid. No sealant or tape is added to enhance this seal.

5.0 PACKAGE LOADING AND CLOSURE

The one-trip drum is designed to operate with the British Nuclear Fuels Limited (BNFL) One-Trip bagless transfer system as modified by WHC test report WHC-SD-W026-TRP-014 Rev 1. The bagless transfer system provides the mechanism for opening and closing the one-trip drum while it is mated to the transuranic gloveboxes of the WRAP-1 plant. Inside of these gloveboxes, retrieved and newly generated solid transuranic waste has undergone limited treatment to meet the current waste acceptance criteria at the designated permanent disposal site(s). The one-trip drum will be loaded with the waste that meets these criteria and upon exit from the WRAP-1 glovebox line will be permanently closed for transport to final disposal.

The waste stream entering WRAP-1 will have the following cross section:

•	Metal	22 vol%
•	Lead	Trace
•	Dirt	4 vol%
•	Filters	1 vol%
•	Wood	1 vol%
•	Concrete	2 vol%

• Glass	2 vol%
• Absorbent	1 vol%
• Rubber	8 vol%
• Plastic	27 vol%
• Paper	20 vol%
• Cloth	6 vol%

The waste stream exiting WRAP-1 (loaded into one-trip drums) will have the same cross section, minus hazardous constituents, mixed waste, and liquids. The limited treatment of the waste in WRAP-1 includes the following (see WRAP-1 SDRD Section 2.4):

- Removal of containerized liquids
- Removal of particulate waste
- Removal of suspect mixed waste
- Removal of HEPA filters
- Removal of closed containers larger than one gallon in size
- Removal of aerosol cans
- Sample all of the above items for characterization
- Treat all of the above items to meet acceptance criteria
 - Depressurize and drain aerosol cans
 - Neutralize corrosive materials
 - Absorb and solidify liquids
 - Immobilize particulates

The glovebox operating procedures will require the operators to repack the waste in such a manner that protects the one-trip drum from damage by large hard objects. In most instances it is predicted that enough soft waste will be available to provide the necessary dunnage for packing these objects. In the case that soft waste was not available, dunnage will be added.

The waste will be dumped from a sorting table within the glovebox onto a chute that directs the waste into the center of the one-trip drum while protecting the inner ring assembly. Heavy objects will be lowered into the one-trip drums by a hoist to preclude damage of the drum during loading.

Once the treated waste has been loaded into the one-trip drum from the glovebox, the BNFL One-Trip bagless transfer system is closed. The One-Trip system port door closes the drum by pressing the inner lid against the inner seal. The inner seal is compressed sufficiently to position bottom of the inner lid below the flange of the inner ring (approx. 1/8" seal compression). The swaging heads of the port door are then actuated with 5,000 psi of hydraulic pressure to swage the inner lid into the inner ring in four locations. The consistency of the swage depths is controlled by tight tolerances on the swaging head locations and the inner lid and inner ring dimensions (see WHC-SD-W026-TRP-014 Rev 1 Page C-3 and Appendix D) in conjunction with limit switches on each swaging head that verify that end of stroke was attained. The swages are approximately 1/8" by 3/8" by 3/16" deep. This operation permanently compresses the inner seal and confines the waste inside of the one-trip drum.

The drum is then separated from the glovebox. The inner gasket is then laid into place over the inner lid. The gasket should lay flat with a minimum gap between the edge of the gasket and the inside of the drum wall. The outer lid (standard UN-1A2 drum lid) and clamp band are placed on the drum. The clamp band is placed over the outer lid and the drum false wire. The clamp bolt is then threaded through the clamp band. The clamp band is lightly impacted around its circumference while the clamp bolt is tightened. This process is repeated until the clamp band will no longer move when impacted and tightened. Then a torque wrench is used to tighten the clamp bolt to a torque of 40 (± 1) ft-lbs. The jam nut on the clamp bolt is then tightened against the threaded portion of the clamp band to 40 (± 1) ft-lbs. If different from the above process, the particular drum manufacturer's recommended closing procedure should supersede. The waste drum will be surveyed for contamination and decontaminated if necessary. A wire and tag will be wrapped through the clamp bolt for tamper indication.

6.0 PACKAGE HANDLING

The WRAP-1 plant is an automated waste processing plant for characterization, limited treatment, and transport to final disposal for LLW and TRU solid waste. Handling of waste packages inside of the plant will be exclusively mechanical.

After the one-trip drum is removed from the glovebox and before shipment out of the WRAP-1 plant, it is weighed. If its weight exceeds the 1,000 pound limit for the package it will not be shipped. The package weight will have to be reduced by further processing.

The one-trip drum, once loaded, is carried by automatic guided vehicles (AGV) to the TRUPAC II loading station. There the drum is mechanically loaded into a seven-pack configuration and shrink wrapped. Two seven-packs of one-trip drums are then mechanically stacked and loaded into the TRUPAC II container. The TRUPAC II container is closed and transported to the disposal site.

9554842

ATTACHMENT 3

Los Alamos draft test report, TR-94-06,
"WRAP-1 Testing and Evaluation"

Consisting of 58 pages,
including coversheet

Los Alamos ENGINEERING SCIENCES & APPLICATIONS LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545	Prepared By: A. Guthrie <i>[Signature]</i>	Document: TR-94-06	
	Reviewed By:	Page 1 of 7	Revision 0

WRAP-1 Testing and Evaluation

Contents

Section	Title	Page
1.	General	1
2.	Packaging Description.....	1
3.	Evaluation Process.....	2
	Appendix 1 - Test Reports (Evaluation to 49 CFR testing requirements).....	3
	Appendix 2 - Testing Procedures.....	4
	Appendix 3 - Design Reports (Evaluation to 49 CFR design requirements)..	5
	Appendix 4 - Listing of Regulatory Requirements.....	6
	Appendix 5 - WHC Drawing of WRAP-1.....	7

1. General

This report evaluates the compliance of the WRAP-1 55 Gallon Waste Drum (Bagless Transfer System) with the DOT-7A Type A packaging requirements.

This evaluation consists of testing and review of the physical packaging and documentation against the regulatory requirements.

The evaluation and testing took place at LANL and WHC in August 1994.

All work was performed in accordance with the LANL ESA Packaging Engineering Manual, 1993 February 17.

The packaging was found to be in full compliance with all applicable regulatory requirements and fully meets the DOT-7A Type A specification.

2. Packaging Description

The packaging assembly is defined in WHC Operating Instruction: WHC-SD-W026-OCD-001, Rev 0 and the associated referenced documents. This packaging consists of an open-head, galvanized, steel drum (UN 1A2) with a second interior lid staked to a ring which is glued to the interior of the drum. This packaging requires special equipment and procedures, located at WHC, to close the package.

Los Alamos	WRAP-1 Testing and Evaluation	Document # TR 94-06	
Engineering Sciences & Applications Los Alamos National Laboratory Los Alamos, New Mexico		Page 2 of 7	Rev 0

3. Evaluation Process

The packaging testing was started in July 1994 with the loading and closure of 5 WRAP-1 drums at WHC. These drums were then shipped to Los Alamos for testing. Testing was conducted on 3 of the drums during August 3rd and 4th. Upon opening the drums it was discovered that the dummy load of sand and lead bricks was slightly damp (a result of damp material being used originally and not the result of water in leakage from the water spray test) and so a valid indication of drum performance (for Form 1 material) was not obtained. At Los Alamos, the 4th drum was opened, inspected, a moisture barrier placed on top of the dummy load and the Flour/Fluorescein indicator replaced. The package was then resealed manually and tested. This package failed the test showing release of the Flour/Fluorescein indicator under black light. Design modifications were made (principally the relocation of the inside ring and the addition of a neoprene gasket between the inner and outer lids) and the modified packagings loaded and retested at WHC on August 30th. Three prototypes of this modified design satisfactorily passed the drop tests. The other required tests (compression, vibration, penetration) were also completed satisfactorily. The Test Reports and procedures are provided in Appendices 1 and 2. The evaluation of the design is provided in Appendix 3. The regulatory requirements upon which this evaluation is based are provided in Appendix 4.

Los Alamos Engineering Sciences & Applications Los Alamos National Laboratory Los Alamos, New Mexico	WRAP-1 Testing and Evaluation	Document # TR 94-06	Page 3 of 7	Rev 0
--	--------------------------------------	-------------------------------	-----------------------	-----------------

Appendix 1 - Test Reports (Evaluation to 49 CFR testing requirements)

Title	Document #	Rev	# pages
Compression Test Report	TR/CT 94-06	0	2
Drop Test Report	TR/DT 94-06	0	13
Vibration Test Report	TR/VT 94-06	0	1
Penetration Test Report	TR/PT 94-06	0	2

WHC-SD-TP-RPT-023
Revision 0

Los Alamos ENGINEERING SCIENCES & APPLICATIONS LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545	Title: COMPRESSION TEST REPORT		DOCUMENT NUMBER: TR/CT-	
			PAGE 1 OF 1	REVISION: 0

Tested In accordance with: ☒ TI-02, Rev. 0 ☐ Other _____ Force/Duration 5200 #
 PI-____, Rev.____ Design I.D. WRAP-1 (440563) Packaging Group A
 Tested Contents sand, lead bricks & flow/flow/flow/flow/flow
 Equipment Used for Testing (Calibration Date):
☐ Water Spray Chamber ☐ Thermotron Enviro. Chamber (____) ?
☒ Lansmont Compression Tester (9/19/12) ☒ Other (dynamic) ch. 2 spray
☐ Dead Weights used / Serial # _____

SAMPLE # _____ Platen: ☒ Swiveling ☐ Fixed Pkg. Gross Wt. 1032 Pkg. Net Wt. n/a
 Sample Conditioning: ☒ TI-13, Rev. 0 ☐ Other: _____
 Duration 1 hr ☒ Water Spray ☐ Temp. _____ ☐ RH _____ 100%
 Sample Preparation/Inspection to: WHC Drawg for WRAP-1 Amount of Fill 2000
 Inspection Results (Pre-Test):
Conforms to drawing except that outer & inner lids were manually removed & reinstalled at Los Alamos.

Test Results (Post-Test):
No observed damage to drum, no indication of distribution at seal area & no release of contents as indicated by inspection with black light (visual).
Drum assembly received no water inter leakage.

☒ PASSED ☐ FAILED Pictures Taken ☐ Yes ☒ No Additional Information Attached ☐ Yes ☐ No	Performed by: <u>[Signature]</u> Reviewed by: _____	Date: <u>9/18/10</u> Date: _____
--	--	-------------------------------------

PH	DESCRIPTION	
1	CLAMP BAND	PURCHASED PER INVOICE STANDARD 35-54-P-2010 RET C
2	OUTER DRUM LD	PURCHASED PER INVOICE STANDARD 35-54-P-2010 RET C
3	INNER DRUM LD	PER ITEM A
4	INNER RING	PER ITEM A
5	INNER SEAL	22-7/16" OD X 10-1/2" ID X 5/16" THICK
6	DRUM BODY	PURCHASED PER INVOICE STANDARD 35-54-P-2010 RET C
7	BOTTOM HEAD	PURCHASED PER INVOICE STANDARD 35-54-P-2010 RET C
8	OUTER OD SEAL	0.17 OD PER INVOICE STANDARD 35-54-P-2010 RET C

531166 K2303

1. IS CALLER DESIR TO MEET DOT UM-142 REQUIREMENTS
AND PURCHASE TO HAWKING STANDARD WS-V-2-0010 SEC C
SUSPENSORS TM-141 1334

2013

- 1 55 CALIBR DRUM MOUNTED FOR 49 GTS 111.3, 171.533, 4400 170.350, STAGWORTH UN-142 MACHINING REQUIREMENTS.
- 2 2000 242-PL ACTIVATED CARBON FILTER 242-PL 3/4 - 14 242 PL CENTER OF WHICH DRUM IS WITH LOCKING WAS PURCHASED FROM NUCLEAR FILTER TECHNOLOGY INC. (FOLLOWING GUNS MAY BE ADDED TO ORDER TO RESTOCK, IF REQUESTED).

L

6-1000 ADVISIVE, BLACK
ELECTRIC PRODUCTS CO.
DISTRIBUTED BY: IPC CO.
BOSTON
(781) 326-1100

STUDY OF THE EFFECTS OF

THE COMING ABILITY OF THE

ORDER OF THE 15th CANTON ARMY WITH ORDER TO
OF CLASH WITH ARMY.

EACH SEAL SHALL MEET THE FOLLOWING SPECIFICATIONS:

HEALTHY MILK DART COGNITIVE SYSTEM
MIND 1000/2000/3000

Output: 2.1 = 3000/1000;
15% compression ratio; 2.0 = 1.0 25%

AP-7L ACTIVATED CARBON FILTER No. 7-013 2/8 - 14 1/2

7. A34 0114-2-7-51 KALLICREIN 0

55 GALLON ONE TRIP DRUM

SCALE:	NONE
--------	------

This is original.
D. McLaughlin.

Los Alamos ENGINEERING SCIENCES & APPLICATIONS LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545	Title: <h2 style="text-align: center;">DROP TEST REPORT</h2>	DOCUMENT NUMBER: TR/DT- 94-06	
		PAGE 1 of 13	REVISION: 0

Tested in accordance with: ☒ TI-01, Rev. 0 ☐ Other W11C Drop pad Drop Height 4'
 Pl- ---, Rev. --- Design I.D. W11C-1 Packaging Group Type A
 Tested Contents Sand & Lead bricks w/ flour / flower dye
 Equipment Used for Testing (Calibration Date):
☐ Water Spray Chamber ☐ Thermotron Enviro. Chamber (---)
☐ Lansmont Drop Tester (---) ☒ Other (Commercial Type) W11C Bldg 305 drop pad
☒ Quick Release Device ☐ K-site Drop Tower (Verify drop height with commercial grade tape measure)
☐ Accelerometers/Electronics used / Serial # ---

SAMPLE # 3 Drop Orientation on bolt (turn) Pkg. Gross Wt. 1024 Pkg. Net Wt. N/A
 Sample Conditioning: ☐ TI-13, Rev. --- ☒ Other: Wt's not packed as is in thick stainless
 Duration --- ☐ Water Spray ☐ Temp. --- ☐ RH. ---
 Sample Preparation/Inspection to: --- Amount of Fill 1024#
by wt.

Inspection Results (Pre-Test):

These drums were fitted with a plastic on top of the sand/lead brick weights to prevent mixing of the flour/flower material with any residual moisture in the sand. Unit closed & tugged to 40 ft/lbs.

UV light showed no loose material.

WHC # 9400454
3614

Test Results (Post-Test):

Passed inspection by UV light. Neutron gasket restricts flow of loose material so none is released from outer drum.

This was a corner ring on the locking ring bolt

☒ PASSED ☐ FAILED Pictures Taken ☒ Yes ☐ No Additional Information Attached ☐ Yes ☐ No	Performed by: <u>[Signature]</u> Reviewed by: <u>[Signature]</u> Date: <u>94/8/31</u> Date: <u>---</u>
--	---

Los Alamos <small>ENGINEERING SCIENCES & APPLICATIONS LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545</small>	<small>Title:</small>	<h2 style="margin: 0;">DROP TEST REPORT</h2>	<small>DOCUMENT NUMBER:</small> TR/DT- 94/06
		<small>PAGE</small> 2 OF 13	<small>REVISION:</small> 0

Tested in accordance with: ☒ TI-01, Rev. 0 ☐ Other WHC Proj P2J Drop Height 4
 Pl. ---, Rev. --- Design I.D. 10243-1 Packaging Group Type A

Tested Contents Sand/Flour/Fluorescence

Equipment Used for Testing (Calibration Date):
☐ Water Spray Chamber ☐ Thermotron Enviro. Chamber (_____)
☐ Lansmont Drop Tester (_____) ☐ Other (_____) _____
☐ Quick Release Device ☐ K-site Drop Tower (Verify drop height with commercial grade tape measure)
☐ Accelerometers/Electronics used / Serial # _____

SAMPLE # 2 Drop Orientation Corner in bolt Pkg. Gross Wt. 1024 Pkg. Net Wt. N/A
 Sample Conditioning: ☐ TI-13, Rev. --- ☒ Other: WIS procedure
 Duration _____ ☐ Water Spray ☐ Temp. _____ ☐ RH _____ 100%T
 Sample Preparation/Inspection to: _____ Amount of Fill by wt.

Inspection Results (Pre-Test):
WHC #9408721
Sand/Flour/Fluorescence dye added to top of drum.
UV ck showed no

Test Results (Post-Test):
Passed. Inspection by UV light showed no dye on outside of drum.

Pictures Taken ☒ Yes ☐ No Additional Information Attached ☐ Yes ☐ No

WHC-SD-TP-RPT-023
Revision 0

Los Alamos ENGINEERING SCIENCES & APPLICATIONS LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545	Title:	<h2 style="margin: 0;">DROP TEST REPORT</h2>	DOCUMENT NUMBER: TR/DT- 94-06 PAGE: <u>3</u> OF <u>3</u> REVISION: <u>6</u>
--	--------	--	--

Tested in accordance with: ☒ TI-01, Rev. 6 ☐ Other WHC Proj 8.20 Drop Height 4

Pl-____, Rev.____ Design I.D. WHC-1 Packaging Group 794

Tested Contents Small solid bricks w/ flow silhouettes in jar

Equipment Used for Testing (Calibration Date):

☐ Water Spray Chamber ☐ Thermotron Enviro. Chamber (____)

☐ Lansmont Drop Tester (____) ☐ Other (Commercial tape WHC Bldg 505)

☒ Quick Release Device ☐ K-site Drop Tower (Verify drop height with commercial grade tape measure)

☐ Accelerometers/Electronics used / Serial # _____

SAMPLE # 5 Drop Orientation in a box Pkg. Gross Wt. 1018 Pkg. Net Wt. N/A

Sample Conditioning: ☐ TI-13, Rev.____ ☐ Other: w/s 100% humidity

Duration _____ ☐ Water Spray ☐ Temp. _____ ☐ RH _____

Sample Preparation/Inspection to: _____ Amount of Fill _____

Inspection Results (Pre-Test):
UV inspected showed no loose material

Test Results (Post-Test):
Passed inspection by UV light. No fragments of

Pictures Taken ☒ Yes ☐ No

Additional Information Attached ☐ Yes ☐ No

Los Alamos

WRAP-1 Drop Test Report Pictures

Engineering Sciences & Applications
Los Alamos National Laboratory
Los Alamos, New Mexico

TR-DT-94-06

Page 4 of 13
Rev 0

Corner Drop: 9403614 Showing placement of dummy load and flour/fluorescein indicator

Corner Drop: 9403614 Showing placement of inner ring

Los Alamos

WRAP-1 Drop Test Report Pictures

Engineering Sciences & Applications
Los Alamos National Laboratory
Los Alamos, New Mexico

Document
TR-DT-94-06

Page 5 of 13
Rev 0

Corner Drop: 9403614 Showing placement of neoprene seal

Corner Drop: 9403614 Showing placement of neoprene seal

WHC-SD-TP-RPT-023
Revision 0

Note: Page 6 of 13, Rev. 0, TR/DI-94-06, WRAP-1 Drop Test Report Pictures, Los Alamos National Laboratory, Los Alamos, New Mexico, is not included in this document as it was never received by Westinghouse Hanford Company.

Los Alamos WRAP-1 Drop Test Report Pictures

Engineering Sciences & Applications
Los Alamos National Laboratory
Los Alamos, New Mexico

Document: TR/DT-9 4-06	
Page 7 of 13	Rev 0

Corner Drop: 9403614 After Drop showing movement of dummy load and flour/fluorescein indicator

Corner Drop: 9403614 After Drop showing movement of inner lid, material escapes into interspace between inner & outer lids but is contained.

Los Alamos

WRAP-1 Drop Test Report Pictures

Engineering Sciences & Applications
Los Alamos National Laboratory
Los Alamos, New Mexico

TR DT-9406

Page
8 of 13

Rev
0

Corner Drop: 9403721 After Drop showing impact on locking ring bolt

Corner Drop: 9403721 After Drop showing impact on locking ring bolt

Los Alamos

WRAP-1 Drop Test Report Pictures

Engineering Sciences & Applications
Los Alamos National Laboratory
Los Alamos, New Mexico

Document #
TR/DT-9 4-06

Page
9 of 13

Rev
0

Corner Drop: 9403721 After Drop showing impact on locking ring bolt

Corner Drop: 9403721 After Drop showing impact on locking ring bolt

Los Alamos Engineering Sciences & Applications Los Alamos National Laboratory Los Alamos, New Mexico	WRAP-1 Drop Test Report Pictures	Document # TR/DT-9 4-06 Page 10 of 13 Rev 0
--	---	--

Corner Drop: 9403721 After Drop showing impact on bottom (secondary impact)

Corner Drop: 9403721 After Drop showing buckling of inner lid

Los Alamos Engineering Sciences & Applications Los Alamos National Laboratory Los Alamos, New Mexico	WRAP-1 Drop Test Report Pictures	Document # TR/DT-9 406 Page 11 of 13 Rev 0
--	---	---

Corner Drop: 9403721 After drop, under blacklight, showing indicator on top of inner lid. Material is contained between inner & outer with no release.

Corner Drop: 9403721 After Drop showing movement of dummy load

WHC-SD-TP-RPT-023
Revision 0

Los Alamos Engineering Sciences & Applications Los Alamos National Laboratory Los Alamos, New Mexico	WRAP-1 Drop Test Report Pictures	Document # TR/DT-94-06 Page 12 of 13 Rev 0
--	---	--

Side Drop: 9400057 After drop.

Side Drop: 9400057 After drop showing impact on locking ring bolt
B-70

Los Alamos Engineering Sciences & Applications Los Alamos National Laboratory Los Alamos, New Mexico	WRAP-1 Drop Test Report Pictures	Document # TR/DT-9 4-06 Page 13 of 13 Rev 0
--	---	---

Side Drop: 9400057 After drop showing bottom of drum.

Side Drop: 9400057 After drop showing material released from inner lid but held by neoprene gasket, no release from drum.

Los Alamos ENGINEERING SCIENCES & APPLICATIONS LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545	Title: <h2 style="text-align: center;">VIBRATION TEST REPORT</h2>	DOCUMENT NUMBER: TR-VT- 94-06 PAGE 1 OF 1 REVISION: 0
--	--	--

☒ Tested in accordance with TI-05, Rev. 0 Test Method ☒ 1 ☐ 2 ☐ 3
 Pl- , Rev. Design I.D. WRAP-1 (940863) Packaging Group A
 Tested Contents Sand, lead bricks & flow/fluorescein indicator
 Equipment Used for Testing (Calibration Date):
☒ Water Spray Chamber ☐ Thermotron Enviro. Chamber ()
☒ Lansmont Vibration Tester (given) ☒ Other (Drop test) outside spray
☐ Accelerometers/Electronics used / Serial #
☐ Other

SAMPLE # 1 Orientation Vertical Pkg. Gross Wt. 1032 Pkg. Net Wt. N/A
 Sample Conditioning: ☒ TI-13, Rev. 0 ☐ Other:
 Duration 1hr ☒ Water Spray ☐ Temp. ☐ RH
 Sample Preparation/Inspection to: WTC Draw for WRAP-1 Amount of Fill 2000g
 Inspection Results (Pre-Test):

Conforms to drawing except that outer & inner lids were manually removed & reinstalled at Los Alamos.

Test Results (Post-Test):

No observed damage to drum, no indication of distortion of seal area & no release of contents as indicated by black light inspection

☒ PASSED ☐ FAILED Pictures Taken ☐ Yes ☒ No Additional Information Attached ☐ Yes ☒ No	Performed by: <u><i>[Signature]</i></u> Date: <u>94/8/10</u> Reviewed by: <u> </u> Date: <u> </u>
---	--

WHC-SD-TP-RPT-023
Revision 0

Los Alamos <small>ENGINEERING SCIENCES & APPLICATIONS LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545</small>	Title:	<h2 style="margin: 0;">PENETRATION TEST REPORT</h2>	DOCUMENT NUMBER: TR/PT- 94-06 PAGE <u>1</u> OF <u>1</u> REVISION: <u>0</u>
Tested In accordance with: ☒ TI-07, Rev. <u>0</u> ☐ Other _____ Drop Height <u>1 m</u> PI- _____, Rev. _____ Design I.D. <u>WILAT-1</u> Packaging Group <u>Type A</u> Tested Contents <u>Sand & lead bricks</u> Equipment Used for Testing (Calibration Date): ☐ Water Spray Chamber ☐ Thermotron Enviro. Chamber (_____) ☐ Other (_____)			
☒ Type A Penetration Rod ☐ Inf-Sub Penetration Rod (Verify drop height w/ commercial grade tape) SAMPLE # <u>1</u> Pkg Orientation <u>Top on file</u> Pkg. Gross Wt. _____ Pkg. Net Wt. _____ Sample Conditioning: ☐ TI-13, Rev _____ ☐ Other: _____ Duration _____ ☐ Water Spray ☐ Temp. _____ ☐ RH _____ Sample Preparation/Inspection to: _____ Amount of Fill <u>by wt</u> Inspection Results (Pre-Test): <p style="margin-left: 20px;">The drum was inspected for loose material with the w/ light. No material was detected.</p> <p style="margin-left: 20px;">WHC# 9460463</p>			
Test Results (Post-Test): <p style="margin-left: 20px;">The effect of the penetration rod is to provide only superficial damage and a small dent in the lid.</p>			

☒ PASSED ☐ FAILED Pictures Taken ☒ Yes ☐ No Additional Information Attached ☐ Yes ☐ No	Performed by: <u>[Signature]</u> Date: <u>94/8/8</u> Reviewed by: _____ Date: _____
--	--

WHC-SD-TP-RPT-023
Revision 0

Los Alamos <small>ENGINEERING SCIENCES & APPLICATIONS LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545</small>	Title:	<h2 style="margin: 0;">PENETRATION TEST REPORT</h2>	<small>DOCUMENT NUMBER:</small> TR/PT- 94-06 <small>PAGE</small> 2 <small>OF</small> 2 <small>REVISION:</small> 0
---	--------	---	--

SAMPLE # <u>7th</u>	Pkg Orientation <u>Side seam</u>	Pkg. Gross Wt. _____	Pkg. Net Wt. _____
Sample Conditioning: ☐ TI-13, Rev _____ ☒ Other: <u>NONE w/s bias w/ effect on pkg</u>			
Duration _____		☐ Water Spray	☐ Temp. _____ ☐ RH _____
Sample Preparation/Inspection to: _____			Amount of Fill _____
Inspection Results (Pre-Test): <u>SEE ABOVE (PRE TEST)</u>			
Test Results (Post-Test):			
Pictures Taken ☐ Yes ☒ No		Additional Information Attached ☐ Yes ☐ No	

SAMPLE # <u>7th</u>	Pkg Orientation <u>locking Bolt</u>	Pkg. Gross Wt. _____	Pkg. Net Wt. _____
Sample Conditioning: ☐ TI-13, Rev _____ ☒ Other: _____			
Duration _____		☐ Water Spray	☐ Temp. _____ ☐ RH _____
Sample Preparation/Inspection to: _____			Amount of Fill _____
Inspection Results (Pre-Test): <u>SEE ABOVE (PRE TEST)</u>			
Test Results (Post-Test):			
Pictures Taken ☐ Yes ☒ No		Additional Information Attached ☐ Yes ☐ No	

Los Alamos Engineering Sciences & Applications Los Alamos National Laboratory Los Alamos, New Mexico	WRAP-1 Testing and Evaluation	Document # TR 94-06 <hr/> Page 4 of 7	Rev 0
--	--------------------------------------	--	-----------------

Appendix 2 - Testing Procedures

Document #	Rev	Title	# pages
TI-01	0	Std Drop Test Method - Certification of Packaging for Hazardous Materials	6
TI-02	0	Std Compression Test Method - Certification of Packaging for Hazardous Materials	4
TI-05	0	Std Vibration Test Method - Certification of Packaging for Hazardous Materials	5
TI-07	0	Std Penetration Test Method - Certification of Packaging for Hazardous Materials	3
TI-13	0	Std Sample Preparation and Conditioning Method - Packaging for Radioactive Materials	3

Los Alamos		Prepared by: <i>[Signature]</i>	Reviewed by: <i>[Signature]</i>	Test Instruction: TI-01
WK-11, ANA LOS ALAM. LOS ALAM.	OS AND TESTING ONAL LABORATORY W MEXICO 87545	Approved By: <i>[Signature]</i>	93/2/16	Page: 1 / 6 Rev: 0
Test Instruction: Standard Drop Test Method - Certification of Packagings for Hazardous Materials.				

1. Scope

This Test Instruction covers methods of drop testing packaging samples for the purpose of evaluation or certification of the packaging designs for use in transporting hazardous materials. The tests are intended to demonstrate compliance with the applicable regulatory requirements for the type of packaging and hazardous material being transported. The methods covered are applicable to box or drum shaped samples having a gross mass up to 880 pounds (400 kg).

2. Safety Precautions

- 2.1 These test procedures may involve falling objects of large mass as well as other hazards associated with the operations and equipment. It is the responsibility of operating personnel to remain alert to potential hazards and take the necessary precautions to ensure a safe working environment.

3. Apparatus

- 3.1 The primary apparatus for performing drop tests is the Lansmont PDT-56E Precision Drop Tester. A technical description of this apparatus is provided in 5.3.1 of the Packaging Engineering Manual.
- 3.2 For samples with gross mass greater than 125 pounds, very large samples (>36 in. front-to-back), or drop heights greater than 12 feet, it will be necessary to use a hoist, sling, and tripping device to conduct the drop test procedure. This alternate drop test apparatus shall conform to the following requirements:
- Permit the sample to be placed in a position, prior to release, that will ensure correct orientation.
 - Provide a release mechanism that does not impart any rotational or side-wise forces to the test sample.
 - Permit accurate control of the drop from specified heights.
 - Provide a rigid and level dropping surface that is integral with a mass at least 50 times the weight of the test sample. The dropping surface, firmly anchored to the mass, shall be a steel plate not less than 1/2 inch thick. Should this type of dropping surface not be available, the required drop height shall be adjusted to ensure that an equivalent amount of shock is imparted to the test sample as if the required dropping surface were used.
 - Provide a measurement of the drop height by means of a commercial measuring tape or other suitable measuring device.

I don't fully understand what's going on here and we need to apply it to Type A packages

Los Alamos <small>WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545</small>	Standard Drop Test Method - Certification of Packagings for Hazardous Materials.	Test Instruction:	
		TI-01	
		Page	Rev.
		2 / 6	0

- 3.3 The Thermotron Environmental Chamber is the primary apparatus for conditioning test samples at proper humidity and temperature in accordance with the specified requirements for the type of packaging being tested. A description of this apparatus is provided in 5.3.5 of the Packaging Engineering manual.
- 3.4 When drop testing packagings for radioactive materials, a water spray apparatus shall be used to condition the packaging sample prior to testing in accordance with Test Instruction TI-013.
4. **Sample Preparation and Conditioning**
- 4.1 Samples shall be prepared in such a way that they represent the packaging design as offered for transport. Actual hazardous contents shall be replaced with dummy loads having the same physical characteristics (mass, density, viscosity, grain size, etc.) except where this would invalidate the results of the test. Water may also be used as a substitute for liquids with density less than 1.2. For liquids with density greater than 1.2, water may be used in accordance with 49 CFR, 178.603, (e), (2), (ii). Inner receptacles or single packagings shall be filled to not less than 95% of their capacity for solids or 98% for liquids. Close each receptacle in the same manner as it would be closed for shipping. All closures shall be installed using the techniques or torques specified by the receptacle manufacturer.
- 4.2 **Paper or fiberboard** packagings must be conditioned for at least 24 hours immediately prior to testing in an atmosphere having controlled temperature and relative humidity. The preferred atmosphere is $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($73^{\circ}\text{F} \pm 3.5^{\circ}\text{F}$) and $50\% \pm 2\%$ relative humidity. The two other options are $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($68^{\circ}\text{F} \pm 3.5^{\circ}\text{F}$) and $65\% \pm 2\%$ relative humidity or $27^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($80^{\circ}\text{F} \pm 3.5^{\circ}\text{F}$) and $65\% \pm 2\%$ relative humidity.
- 4.3 Testing of plastic drums, plastic Jerricans, plastic boxes, composite packagings with plastic inner receptacles, and combination packagings with plastic inner packagings shall be carried out when the temperature of the sample receptacle and its contents has been reduced to -18°C (0°F) or lower. Test liquids shall be kept in the liquid state, if necessary, by the addition of antifreeze.
- 4.4 Packagings for **Infectious Materials** - Test samples shall be prepared and conditioned in accordance with the procedures specified in Test Instruction TI-012.

Los Alamos <small>WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545</small>	Standard Drop Test Method - Certification of Packagings for Hazardous Materials.	Test Instructions: TI-01 Page 3 / 6 Rev. 0
---	---	--

- 4.5 Packagings for **Radioactive Materials** - Test samples shall be prepared and conditioned in accordance with the procedures specified in Test Instruction TI-013.
- 4.6 Packagings other than 4.2, 4.3, 4.4, and 4.5 require no special conditioning or preparation unless specified in the Test Plan.
5. **Test Procedures**
- 5.1 Packagings for **Noninfectious/Nonradioactive Materials** - The number of test samples, drop orientations, and drop heights required for certification of packaging designs are as follows:
- **Boxes** (all materials) and composite packagings that are in the shape of a box require **five test samples** (one for each drop orientation) for the drop test procedure. The drop sequence/sample orientation is:
 - First drop: onto a bottom corner (joint bottom corner of fiberboard box);
 - Second drop: flat on the bottom;
 - Third drop: flat on the top;
 - Fourth drop: flat on the long side;
 - Fifth drop: flat on the short side.
 - **Drums** (all materials), Jerricans (all materials), and composite packagings that are in the shape of a drum require **six test samples** (three for each drop orientation) for the drop test procedure. The drop sequence/sample orientation is:
 - First drop (using three samples): the sample must strike the target diagonally on the chime or, if the sample has no chime, on a circumferential seam or edge;
 - Second drop: (using the other three samples): the sample must strike the target on the weakest part not tested by the first drop (e.g., on a closure or, for some cylindrical drums, on the welded longitudinal seam of the drum body).

<u>Packing Group</u>	<u>Drop Height</u>	<u>Drop Ht. (Water substituted for liquids with density > 1.2)</u>
Packing Group I	1.8 meter (6 ft.)	relative density x 1.5 (m)
Packing Group II	1.2 meter (4 ft.)	relative density x 1.0 (m)
Packing Group III	0.8 meter (2.6 ft.)	relative density x 0.67 (m)
Limited Qty. Package	1.2 meter (4 ft.)	relative density x 1.0 (m)
Excepted Qty. Package	1.8 meter (6 ft.)	relative density x 1.5 (m)

Los Alamos <small>WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545</small>	Standard Drop Test Method - Certification of	Test Instructions TI-01	
	Packagings for Hazardous Materials.	Page 4 / 6	Rev. 0

Note: Packaging designs for **Excepted Quantities** require only one sample for all the required drops. Packaging designs for **Limited Quantities** require only one drop from a height of 1.2 meters (4 ft.) in a position likely to cause the most damage to the sample.

5.2 Packagings for Infectious Materials - The number of test samples, drop orientations, and drop heights required for certification of packaging designs are as follows:

- **Boxes** - For samples that are in the shape of a box, **five samples** must be dropped once each as follows:
 - First drop: onto a bottom corner (joint bottom corner of fiberboard box);
 - Second drop: flat on the bottom;
 - Third drop: flat on the top;
 - Fourth drop: flat on the long side;
 - Fifth drop: flat on the short side.
- **Drums** - For samples that are in the shape of a drum, **three samples** must be dropped once each as follows:
 - First drop: diagonally onto the top chime or circumferential edge with the center of gravity directly above the point of impact.
 - Second drop: diagonally onto the base chime or circumferential edge with the center of gravity directly above the point of impact.
 - Third drop: flat onto the side.
- **Drop Height** - All samples must be subjected to free-fall drops from a height of **9 meters (30 ft.)**. **Note:** While the samples must be released in the required orientation, it is accepted that for aerodynamic reasons the impact may not take place in that position.
- **Dry Ice Packages** - For packaging designs intended to contain dry ice, one additional sample must be subjected to the drop test after all the dry ice has been allowed to dissipate from the package.

5.3 Packagings for Radioactive Materials - The number of test samples, drop orientations, and drop heights required for certification of packaging designs are as follows:

- **Drop Height** - For packagings designed for solids, **one sample** must be subjected to a free drop in a position likely to cause the most damage to the sample. The height of the fall measured from the lowest point of the sample to the target surface shall not be less than **1.2 meters (4 ft.)**. For packagings with gross mass exceeding 5000 kg, refer to 49 CFR, 173.465.
- **Type A Packages Designed for Liquids or Gases** - **one separate sample** must be subjected to a free drop in a position likely to cause the most damage to the sample in terms of containment. The height of the fall measured from the lowest point of the sample to the target surface

Los Alamos <small>WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545</small>	Standard Drop Test Method - Certification of Packagings for Hazardous Materials.	Test Instructions	
		TI-01	
		Page 5 / 6	Rev. 0

shall not be less than 9 meters (30 ft.). **Note:** While the samples must be released in the required orientation, it is accepted that for aerodynamic reasons the impact may not take place in that position.

- **Boxes** - For fiberboard or wood samples not exceeding a mass of 50 kg (110 lbs.), **one separate sample** must be subjected to a free drop onto each corner from a height of 0.3 m (1 ft.).
- **Fiber Drums** - For cylindrical fiber samples not exceeding a mass of 100 kg (220 lbs.), **one separate sample** must be subjected to a free drop onto each of quarter of each rim from a height of 0.3 m (1 ft.).

6. Inspection and Acceptance Criteria

- 6.1 Following the completion of testing, samples shall be rotated through all planes and examined for evidence of leakage or damage that would significantly reduce the ability of the packaging to contain and protect the hazardous contents in the transportation environment. Combination and composite packagings shall then be opened and examined internally for signs of leakage or spillage.
- 6.2 Each packaging for liquids must be leakproof when equilibrium has been reached between the internal and external pressures, except for the inner packagings of combination packagings where it is not necessary that the pressures be equalized. **Note:** Except for packagings for Infectious or Radioactive materials, a slight discharge from the closure of a receptacle upon impact need not be considered to be a failure of the packaging provided that no further leakage occurs.
- 6.3 A packaging for solids is considered to have passed the test if no leakage from the primary containment receptacle(s) occurs. A sample that impacts on the upper face is considered to have passed the test if the entire contents are retained by an inner packaging or inner receptacle (e.g., a plastic bag), even if the closure is no longer sift-proof.
- 6.4 The packaging or the outer packaging of a composite or combination packaging must not exhibit any damage liable to affect safety during transport by significantly reducing the ability of the packaging to contain and protect the hazardous contents. For combination packagings, there shall be no release of any of the inner packages from the outer packaging, but minor exposure of the inner packagings that does not permit their withdrawal may be considered acceptable.
- 6.5 Packagings for Radioactive materials shall exhibit no evidence of a loss of shielding integrity that would result in more than a 20% increase in the radiation level at any external surface of the package.

LCS Alamos <small>WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545</small>	Standard Drop Test Method - Certification of Packagings for Hazardous Materials.	Test Instructions	
		TI-01	
		Page 6 / 6	Rev. 0

7. Test Report

- 7.1 Following the completion of a drop test sequence for certification of a packaging design type, a written test report shall be made by the testing technician(s) who performed the test procedure. The report shall be prepared in accordance with 3.2.8 of the Packaging Engineering Manual.

Los Alamos WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545	PREPARED BY: <i>[Signature]</i>	APPROVED BY: <i>[Signature]</i>	TEST INSTRUCTION: TI-02	
	DATE: <i>9/3/16</i>	PAGE: 1 / 4	REV. 0	
Test Instruction: Standard Compression Test Method - Certification of Packagings for Hazardous Materials.				

1. Scope

This Test Instruction covers methods of performing compression tests on packaging samples for the purpose of evaluation or certification of the packaging designs for use in transporting hazardous materials. The tests are intended to demonstrate compliance with the applicable regulatory requirements for the type of packaging and hazardous material being transported. The methods covered are applicable to box or drum shaped samples having a gross mass up to 880 pounds (400 kg).

(Note: The terms compression test and stacking test are found in various regulation systems. These terms are used synonymously to refer to the same test procedure.

2. Safety Precautions

- 2.1 These test procedures may involve hazards associated with the operations and equipment. It is the responsibility of operating personnel to remain alert to potential hazards and take the necessary precautions to ensure a safe working environment.

3. Apparatus

- 3.1 The primary apparatus for performing compression tests is the Lansmont Model 132-30K Container Compression Tester. A technical description of this apparatus is provided in 5.3.2 of the Packaging Engineering Manual. The swiveling upper platen shall be used unless otherwise specified.
- 3.2 Calibrated dead weights may be used as a means of applying compressive loads to packaging samples for the purpose of performing long-term tests without tying up the Lansmont Compression Tester for extended periods.
- 3.3 The Thermotron Environmental Chamber is the primary apparatus for conditioning test samples at proper humidity and temperature in accordance with the specified requirements for the type of packaging being tested. A description of this apparatus is provided in 5.3.5 of the Packaging Engineering manual.
- 3.4 When conducting a compression test on packagings for radioactive materials, a water spray apparatus shall be used to condition the packaging sample prior to testing in accordance with Test Instruction TI-013.

Los Alamos <small>WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545</small>	Std Compression Test Method - Certification of Packagings for Hazardous Materials.	TEST INSTRUCTIONS TI-02	
		Page 2 / 4	Rev. 0

4. Sample Preparation and Conditioning

- 4.1 Samples shall be prepared in such a way that they represent the packaging design as offered for transport. Actual hazardous contents shall be replaced with dummy loads having the same physical characteristics (mass, density, viscosity, grain size, etc.) except where this would invalidate the results of the test. Water may be used as a substitute for hazardous liquids. Inner receptacles or single packagings shall be filled to not less than 95% of their capacity for solids or 98% for liquids. Close each receptacle in the same manner as it would be closed for shipping. All closures shall be installed using the techniques or torques specified by the receptacle manufacturer.
- 4.2 Paper or fiberboard packagings including composite packagings with outer fiberboard packagings must be conditioned for at least 24 hours immediately prior to testing in an atmosphere having controlled temperature and relative humidity. The preferred atmosphere is $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($73^{\circ}\text{F} \pm 3.5^{\circ}\text{F}$) and $50\% \pm 2\%$ relative humidity. The two other options are $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($68^{\circ}\text{F} \pm 3.5^{\circ}\text{F}$) and $65\% \pm 2\%$ relative humidity or $27^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($80^{\circ}\text{F} \pm 3.5^{\circ}\text{F}$) and $65\% \pm 2\%$ relative humidity.
- 4.3 Testing of plastic drums, plastic Jerricans, and plastic boxes intended for liquids and composite packagings consisting of plastic receptacles for liquids contained within outer plastic drums or plastic boxes shall be carried out when the temperature of the test sample and its contents has been raised to $40 \pm 2^{\circ}\text{C}$ ($104 \pm 4^{\circ}\text{F}$).
- 4.4 Packagings for Radioactive Materials - Test samples shall be prepared and conditioned in accordance with the procedures specified in Test Instruction TI-013.
- 4.5 Packagings for Infectious Substances - Test samples shall be prepared and conditioned in accordance with the procedures specified in Test Instruction TI-012.
- 4.6 Packagings other than those covered in 4.2, 4.3, 4.4, and 4.5 require no conditioning prior to the compression test.

5. Test Procedures

- 5.1 Packagings for Nonradioactive Materials - Three samples of each packaging design type (only one sample is required for Excepted Packages) shall be subjected to a constant load compression test. The force shall be applied uniformly to the top surface of the sample for a period of at least 24 hours. The swiveling upper platen for the compression tester shall be used unless otherwise specified in the Test Plan. The force applied to the

Los Alamos <small>WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545</small>	Std Compression Test Method - Certification of Packagings for Hazardous Materials.	Test Item/Accession: TI-02	
		Page 3 / 4	Rev. 0

test sample shall be equivalent to that which would be exerted on the sample if it were at the bottom of a 3 meter (10 ft.) stack of packages identical to the sample. The force shall be calculated using either of the following formulae:

$$F = [w (120 - h)] / h$$

where: w = gross weight of the package (as shipped) in pounds,
 h = height of the package in inches, and
 F = force applied to the test sample in pounds.

or:

$$F = [9.8 m (300 - h)] / h$$

where: m = gross mass of the package (as shipped) in kilograms,
 h = height of the package in centimeters, and
 F = force applied to the test sample in Newtons.

Note: For plastic drums, plastic Jerricans, and plastic boxes intended for liquids and composite packagings consisting of plastic receptacles for liquids contained within outer plastic drums or plastic boxes, the force shall be applied for a period of 28 days.

- 5.2 Packagings for Radioactive Materials - One sample of each packaging design type shall be subjected to a constant load compression test. The force shall be applied uniformly to two opposite sides of the test sample, one of which must be the base on which the package would normally rest, for a period of at least 24 hours. The swiveling upper platen for the compression tester shall be used unless otherwise specified in the Test Plan. The force applied to the test sample shall be equivalent to the greater of the following:
- 1) five times the mass of the actual package (as shipped); or
 - 2) 1300 kilograms per square meter (285 pounds per square foot) multiplied by the vertically projected area of the package (e.g. largest area obtained by measuring the area of horizontal cross-sections of the test sample).

6. Inspection and Acceptance Criteria

- 6.1 Following the completion of testing, samples shall be rotated through all planes and examined for evidence of leakage and/or any deformation likely to reduce their strength or cause instability in 3 meter (10 ft.) stacks of packages.
- 6.2 The sample is considered to have passed the compression test if:
- No leakage or structural failure likely to cause stacking instability occurs during the test;

WHC-SD-TP-RPT-023
Revision 0

Los Alamos WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545	Std Compression Test Method - Certification of Packagings for Hazardous Materials.	Test PROCEDURE: TI-02 Page 4 / 4 Rev. 0
--	---	---

- After the test is completed, two filled packages of the same type as the test sample are placed on the filled sample and maintain their position for a minimum of 1 hour; and
 - In the case of composite and combination packagings, upon an internal inspection, it is found that no leakage has occurred from the inner receptacle of composite packagings or from the inner packagings of combination packagings.
- 6.3 Packagings for **Radioactive** materials shall exhibit no evidence of a loss of shielding integrity that would result in more than a 20% increase in the radiation level at any external surface of the package.
7. **Test Report**
- 7.1 Following the completion of a compression test for certification of a packaging design type, a written test report shall be made by the testing technician(s) who performed the test sequence. The report shall be prepared in accordance with 3.2.8 of the Packaging Engineering Manual.

LOS ALAMOS WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545		DESIGNED BY: _____ APPROVED BY: <i>Carroll M. Shaw</i> <i>Check 4/31/16</i>	TEST INSTRUCTION: TI-05 Page: 1 / 5 Rev: 0
Test Instruction: Standard Vibration Test Method - Certification of Packagings for Hazardous Materials.			

1. Scope

- 1.1 This Test Instruction covers methods of performing vibration tests on packaging samples for the purpose of evaluation or certification of the packaging designs for use in transporting hazardous materials. The tests measure the ability of packaging designs to withstand vibration spectrums normally encountered in the transportation environment. The tests are intended to demonstrate compliance with the applicable regulatory requirements for the type of packaging and hazardous material being transported. The methods covered are applicable to samples having a gross mass of up to 5,500 pounds.

2. Safety Precautions

- 2.1 These test procedures may involve hazards associated with the operations and equipment. It is the responsibility of operating personnel to remain alert to potential hazards and take the necessary precautions to ensure a safe working environment.

3. Apparatus

- 3.1 The primary apparatus for performing vibration tests is the Lansmont Model 10000-10 Vibration Tester. The vibration tester has an effective frequency range of 1 Hz to 500 Hz with a maximum stroke of 2.5 inches. The maximum load capacity is 5,500 pounds. A full description of this apparatus is provided in 5.3.4 of the Packaging Engineering Manual. For Test Method 2, the 34" X 34" table shall be used for performing the tests. Samples are tested in the restrained and unrestrained modes at frequencies that are representative of the transportation environment as defined by the applicable regulations.
- 3.2 The Thermotron Environmental Chamber is the primary apparatus for conditioning test samples at proper humidity and temperature in accordance with the specified requirements for the type of packaging being tested. A description of this apparatus is provided in 5.3.5 of the Packaging Engineering manual.
- 3.3 When conducting a vibration test on packagings for radioactive materials, a water spray apparatus shall be used to condition the packaging sample prior to testing in accordance with Test Instruction TI-013.

LOS ALAMOS WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545	Standard Vibration Test Method - Certification of Packagings for Hazardous Materials	TEST INSTRUCTION:	
		TI-05	
		Page	Rev.
		2 / 5	0

4. Sample Preparation and Conditioning

- 4.1 Samples shall be prepared in such a way that they represent the packaging design as offered for transport. Actual hazardous contents shall be replaced with dummy loads having the same physical characteristics (mass, density, viscosity, grain size, etc.) except where this would invalidate the results of the test. Water may be used as a substitute for hazardous liquids with a density of less than 1.2. Inner receptacles or single packagings shall be filled to not less than 95% of their capacity for solids or 98% for liquids. Close each receptacle in the same manner as it would be closed for shipping. All closures shall be installed using the techniques or torques specified by the receptacle manufacturer.
- 4.2 Accelerometers shall be used for verification of resonant frequencies when conducting a test using Test Method 2. Accelerometers shall be attached to the outside of the test samples and/or to the inner packagings of combination packages in such a way that their location and method of attachment does not influence the results of the test.
- 4.3 Paper or fiberboard packagings must be conditioned for at least 24 hours immediately prior to testing in an atmosphere having controlled temperature and relative humidity. The preferred atmosphere is $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($73^{\circ}\text{F} \pm 3.5^{\circ}\text{F}$) and $50\% \pm 2\%$ relative humidity. The two other options are $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($68^{\circ}\text{F} \pm 3.5^{\circ}\text{F}$) and $65\% \pm 2\%$ relative humidity or $27^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($80^{\circ}\text{F} \pm 3.5^{\circ}\text{F}$) and $65\% \pm 2\%$ relative humidity.
- 4.4 Testing of plastic drums, plastic Jerricans, plastic boxes, composite packagings with plastic inner receptacles, and combination packagings with plastic inner packagings shall be carried out when the temperature of the sample receptacle and its contents has been reduced to -18°C (0°F) or lower. Test liquids shall be kept in the liquid state, if necessary, by the addition of antifreeze.
- 4.5 Packagings for Infectious Materials - Test samples shall be prepared and conditioned in accordance with the procedures specified in Test Instruction TI-012.
- 4.6 Packagings for Radioactive Materials - Test samples shall be prepared and conditioned in accordance with the procedures specified in Test Instruction TI-013.
- 4.7 Packagings other than 4.2, 4.3, 4.4, 4.5, and 4.6 require no special conditioning or preparation unless specified in the Test Plan.

Los Alamos

Standard Vibration Test Method - Certification

TI-05

WX-11, ANALYSIS AND TESTING
LOS ALAMOS NATIONAL LABORATORY
LOS ALAMOS, NEW MEXICO 87545

of Packagings for Hazardous Materials

Page
3 / 5
Rev.
0

5. Test Procedures

- 5.1 Packagings for all Hazardous Materials - Unless otherwise specified in the Test Plan, it is the general policy of WX-11 to test all packaging designs using both Test Method 1 and Test Method 2.
- 5.2 **Test Method 1 - DOT Repetitive Shock Mode. Three samples** of each packaging design type shall be tested for a period of **one hour each**. The procedure for conducting the vibration test is as follows:

Step 1) Unless otherwise specified in the Test Plan, test samples shall be placed on the vibration table in the following way:

- Samples shall be in their normal shipping orientation with the bottom or base of the test sample contacting the table surface. It is permissible to test more than one sample at a time, so long as there is adequate room on the vibration table for free movement of the samples and the results of the test are not invalidated by this method.

Note: If the packaging might be transported in any other orientation, test at least one sample for one hour in each of the other orientations.

- Samples shall be constrained horizontally to prevent them from falling off the table. Restraining devices shall be positioned so as to permit the sample to bounce and rotate.
- Samples shall be unrestrained in the vertical direction.

Step 2) Adjust the vibration table controls so that a minimum double amplitude displacement (peak-to-peak) of 1 inch shall be maintained over a frequency range of 2 Hz to at least 5 Hz.

Step 3) Start the vibration of the table at a frequency of approximately 2 Hz.

Step 4) Steadily increase the vibration frequency until the test sample repeatedly leaves the table surface.

Step 5) Verify that each sample is leaving the table surface and receiving repetitive shocks by passing a 1/16 inch thick strip of material (e.g., a piece of steel strapping) between the bottom of each test sample and the table. The strip should pass intermittently under the entire bottom of each sample. Record the excitation frequency. (If accelerometers have been attached to the test sample, record the excitation frequency and peak acceleration of test sample at this frequency.)

Step 6) Continue the test at this frequency for one hour, observing the sample periodically for evidence of leakage and/or deterioration. The test may be stopped momentarily to inspect for damage.

Los Alamos <small>WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545</small>	Standard Vibration Test Method - Certification		TEST INSTRUCTIONS
	of Packagings for Hazardous Materials		TI-05 Page 4 / 5 Rev. 0

Step 7) Upon completion of the test, the sample shall be removed from the table and turned on one side for 10 minutes to observe for any evidence of leakage.

5.3 Test Method 2 - IATA Air Transport Spectrum Mode. The procedure for conducting the vibration test is as follows:

- Step 1) Install the 34" X 34" table on the vibration tester if it is not already in place. Fix the sample to the table by means of an appropriate clamping device. Clamp shall prevent any horizontal or vertical movement of the test sample in such a way as to provide a valid measurement of the sample's ability to withstand vibration.
- Step 2) Connect accelerometers from the test sample to the signal conditioning and recording equipment.
- Step 3) Adjust the vibration table controls so that test sample will be subjected to a vibration spectrum ranging from 7 Hz to no less than 200 Hz at a constant acceleration of no less than 1 g.
- Step 4) Start the vibration of the table at a frequency of approximately 7 Hz with a frequency sweep time (lowest frequency to highest frequency) of no less than 2 minutes.
- Step 5) Monitor the acceleration readouts from the test sample as the table vibrations sweep from the one end of the frequency range to the other. Continue this process, noting the resonant frequencies and acceleration levels at those frequencies, until all resonant frequencies have been determined.
- Step 6) Choose the most severe resonant frequencies (limited to a maximum of four) to use as dwell frequencies for testing the sample.
- Step 7) Test the sample at these frequencies for one hour, switching from one resonant frequency to the next at 10-15 minute intervals, at the following acceleration levels:

<u>Frequency Range</u>	<u>Acceleration Level</u>
7 Hz ≤ Test Frequency ≤ 50 Hz	1.0 g
51 Hz ≤ Test Frequency ≤ 100 Hz	2.0 g
101 Hz ≤ Test Frequency ≤ 150 Hz	4.0 g
151 Hz ≤ Test Frequency ≤ 200 Hz	8.0 g

Observe the sample periodically for evidence of leakage and/or deterioration. The test may be stopped momentarily to inspect for damage.

- Step 8) Upon completion of the test, the sample shall be removed from the table and turned on one side for 10 minutes to observe for any evidence of leakage.

Los Alamos WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545	Standard Vibration Test Method - Certification of Packagings for Hazardous Materials	Test Instruction:	
		TI-05	
		Page 5 / 5	Rev. 0

6. Inspection and Acceptance Criteria

- 6.1 Following the completion of testing, samples shall be rotated through all planes and examined for evidence of leakage or deterioration that would significantly reduce the ability of the packaging to contain and protect the hazardous contents in the transportation environment. Combination and composite packagings shall then be opened and examined internally for signs of leakage or rupture.
- 6.2 The sample is considered to have passed the vibration test if:
- No leakage or rupture occurs in any of the test samples;
 - The test samples show no signs of deterioration which would significantly reduce the strength of the package; and
 - In the case of composite and combination packagings, upon an internal inspection, it is found that no leakage has occurred from the inner receptacle of composite packagings or from the inner packagings of combination packagings.
- 6.3 Packagings for Radioactive materials shall exhibit no evidence of a loss of shielding integrity that would result in more than a 20% increase in the radiation level at any external surface of the package.

7. Test Report

- 7.1 Following the completion of a vibration test for certification of a packaging design type, a written test report shall be made by the testing technician(s) who performed the test sequence. The report shall be prepared in accordance with 3.2.8 of the Packaging Engineering Manual.

Los Alamos WL-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545	DESIGNED BY: <i>[Signature]</i>	REVIEWED BY: <i>[Signature]</i>	TEST INSTRUCTION: TI-07
	APPROVED BY: <i>[Signature]</i>	DATE: <i>4/1/16</i>	PAGE: 1 / 3 REV: 0
Test Instruction: Standard Penetration Test Method - Certification of Packagings for Hazardous Materials.			

1. Scope

This Test Instruction covers methods of performing standard penetration tests on packaging samples for the purpose of evaluation or certification of the packaging designs for use in transporting infectious or radioactive materials. The tests are intended to demonstrate compliance with the applicable regulatory requirements for the type of packaging and hazardous material being transported. The methods covered are applicable to box or drum shaped samples having a gross mass up to 880 pounds (400 kg).

2. Safety Precautions

- 2.1 These test procedures may involve hazards associated with the operations and equipment. It is the responsibility of operating personnel to remain alert to potential hazards and take the necessary precautions to ensure a safe working environment.

3. Apparatus

- 3.1 The apparatus required to perform the penetration test includes the following components:

- Packagings for **Infectious** materials shall be tested using a cylindrical steel rod having a mass of not less than 7 kg (15 pounds), a diameter not exceeding 38 mm (1.5 inches), and an impact end with edges having a radius not exceeding 6 mm (0.2 inches). The rod shall also have a provision for attachment to a quick-release device at the non-impact end. Tests conducted on samples having a gross mass exceeding 7 kg (15 pounds) require a fixture for holding the penetration rod rigidly in place with the impact end pointing straight up.
- Packagings for **Radioactive** materials shall be tested using a cylindrical steel rod having a mass of not less than 6 kg (13.2 pounds), a diameter of 32 mm (1.25 inches), and a hemispherical impact end. The rod shall also have a provision for attachment to a quick-release device at the non-impact end.
- A quick release device which is adjustable for height of release, and which shall not impart any horizontal force on the rod upon release.

4. Sample Preparation and Conditioning

- 4.1 Samples shall be prepared in such a way that they are representative of the packaging design as offered for transport. Actual hazardous contents shall be replaced with dummy loads having the same physical

Los Alamos <small>W-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545</small>	Std Penetration Test Method - Certification of Packagings for Hazardous Materials.	TEST INSTRUCTION TI-07	
		Page 2 / 3	Rev. 0

characteristics (mass, density, viscosity, grain size, etc.) except where this would invalidate the results of the test. Water may be used as a substitute for hazardous liquids. Inner receptacles or single packagings for **Radioactive** materials shall be filled to not less than 95% of their capacity for solids or 98% for liquids. Primary receptacles for **Infectious** materials shall be filled to 98% capacity. Packagings for live animals should be tested with the live animal being replaced by an appropriate dummy of similar mass.

- 4.2 Packagings for **Infectious** Materials - Samples shall be tested at ambient conditions (e.g., room temperature and humidity).
- 4.3 Packagings for **Radioactive** Materials - Test samples shall be subjected to the water spray test as specified in Test Instruction TI-013 prior to conducting the penetration test.
5. Test Procedures
- 5.1 Packagings for **Infectious** Materials - Two samples of each packaging design type shall be tested. The drop orientations and drop heights required for certification of packaging designs are as follows:
- Packagings with a gross mass of 7 kg (15 pounds) or less - Samples shall be placed on a rigid, flat, horizontal surface. One sample shall be placed on its base. A second sample shall be placed in an orientation perpendicular to that used for the first. For each sample, the steel rod shall be aimed to impact the primary receptacle and then dropped in a vertical free fall from a height of 1 meter (39 inches), measured from the impact end of the steel rod to the surface of the sample.
 - Packagings with a gross mass exceeding 7 kg (15 pounds) - The rod shall be fixed vertically in a hard, level surface. The rod shall protrude from the surface a distance at least equal to that between the primary receptacle(s) and the outer surface of the sample, with a minimum protrusion of 200 mm (7.9 inches). Using the drop tester or equivalent device capable of maintaining proper test sample orientation, one sample shall be dropped in a vertical free fall from a height of 1 m (39 inches), measured from the impact end of the steel rod. A second sample shall be dropped from the same height in an orientation perpendicular to that used for the first. In each instance the packaging must be so oriented that the steel rod would penetrate the primary receptacle(s).
- 5.2 Packagings for **Solid Radioactive** Materials - One sample shall be placed on a rigid, flat, horizontal surface. The steel rod shall be dropped, with its longitudinal axis vertical, a distance of one meter (3.3 feet) onto the center of the weakest part of the sample, so that, if it penetrates sufficiently far, it will hit the containment system.

Los Alamos <small>WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545</small>	Std Penetration Test Method - Certification of Packagings for Hazardous Materials.	<small>TEST INSTRUCTIONS:</small> TI-07	
		<small>Page</small> 3 / 3	<small>Rev.</small> 0

*Multiple
to not include*

5.3 Packagings for Liquid or Gaseous Radioactive Materials - One sample shall be subjected to the test in 6.2 except that the distance of the fall shall be increased to 1.7 meters (5.5 feet).

6. Inspection and Acceptance Criteria

6.1 Following the completion of testing, samples shall be rotated through all planes and examined for evidence of leakage or damage that would significantly reduce the ability of the packaging to contain and protect the hazardous contents in the transportation environment. Combination and composite packagings shall then be opened and examined internally for signs of leakage or rupture.

6.2 Packagings for Infectious and Radioactive materials are considered to have passed the penetration test if, upon inspection, they meet each of the following criteria:

- No leakage from the primary receptacle(s) occurs following each impact.
- Penetration of the secondary packaging is acceptable, provided that no leakage occurs and there is no significant risk of the primary receptacles being released from the secondary packaging.
- Packagings for Radioactive materials exhibit no evidence of a loss of shielding which would result in more than a 20% increase in the radiation level at any external surface of the package.

7. Test Report

7.1 Following the completion of a penetration test for certification of a packaging design type, a written test report shall be made by the testing technician(s) who performed the test procedure. The report shall be prepared in accordance with 3.2.8 of the Packaging Engineering Manual.

LOS ALAMOS WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545	APPROVED BY: <i>[Signature]</i>	APPROVED BY: <i>[Signature]</i>	TEST INSTRUCTION: TI-13
	APPROVED BY: <i>[Signature]</i> 9/3/2/17		PAGE 1 / 3

Test Instruction: Standard Test Sample Preparation and Conditioning Methods
- Certification of Packagings for Radioactive Materials.

1. Scope

- 1.1 This Test Instruction covers methods of standard test sample preparation and conditioning of packagings for radioactive materials.
- 1.2 Standard sample conditioning procedures include water spray, high temperature, and low temperature methods. Samples may be conditioned using any or all of these conditioning methods, as specified in the Test Plan, prior to conducting performance tests on the test samples.

2. Safety Precautions

- 2.1 These test procedures may involve hazards associated with the operations and equipment. It is the responsibility of operating personnel to remain alert to potential hazards and take the necessary precautions to ensure a safe working environment.

3. Apparatus

- 3.1 The primary apparatus for subjecting the sample to the water spray conditioning procedure is the water spray booth. A technical description of this apparatus is provided in 5.3.8 of the Packaging Engineering Manual.
- 3.2 The Thermotron Environmental Chamber is the primary apparatus for conditioning test samples at the proper temperature for performing the high and low temperature conditioning procedures. A technical description of this apparatus is provided in 5.3.5 of the Packaging Engineering Manual.

4. Sample Preparation and Conditioning

- 4.1 Samples shall be prepared in such a way that they are representative of the packaging design as offered for transport. Actual hazardous contents shall be replaced with dummy loads having the same physical characteristics (mass, viscosity, grain size, etc.) except where this would invalidate the results of the test. Water may be used as a substitute for liquids in the drop test under the conditions set forth in the Test Instruction TI-001. Inner receptacles or single packagings shall be filled to not less than 95% of their capacity for solids or 98% for liquids.
- 4.2 When conducting the performance tests required for packagings for radioactive materials (drop test, compression test, and penetration test), it is permissible to use the same test sample for any or all of the performance

Los Alamos WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545	Std Test Sample Preparation and Conditioning Methods - Certification of Packagings for RAM	SEE INSTRUMENT
		TI-13
		Page 2 / 3 Rev. 0

tests in a certification testing sequence. This also includes repeated use of samples for the same test type but with different conditioning procedures. The number of required samples and conditioning methods shall be specified in the Test Plan.

5. Water Spray Conditioning Procedure

- 5.1 The water spray shall be applied from four different directions simultaneously and shall simulate exposure to rainfall of approximately 5 centimeters (2 inches) per hour for at least one hour. The test sample shall be positioned in the spray booth in a manner that will ensure complete wetting of the top and all sides of the sample for the duration of the test. The bottom of the test sample shall rest on a surface which allows water to freely contact the bottom surface of the sample
- 5.2 During the water spray conditioning procedure, test samples shall be inspected at least once every 15 to 20 minutes to determine that the sample is being fully wetted and no significant deterioration has occurred. If the testing technician needs to inspect the sample more closely, it is permissible to temporarily stop the water flow and enter the booth to inspect the sample.
- 5.3 The sample shall then be subjected to the required performance tests in the certification testing sequence within a period not exceeding 2 hours beyond completion of the water spray conditioning procedure.

6. Low Temperature Conditioning Procedure

- 6.1 Packaging components shall be designed to function properly at temperatures as low as -40°C (-40°F) corresponding to possible ambient temperatures that may be encountered during transport and storage operations. Performance of packaging components at low temperature extremes shall be evaluated with regard to the following items:
 - Expansion of liquid contents due to freezing.
 - Expansion/contraction of components relative to the structural or sealing functions of those components.
 - Tensile/ductile properties of components at low temperatures.
 - Shielding design.
- 6.2 Where loss of containment or shielding due to freezing of contents or possible brittle fracture of packaging components is a concern, one sample of the packaging design type shall be conditioned for a period of not less than 24 hours at a temperature of -40°C (-40°F) or less. This sample shall then be subjected to any or all of the performance tests (drop, penetration, etc.) for radioactive material packagings, as specified in the Test Plan. The

Los Alamos <small>WX-11, ANALYSIS AND TESTING LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545</small>	Std Test Sample Preparation and Conditioning	<small>Test Instructions</small> TI-13
	Methods - Certification of Packagings for RAM	<small>Page</small> 3 / 3 <small>Rev.</small> 0

inspection and test report shall be made in accordance with the Test Instructions for those performance tests.

7. High Temperature Conditioning Procedure

7.1 Packaging components shall be designed to function properly at temperatures as high as 70°C (158°F) corresponding to possible ambient temperatures that may be encountered during transport and storage operations. Performance of packaging components at high temperature extremes shall be evaluated with regard to the following items:

- Expansion of contents due to self-heating or prolonged exposure of the package to direct sunlight.
- Expansion/contraction of components relative to the structural or sealing functions of those components.
- Tensile/ductile properties of components at high temperatures.
- Shielding design.

7.2 Where loss of containment or shielding due to exposure of the packaging or contents to high temperatures is a concern, one sample of the packaging design type shall be conditioned for a period of not less than 24 hours at a temperature of 70°C (158°F) or more. This sample shall then be subjected to any or all of the performance tests (drop, penetration, etc.) for radioactive material packagings, as specified in the Test Plan. The inspection and test report shall be made in accordance with the Test Instructions for those performance tests.

8. Test Report

8.1 Following the completion of testing for certification of a packaging design type, a written test report shall be made by the testing technician(s) who performed the test sequence. The report shall be prepared in accordance with 3.2.8 of the Packaging Engineering Manual and shall include a description of any preconditioning procedures performed on test samples.

Los Alamos Engineering Sciences & Applications Los Alamos National Laboratory Los Alamos, New Mexico	WRAP-1 Testing and Evaluation	Document # TR 94-06	
		Page 5 of 7	Rev 0

Appendix 3 - Design Report (Evaluation to 49 CFR design requirements)

DR/TypA, Type A Design Report (Solids, Land Transport), Revision A, 4 pages

Los AlamosENGINEERING SCIENCES & APPLICATIONS
LOS ALAMOS NATIONAL LABORATORY
LOS ALAMOS, NEW MEXICO 87545

Prepared by:

Arthur Grothue

Approved by:

Document:

DR-Type A

Page

Revision

1 of 4

A

Title

Type A Design Report (Solids, Land Transport)Evaluated in accordance with: ☐ DI-01, Rev ____ ☒ Other 49CFRDesign Identification: WRAP-1 Pocket 94-55-7ADesign Type ☒ Single ☐ Combination ☐ CompositePackage Weight (kg) 1000 Gross 960 Net (Nominal)Outer Package Dimensions (Inches): 34¹³/₁₆ high 25¹/₈ wide _____ long

Compliance (Y/N/A)	49/173	Requirement	Design evaluation	Reference
Handling				
Y	.411(a)	The package can be easily handled and properly secured in or on a conveyance during transport.	STD 55 gal drum can be moved by commercial drum handling equipment.	WRAP-1 8 R 07 (1)
N/A	.411(b)	Means for manual handling (10 kg > gross wt > 50 kg)	WT > 50 kg	"
Y	.411(c)	Safely handled by mechanical means if gross weight > 50 kg	STD 55 gal drum can be handled by commercial drum handling equipment	"
Y	.411(d)	Lifting attachments do not impose unsafe stresses on the package with a minimum safety factor of 3.	No lifting attachments are provided	"

B-98

WHC-SD-TP-RPT-023
Revision 0

Los AlamosENGINEERING SCIENCES & APPLICATIONS
LOS ALAMOS NATIONAL LABORATORY
LOS ALAMOS, NEW MEXICO 87545

Title

Type A Design Report (Solids, Land Transport)

Document:

DR-TypA

Page

2 of 4

Revision

A

Compliance 49/173 Requirement
(Y/N/NA)**Design evaluation****Reference**

Y	.411(d)	Lifting attachment failure under excessive load will not impair the ability of the package to meet all other requirements of this subpart. Each feature on the outer surface of the packaging that could be used to lift the package is removable or otherwise capable of being made inoperable for transport, or is designed with strength equivalent to that required for lifting attachments.	No lifting attachments provided	WRAP-1 SKC111
Y	.411(l)	Failure of any tiedown attachment under excessive load does not impair the ability of the package to meet requirements of this subpart.	No lifting attachments provided	"
Design				
Y	.24a(a)(4)	Metallic devices. Nails, staples and other metallic devices shall not protrude into the interior of the outer packaging in such a manner as to be likely to damage inner packagings or receptacles.	Fasteners are smooth well sized and w/relieving loops	"
Y	.24(b)(2) .412(d)	Package effectiveness (Impact resistance, strength, packaging compatibility, containment & shielding) is not substantially reduced over the temperature range encountered during transportation [-40°C to +70°C].	Drum is galvanized steel not subject to changes in properties over the temp range. Gasket materials are Neoprene, Buna-N and solid aluminum gasket meeting UN 28 requirements. Impact tests showed no adverse changes.	"
Y	.24(e)(2) .412(g) .412(h)	The materials and components of the packaging are physically and chemically compatible with each other & with the contents, taking into account the behavior of each under irradiation. For each component of the containment system account is taken of radiolytic decomposition of materials & the generation of gas by chemical reaction and radiolysis.	Inside of Drum is galvanized, inner lid shows slight discoloration due to rusting as a result of moisture in the dummy load. This rusting is not considered significant. Gases are vented thru the NF-1 filter.	"
N/A	.24(e)(3)	Plastic used in packagings and receptacles must be of a type compatible with the fading and may not be permeable to an extent that a hazardous condition is likely to occur during transportation, handling or refilling.		

B-99

MHC-SD-TP-RPT-023
Revision 0

Los Alamos ENGINEERING SCIENCES & APPLICATIONS LOS ALAMOS NATIONAL LABORATORY LOS ALAMOS, NEW MEXICO 87545		Compliance 49/173 (Y/N/NA)	
Type A Design Report (Solids, Land Transport)		Design evaluation	
Reference		Requirement	
Document:	Date:	3 of 4	A
DR-TypA	Revision:	A	

Y	.24(i)(2)	A closure (including gaskets or other closure components, if any) used on a specification packaging must conform to all applicable requirements of the specification.	Closure conforms to WHC sketch	WHC-P-1 sketch	"	Except as otherwise provided in this subchapter, the evolved gases are not poisonous, likely to create a flammable mixture with air or be asphyxiant under normal conditions of transportation;	(3) The packaging is designed so as to preclude an unintentional release of hazardous materials.	As far as practicable, the external surfaces are free from protrusions & are designed & finished for easy decontamination.	.411(b)	Y	.412(c)	The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect.	The smallest overall external dimension of the package is not less than 10 cm	Tamper indication.	.412(b)	Confirmation system is securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport or contents are special form.	The containment system will retain its radioactive contents under the reduction of ambient pressure to .25 kg/cm ² (3.5 psi).	Each valve is protected against damage & unauthorized operation & has an enclosure to retain leakage.	.412(k)	N/A	Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield	Confirmed by test	There is a radiation shield	"
Y	.24(g)	Venting of packagings is permitted only when requirements of the specification.			"	(2) Except as otherwise provided in this subchapter, the evolved gases are not poisonous, likely to create a flammable mixture with air or be asphyxiant under normal conditions of transportation;	(5) the NRC will file preliminary assessment that preliminary assessment will not be released.	Outside of drum is gasketed to prevent corrosion, shape is a standard drum (55 gal) shape	.411(i)	Y	.412(a)	The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect.	Water may collect on lid the drum will be protected from water. The drum is standard drum section & so is gasket	ϕ is 25 inches	.412(a)	The smallest overall external dimension of the package is not less than 10 cm	Packaging is made the TID in leaking bulk	The lock ring, which is fitted with a tamper proofing device, prevents pressure buildup	N/A	Y	.412(i)	The containment system will retain its radioactive contents under the reduction of ambient pressure to .25 kg/cm ² (3.5 psi).	No valves are provided	"
Y	.412(i)	Each valve is protected against damage & unauthorized operation & has an enclosure to retain leakage.			"	Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield	Confirmed by test	There is a radiation shield	"	Y	.412(k)	Confirmed by test	There is a radiation shield	"										

Los AlamosENGINEERING SCIENCES & APPLICATIONS
LOS ALAMOS NATIONAL LABORATORY
LOS ALAMOS, NEW MEXICO 87545

Title

Type A Design Report (Solids, Land Transport)

Document:

DR-TPA

Page

Revision

4 of 4

A

Compliance 49/173 (Y/N/NA)		Requirement	Design evaluation	Reference
Testing				
Y	.412(m)	The completion of the tests in 173.465.	See Test Reports	TR
Marking				
N/A	178.3 (a)(1) 178.350-3	In an unobstructed area, "USA DOT 7A Type A" and "Radioactive Material"	Drawn shall be marked at time of shipment in accordance with	
N/A	178.3 (a)(2)	The name and address or symbol of the manufacturer, or, for a UN standard packaging, the approval agency certifying compliance with the UN standard.	With with-shipper responsibility in ensure.	
N/A	178.3 (a)(3)	The markings must be stamped, embossed, burned, printed or otherwise marked on the packaging to provide adequate accessibility, permanency, contrast, and legibility so as to be readily apparent and understood.		
N/A	178.3 (a)(4)	Unless otherwise specified, letters and numerals must be at least 12.0 mm (0.47 inches) in height except that for packagings of less than or equal to 30 L (7.9 gallons) capacity for liquids or 30 kg (66 pounds) capacity for solids the height must be at least 6.0 mm (0.2 inches).		

B-101

WHC-SD-TP-RPT-023
Revision 0

Los Alamos Engineering Sciences & Applications Los Alamos National Laboratory Los Alamos, New Mexico	WRAP-1 Testing and Evaluation	Document # TR 94-06 Page 6 of 7 Rev 0	
--	--------------------------------------	--	--

Appendix 4 - Listing of Regulatory Requirements

Excerpts from Title 49, Code of Federal Regulations, 7 pages

Appendix 4 - Regulatory Requirements (excerpts from 49 CFR)

173.24 (b) Containment.

Each package used for the shipment of hazardous materials under this subchapter shall be designed, constructed, maintained, filled, its contents so limited, and closed, so that under conditions normally incident to transportation-

(1) Except as otherwise provided in this subchapter, there will be no identifiable (without the use of instruments) release of hazardous materials to the environment;

(2) The effectiveness of the package will not be substantially reduced; for example, impact resistance, strength, packaging compatibility, etc. must be maintained for the minimum and maximum temperatures encountered during transportation;

(3) There will be no mixture of gases or vapors in the package which could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging.

173.24 (c) Authorized Packagings.

A packaging is authorized for a hazardous material only if-

(1) The packaging is prescribed or permitted for the hazardous material in a packaging section specified for that material in Column 8 of the section 172.101 Table and conforms to applicable requirements in the special provisions of Column 7 of the section 172.101 Table and, for specification packagings (including UN standard packagings), the specification requirements in parts 178 and 179 of this subchapter; or

(2) The packaging is permitted under, and conforms to, provisions contained in sections 171.11, 171.12, 171.12a, 173.3, 173.4, 173.5, 173.7, 173.27 or 176.11 of this subchapter.

173.24 (d) DOT Specification and UN Standard Packagings.

DOT specification and UN standard packagings. For DOT specification packagings (including UN standard packagings), conformance to the applicable specifications in parts 178 and 179 of this subchapter is required in all details. For performance-oriented packagings covered by subpart L of part 178 of this subchapter, each packaging must be capable of meeting the performance test requirements specified in subpart M of part 178 of this subchapter for the applicable packing group shown in Column 5 of the section 172.101 Table.

173.24 (e) Compatibility.

(1) Even though certain packagings are specified in this part, it is, nevertheless, the responsibility of the person offering a hazardous material for transportation to ensure that such packagings are compatible with their lading. This particularly applies to corrosivity, permeability, softening, premature aging and embrittlement.

(2) Packaging materials and contents must be such that there will be no significant chemical or galvanic reaction between the materials and contents of the package.

(3) Plastic packagings and receptacles.

(i) Plastic used in packagings and receptacles must be of a type compatible with the lading and may not be permeable to an extent that a hazardous condition is likely to occur during transportation, handling or refilling.

Appendix 4 - Regulatory Requirements (excerpts from 49 CFR)

(ii) Each plastic packaging or receptacle which is used for liquid hazardous materials must be capable of withstanding without failure the procedure specified in appendix B of this part ("Procedure for Testing Chemical Compatibility and Rate Permeation in Plastic Packagings and Receptacles")...

... (4) Mixed contents. Hazardous materials may not be packed or mixed together in the same outer packaging with other hazardous or nonhazardous materials if such materials are capable of reacting dangerously with each other and causing--

- (i) Combustion or dangerous evolution of heat;
- (ii) Evolution of flammable or poisonous gases; or
- (iii) Formation of unstable or corrosive materials.

(5) Packagings used for solids, which may become liquid at temperatures likely to be encountered during transportation, must be capable of containing the hazardous material in the liquid state.

173.24 (f) Closures.

(1) Closures on packagings shall be so designed and closed that under conditions (including the effects of temperature and vibration) normally incident to transportation--

(i) Except as provided in paragraph (g) of this section, there is no identifiable release of hazardous materials to the environment from the opening to which the closure is applied; and

(ii) The closure is secure and leakproof.

(2) Except as otherwise provided in this subchapter, a closure (including gaskets or other closure components, if any) used on a specification packaging must conform to all applicable requirements of the specification.

173.24 (g) Venting.

Venting of packagings, to reduce internal pressure which may develop by the evolution of gas from the contents, is permitted only when--

(1) Transportation by aircraft is not involved;

(2) Except as otherwise provided in this subchapter, the evolved gases are not poisonous, likely to create a flammable mixture with air or be an asphyxiant under normal conditions of transportation;

(3) The packaging is designed so as to preclude an unintentional release of hazardous materials from the receptacle; and

(4) For shipments in bulk packagings, venting is authorized for the specific hazardous material by a special provision in the section 172.101 Table or by the applicable bulk packaging specification in part 178 of this subchapter.

173.24 (h) Outage and Filling Limits.

(1) *General.* When filling packagings and receptacles for liquids, sufficient ullage (outage) must be left to ensure that neither leakage nor permanent distortion of the packaging or receptacle will occur as a result of an expansion of the liquid caused by temperatures likely to be encountered during transportation. Requirements for outage and filling limits for non-bulk and bulk packagings are specified in sections 173.24a(d) and 173.24b(a), respectively.

Appendix 4 - Regulatory Requirements (excerpts from 49 CFR)

(2) *Compressed gases and cryogenic liquids.* Filling limits for compressed gases and cryogenic liquids are specified in sections 173.301 through 173.306 for cylinders and sections 173.314 through 173.319 for bulk packagings.

173.24 (i) Air Transportation.

Packages offered or intended for transportation by aircraft must conform to the general requirements for transportation by aircraft in section 173.27 except as provided in section 171.11 of this subchapter.

173.24a (a) Packaging Design.

Except as provided in section 172.312 of this subchapter:

(1) *Inner packaging closures.* A combination packaging containing liquid hazardous materials must be packed so that closures on inner packagings are upright.

(2) *Friction.* The nature and thickness of the outer packaging must be such that friction during transportation is not likely to generate an amount of heat sufficient to alter dangerously the chemical stability of the contents.

(3) *Securing and cushioning.* Inner packagings of combination packagings must be so packed, secured and cushioned to prevent their breakage or leakage and to control their movement within the outer packaging under conditions normally incident to transportation. Cushioning material must not be capable of reacting dangerously with the contents of the inner packagings.

(4) *Metallic devices.* Nails, staples and other metallic devices shall not protrude into the interior of the outer packaging in such a manner as to be likely to damage inner packagings or receptacles.

(5) *Vibration.* Each non-bulk package must be capable of withstanding, without rupture or leakage, the vibration test procedure specified in section 178.608 of this subchapter.

173.24a (b) Non-bulk Packaging Filling Limits.

(1) A single or composite non-bulk packaging may be filled with a liquid hazardous material only when the specific gravity of the material does not exceed that marked on the packaging, or a specific gravity of 1.2 if not marked...

... (2) Except as otherwise provided in this section, a single or composite non-bulk packaging may not be filled with a solid hazardous material to a gross mass greater than the maximum gross mass marked on the packaging.

(3) A single or composite non-bulk packaging which is tested or marked for liquid hazardous materials may be filled with a solid hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked...

... (5) No hazardous material may remain on the outside of a package after filling.

NOTE: Type A limits are identified in 49 CFR 173.443.

173.24a (c) Mixed Contents.

(1) An outer non-bulk packaging may contain more than one hazardous material only when--

WHC-SD-TP-RPT-023
Revision 0

Appendix 4 - Regulatory Requirements (excerpts from 49 CFR)

(i) The inner and outer packagings used for each hazardous material conform to the relevant packaging sections of this part applicable to that hazardous material;

(ii) The package as prepared for shipment meets the performance tests prescribed in part 178 of this subchapter for the packing group indicating the highest order of hazard for the hazardous materials contained in the package.

(iii) Corrosive materials (except ORM-D) in bottles are further packed in securely closed inner receptacles before packing in outer packagings; and

(iv) For transportation by aircraft, the total net quantity does not exceed the lowest permitted maximum net quantity per package as shown in Column 9a or 9b, as appropriate, of the section 172.101 Table. The permitted maximum net quantity must be calculated in kilograms if a package contains both a liquid and a solid.

(2) A packaging containing inner packagings of Division 6.2 materials may not contain other hazardous materials, except dry ice.

173.24a (d) Liquid Fill Level.

Liquids must not completely fill a receptacle at a temperature of 55 °C (131 °F) or less.

173.411 (a) Handling and Securing.

Except for a package that contains a limited quantity or excepted instrument or article under sections 173.421 through 173.424, each package used for shipment of radioactive materials shall be designed so that:

(a) The package can be easily handled and properly secured in or on a conveyance during transport;

173.411 (b) Manual Handling.

A package with a gross weight exceeding 10 kilograms (22 pounds) and up to 50 kilograms (110 pounds) has a means for manual handling;

173.411 (c) Mechanical Handling.

A package with a gross weight of 50 kilograms (110 pounds) or more can be safely handled by mechanical means;

173.411 (d) Lifting Attachments.

Each lifting attachment on the package, when used in the intended manner, with a minimum safety factor of three, does not impose an unsafe stress on the structure of the package. In addition, the lifting attachment shall be so designed that failure under excessive load would not impair the ability of the package to meet all other requirements of this subpart. Each attachment or other feature on the outer surface of the packaging that could be used to lift the package must be removable or otherwise capable of being made inoperable for transport, or shall be designed with strength equivalent to that required for lifting attachments;

173.411 (e) External Surface Decontamination.

The external surface, as far as practicable, may be easily decontaminated;

173.411 (f) Outer Layer - Pockets, Crevices (Water Collection).

The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect; and

Appendix 4 - Regulatory Requirements (excerpts from 49 CFR)

173.411 (e) Features Added at Time of Transport.

Each feature that is added to the package at the time of transport, and that is not a part of the package, will not reduce the safety of the package.

173.412 Smallest External Dimension.

In addition to meeting the general design requirements prescribed in section 173.411, each Type A packaging shall be designed so that:

(a) The smallest overall external dimension of the package is not less than 10 centimeters (4 inches);

173.412 (b) Tamper Indication.

The outside of the packaging incorporates a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in exclusive use closed transport vehicles, the cargo compartment may be sealed instead of the individual packages;

173.412 (c) External Surface Protrusions, Decontamination.

As far as practicable, the external surfaces are free from protrusions and are designed and finished so that they can be easily decontaminated;

173.412 (d) Containment and Shielding.

Containment and shielding would be maintained during transportation and storage in a temperature range of -40 °C (-40 °F) to 70 °C (158 °F) with account being taken of the possibility of brittle fracture;

173.412 (e) Acceleration, Vibration.

It is able to withstand the effects of any acceleration, vibration, or vibration resonance that may arise during normal transportation, without any deterioration of the effectiveness of closing devices or of the integrity of the package as a whole and without loosening or unintentional release of nuts, bolts, or other securing devices even after repeated use;

173.412 (f) Secure Containment System.

It includes a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form, as demonstrated in accordance with section 173.469 may be considered as a component of the containment system;

173.412 (g) Physical/Chemical Compatibility, Irradiation.

The materials of the packaging and any components or structures are physically and chemically compatible with each other and with the contents, taking into account the behavior of each under irradiation;

173.412 (h) Radiolytic Decomposition, Chemical Reaction, Radiolysis.

For each component of the containment system account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis;

173.412 (i) Reduction of Ambient Pressure.

Appendix 4 - Regulatory Requirements (excerpts from 49 CFR)

The containment system will retain its radioactive contents under the reduction of ambient pressure to .25 kilograms per square centimeter (3.5 pounds per square inch);

173.412 (j) Valve - Protection Enclosure.

Each valve through which the radioactive contents could otherwise escape is protected against damage and unauthorized operation and, except for a pressure relief device, has an enclosure to retain any leakage;

173.412 (k) Shielding Enclosure.

Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield;

173.412 (l) Tiedown Failure.

Failure of any tiedown attachment on the packaging under excessive load will not impair the ability of the package to meet other requirements of this subpart;

173.412 (m) Evaluation and Testing.

When subjected to the tests specified in section 173.465 or evaluated against these tests by any of the methods authorized by section 173.461(a), the packaging will prevent:

- (1) Loss or dispersal of the radioactive contents; and
- (2) Any significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test;

173.412 (n) Evaluation and Testing of Liquid Packagings.

Each packaging designed for liquids will:

- (1) Meet the conditions prescribed in paragraph (m) of this section when subjected to the tests specified in section 173.466 or evaluated against these tests by any of the methods authorized by section 173.461(a);
- (2) For any package with a liquid volume not exceeding 50 cubic centimeters (1.7 fluid ounces), have sufficient suitable absorbent material to absorb twice the volume of the liquid contents. The absorbent material shall be compatible with the package contents and suitably positioned to contact the liquid in the event of leakage; and
- (3) For any package with a liquid volume exceeding 50 cubic centimeters (1.7 fluid ounces), either:
 - (i) Have sufficient absorbent material as prescribed in paragraph (n)(2) of this section; or
 - (ii) Have a containment system composed of primary inner and secondary outer containment components designed to assure retention of the liquid contents within the secondary outer components in the event that the primary inner components leak; and

173.412 (o) Evaluation and Testing of Gas Packagings.

Each package designed for compressed or uncompressed gases other than tritium or argon-37 not exceeding 200 curies will be able to prevent loss of contents when the package is subjected to the tests prescribed in section 173.466 or evaluated against these tests by any of the methods authorized by section 173.461(a).

Appendix 4 - Regulatory Requirements (excerpts from 49 CFR)

178.3 (a) What and How to Mark.

Each packaging manufactured to a DOT specification or a UN Standard shall be marked as follows:

(1) In an unobstructed area, with letters, and numerals identifying the standards or specification (e.g., UN 1A1, DOT 4B240ET, etc.).

(2) Unless otherwise specified in this part, with the name and address or symbol of the manufacturer, or, for a UN standard packaging, the approval agency certifying compliance with the UN standard. Symbols, if used, must be registered with the Associate Administrator for Hazardous Materials Safety. Duplicative symbols are not authorized.

(3) The markings must be stamped, embossed, burned, printed or otherwise marked on the packaging to provide adequate accessibility, permanency, contrast, and legibility so as to be readily apparent and understood.

(4) Unless otherwise specified, letters and numerals must be at least 12.0 mm (0.47 inches) in height except that for packagings of less than or equal to 30 L (7.9 gallons) capacity for liquids or 30 kg (66 pounds) capacity for solids the height must be at least 6.0 mm (0.2 inches).

178.3 (b) Marking.

Packagings may be marked with the United Nations symbol and packaging identification code as provided in this subchapter, in the ICAO Technical Instructions or in Annex 1 to the IMDG Code, provided the person applying these marks has established that the packaging conforms to the applicable provisions of this subchapter, the ICAO Technical Instructions or Annex 1 to the IMDG Code, respectively.

(1) If an indication of the State in whose territory the specified tests are carried out, or of the State authorizing the allocation of the mark, is required by this part (see section 178.503 of this part), the letters "USA" shall be used if the manufacturing and testing occurs in the United States.

(2) If an indication of the name of the manufacturer or other identification of the packaging as specified by the competent authority is required, the name and address or symbol of the person making the mark shall be entered. Symbols, if used, must be registered with the Associate Administrator for hazardous Materials Safety. Duplicate symbols are not authorized.

(3) Packagings manufactured to UN standards in accordance with this subchapter shall be marked as prescribed in section 178.503 of this part.

178.3 (c) Multiple Markings.

Where a packaging conforms to more than one UN standard or DOT specification, the packaging may bear more than one marking, provided the packaging meets all the requirements of each standard or specification. Where more than one marking appears on a packaging, each marking must appear in its entirety.

Los Alamos Engineering Sciences & Applications Los Alamos National Laboratory Los Alamos, New Mexico	WRAP-1 Testing and Evaluation	Document # TR 94-06 Page 7 of 7 Rev 0	
--	--------------------------------------	--	--

Appendix 5 - WHC Drawing of WRAP-1

One Trip Drum, Revision B, 1 page

[illegible]

9554842

ATTACHMENT 4

Approved Final Evaluation Reports
for Dockets 89-13-7A/90-18-7A and 94-37-7A

Consisting of 77 pages,
including coversheet

FINAL EVALUATION REPORT
DEPARTMENT OF TRANSPORTATION SPECIFICATION 7A
TYPE A RADIOACTIVE MATERIAL PACKAGING

DOT-17C 55 Gallon Steel Drum Packagings
Dockets Nos. 89-13-7A and 90-18-7A

Prepared for the U.S. Department of Energy

Westinghouse Hanford Company
Richland, Washington 99352

B-114

FINAL EVALUATION REPORT
DEPARTMENT OF TRANSPORTATION SPECIFICATION 7A
TYPE A RADIOACTIVE MATERIAL PACKAGING

DOT-17C 55 GALLON STEEL DRUM PACKAGINGS
Dockets Nos. 89-13-7A and 90-18-7A

Prepared by:

Vito Romano
Test Engineer

9/28/91
Date

Reviewed by:

S. M. Cruse
Project Engineer

9/28/91
Date

Approved by:

S. H. Hummer, Manager
Program Integration & Control

9-30-91
Date

WHC-SD-TP-RPT-023
Revision 0

Department of Energy
Washington, DC 20585

NOV 26 1991

Mr. Jim Hummer
MSIN G2-02
Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

Dear Mr. Hummer:

The U.S. Department of Energy approves the Final Evaluation Reports submitted by Westinghouse Hanford Company for DOT-7A Program Dockets 89-13-7A and 90-18-7A, and for Dockets 90-17-7A and 90-20-7A.

The Final Evaluation Report for Docket 90-19-7A is approved subject to the following revision: In Section 5, Additional Information, "E. N. Turner" should read "H. E. Turner."

If you have any questions, please contact Steve Primeau of my staff at (301) 601-9004.

Sincerely,

A handwritten signature in black ink, reading "Michael E. Wangler". The signature is fluid and cursive, with the first name "Michael" being the most prominent.

Michael E. Wangler
Acting Director
Division of Transportation and
Packaging Safety

TABLE OF CONTENTS

1.0	INTRODUCTION	1
1.1	BACKGROUND	1
1.2	PURPOSE AND SCOPE	2
2.0	PACKAGING DESCRIPTION	2
2.1	DESIGN	2
2.2	CONTAINMENT SYSTEM	5
2.3	AUTHORIZED CONTENTS	5
3.0	EVALUATION CRITERIA	6
3.1	TEST CRITERIA	6
3.2	PASS/FAIL CRITERIA	6
4.0	PREPARATION OF SPECIMENS FOR TESTING	6
4.1	PRELOADING INSPECTION - 49 CFR 173.462	6
4.2	TEST CONTENTS	7
4.3	LOADING, ASSEMBLY, AND CLOSURE	8
5.0	PACKAGING EVALUATION RESULTS	8
5.1	DESIGN EVALUATION	9
5.1.1	49 CFR 173.24 - Standard Requirements For All Packages	9
5.1.2	49 CFR 173.411 - General Design Requirements	13
5.1.3	49 CFR 173.412 - Additional Design Requirements	14
5.2	COMPLIANCE TEST EVALUATION	17
5.2.1	49 CFR 173.465 - Type A Packaging Tests	17
5.2.2	49 CFR 173.466 - Additional Tests for Type A Packagings Designed for liquids and Gases	20
6.0	CONCLUSION	22
7.0	QUALITY ASSURANCE PROGRAM	24
8.0	PRIMARY USER/MANUFACTURER	25
9.0	REFERENCES	26
	APPENDIX A	27

1.0 INTRODUCTION

1.1 BACKGROUND

This report documents the Department of Transportation Specification 7A Type A (DOT-7A) compliance test results of the DOT-17C, 55 gallon, steel drum packagings provided by Rocky Flats Plant (RFP) per Dockets Nos. 89-13-7A and 90-18-7A. The packagings were evaluated and tested in January 1990 (89-13-7A) and in January 1991 (90-18-7A) for the Department of Energy-Headquarters (DOE-HQ) at the Test Facility located at Westinghouse Hanford Company (WHC), Richland, Washington. Tests performed included Water Spray, Compression, Penetration, and 4-Foot Drop. All DOT-7A Type A requirements of Title 49 of the Code of Federal Regulations (49 CFR) are addressed whether or not the requirement is applicable to the tested package.

Documentation is provided by this report to satisfy the requirements of 49 CFR 173.415(a), Authorized Type A Packages, which states:

"U.S. Department of Transportation (DOT) Specification 7A (178.350 of this subchapter) Type A general packaging. Each shipper of a Specification 7A must maintain on file for at least one (1) year after the latest shipment, and shall provide to DOT on request, a complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification. Specification 7A packagings designed in accordance with the requirements of 178.350 in effect on June 30, 1983 and constructed prior to July 1, 1985 may continue to be used. Packagings either designed or constructed after June 30, 1985, must meet the requirements of 178.350 applicable at the time of their design or construction."

This document will serve to meet the above stated requirements when the packagings are used as prescribed. In addition, a description of the packaging is provided along with an illustration and/or drawings to allow the user/shipper to obtain the packaging and verify that the packaging hardware complies with all of the specifications of the tested packaging.

By itself, this document does not ensure total compliance with all documentation necessary for making a shipment of radioactive material. In addition to documentation of tests, the shipper must maintain on file other appropriate documentation such as comparison of the physical properties of the actual contents to be shipped with those of the simulated payload used in testing to demonstrate equivalency. Also, implementation and documentation of a quality control program is required.

1.2 PURPOSE AND SCOPE

Design verification and testing were performed to demonstrate that the packagings meet the requirements for a DOT-7A Type A packaging. A design verification procedure (Reference 1) was used to document that the packaging meets the design requirements of 49 CFR Parts 173.24, 173.411, 173.412, and 173.462. Testing was performed per 49 CFR 173.465 using Reference 2.

The packagings were evaluated and tested for a payload of 900 lb. for solids of any particulate size which includes Form Nos. 1, 2, and 3 materials. Test unit packages with payloads of 1000 lb. were also tested but are restricted to solids of large particulate size (soil, sand, etc.), Form No. 2, and solid material with no removable or dispersible contamination, Form No. 3. Test packages were loaded with soil and lead bricks to the required weights. A mixture of fluorescein and flour was added as a tracer material to the two packages tested for Form No. 1 materials.

2.0 PACKAGING DESCRIPTION

2.1 DESIGN

The following presents a general description of the packaging:

The tested packaging consisted of a 55-gallon Specification 17C (DOT-17C) open-head steel drum with a 90 mil open-head high density polyethylene (HDPE) liner. The liner is colored with carbon black to protect against ultraviolet rays. The drum and liner heads have bolted ring closures and a gasket on the head. The bolted ring used on the drum is a 12 gauge, square back ring with a 5/8 inch bolt. The liner bolted ring is 16 gauge mild steel, 1/2 inch square back with a 3/8 inch bolt. The drum is vented with a gasketed Nucfil Model No. Nucfil-014 filter screwed into a 3/4 inch Reike fitting which is welded to the drum head. The filter is composed of a carbon-carbon composite element housed in zinc plated mild steel with a stainless steel 304 cover. A one-inch vent hole is located at the center of the liner head. A 10 mil plastic bag is used inside the liner. Illustrations of the packaging configurations can be found in Appendix A.

DIMENSIONS:

	<u>Height (in.)</u>	<u>Diameter (in.)</u>	<u>Volume (gal)</u>
DOT-17C Drum (Interior)	33.25	22.25	55
(Exterior)	35	24	

MATERIALS/METHOD OF CONSTRUCTION:

- Drums - Standard DOT-17C (Steel or Galvanized Steel)
- Drum Lid - Steel with 3/4 in. Rieke Bung fitting welded on (required on filtered configurations only).
- Drum Gasket - Closed cell neoprene meeting ASTM D1056 grade SCE-45, 30-40 durometer, shore-A.
 - Tubular Styrene-Butadiene
 - Butadiene Foam

Pressure Relief Devices:

- Vent Clip - Stainless Steel, 304, Per Rockwell Hanford Dwg. H-2-28798
- Filter - NFTI Model NucFil-014 ("NucFil")

Liners:

- HF-1, HF-2, MD-1 - Per Hanford Standard No. RHO-Ma-222, Rev. 1
 - Open-head molded polyethylene liner with carbon black.
 - Snap-lock closure; use of adhesive bonding optional, but not required.
 - Vent hole (if used) is at the center of the head and is approximately 3/4 in. diameter.
- LL-1 - Open-head molded polyethylene liner without carbon black.
 - Vent hole (if used) is at the center of the head and is approximately 3/4 in. diameter.
- RF-2, RF-3, RF-4 - Per Rocky Flats Plant Standard No. SX-202
 - Open-head molded polyethylene liner with carbon black.
 - Bolted closure ring with gasket.
 - Vent hole (if used) is at the center of the head and is approximately 3/4 in. diameter.
- RF-5, RF-6, RF-7, RF-8 - Open-head, molded, polyethylene (density-0.946 to 0.953 per ASTM-D-792) liner with 2.5% black color (Type IV) or brown color (Type V) added, minimum 110 mil thick.
 - Head is gasketed and the vent hole (if used) is at the center and is approximately 1 in. diameter.

AUTHORIZED CONFIGURATIONS:

- HF-1 Drum with Vent Clip, Liner, Bag and Catalyst; a DOT-17C drum with a vent clip, with a 90 mil HDPE liner (vented or non-vented), which encloses a 4 mil polyethylene bag which encloses the contents.
- HF-2 Drum with Liner; a DOT-17C (filtered or non-filtered) drum with a HDPE liner (90 mil body, 110 mil head, vented or non-vented) which encloses the contents.
- LL-1 Drum with Liner; a DOT-17C (filtered or non-filtered) drum with a HDPE liner (90 mil body, 110 mil head, vented or non-vented) which encloses the contents.
- MD-1 Drum with Liner; a DOT-17C (filtered or non-filtered) drum with a HDPE liner (90 mil body, 110 mil head, vented or non-vented) which encloses the contents.
- RF-1 Drum with Polyethylene Bag; a DOT-17C non-filtered drum with a 4 mil polyethylene bag which encloses the contents. The bag is not required if the lid gasket to body seal interface is sealed with RTV adhesive.
- RF-2 Filtered Drum, Liner with Bag; a DOT-17C filtered (NucFil-014) drum with a 90 mil HDPE liner, which encloses a 4 mil polyethylene bag which encloses the contents.
- RF-3 Drum with Liner; a DOT-17C non-filtered drum with a HDPE liner (90 mil body, 110 mil head, vented or non-vented) which encloses the contents.
- RF-4 Filtered Drum with Vented Liner and Bag; a DOT-17C filtered (Nucfil-014) drum with a vented HDPE 90 mil liner, which encloses a 10 mil plastic bag which encloses the contents.
- RF-5 Filtered Drum, Closed Type IV Liner; a DOT-17C filtered (Nucfil-014) drum with a Type IV HDPE 110 mil liner, which encloses a 10 mil plastic bag which encloses the contents.
- RF-6 Filtered Drum, PVC Bag with Type V Liner; a DOT-17C filtered (Nucfil-014) drum with a 10 mil plastic drum liner (polyethylene bag) which encloses a PVC glovebox bag, which encloses a Type V HDPE 110 mil liner which encloses the contents.
- RF-7 Filtered Drum, Vented Liner with Bag; a DOT-17C filtered (Nucfil-014) drum with a vented Type IV HDPE 110 mil liner, which encloses a 10 mil plastic bag which encloses the contents.
- RF-8 Filtered Drum, PVC Bag with Type V Liner; a DOT-17C filtered (Nucfil-014) drum with a 10 mil plastic drum liner (polyethelene bag), which encloses a PVC glove box bag, which encloses a vented Type V HDPE 110 mil liner, which encloses the contents.

Evaluation and testing of configurations HF-1, HF-2, LL-1, MD-1, RF-1, RF-2, and RF-3 took place at Mound Laboratory and were documented in Revision 1 of the DOT-7A Evaluation Document in 1987. Westinghouse Hanford performed testing and evaluation to qualify the vented liner versions of HF-2, LL-1, MD-1 and RF-3 and configuration RF-4 in January 1990 as part of Docket 89-13-7A. Configurations RF-5, RF-6, RF-7 and RF-8 were qualified based on evaluation and extension of test results in January 1991 as part of Docket 90-18-7A.

2.2 CONTAINMENT SYSTEM

The containment system consists of the DOT-17C drum, drum head and gasket, NucFil filter, bolted ring and various bag and liner arrangements.

2.3 AUTHORIZED CONTENTS

Form Nos. 1, 2, and 3 radioactive contaminated solid materials (Reference 3). The maximum gross weight is 900 lb. for Form No. 1 and 1,000 lb. for Forms Nos. 2 and 3.

- Form No. 1 - Solids of any particulate size.

A packaging certified for these contents is expected to contain radioactive contents of any representative particulate form.

- Form No. 2 - Solids of large particulate size only (cement grade sand or larger).

Contents of a corresponding particulate size, such as soil or construction debris. (Glass or plastic labware having fine particulate available for dispersion would not fit this category and would require a packaging certified for fine particulate, Form No. 1).

- Form No. 3 - Solid material with no removable or dispersible contamination. (For definition, see 49 CFR 173.443, "Contamination Control.")
 1. Metals with activation products;
 2. Forms of metals/alloys/compounds of uranium, thorium;
 3. Solid materials with the radioactive material firmly fixed in place, possibly by the application of a fixing media (paint, etc.);
 4. Solidified material.

NOTE: This is an example only and each form must be analyzed for compliance with the "no removable or dispersible contamination" criterion found in 49 CFR 173.443. Additional restrictions on contents can be found in Section 6.

3.0 EVALUATION CRITERIA

3.1 TEST CRITERIA

When subjected to the tests specified in 49 CFR 173.465 the packaging will prevent:

1. Loss or dispersal of the radioactive contents; and
2. Any significant increase in the radiation levels recorded or calculated at the external surfaces as compared to the condition before the test.

3.2 PASS/FAIL CRITERIA

For all tests, except where otherwise indicated, a package is considered to fail if there is:

1. For Form No. 1: Visible detection of soil, flour, or fluorescent powder. Black light inspection will be used to detect fluorescent powder.

For Form No. 2: Visible detection of soil.

2. During the water spray test, any water hold-up which could damage the package in the event of freezing or water intrusion through the containment barrier will constitute failure of the test.

NOTE: Near failures will be evaluated and further testing performed if deemed necessary to establish the adequacy of the packaging to meet test requirements.

4.0 PREPARATION OF SPECIMENS FOR TESTING

4.1 PRELOADING INSPECTION - 49 CFR 173.462

1. Each packaging was examined before testing to identify and record any faults or damage, including:

- a. Divergence from the specifications or drawings.

The packaging components were as specified.

- b. Defects in construction.

No defects in construction were found.

- c. Corrosion or other deterioration.

No corrosion or other deterioration was found.

d. Distortion of features.

There were no observable distortions of features.

2. Any deviation found under paragraph (1) of this section from the specified design shall be corrected or suitably taken into account in the subsequent evaluation.

No repair or corrections were required.

3. The containment system of the packaging shall be clearly specified.

The containment system of the tested packaging was identified as the drum, drum head and gasket, NucFil filter, bolted ring, and 10 mil bag.

4. The external features of the packaging shall be clearly identified so that reference may be made to any part of it.

The external features of the packaging are clearly identifiable.

4.2 TEST CONTENTS

The test packages were loaded with the following contents. Note that the designations "RF-1" through "RF-5" are used. These were the test unit numbers used in testing under Docket 89-13-7A and are not to be confused with the packaging configuration designators described above.

<u>Package #</u>	<u>Gross Wt. (lb.)</u>	<u>Contents</u>
RF-1	950	Soil and lead bricks with a mixture of 907 grams of flour and 75 grams of fluorescein spread on top of the soil to simulate Form No. 1 contents.
RF-2	1060	Soil and lead bricks to simulate Forms No. 2 and 3 contents.
RF-3	935	Soil and lead bricks with a mixture of 907 grams of flour and 75 grams of fluorescein spread on top of the soil to simulate Form No. 1 contents.
RF-4	1025	Soil and lead bricks to simulate Forms No. 2 and 3 contents.
RF-5	1050	Soil and lead bricks to simulate Forms No. 2 and 3 contents.

The test packages were loaded above the authorized weights of 900 lb. for Form No. 1 contents and 1000 lb. for Forms No. 2 and 3. Since Form No. 1 includes materials of any particulate size, a mixture of fluorescein and flour was added to simulate the worst case particulate. The soil was sufficient to simulate the worst case for Form No. 2 materials.

4.3 LOADING, ASSEMBLY, AND CLOSURE

The liner was placed inside the drum and a plastic bag was placed inside the liner. Soil and lead brick were loaded into the plastic bag until the package was at the desired weight. Flour and fluorescein were spread on top of the soil (for RF-1 and RF-3 only) and the plastic bag was carefully horse-tailed and taped closed. Where fluorescein was used a black light inspection was made to detect contamination. The HDPE liner head and bolted-ring were installed and tightened until snug tight (lugs near touching). Finally the drum head and bolted ring were installed and torqued to 40 ft-lb. while tapping the lid with a non-metallic mallet. A final black light inspection was made at this time. If fluorescein was detected the package was cleaned and reinspected until there was no evidence of fluorescein.

5.0 PACKAGING EVALUATION RESULTS

The following list shows the primary sections of 49 CFR applicable to Type A packaging:

NOTE: This list highlights the performance requirements and is not intended to present an all-encompassing list.

- 173.24 Standard Requirements for All Packages
- 173.411 General Design Requirements
- 173.412 Additional Design Requirements for Type A Packages
- 173.415(a) Authorized Type A Packages
- 173.461 Demonstration of Compliance with Tests
- 173.462 Preparations of Specimens for Testing
- 173.463 Packaging and Shielding - Testing for Integrity
- 173.465 Type A Packaging Tests
- 173.466 Additional Tests for Type A Packagings Designed for Liquids and Gases
- 173.474 Quality Control for Construction of Packaging
- 173.475 Quality Control Requirements Prior to Each Shipment of Radioactive Material
- 178.350 Specification 7A; General Packaging, Type A

5.1 DESIGN EVALUATION

Following is an evaluation of the ability of the packaging to meet performance related regulations. Compliance with all the indicated regulations will signify that the packaging has met the design and performance testing requirement for a DOT-7A Type A packaging.

5.1.1 49 CFR 173.24 - Standard Requirements For All Packages

1. Each package used for shipping hazardous materials under this subchapter shall be so designed and constructed, and its contents so limited, that under conditions normally incident to transportation:
 - a. There will be no significant release of the hazardous materials to the environment;

The packaging meets the intent of this requirement as demonstrated by meeting the more severe Type A packaging requirements of 49 CFR 173.411, .412, .465, and/or .466 as demonstrated in this report.

- b. The effectiveness of the packaging will not be substantially reduced; and

The packaging meets the intent of this requirement as demonstrated by meeting the more severe Type A packaging requirements of 49 CFR 173.411, .412, .465, and/or .466 as demonstrated in this report.

- c. There will be no mixture of gases or vapors in the package which could, through any credible spontaneous increase of heat or pressure, or through an explosion, significantly reduce the effectiveness of the packaging.

The packaging is constructed of stable and durable materials which will provide good protection for the payload. It is the responsibility of the shipper to ensure that the payload will remain stable during transport.

2. Materials for which detailed specifications for packaging are not set forth in this part must be securely packaged in strong, tight packages meeting the requirements of this section.

The packaging has been qualified to meet DOT Specification 7A per 49 CFR 178.350; therefore, this requirement is not applicable.

3. Packaging used for the shipment of hazardous materials under this subchapter shall, unless otherwise specified or exempted therein, meet all of the following design and construction criteria:

- a. Each specification container must be marked as follows:

- (1) In an unobstructed area with letters and numerals identifying the container specification (e.g., DOT-1A, DOT-17E-304HT, DOT-23G40). See Paragraph 178.0-2 of this subchapter.
- (2) The name and address or symbol of person making the mark specified in paragraph (3.)(a)(1) of this section. Symbol letters, if used, must be registered with the Director, Office of Hazardous Materials Transportation (OHMT). Duplicate symbols are not authorized.
- (3) The markings must be stamped, embossed, burned, printed, or otherwise marked on the packaging to provide adequate accessibility, permanency, and contrast so as to be readily apparent and understood.
- (4) Unless otherwise specified, letters and numerals must be at least 1/2 inch high.
- (5) Packaging which does not comply with the applicable specification listed in Parts 178 and 179 of this subchapter must not be marked to indicate such compliance (see Paragraphs 178.0-2 and 179.1 of this subchapter).

It is the shipper's responsibility to ensure that the above requirements have been properly addressed.

- b. Steel used shall be low-carbon, commercial quality steel. Stainless, open hearth, electric, basic oxygen, or other similar quality steels are acceptable. Steel sheets of specified gauges shall comply with the following:

Gauge No.	Nominal Thickness (inches)	Minimum Thickness (inches)
12	0.1046	0.0946
13	0.0897	0.0817
14	0.0747	0.0677
15	0.0673	0.0603
16	0.0598	0.0533
17	0.0538	0.0478
18	0.0478	0.0428
19	0.0418	0.0378
20	0.0359	0.0324
22	0.0299	0.0269
23	0.0269	0.0239
24	0.0239	0.0209
26	0.0179	0.0159
28	0.0149	0.0129
30	0.0120	0.0110

It is the shipper's responsibility to ensure that this design requirement has been properly addressed by the designer and fabricator. The packages tested met this requirement. Measured thickness of the drum and head ranged from 0.055 to 0.058 inch (16 gauge).

- c. Lumber used shall be well seasoned, commercially dry, and free from decay, loose knots, knots that would interfere with nailing, and other defects that would materially lessen the strength.

Wood is not a component of this packaging; therefore, this requirement is not applicable.

- d. Welding and brazing shall be performed in a workmanlike manner using suitable and appropriate techniques, materials, and equipment.

It is the shipper's responsibility to ensure that this design requirement has been properly addressed by the designer and fabricator. The packages tested met this requirement.

- e. Packaging materials and contents shall be such that there will be no significant chemical or galvanic reaction among any of the materials in the package.

The packaging materials and the arrangement of these materials are such that this requirement is met. It is the responsibility of the shipper to ensure that the contents will not react adversely with the packaging.

- f. Closures shall be adequate to prevent inadvertent leakage of the contents under normal conditions incident to transportation. Gasketed closures shall be fitted with gaskets of efficient material which will not be deteriorated by the contents of the container.

Evaluation of the package design indicates this requirement to be satisfied. The bolted ring on the drum is provided with a jam nut which is used to prevent loosening due to acceleration, vibration, or vibration resonance resulting from normal conditions of transportation.

- g. Nails, staples, and other metallic devices shall not protrude into the interior of the outer packaging in such a manner as to be likely to cause failures.

There are no protrusions which could cause failures.

- h. The nature and thickness of the packaging shall be such that friction during transport does not generate any heating likely to decrease the chemical stability of the contents.

The nature and thickness of the packaging are such that friction during transport will not generate any heating which would adversely effect the contents.

4. *Polyethylene packagings and receptacles.*

- a. Polyethylene used in packagings and receptacles must be of a type compatible with the lading and may not be permeable to an extent that a hazardous condition occurs during transportation, handling or refilling.
- b. Each polyethylene packaging or receptacle which is used for liquid hazardous materials must be capable of withstanding without failure the procedure specified in Appendix B of this part ("Procedure for Testing Chemical Compatibility and Rate of Permeation in Polyethylene Packagings and Receptacles") and the maximum rate of permeation of hazardous lading through or into the polyethylene packaging or receptacles may not exceed the following rates:
 - (1) 0.5 percent for materials meeting the definition of a poison according to this subchapter and 2.0 percent for other hazardous materials, when subjected to temperatures no lower than 18°C. (64°F.) for 180 days in accordance with Test Method 1;
 - (2) 0.5 percent for materials meeting the definition of a poison according to this subchapter and 2.0 percent for other hazardous materials, when subjected to a temperature no lower than 50°C. (122°F.) for 28 days in accordance with Test Method 2; or
 - (3) 0.5 percent for materials meeting the definition of a poison according to this subchapter and 2.0 percent for other hazardous materials, when subjected to a temperature no lower than 60°C. (140°F.) for 14 days in accordance with Test Method 3.
- c. Alternative procedures or rates of permeation are permitted if they yield a level of safety equivalent to or greater than that provided by paragraph (4)(b) of this section and are approved by the Director, OHMT.

- d. Each polyethylene packaging used as an outside packaging for materials meeting the definition of a poison according to this subchapter shall be permanently marked, by embossment or other durable means, with the word "POISON" in letters of at least 1/4 inch in height. Additional text or symbols may be included in the marking. The marking shall be located within six inches of the packaging's closure. The requirements of this subparagraph do not apply prior to September 1, 1985.

Item (4)(a), only, is applicable. This packaging is qualified for solid materials only. The shipper is responsible to ensure that the contents will not react adversely with the inner polyethylene bags and/or liners.

5. For specification containers, compliance with the applicable specifications in Parts 178 and 179 of the subchapter shall be required in all details, except as otherwise provided in this subchapter.

The subject packaging, as documented herein, has been qualified to meet Specification 7A packaging requirements per 49 CFR 178.350. It is the shipper's responsibility to ensure that the packagings used are in compliance with the design discussed in this report.

5.1.2 49 CFR 173.411 - General Design Requirements

Except for a package that contains a limited quantity or excepted instrument or article under Paragraphs 173.421 through 173.424, each package used for shipment of radioactive materials shall be designed so that:

1. The package can be easily handled and properly secured in or on a conveyance during transport;

The packages tested meet the intent of this requirement. The shipper should avoid loading a top-heavy package and should be aware of the need for tie-downs. The packages tested met this requirement. The drums were moved using a fork lift truck with a drum lifting attachment and with nylon straps and a hoist.

2. A package with a gross weight exceeding 10 kilograms (22 lb.) and up to 50 kilograms (110 pounds) has a means for manual handling;

The authorized gross weight for this packaging exceeds 110 lb; therefore, this requirement is not applicable.

3. A package with a gross weight of 50 kilograms (110 pounds) or more can be safely handled by mechanical means;

The packages tested met this requirement. The drums were moved using a fork lift truck with a drum lifting attachment and with nylon straps and a hoist.

4. Each lifting attachment on the package, when used in the intended manner, with a minimum safety factor of three, does not impose an unsafe stress on the structure of the package. In addition, the lifting attachment shall be so designed that failure under excessive load would not impair the ability of the package to meet all other requirements of this subpart. Each attachment or other feature on the outer surface of the packaging that could be used to lift the package must be removable or otherwise capable of being made inoperable for transport, or shall be designed with strength equivalent to that required for lifting attachments;

There are no lifting attachments; therefore, this requirement is not applicable.

5. The external surface, as far as practicable, may be easily decontaminated;

All packages tested met the intent of this requirement. The exterior of the package is smooth with a minimum of cracks and crevices in which surface contamination could reside.

6. The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect; and

All packages tested met the intent of this requirement. There were no pockets or crevices where water might collect. Water collecting on the lid during transport will have no adverse effects on the package.

7. Each feature that is added to the package at the time of transport, and that is not a part of the package, will not reduce the safety of the package.

This is a shipper's responsibility since the regulation addresses items added to the packaging at the time of transport.

5.1.3 49 CFR 173.412 - Additional Design Requirements

In addition to meeting the general design requirements prescribed in Paragraph 173.411, each Type A packaging shall be designed so that:

1. The smallest overall external dimension of the package is not less than 10 centimeters (4 inches);

The external dimensions of the packaging exceed the minimum dimensional requirement.

2. The outside of the packaging incorporates a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in exclusive use closed transport vehicles, the cargo compartment may be sealed instead of the individual packages;

It is the responsibility of the shipper to ensure that appropriate precautions are taken to seal the package in a manner that will provide evidence that the package has not been opened. There are several methods to attach a seal to the packaging.

3. As far as practicable, the external surfaces are free from protrusions and are designed and finished so that they can be easily decontaminated;

The tested packagings meet this requirement. The package surface is smooth and free from protrusions and can easily be decontaminated.

4. Containment and shielding would be maintained during transportation and storage in a temperature range of -40°C (-40°F) to 70°C (158°F) with account being taken of the possibility of brittle fracture;

The thickness of the metal used in the packaging is such to alleviate brittle fracture concerns at -40°C (References 4 and 5). The gaskets used also meet this requirement. Liquid is not an authorized content for this packaging; therefore, freezing of contents is not a concern. Temperatures of 70°C will not result in any significant decrease in containment integrity for materials in this packaging (References 6, 7, and 8).

5. It is able to withstand the effects of any acceleration, vibration, or vibration resonance that may arise during normal transportation, without any deterioration of the effectiveness of closing devices or of the integrity of the package as a whole and without loosening or unintentional release of nuts, bolts, or other securing devices even after repeated use;

Evaluation of the packaging design indicates this requirement to be satisfied. The filter is installed using a Rieke Bung fitting which is welded to the drum lid. The filter is screwed into the fitting, torqued to 10 ft-lb. and will be secured by tack welding or the use of Loctite No. 262 (Red). The bolted ring on the drum is provided with a jam nut which is used to prevent loosening due to acceleration, vibration, or vibration resonance resulting during normal conditions of transportation.

6. It includes a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form, as demonstrated in accordance with Paragraph 173.469 may be considered as a component of the containment system;

The tested packaging meets this requirement. The bolted ring is torqued and a jam nut used to prevent unintentional opening during normal conditions of transport. Since this is a filtered packaging, pressure differentials should not occur.

7. The materials of the packaging and any components or structures are physically and chemically compatible with each other and with the contents, taking into account the behavior of each under irradiation;

The materials of the packaging are physically and chemically compatible with each other. It is the shipper's responsibility to ensure that the contents are compatible with the packaging.

8. For each component of the containment system account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis;

It is the shipper's responsibility to ensure that the effects of radiation from the payload will not degrade the performance of the packaging through gas generation, chemical reaction, or radiolysis.

9. The containment system will retain its radioactive contents under the reduction of ambient pressure to .25 kilograms per square centimeter (3.5 pounds per square inch);

Reduced ambient pressure testing of DOT-17C 55 gallon filtered drums was performed previously by Mound with successful results. This is documented in Reference 3, Table C-1. Pressure differentials due to reduction of ambient pressure will not occur in the drum or HDPE liner due to the presence of the NucFil Filter on the drum lid and the hole in the HDPE liner. The 10 mil plastic bag will experience a pressure differential but the extent of inflation will be limited by confinement inside the HDPE liner.

10. Each valve through which the radioactive contents could otherwise escape is protected against damage and unauthorized operation and, except for a pressure relief device, has an enclosure to retain any leakage;

There are no valves used in this packaging; therefore, this requirement is not applicable.

11. Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield;

The packaging does not utilize shielding; therefore, this requirement is not applicable.

12. Failure of any tie down attachment of the packaging under excessive load will not impair the ability of the package to meet other requirements of this subpart;

There are no tie-down attachments on the packaging; therefore, this requirement is not applicable.

5.2 COMPLIANCE TEST EVALUATION

5.2.1 49 CFR 173.465 - Type A Packaging Tests

1. The proposed packaging with proposed contents must be capable of withstanding the tests prescribed in this section. One prototype may be used for all tests if the requirements of paragraph (2) of this section are complied with.
2. Water Spray Test. The water spray test must precede each test or test sequence prescribed in this section. The water spray test shall simulate exposure to rainfall of approximately 5 centimeters (2 inches) per hour for at least one hour. The time interval between the end of the water spray test and the beginning of the next test shall be such that the water has soaked-in to the maximum extent without appreciable drying of the exterior of the specimen. In the absence of evidence to the contrary, this interval may be assumed to be two hours if the water spray is applied from four different directions simultaneously. However, no time interval may elapse if the water spray is applied from each of the four directions consecutively.

Package RF-2 was subjected to the water spray conditions for one hour with no adverse effect or loss of contents. There were no cracks or crevices where water could collect which would cause damage to the package. Removal of the drum head demonstrated that there was no inleakage of water through the filter or gasket. No other packages were tested since water will not have any adverse affects on the metal packaging.

3. Free Drop Test. The free drop test consists of a fall onto the target in a manner that causes maximum damage to the safety features being tested, and:
 - a. For packages weighing 5,000 kilograms (11,000 pounds) or less, the distance of the fall measured from the lowest point of the packaging to the upper surface of the target shall not be less than 1.2 meters (4 feet).
 - b. For packages weighing more than 5,000 kilograms (11,000 pounds), the distance of the fall shall not be less than the distance specified in Table 11, for the applicable packaging weight:

TABLE 11:
FREE-FALL DISTANCE FOR PACKAGING WEIGHING MORE THAN 5,000 KILOGRAMS.

PACKAGING WEIGHT		FREE-FALL DISTANCE	
KILIGRAMS	POUNDS	FEET	METERS
>5,000 TO 10,000...	>11,000 TO 22,000...	3	0.9
>10,000 TO 15,000...	>22,000 TO 33,000...	2	0.6
More than 15,000...	More than 33,000...	1	0.3

The following packages were drop tested from a height of 4 feet:74

<u>Package #</u>	<u>Weight</u>	<u>Drop Orientation</u>
RF-1	950	CG over bolt, flat on bottom.
RF-3	935	Side flat on bolt, CG over bottom rim, flat on top.
RF-4	1025	CG over bolt, flat on bottom.
RF-5	1050	Side flat on bolt, CG over bottom rim, flat on top.

Packaging RF-1: The center of gravity (CG) over closure ring bolt drop caused the side of the drum to crush down to the first hoop (approximately 2.5 inches). The drum head, side and ring were deformed. No loss of contents was detected when inspected by black light. No damage or loss of contents was detected when the package was dropped flat on the bottom. The drum lid and bolted ring remained in place after each drop.

Packaging RF-3: When dropped horizontally on the side where the bolt was located, damage consisted of a flattening of the side by approximately 1/2 inch. The bolt was bent down against the side of the drum twisting the ring. No loss of contents was detected. The drum bottom was bulged out on the bottom and the rim crushed approximately 2 inches when dropped with the CG over the bottom rim. No loss of contents was detected using a black light. No further damage was visible when the drum was dropped flat on the top. No loss of contents was detected. The drum lid and bolted ring remained in place after each drop.

Packaging RF-4: Damage was similar to RF-1 for the CG over bolt drop except that there was slightly more bulging of the head. No loss of contents was detected. No damage or loss of contents was detected when the package was dropped flat on the bottom. The drum lid and bolted ring remained in place after each drop.

Packaging RF-5: Damage to the drum was the same as RF-3 for the side, bottom rim, and flat on top drops. No loss of contents was detected. The drum lid and bolted ring remained in place after each drop.

- c. For Fissile Class II packaging, the free drop specified in subparagraph (a) or (b) of this paragraph shall be preceded by a drop from a height of 0.3 meter (1 foot) on each corner. For cylindrical packaging, the 0.3 meter (1 foot) drop shall be onto each of the quarters of each rim.

This packaging will not be authorized for Fissile Class II materials; therefore, this requirement is not applicable.

- d. For fiberboard or wood rectangular packages not exceeding 50 kilograms (110 pounds) in weight, a separate specimen of the proposed packaging shall be subjected to a free drop onto each corner from a height of 0.3 meter (1 foot).

The drums are made of metal; therefore, this requirement is not applicable.

- e. For fiberboard cylindrical packages weighing not more than 100 kilograms (220 pounds) a separate specimen of the proposed packaging shall be subjected to a free drop onto each of the quarters of each rim from a height of 0.3 meter (1 foot).

The drums are made of metal; therefore, this requirement is not applicable.

- f. The target shall have a flat, horizontal surface of such mass and rigidity that any increase in its resistance to displacement or deformation upon impact by the specimen would not significantly increase the damage to the specimen.

The test pad used meets this requirement.

4. **Compression Test.** The compression test shall last for a period of at least 24 hours and consists of a compressive load equivalent to the greater of the following:
 - a. Five times the weight of the actual package; or
 - b. 1300 kilograms per square meter (265 pounds per square foot) multiplied by the vertically projected area of the package. The compressive load shall be applied uniformly to two opposite sides of the packaging specimen, one of which must be the base on which the package would normally stand.

Packaging RF-2 was loaded with 5525 lb. (525 lb. over the required 5000 lb. load) and left for 24 hours. The packaging was unloaded and inspected. No damage or loss of contents was detected.

5. **Penetration Test.** For the penetration test the packaging specimen shall be placed on a rigid, flat, horizontal surface that will not move while the test is being performed. The test shall consist of:
 - a. A bar of 3.2 centimeters (1.25 inches) in diameter with a hemispherical end weighing 6 kilograms (13.2 pounds) being dropped with its longitudinal axis vertical, onto the center of the weakest part of the packaging specimen, so that, if it penetrates far enough, it will hit the containment system. The bar must not be deformed by the test; and
 - b. The distance of the fall of the bar measured from its lower end to the upper surface of the packaging specimen shall not be less than 1 meter (3.3 feet).

The prescribed bar was dropped from 40 inches onto the drum top center, side, bottom, and directly onto the filter. No damage was observed other than a slight impression. There was no loss of contents or adverse effect to the filter. Further, the NucFil filters have been previously tested and found to function properly after being struck by the penetration test bar (Reference 3).

5.2.2 49 CFR 173.466 - Additional Tests for Type A Packagings Designed for liquids and Gases

In addition to the tests prescribed in 173.465, Type A packaging designed for liquids and gases shall be capable of withstanding the following tests:

1. **Free Drop Test.** The packaging specimen shall fall onto the target in a manner which will cause it to suffer the maximum damage to its containment. The distance of the fall measured from the lowest part of the packaging specimen shall not be less than 9 meters (30 feet).

Liquids are not authorized as contents for this packaging; therefore, this requirement is not applicable.

2. Penetration Test. The specimen must be subjected to the test specified in 173.465(e) except that the distance of the fall shall be 1.7 meters (5.5 feet).

Liquids are not authorized as contents for this packaging; therefore, this requirement is not applicable.

6.0 CONCLUSION

The evaluation and testing indicates that the packagings meet applicable DOT-7A Type A design and compliance test requirements. The packaging should be loaded, assembled, and closed as described in this document (Section 4.3). Deviations from the tested packaging system will require retesting or approval by the Department of Energy. The following restrictions/specifications shall be followed:

1. The shipper shall ensure that the radiation level at any surface would not increase by more than 20 percent (relative to the radiation level prior to the test) as a result of the decrease in distance to the center of the package resulting from the 4-ft drop test. The decrease in distance to the center of the package was 2 inches (maximum).
2. For heavy, bulky materials (i.e., concrete chunks, motors, pumps, etc), equipment or material with sharp corners or protrusions which could result in highly localized forces, the shipper shall ensure that the contents are securely fastened/positioned within the package.
3. The authorized contents and the maximum gross weight for this packagings is as follows:

<u>CONTENTS</u>	<u>MAXIMUM GROSS WEIGHT (lb.)</u>
Form No. 1	900
Forms No. 2 & 3	1000

4. The inner plastic bag liners shall be a minimum of 10 mil.
5. The HDPE liner bolt closure shall be snug tight (lugs near touching).
6. The drum bolt closure shall be tightened to 40 ft-lb with tapping of lock ring during tightening.
7. Gasket material shall have an operating range of -40°F to 158°F.
8. The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing/analysis must be conducted and documented to demonstrate Specification 7A compliance with the actual contents.
9. The NucFil filter shall be installed using Loctite No. 262 (Red) and torqued to 10 ft-lb. or torqued (10 ft-lb.) and tack-welded to prevent unintentional loosening.

The shipper is the organization which actually uses the package and is, therefore, responsible to make sure it is used in accordance with its design. As a part of this, the shipper shall ensure that the design is suitable in all respects for the contents to be shipped. If it is not, testing/analysis must be conducted and documented to demonstrate Specification 7A compliance with the actual contents. The design will dictate many of the limits placed on the contents, such as mass and physical form.

The manufacturer(s) of the packaging described herein is responsible for using materials, processes and controls in the packaging fabrication which are equivalent to those used in the fabrication of the test unit packagings.

7.0 QUALITY ASSURANCE PROGRAM

Paragraphs 173.474 and 173.475 which are restated below provide the Quality Control elements prescribed in 49 CFR. These requirements must be met for all shipments.

173.474. Quality Control for Construction of Packaging

1. Prior to the first use of any packaging for the shipment of radioactive material, the shipper shall determine that:
 - a. The packaging meets the quality of design and construction requirements as specified in this subchapter; and
 - b. The effectiveness of the shielding, containment, and, when required heat transfer characteristics of the package, are within the limits specified for the package design.

173.475. Quality Control Requirements Prior to Each Shipment of Radioactive Materials

Before each shipment of any radioactive materials package, the shipper shall ensure by examination or appropriate tests, that:

1. The packaging is proper for the contents to be shipped;
2. The packaging is in unimpaired physical condition, except for superficial marks;
3. Each closure device of the packaging, including any required gasket, is properly installed, secured, and free of defects;
4. For fissile material, each moderator and neutron absorber, if required, is present and in proper condition;
5. Each special instruction for filling, closing, and preparation of the packaging for shipment has been followed;
6. Each closure, valve, or other opening of the containment system through which the radioactive content might escape is properly closed and sealed;
7. Each packaging containing liquid in excess of an A₁ quantity and intended for air shipment has been tested to show that it will not leak under an ambient atmospheric pressure of not more than 0.25 atmosphere, absolute, (0.25 kilograms per square centimeter or 3.6 pisa). The test must be conducted on the entire containment system, or on any receptacle or vessel within the containment system, to determine compliance with this requirement.
8. The internal pressure of the containment system will not exceed the design pressure during transportation; and

9. External radiation and contamination levels are within the allowable limits specified in this subchapter.

It is critical that controls are in place to ensure that the packaging hardware to be used complies with the specifications given for the packaging hardware tested, described, and evaluated in this document. Each shipper must have a documented program describing how this is achieved, and the degree of certainty, in addition to documentation (audit trail) demonstrating compliance. The quality assurance program is mandated in DOE Order 5480.3, Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes.

8.0 PRIMARY USER/MANUFACTURER

PRIMARY USER(S):

<u>Site/Contact/Phone</u>	<u>Address</u>
RFP D. M. Krieg FTS 320-2377 L. A. Bearly FTS 345-5557	Rocky Flats Plant P.O. Box 464 Golden, CO 80402-0464
Hanford T. Romano FTS 444-0610	Westinghouse Hanford Co. P.O. Box 1970 Richland, WA 99352
LLNL I. Meisel FTS 543-7406	Lawrence-Livermore National Lab. P.O. Box 808 Livermore, CA 94550
MOUND D. A. Edling FTS 774-3919	EG&G/Mound Mound Road Miamisburg, OH 45342

SUPPLIERS:

Liners: HF, MD - Orbitron Products
901 S. Main St.
Delphos, OH 45833
419-692-9060

RF -	Plasti-Drum 1225 Davies Lockport, IL 60441 815-838-7210	K&M Plastic 1601 Pratt Blvd. Elk Grove, IL 60007 312-439-3311
------	--	--

Russell Stanley Co.
8 Ritter Ave.
Woodbridge, NJ 07095
201-634-6000

9.0 REFERENCES

1. "Department of Energy 7A Type A Packaging Design Verification Procedure"
2. DOE/DP/10930-H1, "Department of Energy 7A Type A Packaging Test Procedure"
3. DOE/DP/00053-H1, "DOE Evaluation Document for DOT-7A Type A Packaging"
4. NUREG/CR-1815, "Recommendations for Protecting Against Failure by Brittle Fracture in Ferritic Steel Shipping Containers Up to Four Inches Thick", W. R. Holman and R. T. Langland, June 15, 1981.
5. "ASME Boiler and Pressure Vessel Code," 1989 Addenda, Section III - Division 1, Subsection NB, December 31, 1989.
6. American Institute of Steel Construction, Inc., "Manual of Steel Construction," Eighth edition.
7. American Institute of Timber Construction, "Timber Construction Manual," Second edition, 1974.
8. Ryan Herco Industrial Plastics, "1988-1989 Product Guide"

APPENDIX A
FIGURES

DOT 7A Type A 49 CFR 178.350

Steel Drum, DOT - 17C, 55 - Gallon

39102077.13FH

DOT 7A Type A 49 CFR 178.350

HDPE Liners for Use with DOT 17 C, 55 Gallon Steel Drums

90 mil
HF-1, HF-2, MD-1

90 mil
LL-1

90 mil
RF-2, RF-3, RF-4

Type IV - 110 mil
RF-5, RF-7

Type V - 110 mil
RF-6, RF-8

39103027.1 FH

WHC-SD-TP-RPT-023
Revision 0

FINAL EVALUATION REPORT
DEPARTMENT OF TRANSPORTATION SPECIFICATION 7A
TYPE A RADIOACTIVE MATERIAL PACKAGING

UN1A2, DOT-17C Equivalent, 55-Gallon, Steel Drum Packaging

Docket 94-37-7A

Prepared for the U.S. Department of Energy

Westinghouse Hanford Company
Richland, Washington 99352

B-147

FINAL EVALUATION REPORT
DEPARTMENT OF TRANSPORTATION SPECIFICATION 7A
TYPE A RADIOACTIVE MATERIAL PACKAGING

UN1A2, DOT-17C Equivalent, 55-GALLON, STEEL DRUM PACKAGING

Docket 94-37-7A

Prepared by:	<u>D. L. Kelly</u> D. L. Kelly Test Engineer	<u>10-04-94</u> Date
Reviewed by:	<u>J. H. O'Brien</u> J. H. O'Brien Project Engineer	<u>10/4/94</u> Date
Approved by:	<u>D. McCall</u> D. L. McCall, Acting Manager Packaging Programs and Testing	<u>10/4/94</u> Date

DOE F 1325.9
(9-87)
EVS (07-80)

United States Government

INCOMING: 9500009

Department of Energy

memorandum

DATE: DEC 12 1994
REPLY TO: Transportation & Packaging Safety Div.:Wangler:3-5078
ATTN OF:
SUBJECT: APPROVAL OF FINAL EVALUATION REPORT FOR DOCKET 94-37-7A

TO: June Hennig, Director, Waste Management Division
DOE Richland Operations Office

The Final Evaluation Report for docket 94-37-7A is approved. If you have any questions, please contact Ashok Kapoor at 301-903-6838 or Stephen Primeau at 301-601-9004.

Ashok Kapoor
Michael E. Wangler
Director
Transportation and Packaging
Safety Division, EH-332

cc:
James Hummer, WHC

RECEIVED

DEC 22 1994

TABLE OF CONTENTS

1.0	INTRODUCTION	1
1.1	BACKGROUND	1
1.2	PURPOSE AND SCOPE	2
2.0	PACKAGING DESCRIPTION	2
2.1	DESIGN	2
2.2	CONTAINMENT SYSTEM	4
2.3	AUTHORIZED CONTENTS	4
3.0	EVALUATION CRITERIA	5
3.1	TEST CRITERIA	5
3.2	PASS/FAIL CRITERIA	5
4.0	PREPARATION OF SPECIMENS FOR TESTING	5
4.1	PRELOADING INSPECTION - 49 CFR 173.462	5
4.2	TEST CONTENTS	6
4.3	LOADING, ASSEMBLY, AND CLOSURE	7
5.0	PACKAGING EVALUATION RESULTS	7
5.1	DESIGN EVALUATION	8
5.1.1	49 CFR 173.24 - General Requirements For Packages and Packagings	8
5.1.2	49 CFR 173.24a - Additional General Requirements for Non-Bulk Packagings and Packages	13
5.1.3	49 CFR 173.24b - Additional General Requirements for Bulk Packagings	18
5.1.4	49 CFR 173.411 - General Design Requirements	19
5.1.5	49 CFR 173.412 - Additional Design Requirements	20
5.1.6	49 CFR 178.3 - Marking of Packagings	24
5.2	COMPLIANCE TEST EVALUATION	25
5.2.1	49 CFR 173.465 - Type A Packaging Tests	25
5.2.2	49 CFR 173.466 - Additional Tests for Type A Packagings Designed for Liquids and Gases	29
5.2.3	49 CFR 178.608 - Vibration Standards	30
7.0	QUALITY ASSURANCE PROGRAM	32
8.0	PRIMARY USER/MANUFACTURER	34
9.0	REFERENCES	35
APPENDIX A		36

FINAL EVALUATION REPORT
DEPARTMENT OF TRANSPORTATION SPECIFICATION 7A
TYPE A RADIOACTIVE MATERIAL PACKAGING

UNIA2, DOT-17C Equivalent, 55-GALLON, STEEL DRUM PACKAGING

Docket 94-37-7A

1.0 INTRODUCTION

1.1 BACKGROUND

This report documents the Department of Transportation Specification 7A Type A (DOT-7A) compliance test results of the UNIA2, DOT-17C equivalent, 208 liter (55-gal), galvanized steel drum packagings provided by Lawrence Livermore National Laboratory (LLNL) under docket 94-37-7A. The LLNL configuration is a continuation of the testing and evaluation that took place under docket number 89-13-7A and 90-18-7A for Rocky Flats. The docket number 94-37-7A packaging configuration was evaluated and tested in August 1994 for the Department of Energy-Headquarters (DOE-HQ) at the test facility located at Westinghouse Hanford Company (WHC), Richland, Washington. Tests performed included the vibration and 1.2 m (4-ft) drop tests. All other requirements were evaluated by comparison to previous testing. All DOT-7A Type A requirements of Title 49 of the Code of Federal Regulations (49 CFR) are addressed whether or not the requirement is applicable to the tested package configuration.

Documentation is provided by this report to satisfy the requirements of 49 CFR 173.415(a), Authorized Type A Packages, which states:

"U.S. Department of Transportation (DOT) Specification 7A (178.350 of this subchapter) Type A general packaging. Each shipper of a Specification 7A must maintain on file for at least one year after the latest shipment, and shall provide to DOT on request, a complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification. Specification 7A packagings designed in accordance with the requirements of 178.350 in effect on June 30, 1983, and constructed prior to July 1, 1985, may continue to be used. Packagings either designed or constructed after June 30, 1985, must meet the requirements of 178.350 applicable at the time of their design or construction."

This document will serve to meet the above stated requirements when the packagings are used as prescribed. In addition, a description of the packaging is provided along with an illustration and/or drawings to allow the user/shipper to obtain the packaging and verify that the packaging hardware complies with all of the specifications of the tested packaging.

By itself, this document does not ensure total compliance with all documentation necessary for making a shipment of radioactive material. In addition to documentation of tests, the shipper must maintain on file other appropriate documentation such as comparison of the physical properties of the actual contents to be shipped with those of the simulated payload used in testing to demonstrate equivalency. Also, implementation and documentation of a quality control program is required.

1.2 PURPOSE AND SCOPE

Under docket 94-37-7A, a design verification procedure (Reference 1) was used to document that the packaging meets the design requirements of 49 CFR Parts 173.24, 173.24a, 173.24b, 173.411, 173.412, and 173.462. Testing was performed to demonstrate that the packagings meet the requirements for a DOT-7A Type A packaging. Testing was performed per 49 CFR 173.465 using Reference 2.

The packagings under docket 94-37-7A were tested for a payload of 408 kg (900 lb) for solids of any particulate size which includes Form Nos. 1, 2, and 3 materials. Test unit packages with payloads of 454 kg (1000 lb) were also tested but are restricted to solids of large particulate size (soil, sand, etc.), Form No. 2, and solid material with no removable or dispersible contamination, Form No. 3. Two test packages were loaded with soil and lead bricks to the required weights, and tested for Form No. 1, 2, and 3 materials. A mixture of fluorescein and flour was added as a tracer material to the two packages tested for Form No. 1 materials.

2.0 PACKAGING DESCRIPTION

2.1 DESIGN

The following presents a general description of the packaging tested under docket 94-37-7A:

The tested packaging consisted of a 208 l (55-gal), UN1A2 drum built to be equivalent to a DOT-17C galvanized, open-head steel drum. A 110-mil, open-head, molded, polyethylene liner with 2.5% black (Type IV) added. The liner is colored with carbon black to protect against ultraviolet rays. The drum has a bolted ring closure and a gasket on the head. The bolted ring used on the drum is a 12 gauge, square back ring with a 1.6 cm (5/8 in) bolt. The drum is vented with a gasketed NucFil Model No. NucFil-013 filter screwed into a 1.9 cm (3/4 in) Reike bung fitting which is welded to the drum head. The metal component, of the filter, is made of stainless steel. A 2.54 cm (1-in) vent hole is located at the center of the liner head. This hole is left unplugged. A 3.5-mil polyethylene bag is used inside the liner. Illustrations of the packaging configurations can be found in Appendix A.

DIMENSIONS:

UN1A2, DOT-17C Equivalent Drum

208-liter (55-gallon) drum	Height cm (in)	Diameter cm (in)
Interior	84.46 (33.25)	56.51 (22.25)
Exterior	88.90 (35.00)	61.24 (24.10)

MATERIALS/METHOD OF CONSTRUCTION:

- Drum - UN1A2, DOT-17C Equivalent (Steel or Galvanized Steel).
- Drum Lid - Steel with a 1.9 cm (3/4 in) Rieke Bung fitting welded on (required on filtered configurations only).
- Drum Gasket - Closed cell neoprene meeting ASTM D1056 grade SCE-45, 30-40 durometer, shore-A.
 - Tubular Styrene-Butadiene.
 - Butadiene Foam.

Pressure Relief Device:

- Filter - Nuclear Filter Technology, Incorporated, Model NucFil-013.

Liner:

- LL-2 - Open-head, molded, polyethylene (density is 0.946 to 0.953 per ASTM-D-792 [ASTM 1986]) liner with 2.5% black (Type IV) added, minimum 110-mil thick.
 - Vent hole is unplugged, and is at the center with approximately 2.54 cm (1-in) diameter.

AUTHORIZED CONFIGURATIONS:

- LL-2 Filtered drum, open Type IV liner, with 3.5-mil bag. A DOT-17C (UN1A2) filtered (NucFil-013) drum with a Type IV liner (unplugged), which encloses a 3.5-mil polyethylene bag, which encloses the contents.

Westinghouse Hanford Company performed testing and evaluation to qualify the LL-2 configuration under docket 94-37-7A in August 1994. This configuration is similar the RF-7 configuration evaluated under docket 90-18-7A, with the exception that a thinner, 3.5-mil polyethylene liner bag replaced the 10-mil polyethylene liner bag.

2.2 CONTAINMENT SYSTEM

The containment system consists of the UN1A2, DOT-17C equivalent drum, drum head and gasket, Nucfil-013 filter, bolted ring and various bag and liner arrangements.

2.3 AUTHORIZED CONTENTS

Form Nos. 1, 2, and 3 radioactive contaminated solid materials (Reference 3). The maximum gross weight is 408 kg (900 lb) for Form No. 1 and 454 kg (1000 lb) for Form Nos. 2 and 3.

- Form No. 1 - Solids of any particulate size.

A packaging certified for these contents is expected to contain radioactive contents of any representative particulate form.

- Form No. 2 - Solids of large particulate size only (cement grade sand or larger).

Contents of a corresponding particulate size, such as soil or construction debris. (Glass or plastic labware having fine particulate available for dispersion would not fit this category and would require a packaging certified for fine particulate, Form No. 1).

- Form No. 3 - Solid material with no removable or dispersible contamination. (For definition, see 49 CFR 173.443, "Contamination Control.")
 1. Metals with activation products;
 2. Forms of metals/alloys/compounds of uranium, thorium;
 3. Solid materials with the radioactive material firmly fixed in place, possibly by the application of a fixing media (paint, etc.);
 4. Solidified material.

NOTE: This is an example only and each form must be analyzed for compliance with the "no removable or dispersible contamination" criterion found in 49 CFR 173.443. Additional restrictions on contents can be found in Section 6 of this report.

3.0 EVALUATION CRITERIA

3.1 TEST CRITERIA

When subjected to the tests specified in 49 CFR 173.465 the packaging will prevent:

1. Loss or dispersal of the radioactive contents; and
2. Any significant increase in the radiation levels recorded or calculated at the external surfaces as compared to the condition before the test.

3.2 PASS/FAIL CRITERIA

For all tests, except where otherwise indicated, a package is considered to fail if there is:

1. For Form No. 1: Visible detection of soil, flour, or fluorescent powder. Black light inspection will be used to detect fluorescent powder.

For Form No. 2: Visible detection of soil.

2. During the water spray test, any water hold-up which could damage the package in the event of freezing or water intrusion through the containment barrier will constitute failure of the test.

NOTE: Near failures will be evaluated and further testing performed if deemed necessary to establish the adequacy of the packaging to meet test requirements.

4.0 PREPARATION OF SPECIMENS FOR TESTING

4.1 PRELOADING INSPECTION - 49 CFR 173.462

- a. Each packaging was examined before testing to identify and record any faults or damage, including:

1. Divergence from the specifications or drawings.

The packaging components were as specified.

2. Defects in construction.

No defects in construction were found.

3. Corrosion or other deterioration.

No corrosion or other deterioration was found.

4. Distortion of features.

There were no observable distortions of features.

- b. Any deviation found under paragraph (a) of this section from the specified design shall be corrected or suitably taken into account in the subsequent evaluation.

No repair or corrections were required.

- c. The containment system of the packaging shall be clearly specified.

The containment system of the packaging tested under docket 94-37-7A (LL-2) was identified as the drum, drum head and gasket, NucFil-013 filter, bolted ring, and 3.5-mil bag.

- d. The external features of the packaging shall be clearly identified so that reference may be made to any part of it.

The external features of the packaging are clearly identifiable.

4.2 TEST CONTENTS

Under docket 94-37-7A, the test packages were loaded with the following contents. Note that the test unit numbers designated for the LL-2 configuration under docket 94-37-7A are 37-TU-01 through 37-TU-04.

<u>Package #</u>	<u>Gross Wt. kg (lb)</u>	<u>Contents</u>
37-TU-01	465 (1025)	Soil and lead bricks to simulate Form No. 2 and 3 contents.
37-TU-02	449 (989)	Soil and lead bricks to simulate Form No. 2 and 3 contents. A mixture of 907 grams (2 lb) of flour and 75 g (3 oz) of fluorescein was spread on top of the soil to simulate Form No. 1 contents.
37-TU-03	459 (1011)	Soil and lead bricks to simulate Form No. 2 and 3 contents.
37-TU-04	422 (930)	Soil and lead bricks to simulate Form No. 2 and 3 contents. A mixture of 907 grams (2 lb) of flour and 75 g (3 oz) of fluorescein spread on top of the soil to simulate Form No. 1 contents.

The test packages were loaded above the authorized weights of 408 kg (900 lb) for Form No. 1, 2, and 3 contents and 454 kg (1000 lb) for Forms No. 2 and 3. Since Form No. 1 includes materials of any particulate size, a mixture of fluorescein (75 g [3 oz]) and flour (907 g [2 lbs]) was added to

simulate the worst case particulate. The soil was sufficient to simulate the worst case for Form No. 2 materials.

4.3 LOADING, ASSEMBLY, AND CLOSURE

Under docket 94-37-7A, the Type IV liner was placed inside the UNIA2, DOT-17C equivalent drum and a 3.5-mil polyethylene bag was placed inside the liner. Lead bricks were placed into vinyl glovebox bagout bags that were horse-tailed and taped shut. The glovebox bagout bags were then placed into secondary plastic bags that were horse-tailed and taped shut. Soil was loaded around the bagged lead bricks until the package was at the desired weight. A mixture of flour (907 g [2 lbs]) and fluorescein (75 g [3 oz]) was added to the bottom of the 3.5-mil bag prior to loading, and also spread on top of the soil prior to closure of the 3.5-mil bag (for 37-TU-02 and 37-TU-04 only). The 3.5-mil polyethylene bag was carefully horse-tailed and taped closed. Where fluorescein was used, a black light inspection was made to detect contamination prior to the testing conducted. The Type IV liner lid was placed on top of the liner and snapped down. No tape or sealant was used. The vent hole in the liner lid was left open. Finally the drum head and bolted ring were installed and torqued to 54 Nm (40 ft-lb) while tapping the lid with a non-metallic mallet. The drum filter vent (NucFil-013) was torqued to 20 Nm (15 ft-lbs). No Loctite 262 (red) was used. A final black light inspection was made at this time. If fluorescein was detected the package was cleaned and reinspected until there was no evidence of fluorescein.

5.0 PACKAGING EVALUATION RESULTS

The following list shows the primary sections of 49 CFR applicable to Type A packaging:

NOTE: This list highlights the performance requirements and is not intended to present an all-encompassing list.

- 173.24 General Requirements for Packagings and Packages
- 173.24a Additional General Requirements for Non-Bulk Packagings and Packages
- 173.24b Additional General Requirements for Bulk Packagings
- 173.411 General Design Requirements
- 173.412 Additional Design Requirements for Type A Packages
- 173.415(a) Authorized Type A Packages
- 173.442 Thermal Limitations
- 173.461 Demonstration of Compliance with Tests
- 173.462 Preparations of Specimens for Testing

- 173.463 Packaging and Shielding - Testing for Integrity
- 173.465 Type A Packaging Tests
- 173.466 Additional Tests for Type A Packagings Designed for Liquids and Gases
- 173.474 Quality Control for Construction of Packaging
- 173.475 Quality Control Requirements Prior to Each Shipment of Radioactive Material
- 178.3 Marking of Packagings
- 178.350 Specification 7A; General Packaging, Type A
- 178.608 Vibration Standards

5.1 DESIGN EVALUATION

Following is an evaluation of the ability of the packaging to meet performance related regulations. Compliance with all the indicated regulations will signify that the packaging has met the design and performance testing requirement for a DOT-7A Type A packaging.

5.1.1 49 CFR 173.24 - General Requirements For Packages and Packagings

- a. Applicability. Except as otherwise provided in this subchapter, the provisions of this section apply to--
 - (1) Bulk and non-bulk packagings;
 - (2) New packagings and packagings which are reused; and
 - (3) Specification and non-specification packagings.

The packagings described have been tested and/or evaluated under docket 94-37-7A and meet DOT 7A Type A packaging criteria.

- b. Each package used for shipment of hazardous materials under this subchapter shall be designed, constructed, maintained, filled, its contents so limited, and closed so that under conditions normally incident to transportation--
 - (1) Except as otherwise provided in this subchapter, there will be no identifiable (without the use of instruments) release of hazardous materials to the environment;

The packaging meets the intent of this requirement as demonstrated by meeting the more severe Type A packaging requirements of 49 CFR 173.411, .412, .465, and/or .466 as demonstrated in this report.

- (2) The effectiveness of the package will not be substantially reduced; for example, impact resistance, strength, packaging compatibility, etc. must be maintained for the minimum and maximum temperatures encountered during transportation;

The packaging meets the intent of this requirement as demonstrated by meeting the more severe Type A packaging requirements of 49 CFR 173.411, .412, .465, and/or .466 as demonstrated in this report.

- (3) There will be no mixture of gases or vapors in the package which could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging.

The packaging is constructed of stable and durable materials which will provide good protection for the payload. It is the responsibility of the shipper to ensure that the payload will remain stable during transport.

- c. Authorized packagings. A packaging is authorized for a hazardous material only if--

- (1) The packaging is prescribed or permitted for the hazardous material in a packaging section specified for that material in Column 8 of the section 172.101 Table and conforms to applicable requirements in the special provisions of Column 7 of the section 172.101 Table and, for specification packagings (including U.N. standard packagings), the specification requirements in parts 178 and 179 of this subchapter; or
- (2) The packaging is permitted under, and conforms to, provisions contained in sections 171.11, 171.12, 171.12a, 173.3, 173.4, 173.5, 173.7, 173.27, or 176.11 of this subchapter.

The subject packaging, as documented herein, has been qualified to meet Specification 7A packaging requirements per 49 CFR 178.350. It is the shipper's responsibility to ensure that the packagings used are in compliance with the design discussed in this report.

- d. DOT specification and U.N. standard packagings. For DOT specification packagings (including U.N. standard packagings, conformance to the applicable specifications in parts 178 and 179 of this subchapter is required in all details. For performance-oriented packagings covered by subpart L of part 178 of this subchapter, each packaging must be capable of meeting the performance test requirements specified in subpart M of part 178 of this subchapter for the applicable packing group shown in Column 5 of the section 172.101 Table.

The subject packaging, as documented herein, has been qualified to meet Specification 7A packaging requirements per 49 CFR 178.350. It is the shipper's responsibility to ensure that the packagings used are in compliance with the design discussed in this report.

e. Compatibility.

- (1) Even though certain packagings are specified in this part, it is, nevertheless, the responsibility of the person offering a hazardous material for transportation to ensure that such packagings are compatible with their lading. This particularly applies to corrosivity, permeability, softening, premature aging and embrittlement.

It is the shipper's responsibility to ensure that these design requirements have been properly addressed by the designer and fabricator. The packages tested and/or evaluated under docket 94-37-7A meet this requirement.

Drums are steel or galvanized steel, 16 gauge (measured thickness of drum and head ranged from 0.055 to 0.058 inches).

Wood is not a component of this packaging; therefore, any defects pertaining to lumber are not applicable to this packaging.

It is the shipper's responsibility to ensure that welding and brazing are performed in a workmanlike manner using suitable and appropriate techniques, materials, and equipment.

- (2) Packaging materials and contents must be such that there will be no significant chemical or galvanic reaction between the materials and contents of the package.

The packaging materials and the arrangement of these materials are such that this requirement is met. It is the responsibility of the shipper to ensure that the contents will not react adversely with the packaging.

- (3) Plastic packagings and receptacles.

- (i) Plastic used in packagings and receptacles must be of a type compatible with the lading and may not be permeable to an extent that a hazardous condition is likely to occur during transportation, handling or refilling.
 - (ii) Each plastic packaging or receptacle which is used for liquid hazardous materials must be capable of withstanding without failure the procedure specified in Appendix B of this part ("Procedure for Testing Chemical Compatibility and Rate of Permeation in Plastic Packagings and Receptacles"). The procedure specified in Appendix B of this part must be performed on each plastic packaging or receptacle used for Packing Group I materials. The maximum rate of permeation of hazardous lading through or into the plastic packaging or receptacles may not exceed 0.5 percent for materials meeting the definition of a Division 6.1 material according to section 173.132 and 2.0 percent for other hazardous materials, when subjected to temperatures no lower than--

- (A) 18 °C (64 °F) for 180 days in accordance with Test Method 1 in Appendix B of this part;
 - (B) 50 °C (122 °F) for 28 days in accordance with Test Method 2 in Appendix B of this part; or
 - (C) 60 °C (140 °F) for 14 days in accordance with Test Method 3 in Appendix B of this part.
- (iii) Alternative procedures or rates of permeation are permitted if they yield a level of safety equivalent to or greater than that provided by paragraph (e)(3)(ii) of this section and are specifically approved by the Associate Administrator for Hazardous Materials Safety.

Item (3)(i), only, is applicable. This packaging is qualified for solid materials only. The shipper is responsible to ensure that the contents will not react adversely with the inner polyethylene bags and/or liners.

- (4) Mixed contents. Hazardous materials may not be packed or mixed together in the same outer packaging with other hazardous or nonhazardous materials if such materials are capable of reacting dangerously with each other and causing--
- (i) Combustion or dangerous evolution of heat;
 - (ii) Evolution of flammable or poisonous gases; or
 - (iii) Formation of unstable or corrosive materials.

Hazardous and/or nonhazardous materials will not be packed or mixed together so as to cause a reaction. The subject packaging, as documented herein, has been qualified to meet Specification 7A packaging requirements per 49 CFR 178.350. It is the shipper's responsibility to ensure that materials will not be combined so as to cause a reaction.

- (5) Packagings used for solids, which may become liquid at temperatures likely to be encountered during transportation, must be capable of containing the hazardous material in the liquid state.

The packaging described in this report is not authorized for liquids. It is the shipper's responsibility to ensure that the packagings used are in compliance with the design discussed in this report.

f. Closures.

- (1) Closures on packagings shall be so designed and closed that under conditions (including the effects of temperature and vibration) normally incident to transportation--

- (i) Except as provided in paragraph (g) of this section, there is no identifiable release of hazardous materials to the environment from the opening to which the closure is applied; and
- (ii) The closure is secure and leakproof.
- (2) Except as otherwise provided in this subchapter, a closure (including gaskets or other closure components, if any) used on a specification packaging must conform to all applicable requirements of the specification.

Testing and evaluation of the package design indicates this requirement to be satisfied. The bolted ring on the drum is provided with a jam nut which is used to prevent loosening due to acceleration, vibration, or vibration resonance resulting from normal conditions of transportation.

Prior to the vibration testing conducted under docket 94-37-7A, one drum (37-TU-04) was filled with a 45.4 kg (100-lb) bag of cement and vibrated under the criteria found in 49 CFR 178.608, "Vibration Standards," for an extended period of 3 hours. The NucFil-013 filter had been torqued to 20 Nm (15 ft-lbs). Loctite 262 (red) had not been applied to the NucFil filter prior to torquing. After the 3-hour time period, the filter was checked to verify if it had loosened. The filter did not loosen, and remained at the same 20 Nm (15 ft-lb) torque.

Vibration testing was then conducted for 1 hour on the test units filled with the actual simulated contents. All NucFil-013 filters were torqued to 20 Nm (15 ft-lbs), and no Loctite 262 (red) was applied to the filter prior to torquing. The filter was checked after the testing of the test units, and none had loosened.

- g. Venting. Venting of packagings, to reduce internal pressure which may develop by the evolution of gas from the contents, is permitted only when--
 - (1) Transportation by aircraft is not involved;
 - (2) Except as otherwise provided in this subchapter, the evolved gases are not poisonous, likely to create a flammable mixture with air or be an asphyxiant under normal conditions of transportation;
 - (3) The packaging is designed so as to preclude an unintentional release of hazardous materials from the receptacle; and
 - (4) For shipments in bulk packagings, venting is authorized for the specific hazardous material by a special provision in the section 172.101 Table or by the applicable bulk packaging specification in part 178 of this subchapter.

The packaging described and tested is not authorized for transportation by aircraft, and utilizes a NucFil-013 filter as a pressure relief device. Venting is authorized by the packaging specification. The gases that are vented will not, under conditions normal to transportation, result in a flammable mixture with air, or be an asphyxiant.

h. Outage and filling limits--

- (1) *General*. When filling packagings and receptacles for liquids, sufficient ullage (outage) must be left to ensure that neither leakage nor permanent distortion of the packaging or receptacle will occur as a result of an expansion of the liquid caused by temperatures likely to be encountered during transportation. Requirements for outage and filling limits for non-bulk and bulk packaging are specified in section 173.24a(d) and 173.24b(a), respectively.
- (2) *Compressed gases and cryogenic liquids*. Filling limits for compressed gases and cryogenic liquids are specified in sections 173.301 through 173.306 for cylinders and sections 173.314 through 173.319 for bulk packagings.
 - (i) *Air transportation*. Packages offered or intended for transportation by aircraft must conform to the general requirements for transportation by aircraft in section 171.11 of this subchapter.

The packaging described and tested is not authorized for shipment of liquids or gases. Air transportation is not authorized.

5.1.2 49 CFR 173.24a - Additional General Requirements for
Non-Bulk Packagings and Packages

NOTE: This section is not applicable as this is a bulk packaging (gross weight exceeds 882 lbs). However, specific areas have been addressed for reporting purposes to provide as much information as possible on the packaging configuration tested.

- a. Packaging design. Except as provided in section 172.312 of this subchapter:
 - (1) *Inner packaging closures*. A combination packaging containing liquid hazardous materials must be packed so that closures on inner packagings are upright.
- Liquids are not authorized for transport in the packaging configurations tested.
- (2) *Friction*. The nature and thickness of the outer packaging must be such that friction during transportation is not likely to generate an amount of heat sufficient to alter dangerously the chemical stability of the contents.

The nature and thickness of the packaging are such that friction during transport will not generate any heating which would adversely effect the contents.

- (3) *Securing and cushioning.* Inner packagings of combination packagings must be so packed, secured and cushioned to prevent their breakage or leakage and to control their movement within the outer packaging under conditions normally incident to transportation. Cushioning material must not be capable of reacting dangerously with the contents of the inner packagings.

For heavy, bulky materials (e.g., concrete chunks, motors, pumps, etc.), equipment or materials with sharp corners or protrusions, or material/container geometries that could result in highly localized forces, the shipper must ensure that the contents are securely fastened/positioned within the package.

- (4) *Metallic devices.* Nails, staples and other metallic devices shall not protrude into the interior of the outer packaging in such a manner as to be likely to damage inner packagings or receptacles.

There are no protrusions that could cause failures.

- (5) *Vibration.* Each non-bulk package must be capable of withstanding, without rupture or leakage, the vibration test procedure specified in section 178.608 of this subchapter.

The package was judged to pass this requirement. Visual examination of the packaging identified no rupture or leakage. Type A packagings are required "to withstand the effects of any acceleration, vibration, or vibration resonance that may arise during normal transportation" [see 49 CFR 173.412 (e)]. The test identified in this section was applied to support the ability of the packaging to meet the requirement.

Prior to the vibration testing that was conducted, one drum (test unit 37-TU-04) was filled with a 45.4 kg (100-lb) bag of cement and vibrated under the criteria found in 49 CFR 178.608, "Vibration Standards," for an extended period of 3 hours. After the 3-hour time period, the NucFil-013 filter was checked to verify if it had loosened. The filter did not loosen, and remained at the same 20 Nm (15 ft-lb) torque.

All drums that were vibration tested under docket 94-37-7A had the NucFil-013 filter installed using a Rieke Bung fitting which is welded to the drum lid. The filter was screwed into the fitting and torqued to 20 Nm (15 ft-lbs). Loctite 262 (red) had not been applied to the NucFil-013 filter prior to torquing. The bolted ring on the drum is provided with a jam nut that is used to prevent loosening due to acceleration, vibration, or vibration resonance resulting during normal conditions of transportation. The drum bolt was torqued 54 Nm (40 ft-lbs). Vibration testing was then conducted for 1 hour on the test units filled with the actual simulated

contents. All NucFil-013 filters were torqued to 20 Nm (15 ft-lbs), and Loctite 262 (red) was not applied to the filter prior to torquing. The filter was checked after the testing of the test units, and it was found that none had loosened.

b. Non-bulk packaging filling limits.

- (1) A single or composite non-bulk packaging may be filled with a liquid hazardous material only when the specific gravity of the material does not exceed that marked on the packaging, or a specific gravity of 1.2 if not marked, except as follows:
 - (i) A Packing Group I packaging may be used for a Packing Group II material with a specific gravity not exceeding the greater of 1.8, or 1.5 times the specific gravity marked on the packaging, provided all the performance criteria can still be met with the higher specific gravity material;
 - (ii) A Packing Group I packaging may be used for a Packing Group III material with a specific gravity not exceeding the greater of 2.7, or 2.25 times the specific gravity marked on the packaging, provided all the performance criteria can still be met with the higher specific gravity material; and
 - (iii) A Packing Group II packaging may be used for a Packing Group III material with a specific gravity not exceeding the greater of 1.8, or 1.5 times the specific gravity marked on the packaging, provided all the performance criteria can still be met with the higher specific gravity material.

This is not applicable to a Type A packaging as Type A packaging does not incorporate Packing Groups. Liquids are not authorized for transport in this packaging configuration.

- (2) Except as otherwise provided in this section, a single or composite non-bulk packaging may not be filled with a solid hazardous material to a gross mass greater than the maximum gross mass marked on the packaging.

Packagings were tested for solids; Form No. 1, 2, and 3. Gross weight of packaging for shipping Form No. 1, Form No. 2, and Form No. 3 is not to exceed 408 kg (900 lbs); gross weight of packaging for shipping Form No. 2 and Form No. 3 is not to exceed 454 kg (1000 lbs). Shipper's responsibility to ensure.

- (3) A single or composite non-bulk packaging which is tested and marked for liquid hazardous materials may be filled with a solid hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked. In addition:

- (i) A single or composite non-bulk packaging which is tested and marked for Packing Group I liquid hazardous materials may be filled with a solid Packing Group II hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by 1.5, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked.
- (ii) A single or composite non-bulk packaging which is tested and marked for Packing Group I liquid hazardous materials may be filled with a solid Packing Group III hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by 2.25, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked.
- (iii) A single or composite non-bulk packaging which is tested and marked for Packing Group II liquid hazardous materials may be filled with a solid Packing Group III hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by 1.5, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked.

This is not applicable to a Type A packaging as Type A packaging does not incorporate Packing Groups. Packagings under docket 94-37-7A were tested for shipment of solids, Form Nos. 1, 2, and 3. Liquids are not authorized for transportation.

- (4) Packagings tested as prescribed in section 178.605 of this subchapter and marked with the hydrostatic test pressure as prescribed in section 178.503(a)(5) of this subchapter may be used for liquids only when the vapor pressure of the liquid conforms to one of the following:
 - (i) The vapor pressure must be such that the total pressure in the packaging [i.e., the vapor pressure of the liquid plus the partial pressure of air or other inert gases, less 100 kPa (15 psi) at 55 °C (131 °F), determined on the basis of a maximum degree of filling in accordance with paragraph (b)(1) of this section and a filling temperature of 15 °C (59 °F)], will not exceed two-thirds of the marked test pressure;
 - (ii) The vapor pressure at 50 °C (122 °F) must be less than four-sevenths of the sum of the marked test pressure plus 100 kPa (15 psi); or
 - (iii) The vapor pressure at 55 °C (131 °F) must be less than two-thirds of the sum of the marked test pressure plus 100 kPa (15 psi).

This is not applicable to Type A packaging as section 178.605 does not pertain to specification packagings. Liquids are not authorized for transportation in this packaging configuration.

- (5) No hazardous material may remain on the outside of a package after filling.

The level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for shipment shall be kept as low as practicable (49 CFR 173.443). It is the shipper's responsibility to ensure.

c. Mixed contents.

- (1) An outer non-bulk packaging may contain more than one hazardous material only when--
- (i) The inner and outer packagings used for each hazardous material conform to the relevant packaging sections of this part applicable to that hazardous material;
 - (ii) The package as prepared for shipment meets the performance tests prescribed in part 178 of this subchapter for the packing group indicating the highest order of hazard for the hazardous materials contained in the package;
 - (iii) Corrosive materials (except ORM-D) in bottles are further packed in securely closed inner receptacles before packing in outer packagings; and
 - (iv) For transportation by aircraft, the total net quantity does not exceed the lowest permitted maximum net quantity per package as shown in Column 9a or 9b, as appropriate, of the section 172.101 Table. The permitted maximum net quantity must be calculated in kilograms if a package contains both a liquid and a solid.
- (2) A packaging containing inner packagings of Division 6.2 materials may not contain other hazardous materials, except dry ice.

It is the shipper's responsibility to ensure that reactive hazardous components are not shipped together in a packaging.

- d. Liquids must not completely fill a receptacle at a temperature of 55 °C (131 °F) or less.

This packaging configuration is not authorized for use with liquids.

5.1.3 49 CFR 173.24b - Additional General Requirements
for Bulk Packagings

a. *Outage and filling limits.*

- (1) Liquids and liquefied gases must be so loaded that the outage is at least one percent of the total capacity of a cargo or portable tank, or compartment thereof, or at least one percent of the total capacity of the tank and dome for tank car and multi-unit tank car tanks at the reference temperature of 46 °C (115 ° F) for uninsulated tanks and 41 °C (105 °F) for insulated tanks.
- (2) Hazardous materials may not be loaded into the dome of a tank car. If the dome of the tank car does not provide sufficient outage, vacant space must be left in the shell to provide the required outage.
- (3) Bulk packagings for materials poisonous by inhalation. For a material which meets the definition of poisonous by inhalation (see section 171.8 of this subchapter), the outage in a bulk packaging must be at least five percent of the total capacity of the tank or compartment at the reference temperature of 46 °C (115 ° F) for uninsulated tanks and 41 °C (105 °F) for insulated tanks.

This is a bulk packaging; however, the above items do not apply as liquids and gases are not authorized contents.

- b. *Equivalent steel.* For the purposes of this section, stainless steel is steel with a guaranteed minimum tensile strength of 51.7 deka newtons per square millimeter (75,000 psi) and a guaranteed elongation of 40 percent or greater. Where the regulations permit steel other than stainless steel to be used in place of a specified stainless steel (for example, as in section 172.102 of this subchapter, special provision B30), the minimum thickness for the steel must be obtained from one of the following formulas, as appropriate:

Formula for metric units:

$$e_1 = (12.74e_0) / (Rm_1A_1)^{1/2}$$

Formula for non-metric units:

$$e_1 = (144.2e_0) / (Rm_1A_1)^{1/2}$$

Where:

e_r = Required thickness of the reference stainless steel in millimeters or inches respectively;
 e_s = Equivalent thickness of the steel used in millimeters or inches respectively;
 R_m = Specified minimum tensile strength of the steel used in deka newtons per square millimeter or pounds per square inch respectively; and
 A_1 = Specified minimum percentage elongation of the steel used multiplied by 100 (for example, 20 percent times 100 equals 20). Elongation values used must be determined from a 50 mm or 2 inch test specimen.

This is not applicable. Specification 49 CFR 178.350 does not require the use of stainless steel or its equivalent.

- c. Air pressure in excess of ambient atmospheric pressure may not be used to load or unload any lading which may create an air-enriched mixture within the flammability range of the lading in the vapor space of the tank.

Air pressure is not used in the loading and unloading process.

- d. A bulk packaging may not be loaded with a hazardous material that:

- (1) Is at a temperature outside of the packaging's design temperature range; or
- (2) Exceeds the maximum weight of lading marked on the specification plate.

This is the shipper's responsibility to ensure.

5.1.4 49 CFR 173.411 - General Design Requirements

Except for a package that contains a limited quantity or excepted instrument or article under Paragraphs 173.421 through 173.424, each package used for shipment of radioactive materials shall be designed so that:

- a. The package can be easily handled and properly secured in or on a conveyance during transport;

The packages tested meet the intent of this requirement. The shipper should avoid loading a top-heavy package and should be aware of the need for tie-downs. The packages tested met this requirement. The drums were moved using a fork lift truck with a drum lifting attachment and with nylon straps and a hoist.

- b. A package with a gross weight exceeding 10 kilograms (22 pounds) and up to 50 kilograms (110 pounds) has a means for manual handling;

The authorized gross weight for this packaging exceeds 50 kg (110 lb); therefore, this requirement is not applicable.

- c. A package with a gross weight of 50 kilograms (110 pounds) or more can be safely handled by mechanical means;

The packages tested met this requirement. The drums were moved using a fork lift truck with a drum lifting attachment and with nylon straps and a hoist.

- d. Each lifting attachment on the package, when used in the intended manner, with a minimum safety factor of three, does not impose an unsafe stress on the structure of the package. In addition, the lifting attachment shall be so designed that failure under excessive load would not impair the ability of the package to meet all other requirements of this subpart. Each attachment or other feature on the outer surface of the packaging that could be used to lift the package must be removable or otherwise capable of being made inoperable for transport, or shall be designed with strength equivalent to that required for lifting attachments;

There are no lifting attachments; therefore, this requirement is not applicable.

- e. The external surface, as far as practicable, may be easily decontaminated;

All packages tested met the intent of this requirement. The exterior of the package is smooth with a minimum of cracks and crevices in which surface contamination could reside.

- f. The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect; and

All packages tested met the intent of this requirement. There were no pockets or crevices where water might collect. Water collecting on the lid during transport will have no adverse effects on the package.

- g. Each feature that is added to the package at the time of transport, and that is not a part of the package, will not reduce the safety of the package.

This is a shipper's responsibility since the regulation addresses items added to the packaging at the time of transport.

5.1.5 49 CFR 173.412 - Additional Design Requirements for Type A Packages

In addition to meeting the general design requirements prescribed in Paragraph 173.411, each Type A packaging shall be designed so that:

- a. The smallest overall external dimension of the package is not less than 10 centimeters (4 inches);

The external dimensions of the packaging exceed the minimum dimensional requirement.

- b. The outside of the packaging incorporates a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in exclusive use closed transport vehicles, the cargo compartment may be sealed instead of the individual packages;

It is the responsibility of the shipper to ensure that appropriate precautions are taken to seal the package in a manner that will provide evidence that the package has not been opened. There are several methods to attach a seal to the packaging.

- c. As far as practicable, the external surfaces are free from protrusions and are designed and finished so that they can be easily decontaminated;

The tested packagings meet this requirement. The package surface is smooth and free from protrusions and can easily be decontaminated.

- d. Containment and shielding would be maintained during transportation and storage in a temperature range of -40°C (-40°F) to 70°C (158°F) with account being taken of the possibility of brittle fracture;

The thickness of the metal used in the packaging is such to alleviate brittle fracture concerns at -40°C (References 4 and 5). The gaskets used also meet this requirement. Liquid is not an authorized content for this packaging; therefore, freezing of contents is not a concern. Temperatures of 70°C will not result in any significant decrease in containment integrity for materials in this packaging (References 6, 7, and 8).

- e. It is able to withstand the effects of any acceleration, vibration, or vibration resonance that may arise during normal transportation, without any deterioration of the effectiveness of closing devices or of the integrity of the package as a whole and without loosening or unintentional release of nuts, bolts, or other securing devices even after repeated use;

The package was judged to pass this requirement. Visual examination of the packaging identified no rupture or leakage. The test identified in 49 CFR 178.608 was applied to support the ability of the packaging to meet the requirement.

Prior to the vibration testing that was conducted, one drum (test unit 37-TU-04) was filled with a 45.4 kg (100-lb) bag of cement and vibrated under the criteria found in 49 CFR 178.608, "Vibration Standards," for an extended period of 3 hours. After the 3-hour time period, the NucFil-013 filter was checked to verify if it had loosened. The filter did not loosen, and remained at the same 20 Nm (15 ft-lb) torque.

All drums that were vibration tested under docket 94-37-7A had the NucFil-013 filter installed using a Rieke Bung fitting which is welded to the drum lid. The filter was screwed into the fitting and torqued to 20 Nm (15 ft-lbs). Loctite 262 (red) had not been applied to the NucFil-013 filter prior to torquing. The bolted ring on the drum is provided

with a jam nut that is used to prevent loosening due to acceleration, vibration, or vibration resonance resulting during normal conditions of transportation. The drum bolt was torqued 54 Nm (40 ft-lbs). Vibration testing was then conducted for 1 hour on the test units filled with the actual simulated contents. All NucFil-013 filters were torqued to 20 Nm (15 ft-lbs), and Loctite 262 (red) was not applied to the filter prior to torquing. The filter was checked after the testing of the test units, and it was found that none had loosened.

- f. It includes a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form, as demonstrated in accordance with Paragraph 173.469 may be considered as a component of the containment system;

The tested packaging meets this requirement. The bolted ring is torqued and a jam nut used to prevent unintentional opening during normal conditions of transport. Since this is a filtered packaging, pressure differentials should not occur.

- g. The materials of the packaging and any components or structures are physically and chemically compatible with each other and with the contents, taking into account the behavior of each under irradiation;

The materials of the packaging are physically and chemically compatible with each other. It is the shipper's responsibility to ensure that the contents are compatible with the packaging.

- h. For each component of the containment system account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis;

It is the shipper's responsibility to ensure that the effects of radiation from the payload will not degrade the performance of the packaging through gas generation, chemical reaction, or radiolysis.

- i. The containment system will retain its radioactive contents under the reduction of ambient pressure to .25 kilograms per square centimeter (3.5 pounds per square inch);

The reduced ambient pressure testing for this docket was not conducted with the 3.5 mil polyethylene liner bag configuration. The 3.5 mil plastic bag will experience a pressure differential but the extent of inflation will be limited by confinement inside the Type IV liner. The packaging is judged to pass this requirement based on previous tests on filtered drums. Reduced ambient pressure testing of DOT-17C 55 gallon filtered drums was performed previously by Mound with successful results. This is documented in Reference 3, Table C-1. Pressure differentials due to reduction of ambient pressure will not occur in the drum or HDPE liner due to the presence of the NucFil filter on the drum lid and the hole in the HDPE liner. The plastic bag will experience a pressure differential but the extent of inflation will be limited by confinement inside the HDPE liner.

- j. Each valve through which the radioactive contents could otherwise escape is protected against damage and unauthorized operation and, except for a pressure relief device, has an enclosure to retain any leakage;

There are no valves used in this packaging; therefore, this requirement is not applicable.

- k. Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield;

The packaging does not utilize shielding; therefore, this requirement is not applicable.

- l. Failure of any tie down attachment of the packaging under excessive load will not impair the ability of the package to meet other requirements of this subpart;

There are no tie-down attachments on the packaging; therefore, this requirement is not applicable.

- m. When subjected to the tests specified in Paragraph 173.465 or evaluated against these tests by any of the methods authorized by Paragraph 173.461(a), the packaging will prevent:

- (1) Loss or dispersal of the radioactive contents; and
- (2) Any significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test.

Packagings tested and evaluated as a part of docket 94-37-7A meet the requirements of this paragraph. Refer to Section 5.2, "Compliance Test Evaluation," of this final evaluation report for specific information. The shipper must ensure that the radiation level at any surface of the packaging would not increase by more than 20% as a result of the decrease in distance to the center of the package load. Consideration of the internal load and shifting of contents needs to be taken into account during transport.

- n. Each packaging designed for liquids will:

- (1) Meet the conditions prescribed in paragraph (m) of this section when subjected to the tests specified in Paragraph 173.466 or evaluated against these tests by any of the methods authorized by Paragraph 173.461(a);

- (2) For any package with a liquid volume not exceeding 50 cubic centimeters (1.7 fluid ounces), have sufficient suitable absorbent material to absorb twice the volume of the liquid contents. The absorbent material shall be compatible with the package contents and suitably positioned to contact the liquid in the event of leakage; and
- (3) For any package with a liquid volume exceeding 50 cubic centimeters (1.7 fluid ounces), either:
 - (i) Have sufficient absorbent material as prescribed in paragraph (n) (2) of this section; or
 - (ii) Have a containment system composed of primary inner and secondary outer containment components designed to assure retention of the liquid contents within the secondary outer components in the event that the primary inner components leak; and

Liquids are not authorized for use in this packaging configuration.

- o. Each package designed for compressed or uncompressed gases other than tritium or argon-37 not exceeding 200 curies will be able to prevent loss of contents when the package is subjected to the tests prescribed in 173.466 or evaluated against these tests by any of the methods authorized by Paragraph 173.461(a).

Compressed or uncompressed gases are not authorized for use in this packaging configuration.

5.1.6 49 CFR 178.3 - Marking of Packagings

- a. Each packaging manufactured to a DOT specification or a UN standard shall be marked as follows:
 - (1) In an unobstructed area with letters and numerals identifying the standards or specification (e.g., UN 1A1, DOT 4B240ET, etc.).
 - (2) Unless otherwise specified in this part, with the name and address or symbol of the manufacturer, or, for a UN standard packaging, the approval agency certifying compliance with the UN standard. Symbols, if used, must be registered with the Associate Administrator for Hazardous Materials Safety. Duplicate symbols are not authorized.
 - (3) The markings must be stamped, embossed, burned, printed or otherwise marked on the packaging, to provide adequate accessibility, permanency, contrast, and legibility so as to be readily apparent and understood.

- (4) Unless otherwise specified, letters and numerals must be at least 12.0 mm (0.47 inches) in height except that for packagings of less than or equal to 30 L (7.9 gallons) capacity for liquids or 30 kg (66 pounds) capacity for solids, the height must be at least 6.0 mm (0.2 inches).
- b. Packagings may be marked with the United Nations symbol and packaging identification code as provided in this subchapter, in the ICAO Technical Instructions or in Annex 1 to the IMDG Code, provided the person applying these marks has established that the packaging conforms to the applicable provisions of this subchapter, the ICAO Technical Instructions or Annex 1 to the IMDG Code, respectively.
 - (1) If an indication of the State in whose territory the specified tests are carried out, or of the State authorizing the allocation of the mark, is required by this part (see paragraph 178.503 of this part), the letters "USA" shall be used if the manufacturing and testing occurs in the United States.
 - (2) If an indication of the name of the manufacturer or other identification of the packaging as specified by the competent authority is required, the name and address or symbol of the person making the mark shall be entered. Symbols, if used, must be registered with the Associate Administrator for hazardous Material Safety. Duplicate symbols are not authorized.
 - (3) Packagings manufactured to UN standards in accordance with this subchapter shall be marked as prescribed in paragraph 178.503 of this part.
 - c. Where a packaging conforms to more than one UN standard or DOT specification, the packaging may bear more than one marking, provided the packaging meets all the requirements of each standard or specification. Where more than one marking appears on a packaging, each marking must appear in its entirety.

It is the shipper's responsibility to ensure that the above requirements have been properly addressed.

5.2 COMPLIANCE TEST EVALUATION

5.2.1 49 CFR 173.465 - Type A Packaging Tests

- a. The proposed packaging with proposed contents must be capable of withstanding the tests prescribed in this section. One prototype may be used for all tests if the requirements of paragraph (b) of this section are complied with.

- b. **Water Spray Test.** The water spray test must precede each test or test sequence prescribed in this section. The water spray test shall simulate exposure to rainfall of approximately 5 centimeters (2 inches) per hour for at least one hour. The time interval between the end of the water spray test and the beginning of the next test shall be such that the water has soaked-in to the maximum extent without appreciable drying of the exterior of the specimen. In the absence of evidence to the contrary, this interval may be assumed to be two hours if the water spray is applied from four different directions simultaneously. However, no time interval may elapse if the water spray is applied from each of the four directions consecutively.

Test units did not undergo the water spray testing as similar packagings have been proven sound. Package RF-2 (tested under docket 89-13-7A) was subjected to the water spray conditions for one hour with no adverse effect or loss of contents. There were no cracks or crevices where water could collect which would cause damage to the package. Removal of the drum head demonstrated that there was no inleakage of water through the filter or gasket. No other packages were tested since water will not have any adverse affects on the metal packaging.

- c. **Free Drop Test.** The free drop test consists of a fall onto the target in a manner that causes maximum damage to the safety features being tested, and:
1. For packages weighing 5,000 kilograms (11,000 pounds) or less, the distance of the fall measured from the lowest point of the packaging to the upper surface of the target shall not be less than 1.2 meters (4 feet).
 2. For packages weighing more than 5,000 kilograms (11,000 pounds), the distance of the fall shall not be less than the distance specified in Table 11, for the applicable packaging weight:

TABLE 11:
FREE-FALL DISTANCE FOR PACKAGING WEIGHING MORE THAN 5,000 KILOGRAMS.

PACKAGING WEIGHT		FREE-FALL DISTANCE	
KILOGRAMS	POUNDS	FEET	METERS
>5,000 TO 10,000...	>11,000 TO 22,000...	3	0.9
>10,000 TO 15,000...	>22,000 TO 33,000...	2	0.6
More than 15,000...	More than 33,000...	1	0.3

The following packages were drop tested from a height of four feet under docket 94-37-7A:

<u>Package #</u>	<u>Gross Wt. kg (lb)</u>	<u>Drop Orientation</u>
37-TU-01	465 (1025)	Side, flat at bolt location.
37-TU-02	449 (989)	Side, flat at bolt location.
37-TU-03	459 (1011)	Top of drum at bolt location, center of gravity (cg) over impact point.
37-TU-04	422 (930)	Top of drum at bolt location, cg over impact point.

Results:

37-TU-01: This test unit was dropped onto its side, flat at the bolt location. Contents were loaded to over 454 kg (1000 lbs) gross, and represented Form Nos. 2 and 3. Damage to the drum consisted of a flattening of the side by approximately 1.3 cm (1/2 in). The bolt bent down against the side of the drum. The closure ring bolt and side of drum pushed in slightly, and were deformed. No loss of contents (sand) was detected. The drum was opened and soil was evident from the 3.5-mil bag being torn. There was no visible damage to the Type IV liner and lid. The 3.5-mil polyethylene liner was badly torn. The drum lid and bolted ring remained in place after the drop.

37-TU-02: This test unit was dropped onto its side, flat at the bolt location. Contents were loaded to over 408 kg (900 lbs) gross, and represented Form Nos. 1, 2, and 3. Damage to the drum was similar as that described above for 37-TU-01. Drum dented at bolt location and along side of impact. No loss of contents (fluorescein and flour mixture, sand) was detected using a black light and water spray. The drum was opened and fluorescein and sand was evident from the 3.5-mil bag being torn 10.6 cm (4 in) across the top. The Type IV liner was undamaged.

37-TU-03: This test unit was dropped onto the top of the drum at the bolt location, cg over impact point. Contents were loaded to over 454 kg (1000 lbs) gross, and represented Form Nos. 2 and 3. The closure ring crushed down and inward at the bolt location. The contents of the package pushed the lid outward. The drum head, side, and ring were deformed. The drum lid and bolted ring remained in place after the drop. No loss of contents (sand) was detected. The drum was opened and soil was evident from the 3.5-mil bag being torn. There was slight damage (cuts) in the Type IV liner lid bottom rim, and slight inward warpage of the liner and liner lid due to the shifting and impact of contents. The 3.5-mil polyethylene liner was badly shredded. Tears in the liner bag existed from the top until mid-way down into the drum. The 3.5-mil liner

was not torn from mid-way to bottom of package. The glove box and secondary bags were also badly torn.

37-TU-04: This test unit was dropped onto the top of the drum at the bolt location, cg over impact point. Contents were loaded to over 408 kg (900 lbs) gross, and represented Form Nos. 1, 2, and 3. Damage to the drum was similar as that described for 37-TU-03 above. Drum dented slightly at bolt location and along side of impact. The drum head, side, and ring were deformed. The drum lid and bolted ring remained in place after the drop. No loss of contents (fluorescein, flour, sand) was detected using a black light and water spray. The drum was opened and fluorescein and sand were evident from the 3.5-mil bag being torn across the top. The Type IV liner was undamaged.

3. For Fissile Class II packagings, the free drop specified in subparagraph (1) or (2) of this paragraph shall be preceded by a drop from a height of 0.3 meter (1 foot) on each corner. For cylindrical packagings, the 0.3 meter (1 foot) drop shall be onto each of the quarters of each rim.

This packaging will not be authorized for Fissile Class II materials; therefore, this requirement is not applicable.

4. For fiberboard or wood rectangular packages not exceeding 50 kilograms (110 pounds) in weight, a separate specimen of the proposed packaging shall be subjected to a free drop onto each corner from a height of 0.3 meter (1 foot).

The drums are made of metal; therefore, this requirement is not applicable.

5. For fiberboard cylindrical packages weighing not more than 100 kilograms (220 pounds) a separate specimen of the proposed packaging shall be subjected to a free drop onto each of the quarters of each rim from a height of 0.3 meter (1 foot).

The drums are made of metal; therefore, this requirement is not applicable.

6. The target shall have a flat, horizontal surface of such mass and rigidity that any increase in its resistance to displacement or deformation upon impact by the specimen would not significantly increase the damage to the specimen.

The test pad used meets this requirement.

- d. **Compression Test.** The compression test shall last for a period of at least 24 hours and consists of a compressive load equivalent to the greater of the following:

1. Five times the weight of the actual package; or
2. 1300 kilograms per square meter (265 pounds per square foot) multiplied by the vertically projected area of the package. The compressive load shall be applied uniformly to two opposite sides of the packaging specimen, one of which must be the base on which the package would normally stand.

The compression test was not conducted on test units specified for this docket. The package is judged to pass this requirement by comparison to previous testing on a similar packaging. A compression test was conducted under docket 89-13-7A with a load of 2506 kg (5525 lb) for a 24-hour period with no evidence of damage or loss of contents detected.

- e. Penetration Test. For the penetration test the packaging specimen shall be placed on a rigid, flat, horizontal surface that will not move while the test is being performed. The test shall consist of:
 1. A bar of 3.2 centimeters (1.25 inches) in diameter with a hemispherical end weighing 6 kilograms (13.2 pounds) being dropped with its longitudinal axis vertical, onto the center of the weakest part of the packaging specimen, so that, if it penetrates far enough, it will hit the containment system. The bar must not be deformed by the test; and
 2. The distance of the fall of the bar measured from its lower end to the upper surface of the packaging specimen shall not be less than 1 meter (3.3 feet).

The penetration test was not conducted under docket 94-37-7A as similar packagings have been proven sound. The package was judged to pass this test by comparison to previous testing on a similar packaging. Under docket 89-13-7A, the prescribed bar was dropped from 101.6 cm (40 in) onto the drum top center, side, bottom, and directly onto the filter. No damage was observed other than a slight impression. There was no loss of contents or adverse effect to the filter. Further, the NucFil filters have been previously tested and found to function properly after being struck by the penetration test bar (Reference 3).

5.2.2 49 CFR 173.466 - Additional Tests for Type A Packagings Designed for Liquids and Gases

In addition to the tests prescribed in 173.465, Type A packaging designed for liquids and gases shall be capable of withstanding the following tests:

1. Free Drop Test. The packaging specimen shall fall onto the target in a manner which will cause it to suffer the maximum damage to its containment. The distance of the fall measured from the lowest part of the packaging specimen shall not be less than 9 meters (30 feet).

Liquids are not authorized as contents for this packaging; therefore, this requirement is not applicable.

2. Penetration Test. The specimen must be subjected to the test specified in 173.465(e) except that the distance of the fall shall be 1.7 meters (5.5 feet).

Liquids are not authorized as contents for this packaging; therefore, this requirement is not applicable.

5.2.3 49 CFR 178.608 - Vibration Standards

- a. Each packaging must be capable of withstanding, without rupture or leakage, the vibration test procedure outlined in this section.
- b. Test method.
 - (1) Three sample packagings, must be filled and closed as for shipment.
 - (2) The three samples must be placed on a vibrating platform that has a vertical or rotary double-amplitude (peak-to-peak displacement) of one inch. The packages should be constrained horizontally to prevent them from falling off the platform, but must be left free to move vertically, bounce, and rotate.
 - (3) The test must be performed for one hour at a frequency that causes the package to be raised from the vibrating platform to such a degree that a piece of material of approximately 1.6 mm (0.063 inch [1/16 inch]) thickness (such as steel strapping or paperboard) can be passed between the bottom of any package and the platform.
 - (4) Immediately following the period of vibration, each package must be removed from the platform, turned on its side, and observed for any evidence of leakage.
 - (5) Other methods, at least equally effective, may be used, if approved by the Associate Administrator for Hazardous Material Safety.
- c. Criteria for passing the test. A packaging passes the vibration test if there is no rupture or leakage from any of the packages. No test sample should show any deterioration which could adversely affect transportation safety or any distortion liable to reduce packaging strength.

The package was judged to pass this requirement. Visual examination of the packaging identified no rupture or leakage. Type A packagings are required "to withstand the effects of any acceleration, vibration, or vibration resonance that may arise during normal transportation" [see 49

CFR 173.412 (e)]. The test identified in this section was applied to support the ability of the packaging to meet the requirement.

Prior to the vibration testing that was conducted, one drum (test unit 37-TU-04) was filled with a 45.4 kg (100-lb) bag of cement and vibrated under the criteria found in 49 CFR 178.608, "Vibration Standards," for an extended period of 3 hours. After the 3-hour time period, the NucFil-013 filter was checked to verify if it had loosened. The filter did not loosen, and remained at the same 20 Nm (15 ft-lb) torque.

All drums that were vibration tested under docket 94-37-7A had the filter installed using a Rieke Bung fitting which is welded to the drum lid. The filter was screwed into the fitting and torqued to 20 Nm (15 ft-lbs). Loctite 262 (red) had not been applied to the NucFil-013 filter prior to torquing. The bolted ring on the drum is provided with a Jam nut that is used to prevent loosening due to acceleration, vibration, or vibration resonance resulting during normal conditions of transportation. The drum bolt was torqued 54 Nm (40 ft-lbs). Vibration testing was then conducted for 1 hour on the test units filled with the actual simulated contents. All NucFil-013 filters were torqued to 20 Nm (15 ft-lbs), and Loctite 262 (red) was not applied to the filter prior to torquing. The filter was checked after the testing of the test units, and it was found that none had loosened.

6.0 CONCLUSION

The evaluation and testing indicates that the packagings meet applicable DOT-7A Type A design and compliance test requirements. The packaging should be loaded, assembled, and closed as described in this document (Section 4.3, "Loading, Assembly, and Closure"). Deviations from the tested packaging system will require retesting or approval by the Department of Energy. The following restrictions/specifications shall be followed:

1. The shipper shall ensure that the radiation level at any surface would not increase by more than 20 percent (relative to the radiation level prior to the test) as a result of the decrease in distance to the center of the package resulting from the 1.2 m (4-ft) drop test.
2. For heavy, bulky materials (i.e., concrete chunks, motors, pumps, etc), equipment or material with sharp corners or protrusions which could result in highly localized forces, the shipper shall ensure that the contents are securely fastened/positioned within the package.
3. The authorized contents and the maximum gross weight for this packagings is as follows:

CONTENTS

MAXIMUM GROSS WEIGHT kg (lb)

Form No. 1
Forms No. 2 & 3

408 kg (900 lb)
454 kg (1000 lb)

4. The inner plastic bag liners may be a minimum of 3.5 mil if used with the Type IV liner, and if large, bulky contents are wrapped and sealed in a glovebox bag and then wrapped and sealed in a secondary bag prior to loading and closure. Special attention must also be taken for heavy, bulky materials, equipment or material with sharp corners or protrusions that could result in highly localized forces. The shipper shall ensure that the contents are securely fastened/positioned within the package.
5. The HDPE liner bolt closure shall be snug tight (lugs near touching).
6. The drum bolt closure shall be tightened to 54 Nm (40 ft-lb) with tapping of lock ring during tightening.
7. Gasket material shall have an operating range of -40° C to 70° C (-40° F to 158° F).
8. The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing/analysis must be conducted and documented to demonstrate Specification 7A compliance with the actual contents.
9. The NucFil filter shall be installed and torqued to 20 Nm (15 ft-lbs).

The shipper is the organization which actually uses the package and is, therefore, responsible to make sure it is used in accordance with its design. As a part of this, the shipper shall ensure that the design is suitable in all respects for the contents to be shipped. If it is not, testing/analysis must be conducted and documented to demonstrate Specification 7A compliance with the actual contents. The design will dictate many of the limits placed on the contents, such as mass and physical form.

The manufacturer(s) of the packaging described herein is responsible for using materials, processes and controls in the packaging fabrication which are equivalent to those used in the fabrication of the test unit packagings.

7.0 QUALITY ASSURANCE PROGRAM

Paragraphs 173.474 and 173.475 that are restated below provide the Quality Control elements prescribed in 49 CFR. These requirements must be met for all shipments.

173.474. Quality Control for Construction of Packaging

- a. Prior to the first use of any packaging for the shipment of radioactive material, the shipper shall determine that:
 1. The packaging meets the quality of design and construction requirements as specified in this subchapter; and

2. The effectiveness of the shielding, containment, and, when required heat transfer characteristics of the package, are within the limits specified for the package design.

173.475. Quality Control Requirements Prior to Each Shipment of Radioactive Materials

Before each shipment of any radioactive materials package, the shipper shall ensure by examination or appropriate tests, that:

- a. The packaging is proper for the contents to be shipped;
- b. The packaging is in unimpaired physical condition, except for superficial marks;
- c. Each closure device of the packaging, including any required gasket, is properly installed, secured, and free of defects;
- d. For fissile material, each moderator and neutron absorber, if required, is present and in proper condition;
- e. Each special instruction for filling, closing, and preparation of the packaging for shipment has been followed;
- f. Each closure, valve, or other opening of the containment system through which the radioactive content might escape is properly closed and sealed;
- g. Each packaging containing liquid in excess of an A₂ quantity and intended for air shipment has been tested to show that it will not leak under an ambient atmospheric pressure of not more than 0.25 atmosphere, absolute, (0.25 kilograms per square centimeter or 3.6 pisa). The test must be conducted on the entire containment system, or on any receptacle or vessel within the containment system, to determine compliance with this requirement.
- h. The internal pressure of the containment system will not exceed the design pressure during transportation; and
- i. External radiation and contamination levels are within the allowable limits specified in this subchapter.

It is critical that controls are in place to ensure that the packaging hardware to be used complies with the specifications given for the packaging hardware tested, described, and evaluated in this document. Each shipper must have a documented program describing how this is achieved, and the degree of certainty, in addition to documentation (audit trail) demonstrating compliance. The quality assurance program is mandated in DOE Order 5480.3, Safety Requirements for the Packaging and Transportation of Hazardous Materials, Hazardous Substances, and Hazardous Wastes.

8.0 PRIMARY USER/MANUFACTURER

PRIMARY USER(S):

<u>Site/Contact/Phone</u>	<u>Address</u>
Rocky Flats L. Smith 303-966-7156 K. Lenarcic 303-966-2377	Rocky Flats P.O. Box 464 Golden, CO 80402-0464
Hanford T. Romano 509-373-0310	Westinghouse Hanford Company P.O. Box 1970 Richland, WA 99352
Lawrence-Livermore National Laboratory K. Hainebach 510-422-4572	Lawrence-Livermore National Laboratory P.O. Box 808 Livermore, CA 94550
MLM L. Lamsa 513-865-4182	EG&G/Mound Mound Road Miamisburg, OH 45343

SUPPLIERS:

Liners: HF, MD -	Meese Incorporated 1745 Cragmont Street Madison, IN 47250 812-273-1008
RF -	K&M Plastic 1601 Pratt Blvd. Elkgrove, IL 60007 708-439-3311
	Plasti-Drum 1225 Davies Lockport, IL 60441 815-838-7210
	Russell Stanley Co. 8 Ritter Ave. Woodbridge, NJ 07095 201-634-6000

9.0 REFERENCES

1. "DOT-7A Type A Packaging Design Guide," D. L. Kelly, Rev. 0, Draft, March 25, 1994.
2. "DOT-7A Packaging Test Procedure," J. M. Cruse, Rev. 1, Draft, July 1, 1991.
3. "Test and Evaluation Document for DOT Specification 7A Type A Packaging," WHC-EP-0558, J. M. Cruse, Rev. 2.
4. NUREG/CR-1815, "Recommendations for Protecting Against Failure by Brittle Fracture in Ferritic Steel Shipping Containers Up to Four Inches Thick", W. R. Holman and R. T. Langland, June 15, 1981.
5. "ASME Boiler and Pressure Vessel Code," 1989 Addenda, Section III - Division 1, Subsection NB, December 31, 1989.
6. American Institute of Steel Construction, Inc., "Manual of Steel Construction," Eighth edition.
7. American Institute of Timber Construction, "Timber Construction Manual," Second edition, 1974.
8. Ryan Herco Industrial Plastics, "1988-1989 Product Guide"

APPENDIX A
FIGURES

DOT 7A Type A
49 CFR 178.350

*NucFil is a trademark of Nuclear Filter Technology, Incorporated. 39102077.13FH

DOT 7A Type A
49 CFR 178.350