

MEMORANDUM

February 20, 1996

Distribution for WHC-EP-0558

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DISTRIBUTION OF REVISION 3, WHC-EP-0558, "TEST AND EVALUATION DOCUMENT FOR DOT SPECIFICATION 7A TYPE A PACKAGING" (BLUE BOOK)

Reference: Letter, Sarbes Acharya, DOE (EH-32), to T. K. Teynor, DOE-RL, "Approval of Surveys and Revision 3 Blue Book Pages," dated August 30, 1995.

The attached Revision 3 page changes to the subject document were approved by the U.S. Department of Energy, Office of Facility Safety Analysis (EH-32), on August 30, 1995. These revision changes are being distributed by Westinghouse Hanford Company's Packaging Operations and Development group for EH-32.

Revision 3 incorporates several changes. The major changes are: (1) Correction of the DOE-HQ administrative office noted, updates and corrections to the regulatory requirements, and inclusion of the vibration standard; (2) addition of three new dockets (for a total of seven packaging configurations); (3) revision to existing Appendices to include corrections and new packaging configuration information; (4) addition of new Appendices to incorporate HM-181 requirements; and (5) replacement of the distribution pages.

The three dockets added are:

Docket 92-33-7A	Idaho National Engineering Laboratory, Mark III Concrete Container (with and without impact limiter)
Docket 94-37-7A	Los Alamos National Laboratory, 55-Gallon Drum/Bag/Liner Configuration (LL-2)
Docket 94-39-7A	Westinghouse Hanford Company, Hedgehog Shielded Container (30-mL, 125-mL, 250-mL, and 1-L)

Please refer to the attached "Record of Revision" for the replacement, addition, or deletion of pages appropriate for this particular revision.

Please take a moment to complete the attached survey for the Blue Book.
Return it to the individual listed on the survey.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

Survey for User's of WHC-EP-0558
"TEST AND EVALUATION DOCUMENT FOR DOT SPECIFICATION 7A TYPE A PACKAGING "
(the Blue Book)

Please take a few minutes to answer the following questions about DOE's DOT Specification 7A Type A Packaging Testing Program. When completed, send this form to Donna Kelly, Westinghouse Hanford Company, P.O. Box 1970, MSIN: G1-12, Richland, WA 99352, or fax to (509) 376-7551, by May 1, 1996.

Scale: 1 = Low 3 = Average 5 = Above Average

1. How often do you refer to the Blue Book?

1 time a month
2 times a month
Several times a month

☐
☐
☐

1 time a year
2 times a year
Several times a year

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2. Do you find the Blue Book easy to use?

Yes ☐

No ☐

3. How easy/helpful do you find the Blue Book? (Rate the Blue Book's ease of use).

1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

4. Mark the following items that you feel would make the Blue Book easier to use and make it a better reference document.

☐

Break into 2 Parts.

Part 1 - Introduction and basic packaging information
Part 2 - Appendices (Testing and Evaluation Results)

☐

Addition of procedure on how to open a docket.

☐

Addition of vendor-tested and/or contractor tested packagings.

☐

Other (please list below).

5. Please provide any suggestions you may have for improvement of this document.

Thank you for your time. All inputs are valuable.

RELEASE AUTHORIZATION

Document Number: WHC-EP-0558, Rev. 3

Document Title: Test and Evaluation Document for DOT Specification
7A Type A Packaging

Release Date: 1/30/96

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

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:



C. Willingham

1/30/96

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RECORD OF REVISION		(1) Document Number WHC-EP-0558		Page 1
(2) Title Test and Evaluation Document for DOT Specification 7A Type A Packaging				
CHANGE CONTROL RECORD				
(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release		
		(5) Cog. Engr.	(6) Cog. Mgr.	Date
3	(7) Replace pages vii through xiv with vii through xvi due to text rotation from the addition of new packagings, appendices, list of figures, and list of terms.	D.L. Kelly/ <i>D.L. Kelly</i> 1-22-96	D.L. McCall/ <i>D.L. McCall</i> 1-23-96	
3	Replace entire Section 1.0, pages 1-1 through 1-16. Correction to DOE Headquarters Office, identification of new packaging configurations, contacts, and regulatory requirements.			
3	Replace Pages 2-3 and 2-4. Page 2-3, 5-gallon drum drawing revised (no rolling hoops); Page 2-4 double-sided copy only.			
3	Replace Pages 2-27 through 2-36. Added new LL-2 configuration throughout this section. Page 2-29 and 2-30 under "Authorized Configurations" table "which" has been changed to "that" and the LL-2 configuration has been added. Dimensions have been corrected. Page 2-31 filter information adds the use of a NucFil-013 filter. Under RF-5, RF-6, RF-7, and RF-8 configurations the reference to "Head is gasketed" has been deleted after confirming that this information is incorrect from what was evaluated. Page 2-35a updates primary users and suppliers. Page 2-36 no change, double-sided copy.			
3	Replace Pages 2-47 and 2-48. Page 2-47 double-sided copy; Page 2-48 correction to telephone number.			
3	Replace Pages 3-45 and 3-46. Page 3-45 double-sided copy; Page 3-46 correction to drawing--optional eyebolt lifting rings added, and optional filter placement corrected.			
3	Replace Pages 7-89 and 7-90. Page 7-89 deleted incorrect reference to Table C-14; Page 7-90 double-sided copy.			
3	Addition of Pages 7-109 through 7-124 (Section 7.17). Addition of new packaging.			
3	Addition of Pages 8-57 through 8-66 (Section 8-10). Addition of new packaging.			

RECORD OF REVISION		(1) Document Number WHC-EP-0558		Page 2
(2) Title Test and Evaluation Document for DOT Specification 7A Type A Packaging				
CHANGE CONTROL RECORD				
(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release		
		(5) Cog. Engr.	(6) Cog. Mgr.	Date
3	(7) Replace Pages A-1 and A-2. Page A-1 title change, Page A-2 double-sided copy.	D.L. Kelly/ <i>1-22-96</i> <i>D.L. Kelly</i>	D.L. McCall <i>D.L. McCall</i> <i>1-23-96</i>	
3	Replace Pages B-31 and B-32. Page B-31 double-sided copy; Page B-32 addition of Mark III Concrete Container information.			
3	Replace Pages C-3 and C-4. Page C-3 delete incorrect reference to Table C-15 and correct title to Table C-14.			
3	Replace Pages C-11 through C-14. Addition of "action required by/whom" and "packaging category" information. Double-sided copy.			
3	Replace Pages C-25 through C-28. Addition of "action required by/whom" and "packaging category" information. Double-sided copy.			
3	Replace Pages C-39 through C-42. Addition of "action required by/whom" and "packaging category" information. Double-sided copy.			
3	Replace Pages C-53 through C-56. Addition of "action required by/whom" and "packaging category" information. Double-sided copy.			
3	Replace Pages C-61 through C-64. Addition of "action required by/whom" and "packaging category" information. Double-sided copy.			
3	Replace Pages C-71 through C-74. Addition of "action required by/whom" and "packaging category" information. Double-sided copy.			
3	Replace Pages C-75 through C-78. Total pages modified on Table C-11, added Hedgehog Container information on Page C-77a, and double-sided copy for Page C-77b. Total pages modified on Table C-12, added Hedgehog Container information on Page C-78a, and double-sided copy for Page C-78b.			
3	Replace Pages C-83 through C-90. Page C-83 double-sided copy; Pages C-84 and C-85 addition of Mark III Concrete Container information. Pages C-86 and C-87 addition of "action required by/whom" and "packaging category" information. Pages C-88 through C-90--Table C-14 completely replaced. Pages C-91 and C-92 are deleted. Table C-15 is completely replaced with the corrected Table C-14.			

RECORD OF REVISION		(1) Document Number WHC-EP-0558	Page 3
(2) Title Test and Evaluation Document for DOT Specification 7A Type A Packaging			
CHANGE CONTROL RECORD			
(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release	
		(5) Cog. Engr.	(6) Cog. Mgr. Date
3	(7) Replace Pages D-3 and D-4. Page D-3 revision to Table titles; Page D-4 double-sided copy.	D.L. Kelly/ 1-22-96 <i>D.L. Kelly</i>	D.L. McCall/ <i>D.L. McCall</i> 1-23-96
3	Replace Pages D-7 through D-10. Page D-7 double-sided copy; Page D-8 correction of typo and addition of footnote reference; Page D-9 double-sided copy; Page D-10 footnote added.		
3	Replace Pages D-20a through D-62. Page D-20a addition of Hedgehog Container; Page D-20b double-sided copy. Page D-21 correction of typo, page total call out; Page D-21a added for text rotation and addition of Mark III Concrete Container; Page D-21b double-sided copy. Pages D-22 and D-23 double-sided copy. Pages D-24 through D-36 Table D-10 title revision. Also Page D-25 adds LL-2 drum configuration; Pages D-26 and D-27 adds footnote reference; Page D-28 double-sided copy; Page D-36 footnote added. Pages D-37 through D-46--Table D-11 title revision. Pages D-47 through D-60g--Table D-12 through Table D-18 title revision. Pages D-60d through D-60g Hedgehog Container information added into Table D-18. Pages D-60h through D-60m added as Table D-18a. Table D-18a title revision, and Hedgehog Container information added. Page D-60n added for 2-sided copy. Page D-61 through D-61b typo corrected, Table D-19 title changed, total page number revised. Added Pages D-61c through D-61h for Mark III Concrete Container information. Page D-62 double-sided copy.		
3	Replace Pages D-67 and D-68. Addition of footnote call out and information.		
3	Replace Pages D-81 through D-90. Page D-81 double-sided copy; Page D-82 through D-85 revision to page number total. Page D-85a addition of Hedgehog Container information; Page D-85b and D-86 double-sided copy. Page D-86a addition of Mark III Concrete Container information; Page D-86b double-sided copy. Pages D-87 and D-88 double-sided copy only. Pages D-89 and D-90 call out of footnote reference.		

RECORD OF REVISION		(1) Document Number WHC-EP-0558		Page 4
(2) Title Test and Evaluation Document for DOT Specification 7A Type A Packaging				
CHANGE CONTROL RECORD				
(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release		
		(5) Cog. Engr.	(6) Cog. Mgr.	Date
3	(7) Replace Pages D-105 through D-108. Pages D-105 through D-108 Table D-35 total page number changed. Addition of Hedgehog Container (text rotation).	D.L. Kelly/ 1-22-96 <i>D.L. Kelly</i>	D.L. McCall/ <i>D.L. McCall</i> 1-23-96	
3	Addition of Pages D-109 and D-110. Text rotation of Table D-36. Addition of Mark III Concrete Container information.			
-	Delete current Appendix E, "U.S. Department of Transportation Letter of Concurrence." This will be replaced with a new Appendix I via this ROR.			
3	Add new Appendix E, "Compliance with Vibration Standards," Pages E-1 through E-14.			
3	Add new Appendix F, "Compliance with General Requirements for Packages and Packaging" (post HM-181), Pages F-1 through F-62.			
3	Add new Appendix G, "Compliance with Additional General Requirements for Non-Bulk Packaging and Packages" (post HM-181), Pages G-1 through G-60.			
3	Add new Appendix H, "Compliance with Additional General Requirements for Bulk Packagings" (post HM-181), Pages H-1 through H-26.			
3	Replacement of the previous Appendix E, "U.S. Department of Transportation Letter of Concurrence," with the new Appendix I. Pages I-1 through 4.			
3	Replace Distr-1 through Distr-36 with new Distribution listing (Distr-1 through Distr-37).			

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LIST OF TERMS

ACGLF	adjustable center of gravity lift fixture
AE	Argonne National Laboratory - East
ANL-E	Argonne National Laboratory - East
ANL-W	Argonne National Laboratory - West
ASTM	American Society for Testing and Materials
AW	Argonne National Laboratory - West
Battelle	Battelle Columbus Laboratory
Btu	British thermal unit
C	Celsius
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
DOE-HQ	U.S. Department of Energy-Headquarters
DOT	U.S. Department of Transportation
DOT-7A	DOT Specification 7A
F	Fahrenheit
FEMA	Federal Emergency Management Agency
FM	Feed Materials Production Center
FMPC	Feed Materials Production Center
gal	gallon
HDPE	high-density polyethylene
HF	Hanford, Richland, Washington
INEL	Idaho National Engineering Laboratory
kg	kilogram
kPa	kilopascal (1 atmosphere=14.7 psig=1 bar=100kPa)
L	liter
LANL	Los Alamos National Laboratory
LL	Lawrence Livermore National Laboratory
LLNL	Lawrence Livermore National Laboratory
MD	Mound Laboratory
mil	0.001 inches
mL	milliliter
MLM	Mound Laboratory
MS	military specification
NFTI	Nuclear Filter Technology, Inc.
NLO	National Lead Corporation
NRC	U.S. Nuclear Regulatory Commission
OR	Oak Ridge National Laboratory
ORNL	Oak Ridge National Laboratory
Pa	pascal
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
PVC	polyvinylchloride
RF	Rocky Flats Plant
RFP	request for proposal
RH	Hanford, Richland, Washington
RTV	room temperature vulcanizing
SNR	Schenectady Naval Reactors Office
Spec	specification
SR	Savannah River Plant and Laboratory
SRP	Savannah River Plant and Laboratory
SWB	standard waste box

LIST OF TERMS (cont.)

TRUPACT	transuranic package transporter
UN	United Nations
UV	ultraviolet
Westinghouse Hanford	Westinghouse Hanford Company
WHC	Westinghouse Hanford Company
WIPP	Waste Isolation Pilot Plant
WMCO	Westinghouse Materials Company of Ohio
WVNS	West Valley Nuclear Services

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**TEST AND EVALUATION DOCUMENT FOR THE U.S. DEPARTMENT OF TRANSPORTATION
SPECIFICATION 7A TYPE A PACKAGINGS**

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) has been conducting, through several of its operating contractors, an evaluation and testing program to qualify Type A radioactive material packagings per U.S. Department of Transportation (DOT) Specification 7A (DOT-7A) of the Code of Federal Regulations (CFR), Title 49, Part 178 (49 CFR 178). The program is currently administered by the DOE, Office of Facility Safety Analysis, DOE/EH-32, at DOE-Headquarters (DOE-HQ) in Germantown, Maryland.

This document summarizes the evaluation and testing performed for all of the packagings successfully qualified in this program. This document supersedes *DOE Evaluation Document for DOT-7A Type A Packaging* (Edling 1987), originally issued in 1987 by Monsanto Research Corporation - Mound Laboratory (MLM), Miamisburg, Ohio, for the Department of Energy, Security Evaluation Program (DP-4). Mound Laboratory issued four revisions to the document between November 1988 and December 1989. In September 1989, the program was transferred to Westinghouse Hanford Company (Westinghouse Hanford) in Richland, Washington. One additional revision was issued in March 1990 by Westinghouse Hanford.

This revision reflects the earlier material and incorporates a number of changes. Evaluation and testing activities on three DOT-7A Program Dockets resulted in the qualification of seven new packaging configurations, which are incorporated herein and summarized below.

New Packaging Configurations.

Docket(s)	Configurations	Description
92-33	2	INEL Mark III Concrete Container
94-37	1	LLNL 17C 55-Gallon Drum Liner Configuration
94-39	4	WHC Hedgehog Container

This document was prepared initially in July 1991 as a draft and submitted to DOE-HQ for review. The DOE-HQ forwarded a copy of the draft to the DOT for review. The DOT provided concurrence to the draft in April 1992 via a letter (included herein as Appendix I) which was forwarded to Westinghouse Hanford with DOE's direction to distribute this document. A number of miscellaneous changes have been made for completeness and to reflect the programmatic changes that have occurred since 1987.

1.1 PURPOSE AND SCOPE

The purpose of this document is to provide technical documentation of the evaluation and testing activities successfully completed to qualify a number of packagings to the requirements of DOT-7A (49 CFR 178.350). The packagings described herein are considered acceptable for transport of Type A quantities of radioactive material subject to the applicable restrictions and specifications.

This document is not intended to supply all of the information necessary for the fabrication of the identified DOT-7A packagings. The drawings in the document are for illustrative purposes and are intended to assist the reader in selecting a packaging meeting the requirements for the material to be shipped. If one desires to fabricate one of the packagings in the document, the primary user, or custodian, of that packaging should be contacted for the information.

The specific packaging data contained in this document will serve to meet the requirements of 49 CFR 173.415(a) for ". . . documentation of tests . . ." when the packagings are used as prescribed. In addition to the documentation of tests, the shipper must maintain on file other appropriate data applicable to the shipment, such as the following:

- Evaluation of the properties of the actual contents to be shipped for compatibility with the packaging
- The Quality Control Program and its implementation.

Therefore, it is apparent that this document does not "stand alone" for all the documentation needed when offering a package for transportation. The shipper is responsible in many areas for ensuring that the loaded package is acceptable.

Changes in technology and in the mission of the various DOE facilities and contractors will generate the need for new packaging designs on a continuing basis. If a new design is needed (i.e., not currently covered in this document), contact one of the DOT-7A Program administrative or technical contacts listed in Sections 1.1.1 and 1.1.2, respectively, for assistance on qualifying a new packaging.

1.1.1 Administrative Contacts

The DOT-7A Program is currently administered by the DOE, Office of Facility Safety Analysis, DOE/EH-32, at DOE-HQ in Germantown, Maryland. The responsible persons are as follows:

M. E. Wangler
Office of Facility Safety Analysis
U.S. Department of Energy, EH-32
19901 Germantown Road
Germantown, MD 20874
COMM/FTS 301-903-5078

A. Kapoor
Office of Facility Safety Analysis
U.S. Department of Energy, EH-32
19901 Germantown Road
Germantown, MD 20874
COMM/FTS 301-903-6838

Any organization wishing to have a packaging qualified in this program should contact the person listed above.

1.1.2 Technical Contacts

Westinghouse Hanford, Transportation and Packaging, is currently conducting the evaluation and testing activities. The persons responsible for these activities are as follows:

D. L. McCall, Manager
Packaging Operations and
Development, MSIN G2-02
Westinghouse Hanford Company
P.O. Box 1970
2355 Stevens Drive
Richland, WA 99352
COMM/FTS 509-376-1651

J. H. O'Brien, Project Engineer
Packaging Operations and
Development, MSIN G2-02
Westinghouse Hanford Company
P.O. Box 1970
2355 Stevens Drive
Richland, WA 99352
COMM/FTS 509-376-7154

Please contact one of the persons listed above with any technical questions or any questions regarding dockets that have been established in the program.

The program has a great deal of experience with designs and materials that adequately perform to the requirements.

The normal approach to qualification of a new packaging design is to develop the design and operational documentation, review this documentation, and expose several test units to the Type A packaging tests (49 CFR 173.465 and 173.466). If the packaging performs adequately, it will be approved for use and included in this document at the next revision.

1.2 RESPONSIBILITIES

There are a number of specific functions that must be performed to ensure that a DOT-7A package is properly prepared for safe transport and in full compliance with the applicable regulations. The affiliation or the specific arrangements between the designer, manufacturer, and user should be adequately described and understood.

The following paragraphs discuss specific responsibilities.

1.2.1 The U.S. Department of Energy

The Packaging Certification Staff of DOE/EH-32 is responsible for the administration of the DOT-7A Program. This includes approval authority for all of the various program documents, requests for evaluation and testing of new packagings, and approval of their qualification. General programmatic direction is also under the control of DOE/EH-32.

1.2.2 Shipper

Shippers of Type A quantities of radioactive material are generally responsible for all aspects of the shipment. It is DOE policy to fully comply with the regulations for such shipments as established in 49 CFR 173. Normally the shipper will be able to locate an acceptable packaging, which places primary emphasis on ensuring compatibility with contents and correctness in operations.

1.2.3 Manufacturer

The manufacturer of a DOT-7A Type A packaging, which is covered in this document or otherwise authorized for use within the DOE system, is responsible for using materials, fabrication methods, manufacturing, and quality controls to ensure that the packaging is equivalent to the specified design. No design changes, substitutions, or changes in fabrication methods or controls are authorized without the approval of DOE/EH-32.

1.2.4 Testing Laboratory

The testing laboratory is responsible for evaluation and testing of new DOT-7A packaging designs based on the direction of DOE/EH-32. This process involves review of the applicants' design data, inspection of the test unit packages, performance of the Type A packaging tests, and documentation of the results. Westinghouse Hanford is currently performing this function for DOE/EH-32; Westinghouse Hanford is also maintaining and distributing the various DOT-7A Program documents.

1.3 APPLICABLE U.S. DEPARTMENT OF TRANSPORTATION REGULATIONS

The DOT regulations for shipping hazardous materials are located in 49 CFR, Parts 100-499. Copies of these regulations can be obtained from the Government Printing Office or other sources. The packagings described herein have been qualified to meet DOT-7A (49 CFR 178.350) for Type A packagings. Specification 7A is a general specification and invokes the applicable requirements of 49 CFR 173, Subparts A, B, and I.

Some of the important regulations affecting shipments of Type A quantities of radioactive material are summarized in the following paragraphs. The primary sections of the regulations applicable to Type A packaging requirements are as follows:

- 173.21 Forbidden materials and packages
- 173.22 Shipper's responsibility
- | 173.24 General requirements for packagings and packages
- | 173.24(a) Additional general requirements for non-bulk packagings and packages
- | 173.24(b) Additional general requirments 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 standard.

1.3.1 Contents Characterization

Specification 7A packagings are qualified for transporting Type A quantities of radioactive material. Characterization of contents for compatibility with the selected packaging is an important aspect of any shipment and is primarily the responsibility of the shipper. The regulations address this area with a number of items, which are summarized in the following paragraphs.

1.3.1.1 Radiological. The following items in 49 CFR 173, Subpart I address the radiological characteristics of the material to be shipped:

- 173.417 Authorized packagings--fissile materials
- 173.431 Activity limits for Type A and Type B packages
- 173.433 Requirements for determination of A_1 and A_2 values for radionuclides
- 173.441 Radiation level limitations
- 173.451 Fissile materials--general requirements
- 173.453 Fissile materials--exceptions
- 173.455 Classification of fissile materials packages
- 173.459 Mixing of fissile material packages.

The shipper must characterize the payload as needed to determine compliance with these requirements.

1.3.1.2 Physical Form. The physical form of the material has a direct and an indirect effect on the applicability of a number of requirements. For example, the form affects the density of the material, which will affect the gross weight, which affects the requirements invoked for package handling features. In the DOT-7A Program, solid materials are classed into one of three Material Forms (Forms) as follows:

- Form Number 1: Solids--any particle size
 - A packaging qualified for these contents is expected to contain radioactive contents of any representative particulate size.
- Form Number 2: Solids--large particle size only (i.e., sand, concrete, debris, soil)
 - 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 qualified for fine particulate, Form Number 1.)
- Form Number 3: Solids--objects with no significant dispersible or removable contamination (for definition, see 49 CFR 173.443, "Contamination control").
 - Metals with activation products
 - Forms of metals/alloys/compounds of uranium, thorium

- Solid materials with the radioactive material firmly fixed in place, possibly by the application of a fixing media (i.e., paint)
- Solidified material.

NOTE: These are examples only and each form must be analyzed for compliance with the "no removable or dispersible contamination" criterion found in 49 CFR 173.443.

Packagings intended to transport liquids and gases must be designed to withstand more severe test conditions than those designed for solids.

1.3.1.3 Thermal. Thermal limitations and requirements applicable to packagings are addressed in the following sections:

- 173.412(d) Containment and shielding--temperature range
- 173.442 Thermal limitations
- 173.448(b) Heat output.

The thermal heat generation of the contents, for whatever reason, must not degrade the packaging. Normally, Type A quantities of radionuclides do not generate enough decay heat to be of concern. If there is any doubt, the decay heat should be calculated and the package design analyzed to ensure no problems.

1.3.1.4 Chemical. The chemical characteristics of the contents are addressed by the following requirements:

- 173.21 Forbidden materials and packages
- 173.24(b)(3) Mixture, reaction
- 173.24(e)(2) Reaction
- 173.24(e)(3) Plastic compatibility/permeability
- 173.24(f) Closures, gaskets
- 173.412(g) Compatibility, behavior under irradiation
- 173.412(h) Gas generation, radiolysis.

The contents must not react with the packaging so as to degrade it and must not develop chemical conditions which could lead to an explosion. The basic chemical makeup of the nonradioactive constituents of the contents to be shipped must be understood in order to adequately design a packaging.

1.3.2 Packaging Design

The regulatory requirements primarily applicable to the design of a Type A packaging are listed as follows:

- | 173.24(b) Design and construction
- | 173.24(e)(3) Plastic packagings and receptacles
- | 173.411(a)-(f) General design requirements
- | 173.412 Additional design requirements for Type A packages
- | 173.462(c) Containment system . . . specified
- | 173.462(d) External features . . . clearly identified
- | 178.3 Marking of packagings.

The packagings identified in this document have been designed and qualified to meet these requirements for transporting contents as shown in the subsequent sections. The following paragraphs are intended to summarize the design-related requirements.

- | 1.3.2.1 General Arrangement. The packaging design will generally fall into one of three basic configurations: (1) single packaging, (2) composite packaging, or (3) combination packaging (see definitions 49 CFR 171.8). Single packagings are generally recommended for solids meeting the definition of Form Number 2 or Form Number 3, or gases. For packaging of solids classed as Form Number 1 and liquids, composite or combination packagings are recommended.

1.3.2.2 Containment. The requirements that pertain directly to containment of contents are as follows:

- | 173.24(b) Design and construction
- | 173.24(e)(2) Reaction
- | 173.24(e)(3) Plastic packagings and receptacles
- | 173.24(f) Closures and gaskets
- | 173.462(c) Containment system . . . specified
- | 173.469(a)(4) Leak tightness.

Basically, there can be "no significant release of the hazardous materials to the environment," and the packaging must remain effective when subjected to normal conditions of transport, with account being taken for any reactions between the contents and the packaging materials. In practice, "no significant release," implies no measurable leakage based on visual evaluation.

Containment is formed by those materials or components that are or may be in direct contact with the contents during shipment. The design process will involve choices of basic material, use of filters or other pressure relief devices, gaskets or other seal materials, closure mechanisms, and other features. Typical containment materials are high-density polyethylene (HDPE), polypropylene, glass, and steel.

1.3.2.3 Shielding. The following requirements directly address shielding design of Type A packagings:

- | 173.412(d) Temperature (-40 to 70 °C [-40 to 158 °F]), brittle fracture
- 173.412(k) Shielding/containment interface
- 173.441 Radiation level limitations.

Shielding may be required for Type A quantities of radionuclides. Lead or steel are commonly used materials for shielding. The regulations require that the shielding and containment system remain intact and effective when subjected to normal conditions of transport.

1.3.2.4 Lifting and Handling. The following requirements directly address the design of lifting and handling features of Type A packagings:

- 173.411(a) Handling, securing
- | 173.411(b) Manual handling (gross weight 10 to 50 kg [22 to 110 lb])
- | 173.411(c) Mechanical handling (gross weight above 50 kg [110 lb])
- 173.411(d) Lifting attachments.
- | The exterior design of the packaging shall meet the above requirements.

1.3.2.5 Tiedown. The following requirements directly address the design of tiedown features of Type A packagings:

- 173.411(a) Handling, securing
- 173.412(l) Tiedown, failure.

- | Package tiedown features and equipment shall be designed to comply with these requirements.

1.3.3 Package Qualification and Testing

Type A packagings must be designed to withstand the tests delineated in 49 CFR 173, Sections 173.465 and/or 173.466 as applicable. Section 173.461 addresses the methods by which compliance with these requirements may be addressed. The DOT-7A Program typically demonstrates acceptable performance by exposing several prototype test units to the test conditions. The tests that are performed are described briefly below.

1.3.3.1 Reduced Pressure Test [49 CFR 173.412(i)]. The reduced pressure test is intended to simulate the reduction of ambient (external) pressure to the package to 25 kPa (3.5 psia). This may be achieved by pressurizing the internal cavity of the packaging to 78 kPa (11.2 psig) or by placing a closed packaging into a chamber that can be evacuated to 25 kPa (3.5 psia). In both cases, leak detection by visual, soap bubble, pressure change, or other method is used.

1.3.3.2 Water Spray Test [49 CFR 173.465(b)]. The water spray test simulates exposure to rainfall of approximately 5 cm (2 in.)/hour for at least one hour. This test must precede each of the other tests or test sequences described in 49 CFR 173.465. 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 package. The time interval is two hours if the spray is applied from four different directions simultaneously. Other tests will follow immediately if the spray is applied from each of the four directions consecutively.

1.3.3.3 Compression Test [49 CFR 173.465(d)]. The compression test lasts for a period of at least twenty-four hours. The compressive load is equivalent to either five times the weight of the actual package or $1,300 \text{ kg/m}^2$ (265 lb/ft^2) multiplied by the vertically projected area of the package, whichever is greater. The load is applied uniformly to two opposite sides of the package, one of which must be the base on which the package would normally stand.

1.3.3.4 Penetration Test [49 CFR 173.465(e) and 173.466(a)(2)]. The package is placed on a rigid, flat, horizontal surface. A bar (penetration bar) 3.2 cm (1.25 in.) in diameter with a hemispherical end, weighing 6 kg (13.2 lb), with its longitudinal axis vertical, is dropped onto the center of the weakest part of the package, so that, if it penetrates far enough, it will hit the containment system. The bar must not be deformed by the test.

The distance of the fall of the bar is measured from its lower end to the upper surface of the package. The determination of this distance depends on the basic physical form of the contents for which the packaging is designed. The penetration drop height for packagings designed to contain only solids is 1 m (3.3 ft). This distance is 1.7 m (5.5 ft) for packagings designed to contain liquids and/or gases.

1.3.3.5 Free Drop Test [49 CFR 173.465(c) and 173.466(a)(1)]. The free drop test consists of a fall onto a flat, horizontal, rigid surface. The orientation of the test package is such that the fall will cause maximum damage to the package and its safety features. The distance of the fall will be measured from the lowest part of the packaging to the upper surface of the target. The distance of the fall is determined by the gross weight of the packaging, packaging material type, and material form to be shipped.

1.3.3.6 Vibration Standard [49 CFR 178.608]. Three randomly selected sample packagings are filled and closed as for shipment. The sample packagings are placed on a vibrating platform that has a vertical or rotary double-amplitude (peak-to-peak displacement) of 2.54 cm (1 in.). The packages should be constrained horizontally to prevent them from falling off the platform, but must be free to move vertically, bounce, and rotate.

The test must be performed for at least one hour at a frequency that causes the package to be raised from the vibrating platform so that a piece of material of approximately 1.6-mm (0.063-in.) thickness can be passed between the bottom of any package and the platform.

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.

1.3.3.7 Demonstration of Compliance With Tests. Following the test sequences, which expose the prototypes to the applicable tests, the performance of the packaging is evaluated. If determined acceptable, the packaging is approved for use by DOE/EH-32 and included in this document.

1.3.4 The HM-181 Regulation Changes

The now implemented HM-181 regulations affect requirements for packaging and transportation of hazardous materials in the United States, similar to the United Nations (UN) recommendations for packaging of dangerous goods.

The implementation of HM-181 took effect as of October 1, 1994. Under the HM-181 regulation changes, most nonbulk hazardous material packagings must be tested against performance criteria that simulate stresses encountered during shipment. The results of these tests must be documented and the packagings marked or certified with a UN certification. Packagings not marked with the certification will be refused entry into international destinations and may be refused by domestic air carriers. The transition period in which all domestic shipments must attain compliance is five years or sooner, depending on the material to be shipped.

The packaging test requirements vary depending on the density, vapor pressure and packing group for a particular material. Packing Group I packagings are subjected to the most stringent performance tests. Packing Groups II and III invoke progressively less stringent performance requirements.

The HM-181 regulation changes have no direct effect on this document or the use of Specification 7A. However, there is an indirect effect since HM-181 resulted in the deletion of many of the specification packagings covered in 49 CFR 178. For example, the DOT Specification 17-C drum (49 CFR 178.115) was deleted from the regulations. This document refers in many places to this and similar specifications. Accordingly, when referring to these specifications in procedures, specifications, and purchasing documents, reference the specification followed by the words, "in effect in December 1990 (i.e., prior to DOT rulemaking HM-181)." Another indirect effect may be encountered when shipping liquids via an air carrier. The HM-181 requirements regarding qualification of the packaging to the reduced external pressure conditions may be invoked, requiring review and/or additional testing of the packagings described herein.

Note that the appendices are divided into pre-HM-181 and post-HM-181 sections. The as-tested packaging information has been placed accordingly into the appendices.

1.4 USE OF TYPE B PACKAGINGS

The U.S. Nuclear Regulatory Commission (NRC)-approved Type B packagings may be used to transport Type A quantities of radioactive materials provided applicable requirements are met. The NRC provided some clarification regarding such use of NRC-approved Type B packagings in Information Notice 90-82 dated December 31, 1990 (NRC 1990). This information is summarized in the following paragraphs.

The NRC and DOT share primary responsibility for approving package designs for transportation of radioactive materials within the United States. The NRC regulations for the transportation of radioactive materials are codified in 10 CFR Part 71, "Packaging and Transportation of Radioactive Material." The DOT's hazardous materials regulations, which include radioactive material, are codified in 49 CFR Parts 100-199. Requirements for shippers of radioactive materials are given in 49 CFR 173.400 through 173.478. In addition, a provision in the NRC regulations, 10 CFR 71.5, requires that NRC licensees comply with DOT's hazardous materials regulations.

In general, pursuant to 10 CFR Part 71, NRC approves package designs for shipment of fissile and greater-than-Type A quantities of radioactive material. The design for packages up to Type A quantities is subject to the requirements of DOT in 49 CFR Part 173.

In authorizing the use of NRC-approved packages for transportation of Type A quantities of radioactive material, DOT regulations specify, in 49 CFR 173.415, that certain conditions be met. One condition (49 CFR 173.471) is that the shipment of the package be made in compliance with the terms of the NRC certificate of compliance (certificate). For example, a radiographic source changer authorized for a Type B quantity of a specific radionuclide in special form is also authorized for a Type A quantity of the same specific radionuclide in special form, provided that all the terms and conditions of the certificate are met. Note that NRC approvals include the type and form of material, the maximum quantity of material per package, and the operating instructions and maintenance procedures for the package.

Alternately, an NRC-approved package may be shipped under the provisions of 49 CFR 173.415(a) as a DOT-7A package. In this instance, the shipper (if requested) must provide DOT with 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 DOT-7A. The shipper is required to maintain this documentation on file for at least one year after the latest shipment. Thus, a radiographic source changer approved by NRC for shipment of a specific radionuclide in special form could be used to ship a Type A quantity of a different nuclide, provided that the package is re-evaluated under the provisions of 49 CFR 173.415(a).

When an NRC-approved package is used as a DOT-7A package, the NRC package identification marking should be covered and new markings ("USA DOT-7A TYPE A" and "radioactive material") affixed to the package, pursuant to 49 CFR 173.415(a).

Users of the NRC-approved packages should be aware of the requirements for using NRC-approved packages for low-level radioactive materials exempted under 10 CFR 71.10. In particular, users of NRC-approved packages should:

- Determine what provision of 49 CFR 173.415 applies
- Comply with all requirements in 49 CFR 173.415(a) and 49 CFR 178.350 when the shipment is made pursuant to 49 CFR 173.415(a). Note that the use of an NRC-approved package pursuant to 49 CFR 173.415(a) requires that the package be re-evaluated as a DOT-7A Type A package, and that the shipper maintain the evaluation on file for one year after the last shipment
- Comply with all terms and conditions in the NRC certificate when the shipment is made pursuant to 49 CFR 173.415(c).

1.5 PROCUREMENT

Normally DOE shippers will procure complete packagings or components of packagings from commercial suppliers to satisfy shipment needs. The DOE/EH-32 recommends that any packaging procurement be conducted in two basic steps:

1. Obtain from the packaging supplier the documentation that will demonstrate compliance with the requirements (i.e., drawings, specifications, etc.) and perform a technical review.
2. Upon acceptance of the documentation (i.e., all comments satisfactorily resolved), release the supplier to manufacture the packagings or components.

Procurement of the packagings identified herein or their components will involve preparation of a technical specification followed by execution of the normal process used for procuring equipment or components. The following paragraphs summarize this process.

1.5.1 Specification Development

The shipper should prepare a technical specification for the packaging or component to be supplied that includes, as a minimum, any technical requirements specified in this document. The specification should also identify any other deliverables desired and the requirements applicable to each. When the specification is complete, the shipper normally will prepare a purchase requisition, which will accompany the specification, to initiate the formal procurement process.

1.5.2 Request for Proposals

The first formal step in the procurement process is preparation of a purchase requisition and the subsequent issuance of a request for proposal (RFP). The procurement package will include the completed specification, schedule requirements, and other pertinent technical information such as technical evaluation criteria, technical proposal instructions to bidders,

etc. Upon completion and management approval of the purchase requisition and the specification, the shipper should contact the purchasing organization at the site or facility to coordinate the RFP process. The buyer who is the cognizant purchasing representative will become the focal point in the process of negotiating with potential suppliers.

1.5.3 Order Placement

Normally several or more suppliers will respond to the RFP. This will initiate a selection process for determining the candidate who will supply acceptable deliverables for the lowest cost. The selection process will normally involve the shipper's technical review of each of the proposals and procurement department review including cost and price analysis. Upon completion of the reviews, a supplier (the seller) will be selected and the order placed.

1.5.4 Documentation Review and Approval

The next major action for the shipper will be to review any seller-provided documentation such as drawings, specifications, analyses, manufacturing processing instructions, and quality control processes. Upon acceptance of this data, the supplier will be released to manufacture the components or packagings per the purchase order.

1.5.5 Packaging Manufacturing and Delivery

The seller will manufacture the fleet packagings as specified in the purchase order when released by the buyer. When complete, the packagings will be delivered to the shipper's facility for receiving inspection and use.

1.6 PACKAGING OPERATIONS

Packaging operations involve assembling the packaging, loading the contents, closing the package, and preparing for shipment. The operating instructions for a packaging are the primary vehicle for the shipper to maintain control on the assembly, loading, and closure processes for a packaging and its preparation for shipment and other items. Accordingly, shippers are requested to ensure that the operating instructions for the packaging system to be used implement the operational requirements discussed in the following paragraphs.

The operating instructions should consist of the following primary elements:

- Packaging description
- Authorized contents
- Preloading inspections
- Loading procedure
- Preparation for shipment
- Preshipment inspections

- Shipment requirements
- Unloading procedure
- Reuse/reconditioning (if applicable).

The packaging description and authorized contents sections should be similar to the material for a packaging included herein.

The shipper should determine, per the following requirements, the preloading inspections to be performed and the acceptance criteria considered necessary to ensure that the packaging complies and that adequate quality control is implemented.

173.474 Quality control for construction of packaging

173.475 Quality control requirements prior to each shipment of radioactive materials.

The loading procedure should address all operations necessary to correctly assemble the packaging components, load the contents, and close the packaging.

The section addressing preparation for shipment should address labeling and placarding requirements (49 CFR 173.444 and 173.446) and any other applicable requirements. If the package must be secured to the conveyance in a particular fashion, this should also be specified in a subsection to be entitled, "Tiedown."

The section(s) addressing preshipment inspections should address verifications for compliance with the following requirements:

173.441 Radiation level limitations

173.442 Thermal limitations

173.443 Contamination control.

The section addressing shipment requirements should address requirements and procedures applicable when the package is en route to its destination. For example, the requirements of 49 CFR 173.447, "Storage incident to transportation," should be addressed in this section.

The unloading procedure should detail all steps necessary to safely unload the package from the conveyance and for unloading the contents from the packaging.

If the packaging may be reused, the operating instructions should include procedures for reconditioning the packaging to a state that will meet the design requirements established in the drawing and specification.

1.7 QUALITY ASSURANCE

The quality assurance program implemented by the shipper's organization must implement actions to provide adequate confidence that the shipments will comply with the regulations. The DOE Order 5700.6C includes general quality

elements to be considered in development of the shippers quality program. Shippers are cautioned to invoke only the quality requirements applicable to Type A packaging and transportation.

The following regulatory requirements address quality control applicable to Type A packagings:

173.474 Quality control for construction of packaging

173.475 Quality control requirements prior to each shipment of radioactive materials.

The shipper is responsible for ensuring that the packaging materials, components, and arrangement are in accordance with the qualified design as documented herein. The shipper is also responsible for ensuring that the packaging is assembled, loaded (with compatible contents), closed, and prepared for shipment properly.

The DOE/EH-32 recommends that quality control be implemented as needed for the shipper to ensure compliance with the regulations. This is considered best achieved at three possible points in the packaging operation process:

1. Receiving inspections for procured packagings or components. The inspections should be of adequate scope and detail to ensure that the supplied hardware complies with the qualified design.
2. Preloading inspections to be performed prior to assembly and loading of the packaging. These inspections should verify that no packaging components have been damaged or altered and the arrangement is in accordance with the qualified design.
3. Preshipment inspections to be performed prior to shipment. This final inspection should verify that the assembled package, its marking and labeling, and its tiedown arrangement (if applicable) are correct. Further, preshipment inspections should address verifications for compliance with the following requirements:

173.441 Radiation level limitations

173.442 Thermal limitations

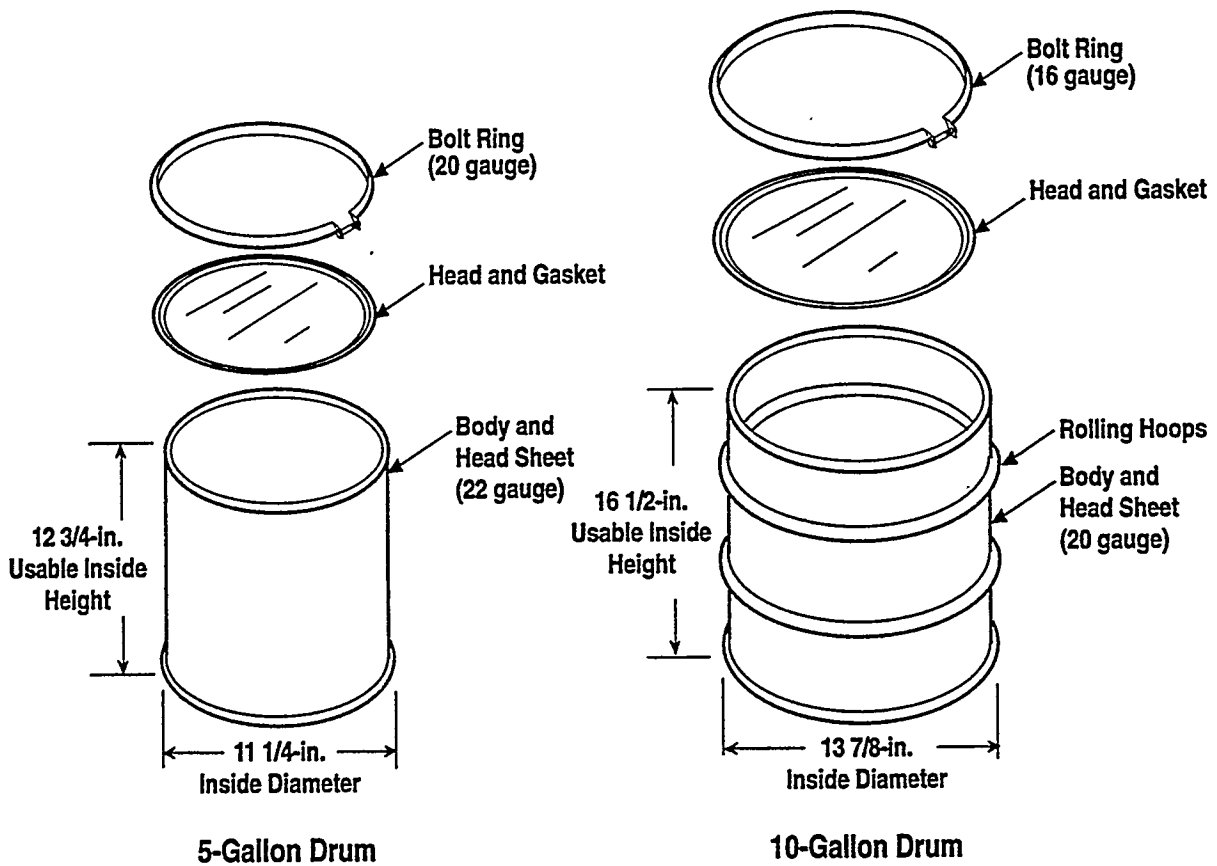
173.443 Contamination control.

The data presented for specific packagings in this document includes applicable quality control elements. This data should be used for guidance in implementing the inspections mentioned above.

Figure 2-1. DOT-6C 5- and 10-Gallon Steel Drums, 49 CFR 178.99
(contents restricted, see Section 2.1.3).

DOT 7A Type A

49 CFR 178.350



S9504030.2

2.1 DOT-6C 5- AND 10-GALLON STEEL DRUMS (DOCKETS: MLM)

2.1.1 Package Description

Dimensions

Drum	Height (in.)	Diameter (in.)
5-gallon interior	12.50	11.25
5-gallon exterior	13.50	12.25
10-gallon interior	15.75	14.00
10-gallon exterior	17.25	15.00

Materials/Method of Construction

5 gallon		10 gallon	
Body and head sheet	22 gauge	Body and head sheet	20 gauge
Ring	20 gauge	Ring	16 gauge
Bolt	0.218 in.	Bolt	0.312 in.
Gasket required		Gasket required	

2.1.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

2.1.2.1 Physical Form

2.1.2.1.1 Solids only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., room temperature vulcanizing [RTV], etc.).

- Material Form No. 1: Solids--any particle size.
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination controls.)

2.1.2.1.2 Maximum Gross Weight. Form No. 1, No. 2, and No. 3:

- 5-gal = 80 lb
- 10-gal = 160 lb.

2.1.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

2.1.2.3 Radiological. Dents approximately 1.1 in. and 1.5 in. appeared in the 5-gal and 10-gal drums, respectively, following the 4-ft drop test on the bottom edge. The shipper must ensure that the radiation level at the surface of the package would not increase by more than 20% if such deformations occurred.

2.1.3 Restrictions/Specifications

For Form No. 1 Contents--RTV sealant (or equivalent) must be applied to the surface of the gasket in contact with the drum body.

For Form No. 2 and No. 3 Contents--No packaging component requirements other than specified in Section 2.1.1.

Bolt closure tightened, with tapping, until the lugs begin to bend inward or come together--typically less than 40 ft-lb. A jam nut shall also be used to prevent unintentional loosening during transport.

The gasket material must have an operating range of -40 °F to +158 °F.

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/positioned within the package.

2.1.4 49 CFR 178.350 REGULATORY REQUIREMENTS

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-1.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-1.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-1.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	<u>Pass.</u> This test was conducted on nine different types of steel drums and a total of 26 packages. In all cases, there was no detectable effect on the ability of the packaging to meet the subsequent Type A tests. Also, in all cases, there was no inleakage of water as a result of this test. See Appendix D, Table D-1.
Free drop	<u>Pass.</u> 4-ft drop test conducted on: Top - approximately 45° on bolt Bottom - approximately 45° Side - flat on bolt. See Appendix D, Table D-10.
Corner drop	Not required.
Compression	<u>Pass.</u> This test was conducted at greater than five times the gross weight for 24 hr. No detectable effect on the packaging was observed. See Appendix D, Table D-23.
Penetration	<u>Pass.</u> This test was conducted on the center of the lid, on the center of side body, and on the lid close to the closure ring. See Appendix D, Table D-30.

2.1.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: • Ease of lid/closure ring application • Bolt closure ring--bolt size • Gasket, adhesive, as specified • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces • Dimensions, as specified • Continuous welds, no sharp edges
Gasket		
Weld areas		
Body and chime	Metal thickness	Lot tests by shipper, as appropriate.
Air leak tests	Bolt size	Vendor Data and/or Certification: • Marking • Test data • Type A document provided as appropriate • Air leak tests
	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

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

2.1.6 Additional Information

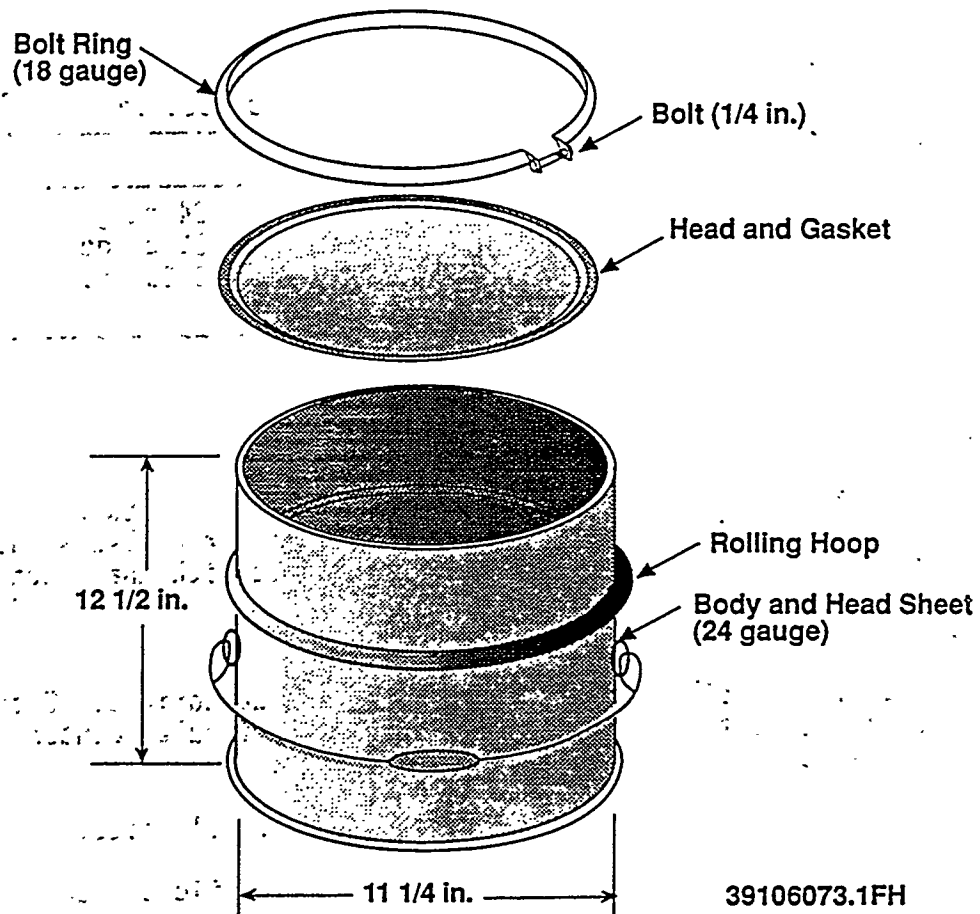
Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.1.6.1 Primary Users

<u>Site/Contact/Phone</u>	<u>Address</u>
Rocky Flats Plant D. M. Krieg COMM/FTS 303-966-2377	Rocky Flats Plant P. O. Box 464 Golden, CO 80402-0464

Figure 2-2. DOT-17C 5-Gallon Steel Drum, 49 CFR 178.115.

DOT 7A Type A
49 CFR 178.350



2.2 DOT-17C 5-GALLON STEEL DRUM (DOCKETS: MLM)

2.2.1 Package Description

Dimensions

5-gallon drum	Height (in.)	Diameter (in.)
Interior	12.5	11.25
Exterior (with ring)	13.0	12.00

Materials/Method of Construction

5 gallon	
Body and head sheet	24 gauge
Ring	18 gauge
Bolt	0.25 in.
Gasket required	

2.2.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

2.2.2.1 Physical Form

2.2.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., RTV, etc.).

- Material Form No. 1: Solids--any particle size.
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

2.2.2.1.2 Maximum Gross Weight. Form No. 1, No. 2 and No. 3:

- 100 lb.

2.2.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

2.2.2.3 Radiological. The 4-ft drop test caused deformation of the package resulting in a decrease in the distance from the exterior to the center of the package at the bottom edge of 0.5 in. (approximate). The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such a deformation would occur.

2.2.3 Restrictions/Specifications

For Form No. 1 Contents--RTV sealant (or equivalent) must be applied to the surface of the gasket in contact with the drum body.

For Form No. 2 and No. 3 Contents--No packaging component requirements other than as specified in Section 2.2.1.

Bolt closure tightened, with tapping, until the lugs begin to bend inward or come together--typically less than 40 ft-lb. A jam nut shall also be used to prevent unintentional loosening during transport.

The gasket material must have an operating range of -40 °F to +158 °F.

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/positioned within the package.

2.2.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-1.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-1.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-1.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	<u>Pass.</u> Tests were conducted on all three styles of drums and demonstrated no inleakage of water. Further, the water spray test preceded each of the remaining Type A tests. In no case was there any effect on the ability of the packagings to meet the required tests. See Appendix D, Table D-1.
Free drop	<u>Pass.</u> Sixty-nine separate drop tests were conducted (22 on Styles 1A and B, 26 on Style 2, and 21 on Style 3). Drops were conducted on edges, top corners, bottom corners, and the ends. In all cases, there was no loss of contents or major distortion of the packagings. See Appendix D, Table D-10.
Corner drop	Not required.
Compression	<u>Pass.</u> The test was conducted on all three styles at greater than five times the gross weight for greater than 24 hr. There was no visible distortion of the packagings or loss of contents. See Appendix D, Table D-23.
Penetration	<u>Pass.</u> The test was conducted at several points on all three styles of the packagings with no significant effect. The tests on the bungs left no discernable mark. The impact on the centers of the covers resulted in a maximum dent of 0.25 in. The tests on the closure rings left no visible effect. See Appendix D, Table D-30.

2.2.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: • Ease of lid/closure ring application • Bolt closure ring--bolt size • Gasket, adhesive, as specified • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces • Dimensions, as specified • Continuous welds, no sharp edges
Gasket		
Weld areas		
Body and chime	Metal thickness	Lot tests by shipper, as appropriate.
Air leak tests	Bolt size	Vendor Data and/or Certification: • Marking • Test data • Type A document provided as appropriate • Air leak tests
	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

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

2.2.6 ADDITIONAL INFORMATION

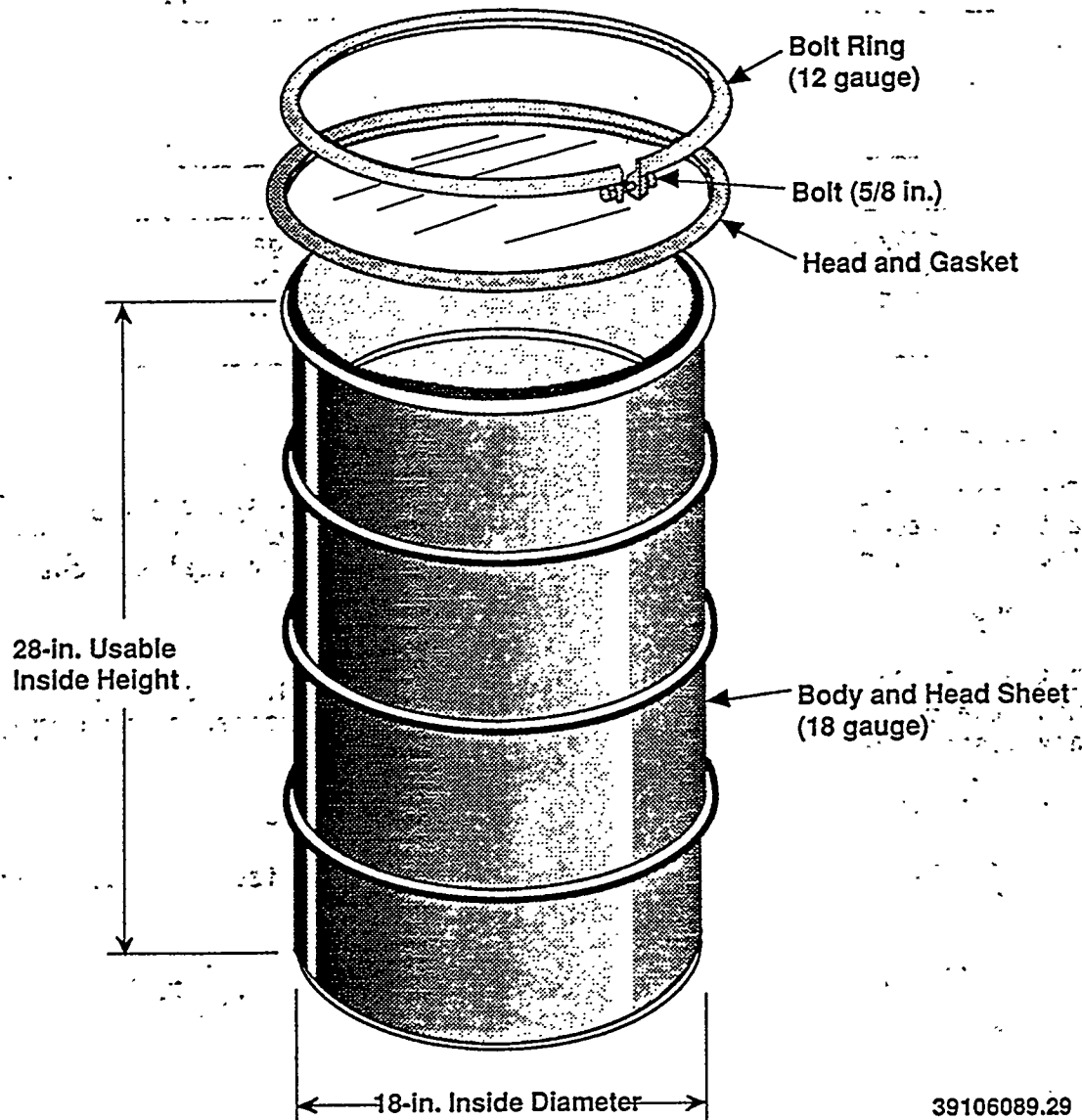
Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.2.6.1 Primary Users

<u>Site/Contact/Phone</u>	<u>Address</u>
Los Alamos National Laboratory N. King COMM/FTS 505-667-4125	Los Alamos National Laboratory P.O. Box 1663 Los Alamos, NM 87545
Battelle Columbus Laboratories T. R. Emsweiler 614-879-5165	Battelle Columbus Laboratories 505 King Avenue Columbus, OH 43201

Figure 2-3. DOT-17C 30-Gallon Steel Drum, 49 CFR 178.115.

DOT 7A Type A 49 CFR 178.350



2.3 DOT-17C 30-GALLON STEEL DRUM (DOCKETS: MLM)

2.3.1 Package Description

Dimensions		
30-gallon drum	Height (in.)	Diameter (in.)
Interior	28.0	18.0
Exterior	29.5	20.0

Materials/Method of Construction

30 gallon	
Body and head sheet	18 gauge
Ring	12 gauge
Bolt	0.625 in.
Gasket required	

2.3.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

2.3.2.1 Physical Form

2.3.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., RTV, etc.).

- Material Form No. 1: Solids--any particle size.
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.)
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

2.3.2.1.2 Maximum Gross Weight

- Form No. 1 = 400 lb
- Form No. 2 = 500 lb
- Form No. 3 = 500 lb.

2.3.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

2.3.2.3 Radiological. The 4-ft drop test caused deformation of the package resulting in a decrease in the distance from the exterior to the center of the package at the bottom edge of 2.75 in. (approximate). The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such a deformation would occur.

2.3.3 Restrictions/Specifications

For Form No. 1 Contents--RTV sealant (or equivalent) must be applied to the surface of the gasket in contact with the drum body.

For Form No. 2 and No. 3 Contents--No packaging component requirements other than specified in Section 2.3.1.

The lid closure ring bolt shall be tightened to 40 ± 4 ft-lb with tapping of ring during tightening. A jam nut shall also be used to prevent unintentional loosening during transport.

The gasket material must have an operating range of -40°F to $+158^{\circ}\text{F}$.

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/positioned within the package.

2.3.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-1.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-1.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-1.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	<u>Pass.</u> This test was conducted on nine different types of steel drums and a total of 26 packages. In all cases, there was no detectable effect on the ability of the packaging to meet the subsequent Type A tests. Also, in all cases, there was no inleakage of water as a result of this test. See Addendum 1, Table D-1.
Free drop	<u>Pass.</u> 4-ft drop test conducted on: Top - approximately 45° on bolt Bottom - approximately 45° Side - flat on bolt. See Appendix D, Table D-10.
Corner drop	Not required.
Compression	<u>Pass.</u> This test was conducted at greater than five times the gross weight for 24 hr. No detectable effect on the packaging was observed. See Appendix D, Table D-23.
Penetration	<u>Pass.</u> This test was conducted on the center of the lid, on the center of the side body, and on the lid close to the closure ring. See Appendix D, Table D-30.

2.3.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: • Ease of lid/closure ring application • Bolt closure ring--bolt size • Gasket, adhesive, as specified • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces • Dimensions, as specified • Continuous welds, no sharp edges
Gasket		
Weld areas		
Body and chime	Metal thickness	Lot tests by shipper, as appropriate.
Air leak tests	Bolt size	Vendor Data and/or Certification: • Marking • Test data • Type A document provided as appropriate • Air leak tests
	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

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

2.3.6 Additional Information

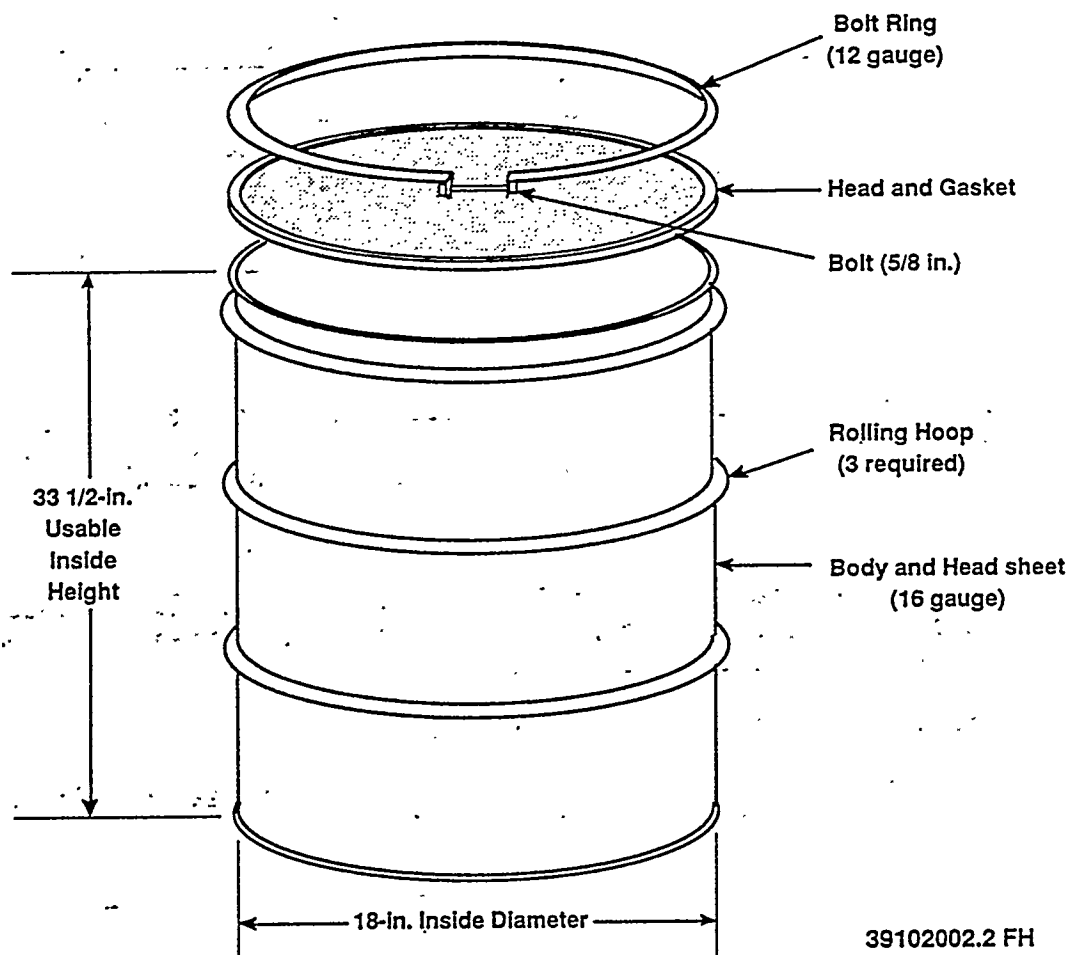
Evaluation and testing of the subject packaging took place at MLM. A complete test report is available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.3.6.1 Primary Users

<u>Site/Contact/Phone</u>	<u>Address</u>
Battelle Columbus Laboratories T. R. Emsweiler 614-879-5165	Battelle Columbus Laboratories 505 King Avenue Columbus, OH 43201

Figure 2-4. DOT-17C 35-Gallon Steel Drum, 49 CFR 178.115.

DOT 7A Type A **49 CFR 178.350**



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2.4 DOT-17C 35-GALLON STEEL DRUM (DOCKETS: MLM)

2.4.1 Package Description

Dimensions

35-gallon drum	Height (in.)	Diameter (in.)
Interior	33.50	18.00
Exterior	34.75	20.50

Materials/Method of Construction

35 gallon	
Body and head sheet	16 gauge
Ring	12 gauge
Bolt	0.625 in.
Gasket required	

2.4.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the test contents. If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

2.4.2.1 Physical Form

2.4.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements (e.g., RTV, etc.).

- Material Form No. 1: Solids--any particle size.
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.).
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see CFR 173.443, Contamination control.)

2.4.2.1.2 Maximum Gross Weight. Form No. 1, No. 2 and No. 3:

- 400 lb.

2.4.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

2.4.2.3 Radiological. The 4-ft drop test caused deformation of the package resulting in a decrease in the distance from the exterior to the center of the package at the top edge of 1.125 in. (approximate). The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such a deformation would occur.

2.4.3 Restrictions/Specifications

For Form No. 1 and No. 2 Contents--RTV sealant (or equivalent) must be applied to the surface of the gasket in contact with the drum body.

For Form No. 3 Contents--No packaging component requirements other than as specified in Section 2.4.1.

The locking ring bolt shall be tightened to 40 ± 4 ft-lb with tapping of the ring during tightening per the following procedure:

1. Tighten the bolt to 40 ft-lb torque.
2. Hit the closure ring vigorously with a metal hammer, eight to nine times, equally spaced around the ring.
3. Repeat this cycle three additional times.
4. Torque bolt one last time to 40 ft-lb.

A jam nut shall also be used to prevent unintentional loosening during transport.

The cover seal gasket material must have operating range of -40°F to $+158^{\circ}\text{F}$.

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/positioned within the package.

2.4.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-1.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-1.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-1.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	<u>Pass.</u> This test was conducted on a total of six packagings. In all cases, there was no detectable effect on the ability of the packaging to meet the subsequent Type A test. Also, there was no inleakage of water as a result of this test. See Appendix D, Table D-1.
Free drop	<u>Pass.</u> 4-ft drop test conducted on: Top - approximately 45° on bolt Bottom - approximately 45° Side - flat on bolt. See Appendix D, Table D-10.
Corner drop	Not required.
Compression	<u>Pass.</u> This test was conducted at greater than five times the gross weight for 24 hr. No detectable effect on the packaging was observed. See Appendix D, Table D-23.
Penetration	<u>Pass.</u> This test was conducted on the center of the lid, on the center of side body, and on the lid close to the closure ring. Only minor dents occurred. See Appendix D, Table D-30.

2.4.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: • Ease of lid/closure ring application • Bolt closure ring--bolt size • Gasket, adhesive, as specified • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces • Dimensions, as specified • Continuous welds, no sharp edges
Gasket		
Weld areas		
Body and chime	Metal thickness	Lot tests by shipper, as appropriate.
Air leak tests	Bolt size	Vendor Data and/or Certification: • Marking • Test data • Type A document provided as appropriate • Air leak tests
	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

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

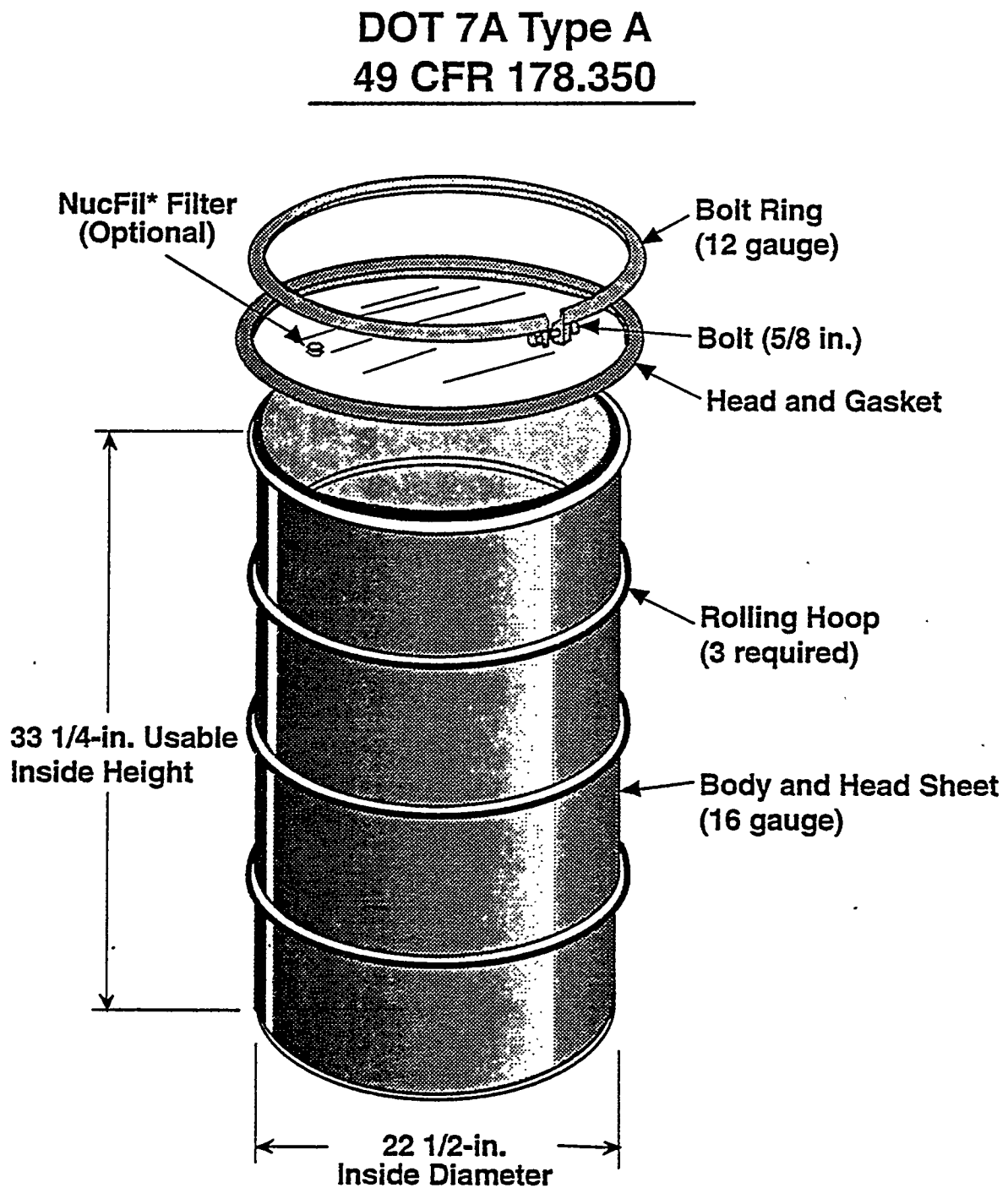
2.4.6 Additional Information

Evaluation and testing of the subject packaging took place at MLM in 1989. A complete test report is available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.4.6.1 Primary User(s):

<u>Site/Contact/Phone</u>	<u>Address</u>
Rocky Flats Plant Doyle Mitchell COMM/FTS 303-966-4421	Rocky Flats Plant P.O. Box 464 Golden, CO 80402-0464

Figure 2-5. DOT-17C 55-Gallon Steel Drum.

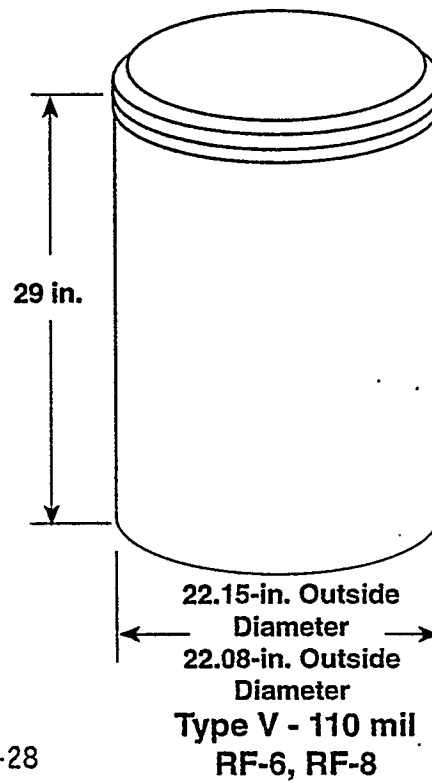
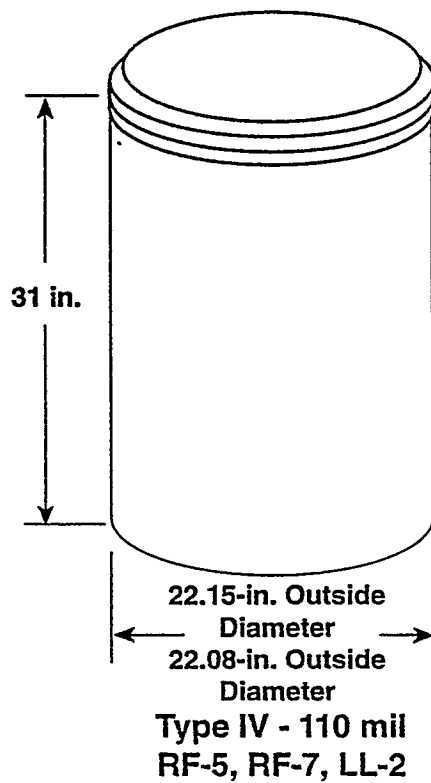
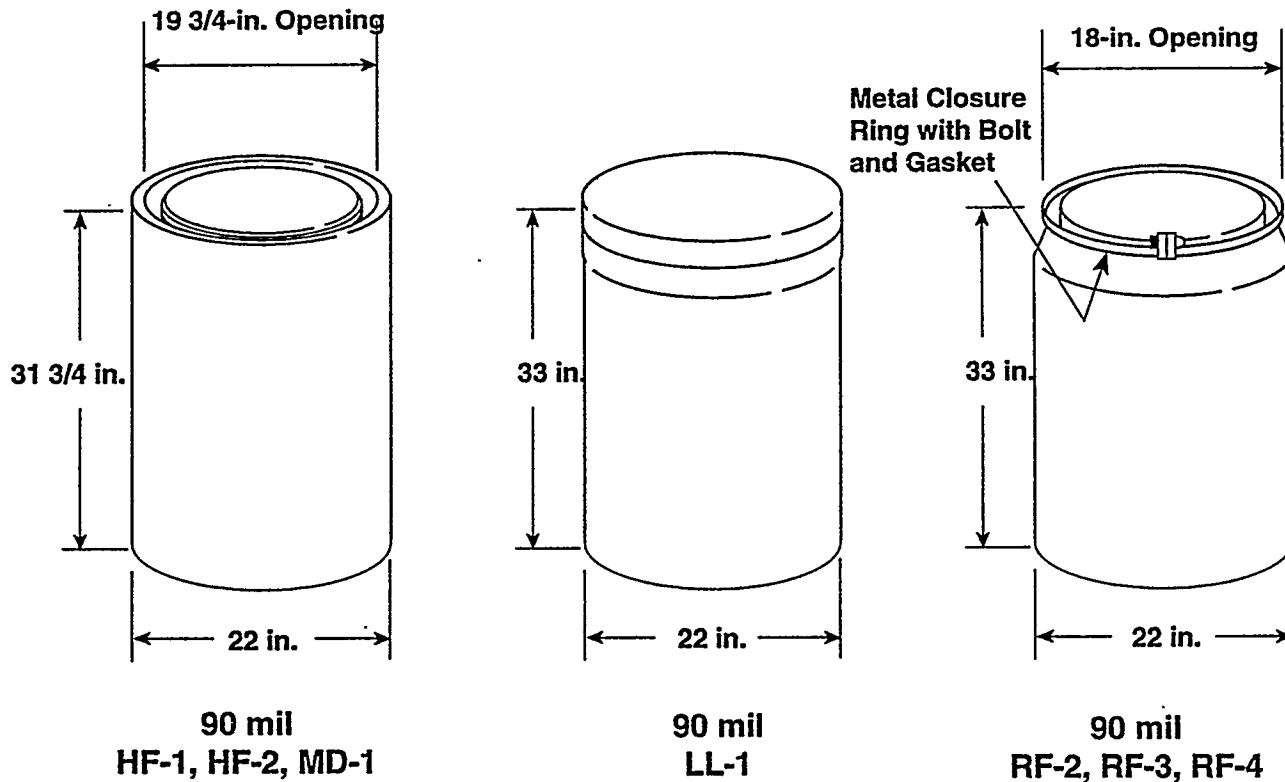


*NucFil is a trademark of Nuclear Filter Technology, Incorporated.

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Figure 2-6. High-Density Polyethylene Liners for Use with DOT-17C 55-Gallon Steel Drums.

DOT 7A Type A 49 CFR 178.350



2.5 DOT-17C 55-GALLON STEEL DRUM, OPTIONAL
PRESSURE RELIEF DEVICE AND/OR HIGH-
DENSITY POLYETHYLENE LINER
(DOCKETS: MLM;
89-13-7A, 01/90;
90-18-7A, 01/91;
94-37-7A, 08/94)

2.5.1 Package Description

Authorized Configurations (sheet 1 of 2)

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 nonvented), that encloses a 4-mil polyethylene bag, that encloses the contents.
HF-2	Drum with liner: a DOT-17C (filtered or nonfiltered) drum with an HDPE liner (90-mil body, 110-mil head, vented or nonvented), that encloses the contents.
LL-1	Drum with liner: a DOT-17C (filtered or nonfiltered) drum with an HDPE liner (90-mil body, 110-mil head, vented or nonvented), that encloses the contents.
MD-1	Drum with liner: a DOT-17C (filtered or nonfiltered) drum with an HDPE liner (90-mil body, 110-mil head, vented or nonvented), that encloses the contents.
RF-1	Drum with polyethylene bag: a DOT-17C nonfiltered drum with an optional 4-mil polyethylene bag, that encloses the contents. For Form No. 1 materials, either the bag or sealing the lid gasket to the body seal interface with RTV adhesive is required.
RF-2	Filtered drum, liner with bag: a DOT-17C filtered (NucFil-014*) drum with a 90-mil HDPE liner, that encloses a 4-mil polyethylene bag, that encloses the contents.
RF-3	Drum with liner: a DOT-17C nonfiltered drum with an HDPE liner (90-mil body, 110-mil head, vented or nonvented), that 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, that encloses a 10-mil plastic bag, that 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, that encloses a 10-mil plastic bag, that 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), that encloses a PVC glovebox bag, that encloses a Type V HDPE 110-mil liner, that encloses the contents.

Authorized Configurations (sheet 2 of 2)

RF-7	Filtered drum, vented liner with bag: a DOT-17C filtered (NucFil-014) drum with a vented Type IV HDPE 110-mil liner, that encloses a 10-mil plastic bag, that 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), that encloses a PVC glovebox bag, that encloses a vented Type V HDPE 110-mil liner, that encloses the contents.
G-1	Filtered drum: a DOT-17C drum with catalyst packet and NucFil filter or vent clip--single packaging. Authorized only for use with Form No. 2 and 3 contents, see Section 2.5.2.1.
G-2	Drum (nonfiltered): a DOT-17C drum (nonfiltered)--single packaging. Authorized only for use with Form No. 2 and 3 contents, see Section 2.5.2.1.
LL-2	Filtered drum, open Type IV liner: a DOT-17C (or UN1A2 built to be equivalent to the DOT-17C) filtered (NucFil-013) drum with a Type IV HDPE 110-mil liner, that encloses a 3.5-mil plastic bag that encloses the contents.

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

HDPE = high-density polyethylene.

PVC = polyvinyl chloride.

RTV = room temperature vulcanizing.

Dimensions

208-Liter (55-gallon) drum	Height		Diameter	
	cm	in.	cm	in.
Interior	84.46	33.25	56.51	22.50
Exterior	88.90	35.00	61.24	24.10

Materials/Method of Construction (sheet 1 of 2)

Drums	DOT-17C (or UN1A2 built to be equivalent to the DOT-17C), steel or galvanized steel
Drum lid	Steel with 1.9-cm (0.750-in.) Rieke Bung fitting welded on (required on filtered configurations only)
Drum gasket	Closed cell Neoprene ^a meeting ASTM D1056 grade SCE-45, 30-40 durometer, shore-A Tubular styrene-butadiene Butadiene foam

Materials/Method of Construction (sheet 2 of 2)

Pressure relief devices	
Vent Clip	Stainless steel, 304, per Rockwell Hanford drawing H-2-28798
Filter	Nuclear Filter Technology, Incorporated Model NucFil-014 ^b or Model NucFil-013
Liners	
HF-1, HF-2, MD-1	Per RHO-MA-222, Rev. 4 (RHO 1987) 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 with approximately 1.9-cm (0.750-in.) diameter
LL-1	Open-head molded polyethylene liner without carbon black Vent hole (if used) is at the center of the head with approximately 1.9-cm (0.750-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 with approximately 1.9-cm (0.750-in.) diameter
RF-5, RF-6, RF-7, RF-8	Open-head, molded, polyethylene (density is 0.946 to 0.953 per ASTM-D-792 [ASTM 1986]) liner with 2.5% black (Type IV) or brown color (Type V) added, minimum 110-mil thick Vent hole (if used) is at the center with approximately 2.54-cm (1-in.) diameter
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.

^aNeoprene is a trademark of E. I. duPont de Nemours & Company.

^bNucFil is a trademark of Nuclear Filter Technology, Incorporated.

ASTM = American Society for Testing and Materials.

2.5.2 Authorized Contents

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 DOT-7A compliance with the actual contents.

2.5.2.1 Physical Form

2.5.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents and comply with any special requirements.

- Material Form No. 1: Solids--any particle size.
- Material Form No. 2: Solids--large particle size only (e.g., sand, concrete, debris, soil, etc.).
- Material Form No. 3: Solids--objects with no significant dispersible or removable contamination. (For definition, see 49 CFR 173.443, Contamination control.)

2.5.2.1.2 Maximum Gross Weight

- Form No. 1 = 408 kg (900 lb)
- Form No. 2 = 454 kg (1,000 lb)
- Form No. 3 = 454 kg (1,000 lb).

2.5.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

2.5.2.3 Radiological. The 1.2-m (4-ft) drop test caused deformation of the package resulting in a decrease in the distance from the exterior to the center of the package at the bottom chime of 6.35 cm (2.5) in. (approximate). The shipper must ensure that the radiation level at any surface would not increase by more than 20% (relative to the radiation level of the undamaged configuration) if such a deformation would occur.

2.5.3 Restrictions/Specifications

The lid-locking ring bolt shall be tightened to 54 ± 5 Nm (40 ± 4 ft-lb) torque with tapping of ring during tightening. A jam nut shall also be used to prevent unintentional loosening during transport.

To prevent unintentional loosening, the NucFil filter (if used) shall be:

1. Installed and torqued to 13.6 Nm (10 ft-lb) and tack-welded; or
2. Secured by use of Loctite* No. 262 (red) and torqued to 13.6 Nm (10 ft-lb); or
3. Torqued to 20.3 Nm (15 ft-lb).

The drum gasket material must have an operating range of -40 °C to 70 °C (-40 °F to +158 °F).

If a vented liner is used, a 10-mil (minimum thickness) polyethylene bag must be placed inside the liner to enclose the contents.

If an open Type IV liner is used, a 3.5-mil polyethylene bag may be placed inside the liner to enclose the contents. Any contents that are heavy, sharp objects should be enclosed by a plastic bag (e.g., glovebox bag) that has been enclosed by a secondary plastic bag.

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/positioned within the package.

*Loctite is a trademark of Loctite Corporation.

2.5.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-1.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-1.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-1.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	<u>Pass</u> . This test was conducted and there was no inleakage of water. See Appendix D, Table D-1.
Free drop	<u>Pass</u> . Multiple 4-ft drop tests have been conducted on a number of test units with successful results. The impact orientations included: Top - CG over corner on bolt Top - flat on top Bottom - CG over corner Bottom - flat on bottom Side - flat on bolt. See Appendix D, Table D-10.
Corner drop	Not required.
Compression	<u>Pass</u> . This test was conducted on a number of test units with successful results. See Appendix D, Table D-23.
Penetration	<u>Pass</u> . Penetration bar was dropped on a number of test units impacting all potentially vulnerable features with no adverse effects on the packaging. The features impacted included the lid, the filter, the side, and the bottom center. See Appendix D, Table D-30.
49 CFR 178.608, Vibration standards [Applied to demonstrate compliance with 49 CFR 173.412 (e)]	Meets applicable requirements. See Appendix E, Table E-1.

2.5.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: - Ease of lid/closure ring application - Bolt closure ring--bolt size - Gasket, adhesive, as specified - Geometry, as specified Acceptable Conditions: - Lack of dents, no deformation of sealing surfaces - Dimensions, as specified - Continuous welds, no sharp edges
Gasket		
Weld areas		
Body and chime	Metal thickness	Lot tests by shipper, as appropriate.
Air leak tests	Bolt size	Vendor Data and/or Certification: - Marking - Test data - Type A document provided as appropriate - Air leak tests
	Protective coating application	Visual: - Surface/coating as specified - Lack of imperfections in application - Lack of rust, dents, nicks

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

2.5.6 Additional Information

Evaluation and testing of configurations HF-1, HF-2, LL-1, MD-1, RF-1, RF-2, and RF-3 took place at MLM and were documented in Edling 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. Configuration on LL-2 was vibration and 1.2-m (4-ft) drop tested by Westinghouse Hanford in August 1994 as a part of Docket 94-37-7A. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.5.6.1 Primary Users

<u>Site/Contact/Phone</u>	<u>Address</u>
Rocky Flats L. Smith COMM/303-966-7516 K. Lenarcic COMM/303-966-2377	Rocky Flats P.O. Box 464 Golden, CO 80402-0464
Hanford T. Romano COMM/509-373-0310	Westinghouse Hanford Company P.O. Box 1970 Richland, WA 99352
Lawrence-Livermore National Laboratory K. Hainebach COMM/510-422-4572	Lawrence-Livermore National Laboratory P.O. Box 808 Livermore, CA 94550
MLM L. Lamsa COMM/513-865-4182	EG&G/Mound Mound Road Miamisburg, OH 45343

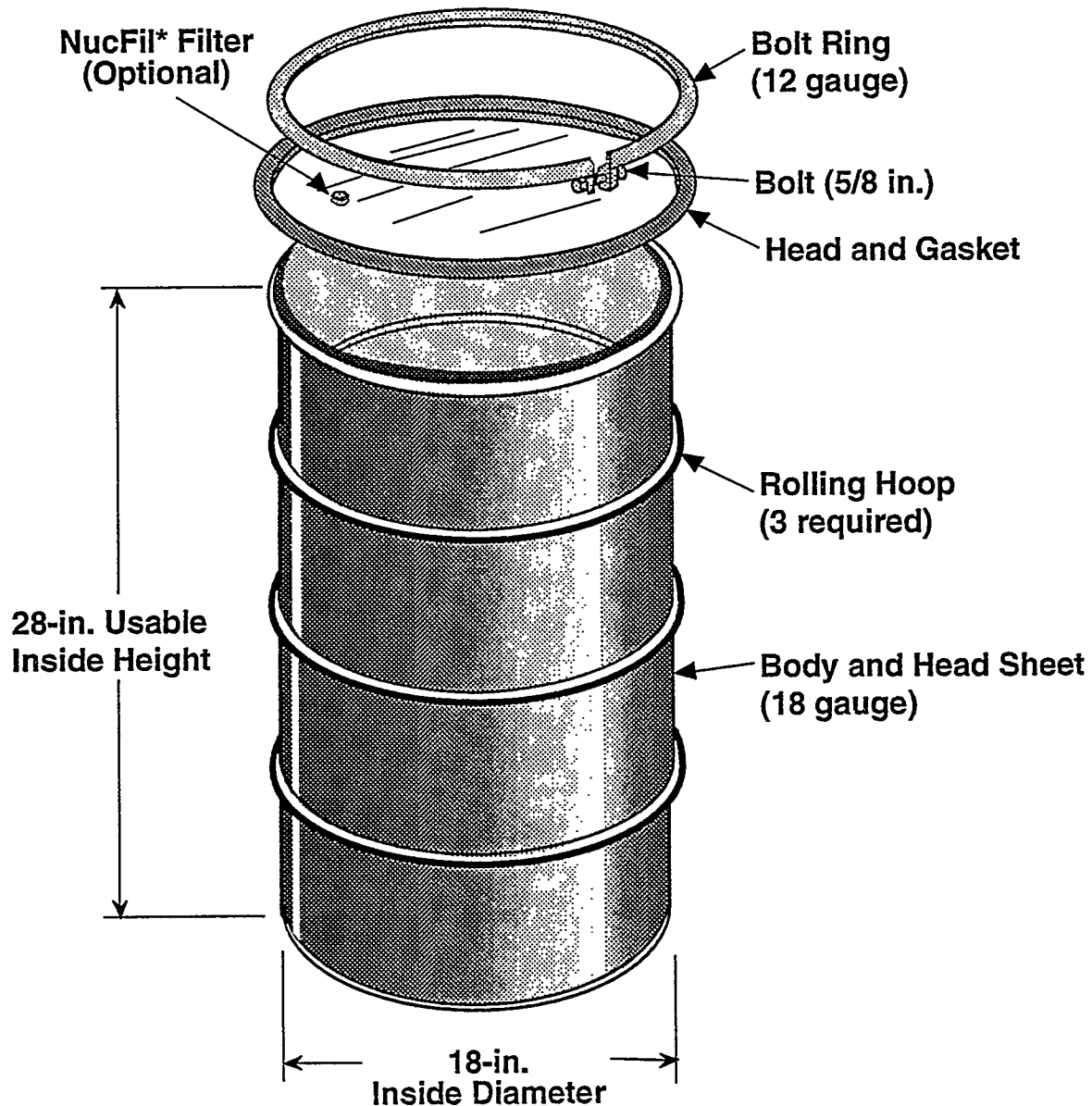
2.5.6.2 Suppliers

Liners: HF, MD - Meese Incorporated 1745 Cragmont St. 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

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Figure 2-7. DOT-17H 30-Gallon Steel Drum, 49 CFR 178.118.

DOT 7A Type A 49 CFR 178.350



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

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2.7.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface sealing surface	Vendor qualifications and experience	Functional: • Ease of lid/closure ring application • Bolt closure ring--bolt size • Gasket, adhesive, as specified • Geometry, as specified Acceptable Conditions: • Lack of dents, no deformation of sealing surfaces • Dimensions, as specified • Continuous welds, no sharp edges
Gasket		
Weld areas		
Body and chime	Metal thickness	Lot tests by shipper, as appropriate.
Air leak tests	Bolt size	Vendor Data and/or Certification: • Marking • Test data • Type A document provided as appropriate • Air leak tests
	Protective coating application	Visual: • Surface/coating as specified • Lack of imperfections in application • Lack of rust, dents, nicks

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

2.7.6 Additional Information

Evaluation and testing of this packaging were performed at MLM and were documented in Edling 1987. Complete evaluation reports are available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

2.7.6.1 Primary Users

<u>Site/Contact/Phone</u>	<u>Address</u>
MLM Don Wikstrom COMM/FTS 513-865-3919	Mound Laboratories Mound Road Miamisburg, OH 45342
Battelle T. R. Emsweiler 614-879-5165	Battelle Columbus Laboratories 505 King Avenue Columbus, OH 43201
ORNL H. E. Crowder COMM/FTS 615-576-9100	Martin-Marietta Energy Systems, Inc. P.O. Box Y Oak Ridge Y-12 Plant Oak Ridge, TN 37830

3.7.6 Additional Information

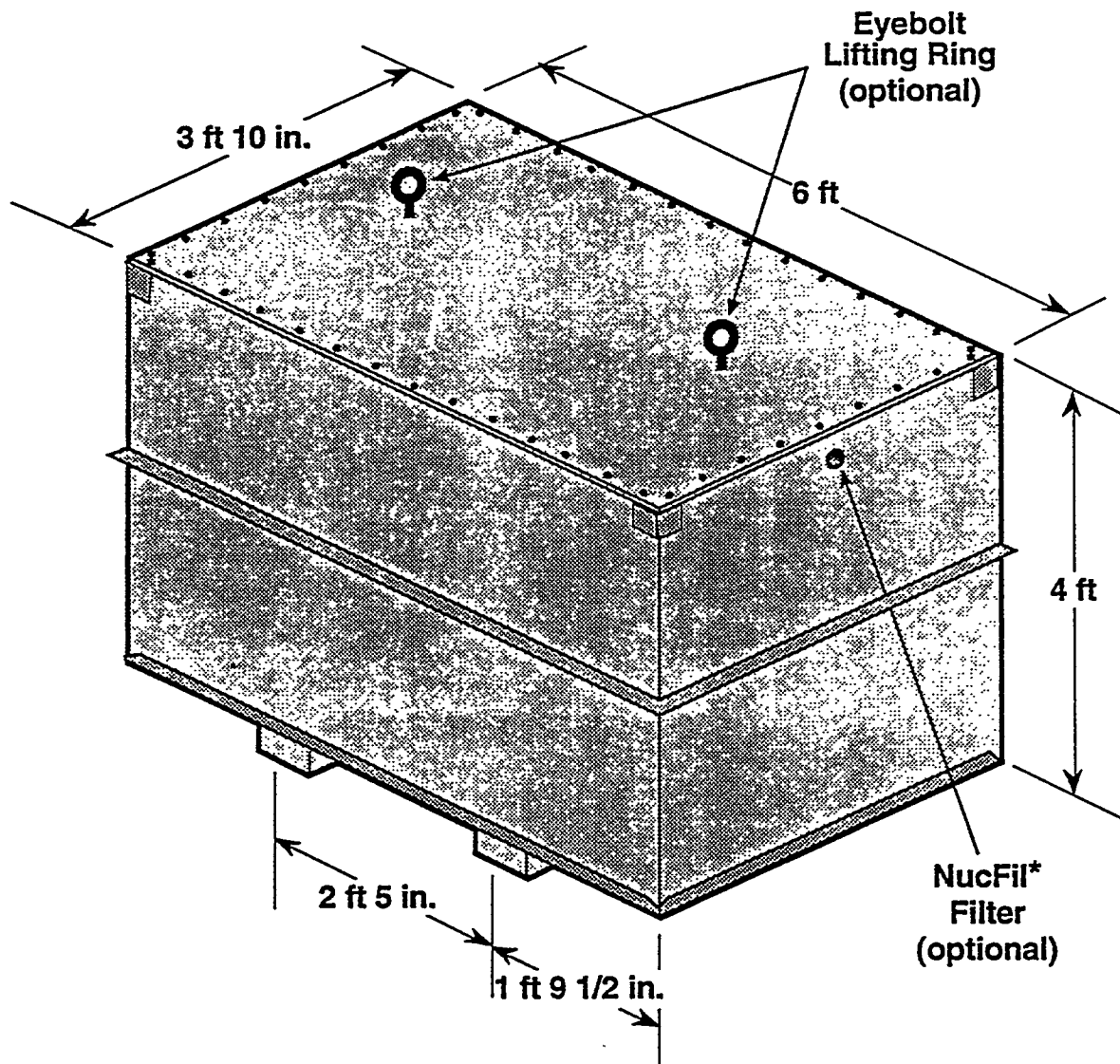
Evaluation and testing of the subject packaging took place at MLM in 1989. A complete test report is available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

3.7.6.1 Primary User(s)

<u>Site/Contact/Phone</u>	<u>Address</u>
Waste Isolation Pilot Plant M. L. Caviness 505-885-8883	Westinghouse/Waste Isolation Division P.O. Box 2078 Carlsbad, NM 88221

Figure 3-8. ORNL Low-Level Waste Container.

DOT 7A Type A 49 CFR 178.350



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

S9504030.3

7.14.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages	Meets applicable requirements. See Appendix A, Table A-6.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-6.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-10.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	<u>Pass</u> . The package was tested satisfactorily with no inleakage of water. See Appendix D, Table D-8.
Free drop	<u>Pass</u> . The package was tested satisfactorily from 1.2 m (4 ft) and three orientations: flat on bottom, flat on top, and flat on side with bolt down. See Appendix D, Table D-18a.
Corner drop	Not required.
Compression	<u>Pass</u> . The package was tested satisfactorily with 1,387 kg (3,058 lb) for 27 hours with no adverse effect. See Appendix D, Table D-28.
Penetration	<u>Pass</u> . The package was tested satisfactorily from 1 m (3.3 ft), targeting the center and the drum lid and on the side at the midpoint of the drum. See Appendix D, Table D-35.
49 CFR 173.466, Additional tests for Type A packagings designed for liquids and gases	Meets applicable requirements.
Free drop	<u>Pass</u> . The package was tested satisfactorily from 9 m (30 ft) and three orientations: flat on bottom, flat on top, and flat on side with bolt down. See Appendix D, Table D-18a.
Penetration	<u>Pass</u> . The package was tested satisfactorily from 1.7 m (5.5 ft), targeting the center and the drum lid and on the side at the midpoint of the drum. See Appendix D, Table D-35.

7.14.5 Quality Control

Packaging/Acceptance/Use Criteria

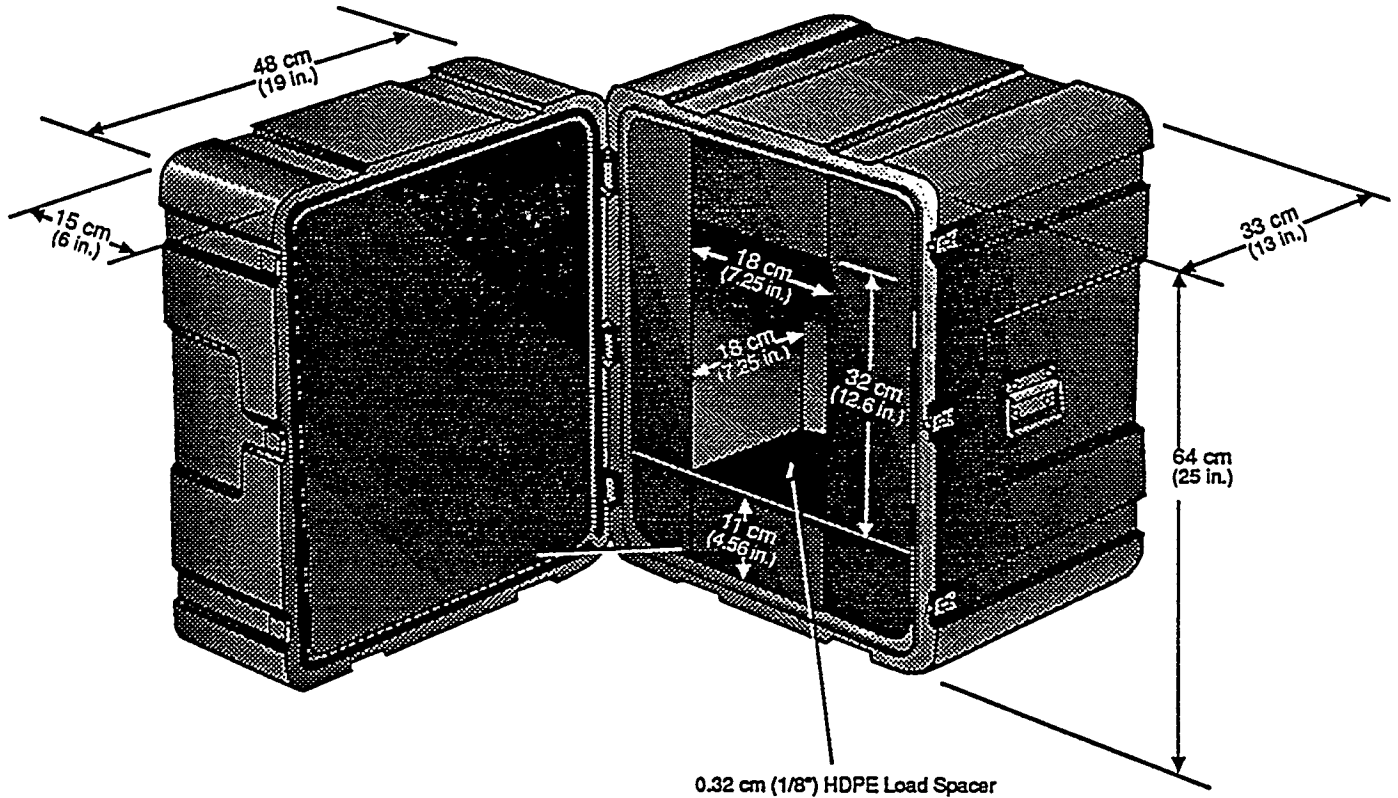
Critical	Major	Acceptance/pre-use/ inspection criteria ^a
Shielding Containment Seals/O-rings ^b Sealing surfaces	Weld seams	Functional: • Size, materials, and geometry, as specified • Lack of rust, dents, nicks Acceptable conditions: • Continuous welds, no sharp edges • Lack of dents, no deformations of mating surfaces
Foam	Metal thickness	• Dimensions, as specified • Lot tests by shipper, as appropriate
	Vendor data/ certification	• Marking • Test data • Type A certification document provided, as appropriate
	Verification of shielding and containment	Visual: • Lack of corrosion, rust, dents, nicks

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

^bNOTE: Inspect and replace seals and O-rings in accordance with applicant-provided operating instructions.

Figure 7-24. WHC Hedgehog Container, Outer Case.

DOT 7A Type A
49 CFR 178.350



S9501049.5

Figure 7-25. WHC Hedgehog Container,* 30-mL Version.
*without outer case

DOT 7A Type A
49 CFR 178.350

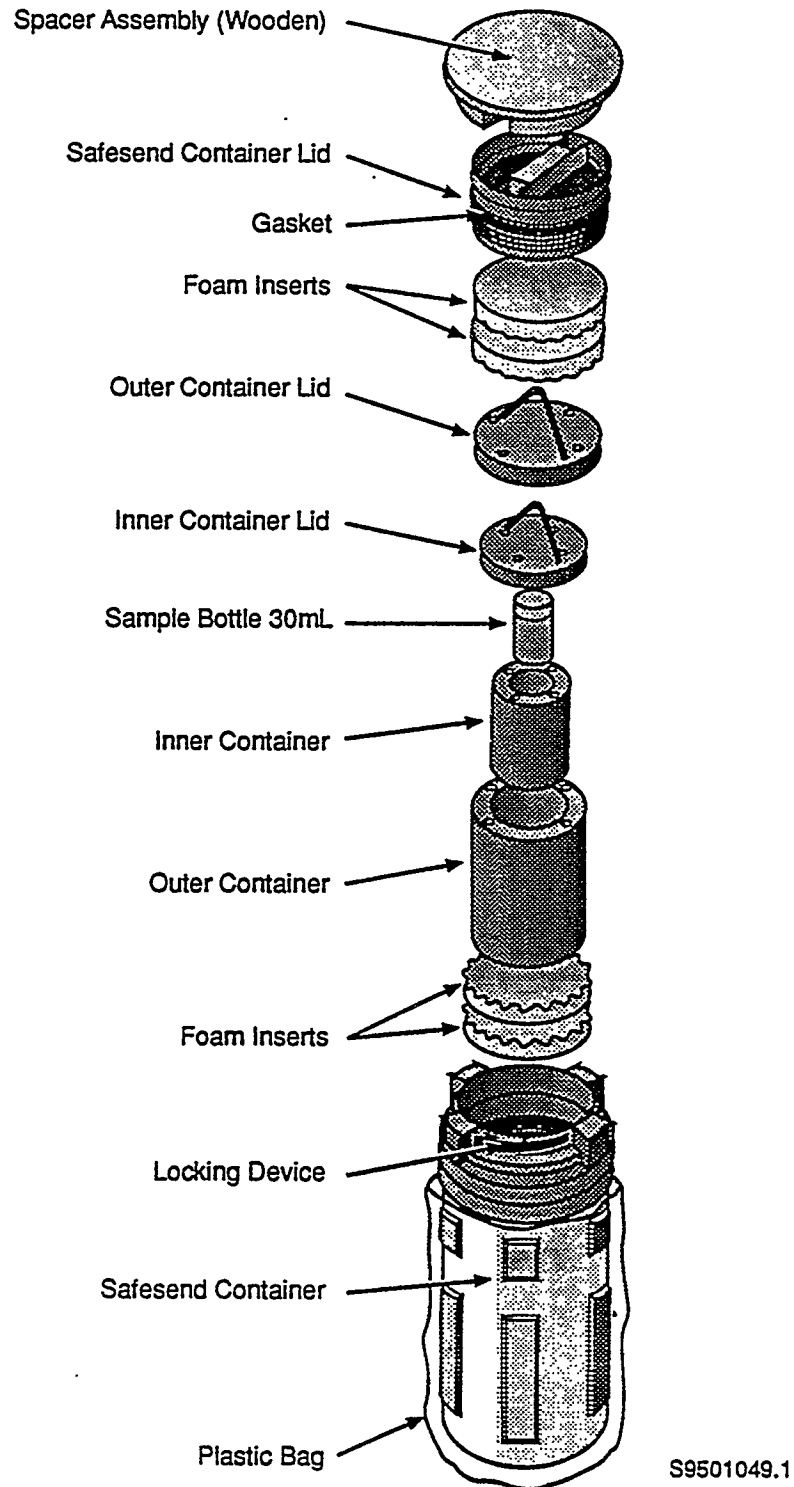
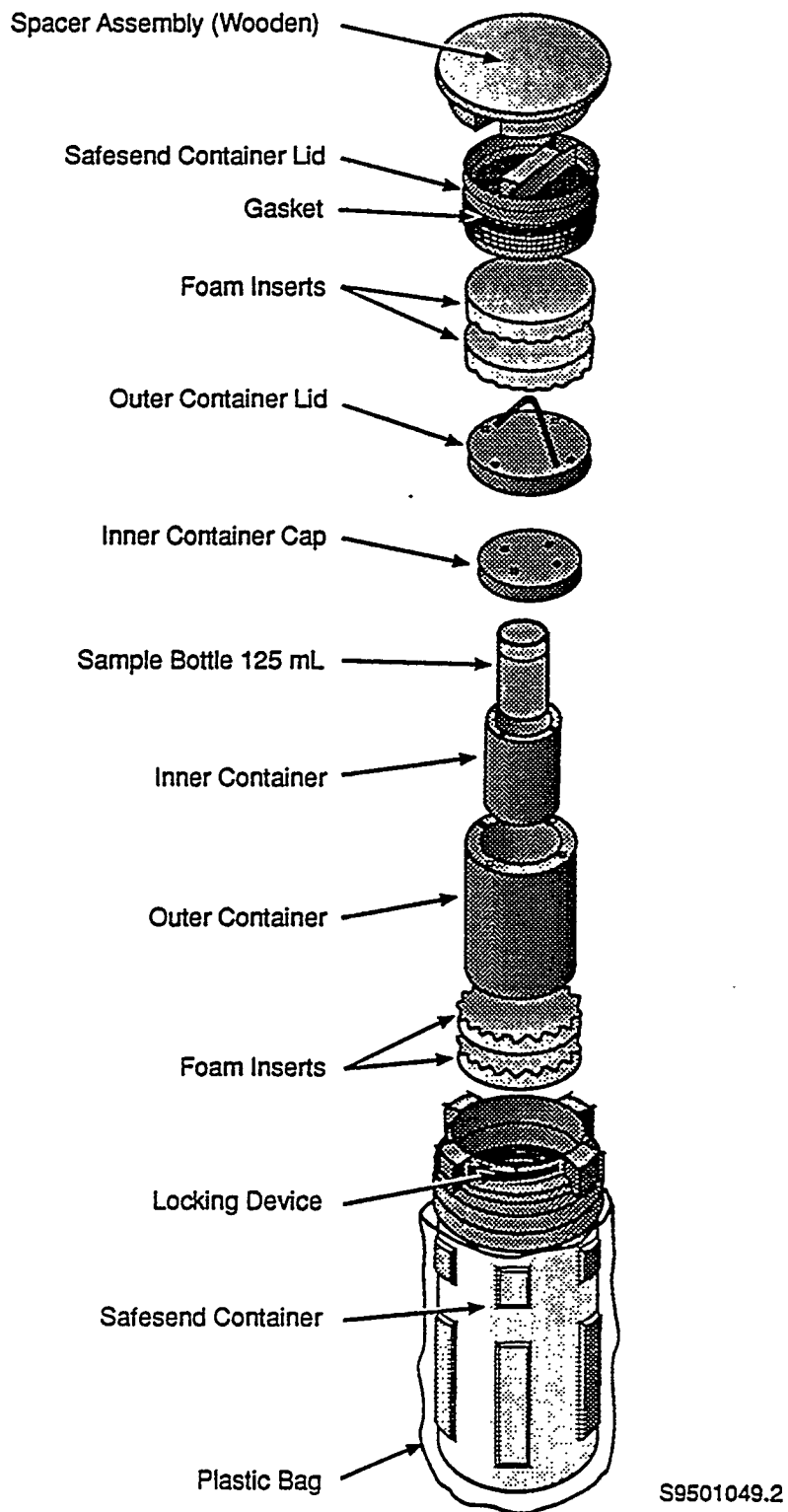


Figure 7-26. WHC Hedgehog Container,* 125-mL Version.
*without outer case.

DOT 7A Type A
49 CFR 178.350



S9501049.2

Figure 7-27. WHC Hedgehog Container,* 250-mL Version.
*without outer case

DOT 7A Type A
49 CFR 178.350

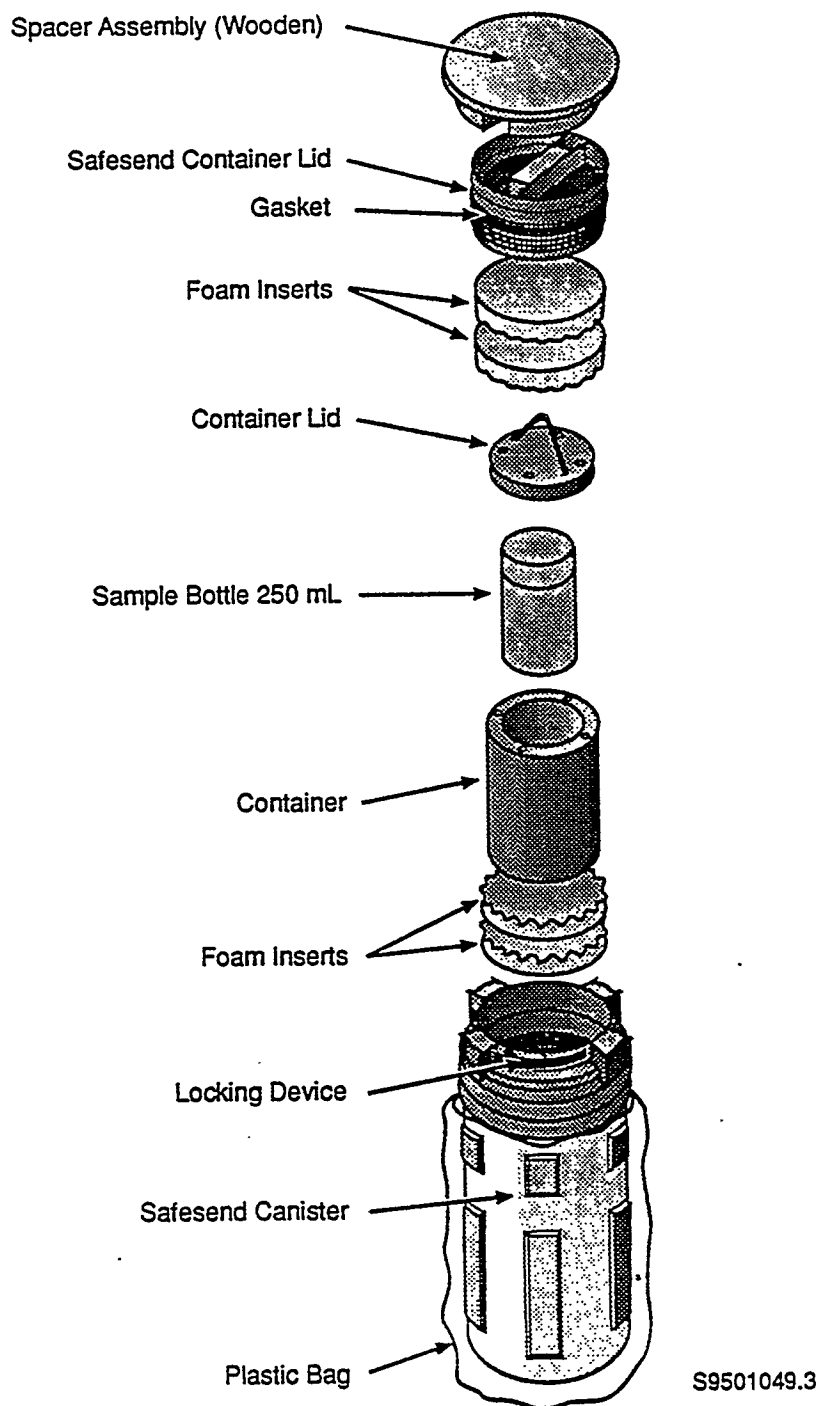
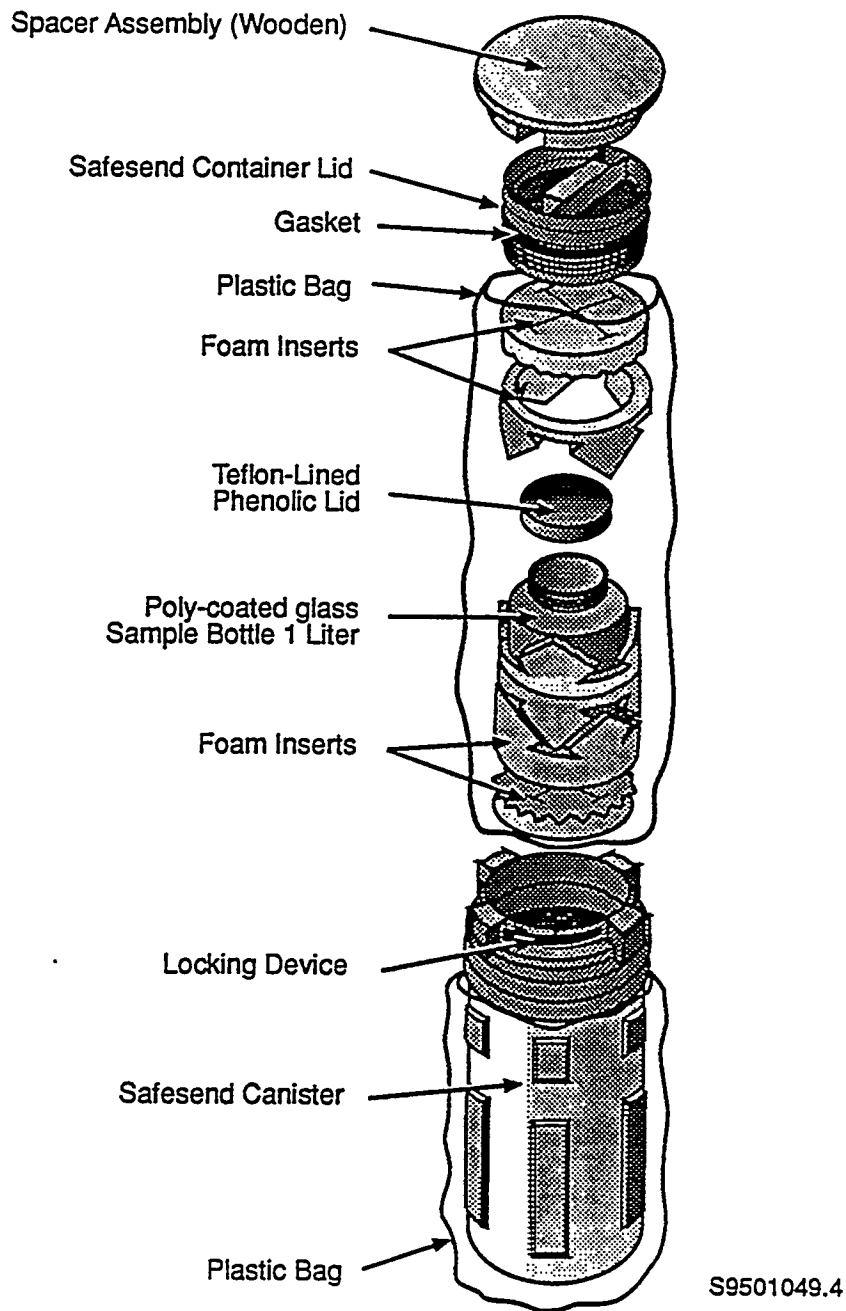


Figure 7-28. WHC Hedgehog Container,* 1-L Version.
*without outer case

DOT 7A Type A
49 CFR 178.350



7.17 WHC HEDGEHOG CONTAINER (DOCKET: 94-39-7A, 02/95)

7.17.1 Package Description

NOTE: Design measurements noted for this packaging were provided in English and were converted to metric. Measurements are nominal (1 in. = 2.54 cm).

Dimensions (Nominal)

Item	External dimensions nominal--cm (in.)	Internal dimensions nominal--cm (in.)
Hardigg Case ^a	64 L x 48 W x 48 H (25 L x 19 W x 19 H)	<u>Internal cavity:</u> 32 L x 18 W x 18 H (12.6 L x 7.25 W x 7.25 H)
Spacer assembly Round disk	0.64 thick x 17.7 dia. (0.25 thick x 7 dia.)	
Half-moons	4.9 W x 3.0 thick (1.937 W x 1.187 thick)	
SafeSend SP-R1L kit Canister	16.51 (6.5) dia. 31.5 (12.4) tall	12.40 (4.88) dia. 21.00 (8.25) tall
Outer container assembly (30-, 125-, and 250-mL)	17.8 tall x 11.3 dia. (7 tall x 4.5 dia.)	15.2 tall x 9.4 dia. (6 tall x 3.7 dia.)
Inner container assembly (125-mL)	13.7 tall x 8.9 dia. (5.4 tall x 3.5 dia.)	10.9 tall x 6.6 dia. (4.3 tall x 2.6 dia.)
Inner container assembly (30-mL)	13.2 tall x 8.9 dia. (5.2 tall x 3.5 dia.)	9.9 tall x 3.8 dia. (3.9 tall x 1.5 dia.)

^aHardigg Case is a trademark of Hardigg Industries, Inc.

The approximate shielding thickness for each configuration tested is as follows:

- 30-mL version 3.81 cm (1.5 in.)
- 125-mL version 2.54 cm (1.0 in.)
- 250-mL version 1.27 cm (0.5 in.)
- 1-L version no shielding.

Materials/Method of Construction (sheet 1 of 3)

Item/Component	Description
Hardigg Case	Part No. AL2216-1205-14274-HHBA00. Polyethylene case that includes zinc chromate hardware, steel butterfly latches, cardholder, 2-PCF polyethylene foam, and 0.32 cm (1/8-in.) thick ABS load spreader.
Spacer assembly	WHC Drawing No. H-2-824999. Consists of maple half-moon spacers glued onto a fir plywood disk.
SafeSend SP-R1L ^a kit	Labelmaster Catalog Part No. KSP-1LR.
Canister	High-density polyethylene; two-piece welded assembly. Canister incorporates an integral sorbent material that is 300 g (0.66 lb) of microwebs, powersorb, universal white with surfactant.
Lid	High-density polyethylene that incorporates an integral sorbent material that is 97 g (0.21 lb) of microwebs, powersorb, universal white with surfactant.
Quad ring gasket	Teflon ^b -coated ethylene propylene. The ring has a thin film of Dow Corning #7 Silicone Paste Lubricant ^c used on the bottom surface.
Snap latch	Acetal. The application torque range of the lid is 5-6 N-m (45-55 in.-lb).
Bag	Gusseted, polyethylene.
Foam inserts	Open-cell, urethane foam.
Outer container assembly (30-, 125-, and 250-mL)	WHC Drawing Number H-2-824999.
Cover	Type 304 stainless steel (ss), ASTM A 240. Screws are alloy steel, ASTM F 835, hexagon socket flat countersunk head cap screws; #8-32UNC-3A x 1-in.
Wall	Type 304 ss, ASTM A 511, cold finish, or ASTM A 276.
Base	Type 304 ss, ASTM A 240. Screws are alloy steel, ASTM F 835, hexagon flat countersunk head cap screw; #8-32UNC-3A x 3/4 in.

Materials/Method of Construction (sheet 2 of 3)

Item/component	Description
O-rings	Nitrile, Parker #2-153-N304-75 or #2-153-N103-70; 8.9-cm (3.487-in.) inner diameter (ID), 0.26-cm (0.103-in.) cross section.
Lifting cable	SAVA #2065, 19.05-cm (7.5-in) long by 0.159-cm (0.063-in.) diameter, uncoated ss, 7 by 19 construction.
Cable fitting	SAVA #805-C, for 0.159-cm (0.063-in.) cable, 0.528-cm (0.208-in.) diameter by 0.762-cm (0.3-in.) long sleeve, copper. To be crimped onto lifting cable using SAVA tool T-188.
Inner container assembly (125-mL)	WHC Drawing Number H-2-824999.
Cover and base	Type 304 ss, ASTM A 240. Screws are alloy steel, ASTM F 835, hexagon socket flat countersunk head cap screws; #8-32UNC-3A x 3/4-in.
Wall	Type 304 ss, ASTM A 511, cold finish, or ASTM A 276.
O-rings	Nitrile, Parker #2-153-N304-75 or #2-153-N103-70; 6.0-cm (2.362-in.) ID, 0.26-cm (0.103-in.) cross section.
Inner container assembly (30-mL)	WHC Drawing Number H-2-824999.
Cover and base	Type 304 ss, ASTM A 240. Screws are alloy steel, ASTM F 835, hexagon socket flat countersunk head cap screws; #8-32UNC-3A x 1-in.
Wall	Type 304 ss, ASTM A 511, cold finish, or ASTM A 276.
O-rings	Nitrile, Parker #2-153-N304-75 or #2-153-N103-70; 3.3-cm (1.299-in.) ID, 0.26-cm (0.103-in.) cross section.
Lifting cable	SAVA #2065, 14-cm (5.5-in.) long by 0.159-cm (0.063-in.) diameter, uncoated ss, 7 by 19 construction.

Materials/Method of Construction (sheet 3 of 3)

Item/component	Description
Cable fitting	SAVA #805-C, for 0.159-cm (0.063-in.) cable, 0.528-cm (0.208-in.) diameter by 0.76-cm (0.3-in.) long sleeve, copper. To be crimped onto lifting cable using SAVA tool T-188.
1-L bottle and lid	Nalgene, ^d PVC-coated, 70-mm (2.76-in.) wide-mouth glass bottle, 946-mL (32-oz) capacity, 89 tare weight. Overall dimensions 19.4-cm (7.64-in.) tall by 9.14-cm (3.60-in.) dia. (Labelmaster Catalog Part No. KG3280) with Teflon-lined phenolic lid (Labelmaster Catalog Part No. KC70PTW).
30-, 125-, and 250-mL bottles and lid	User to supply as they desire (considered as packaging not required).

^aSafeSend SP-R1L is a trademark of 3M Company.

^bTeflon is a trademark of E. I. du Pont de Nemours & Company.

^cDow Corning #7 Silicone Paste Lubricant is a trademark of Dow Corning Corporation.

^dNalgene is a trademark of Sybron Corporation.

ABS = Acrylonitrile-butadiene-styrene.

ASTM = American Society for Testing and Materials.

PCF = Pounds per cubic foot.

PVC = Polyvinyl chloride.

7.17.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the payload used during testing (see Section 7.17.2.4). If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

7.17.2.1 Physical Form. Liquid radioactive materials having a specific gravity up to 2 when packaged as described. Solids are also authorized, in normal or special form. The solid materials are limited in weight, including packaging, to the gross weight of the as-tested liquids and bottles. The packaging provides double containment.

7.17.2.1.1 Maximum Gross Weight (Nominal). The following table provides the weight of the as-tested sample bottle, lid, and simulated contents. In addition, it provides the as-tested simulated content weight. The gross weight of the entire Hedgehog Container is also shown.

Maximum Gross Weights for Packaging Configurations (Nominal)

Version	Bottle and contents g (lb)	Packaging gross weight g (lb)
30-mL	Bottle and contents = 99.3 (0.219) Contents only = 88.9 (0.196)	28,576 (63)
125-mL	Bottle and contents = 364.9 (0.805) Contents only = 340.2 (0.749)	27,216 (60)
250-mL	Bottle and contents = 562.9 (1.24) Contents only = 524.3 (1.156)	24,040 (53)
1-L	Bottle and contents = 2,495 (5.5) Contents only = 2,041.1 (4.5)	18,144 (40)

7.17.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

7.17.2.3 Radiological. 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.

7.17.2.4 Simulated Payload. The simulated payload used was water and carbon steel shot to equal a liquid having a specific gravity of 2.

7.17.3 Restrictions/Specifications

1. The packagings are approved for shipping liquids having a specific gravity of 2 or less, and solids. The solid versions would allow the shipment of normal or special form solids. The solid materials are limited in weight, to include packaging, to the gross weight of the as-tested liquids and bottles. 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.
2. Ensure that the proper orientation of the Hardigg Case is marked. Note that the internal black, ABS load spacer is the bottom of the packaging in which it normally sits. The slit in the lid gasket is located at the bottom of the packaging in which it normally sits.
3. A fluid indicator is incorporated into the sorbent cylinder lining of the SafeSend container. Any appearance other than a uniform blue color indicates leakage or breakage of contents. The presence of a uniform blue color does not ensure that contents are intact.

4. Use of these packaging configurations with incompatible materials may cause leakage of contents, posing such risks as serious physical injury or property damage. Incompatible SafeSend container materials include the following:
 - Those having a vapor pressure of greater than 130 kPa (18.8 lbs/in.²) at 55 °C (130 °F)
 - Those which in combination could increase heat or vapor pressure
 - Materials that may chemically attack this packaging or its components.
5. A vapor pressure of 130 kPa (18.8 psi) at 55 °C (130 °F) should never be exceeded.
6. Improper tightening of the SafeSend canister may cause leakage or breakage of contents. To ensure proper seal for transporting inner packaging, the SafeSend cap must be tightened until the latch snaps into place. The canister or latch should not be used if damaged.
7. The SafeSend identification numbers, located on the label to the right of the 3M instruction book and located in the right corner of the red label on the cap, must be identical. Do not use if they are not identical.
8. When storing the SafeSend container, unscrew the cap one full turn from the latched position.
9. Note that two different screw sizes exist with the stainless steel pig assemblies. The user should refer to the drawings and operating instructions when assembling packaging configurations.
10. The top lid of each pig will be notched. Each pig assembly is identified with a serial number. Do not use if the serial number for the parts of the pig assembly are not identical.
11. Pig assembly screws shall be torqued to 1.9 to 2.0 N-m (1.4 to 1.5 ft-lb or 17-18 in.-lb).
12. The 1-L version requires that the bottle remain intact and not break. The shipper must either use the same 1-L bottle that was used during testing (Nalgene, high-density, PVC-coated, wide-mouth glass jar with Teflon-lined phenolic lid) or document that if a different bottle is used, that it is equivalent to what was used during testing.
13. The top portion of the wooden disk assembly must not be in contact with the top of the base of the SafeSend container. If it is, do not use. Check the assembly fit by holding or weighting the spacer down onto the top of the SafeSend lid. Suitable shim material may be used per sponsor's operating instructions.

14. The shipper shall ensure that the radiation level at any surface would not increase by more than 20%.
15. Operation, maintenance, and reuse of packaging shall be in accordance with applicant-provided operating instructions.

For airborne shipments, HM-181 requirements pertinent to reduced external pressure conditions may be included; see discussion in Section 1.3.4.

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

7.17.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment (page 1 of 2)

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages (pre-HM-181)	Appendix A contains pre-HM-181 information. This packaging was designed and tested after 10/94; therefore, this appendix is not applicable to this packaging.
49 CFR 173.24, Compliance with general requirements for packages and packaging (post-HM-181)	Meets applicable requirements. See Appendix F, Table F-6.
49 CFR 173.24a, Compliance with additional general requirements for non-bulk packaging and packages (post-HM-181)	Meets applicable requirements. See Appendix G, Table G-6.
49 CFR 173.24b, Compliance with additional general requirements for bulk packagings (post-HM-181)	Meets applicable requirements. See Appendix H, Table H-6.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-6.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-10.
49 CFR 173.465, Type A packaging tests	Meets applicable requirements.
Water spray	<u>Pass</u> . This test was conducted on an empty Hardigg Case with no detectable effect. See Appendix D, Table D-8.
Free drop 9 m (30 ft)	<u>Pass</u> . Drop tests were conducted on the 30-mL and 1-L configurations, in several orientations. In the 30-mL configuration, there was no loss of contents. In the 1-L configuration, there was a slight discharge of contents noted around the bottle lid. See Appendix D, Table D-18.
Free drop 1.2 m (4 ft)	<u>Pass</u> . Drop tests were conducted on the 30-mL and 1-L configurations, several orientations. In all cases there was no loss of contents. See Appendix D, Table D-18a.

Regulatory Compliance Assessment (page 2 of 2)

Regulatory requirements	Testing/analysis results
49 CFR 173.465, Type A packaging tests (cont) Compression Penetration	Meets applicable requirements. <u>Pass.</u> The test was conducted for over a 24-hr period by applying a load of 318 kg (700 lb). There was no significant distortion of the packaging or loss of contents. See Appendix D, Table D-28. <u>Pass.</u> The test was conducted on center of the lid of the packaging with no significant effect. See Appendix D, Table D-35.
49 CFR 178.608, Vibration standards (applied to demonstrate compliance with 49 CFR 173.412[e])	Meets applicable requirements. See Appendix E, Table E-6.

7.17.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria ^a
Shielding		
Containment		Functional: - Size, materials, and geometry, as specified - Lack of dust, dents, nicks, cracks
O-rings ^b Gasket Sealing surfaces 1-L bottle & lid Identical identification numbers (SafeSend lid & base; ss Pig assemblies)	Weld Seams	Acceptable conditions: - Continuous welds, no cracks - Lack of dents, no deformations of mating surfaces
Spacer assembly	Wood thickness	- Dimensions, as specified - Lot tests by shipper, as appropriate
	Vendor data/certification	- Marking - Test data - Type A certification document provided, as appropriate
	Verification of shielding and containment	Visual: Lack of corrosion, rust, dents, nicks

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

NOTE: Inspect and replace O-rings in accordance with applicant-provided operating instructions.

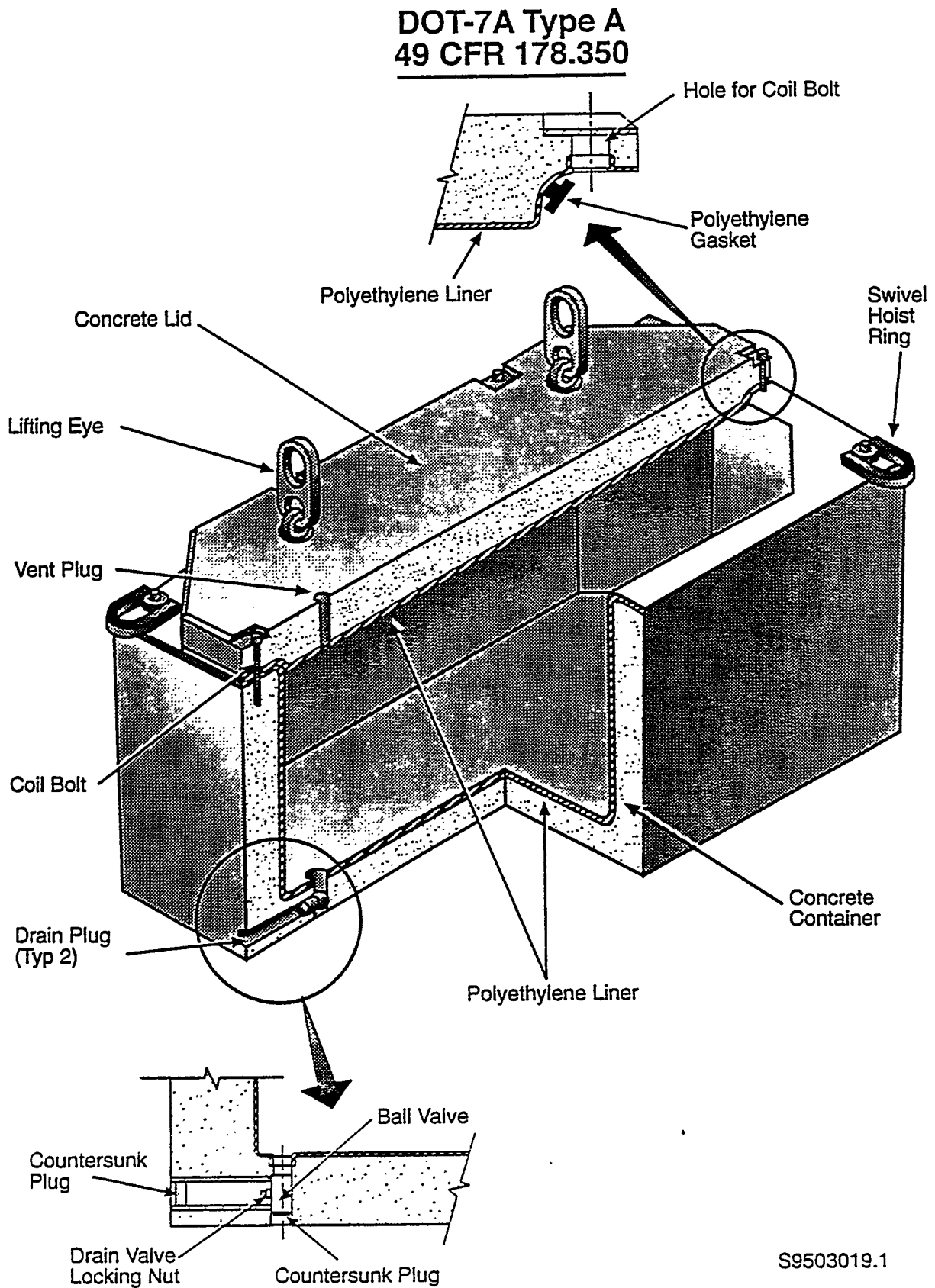
7.17.6 Additional Information

Evaluation and testing of the subject packaging took place at Westinghouse Hanford in 1995 as Docket Number 94-39-7A. A complete test report is available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

7.17.6.1 Primary Users

<u>Site/Contact/Phone</u>	<u>Address</u>
Hanford Site M. S. Mercado (509) 376-9129	Westinghouse Hanford Company P.O. Box 1970 Richland, WA 99352

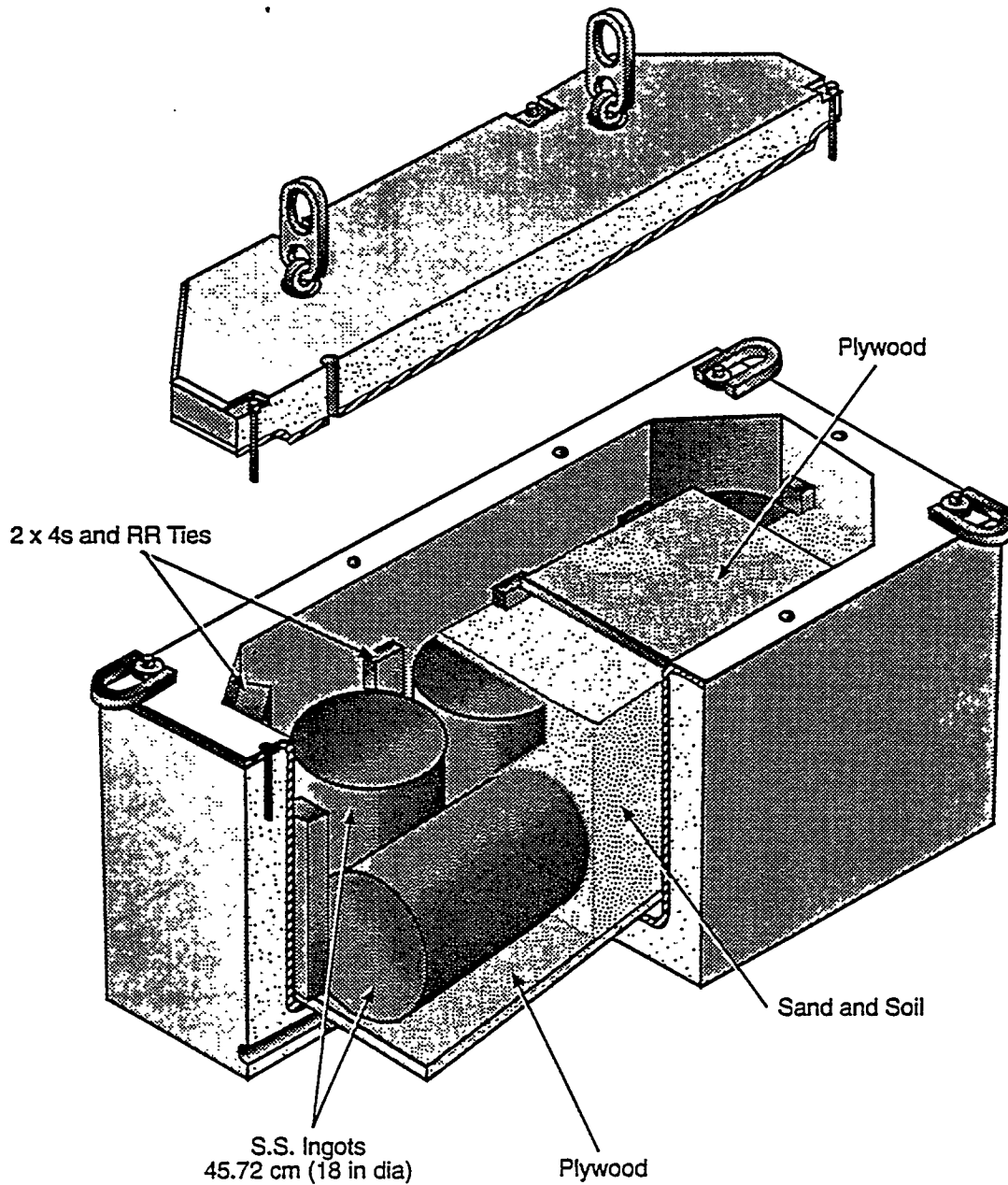
Figure 8-11. INEL Mark III Concrete Container.



S9503019.1

Figure 8-12. Mark III Concrete Container with
As-Tested Payload and Bracing.

DOT-7A Type A
49 CFR 178.350



S9503019.2

8.10 INEL MARK III CONCRETE CONTAINER (DOCKET: 92-33-7A, 10/94)

8.10.1 Package Description

Dimensions

Description	Length cm (in.)	Width cm (in.)	Height cm (in.)
Body and lid (closed [overall dimensions])	243.84 (96)	121.92 (48)	121.92 (48)
Body	243.84 (96)	121.92 (48)	113.665 (44.75)
Lid (overall dimensions)	243.84 (96)	121.92 (48)	15.24 (6)
Top impact limiter- optional (overall dimensions)	287.02 (113)	165.1 (65)	38.1 (15)

Materials/Method of Construction (sheet 1 of 2)

Item	Description
Concrete	Shall be per sponsor's document specification ES-51294. Portland cement, ASTM C150, Type I-II. The cement shall contain no more than 0.60% by weight of alkalis calculated as ($\text{Na}_2\text{O} + 0.658 \text{ K}_2\text{O}$). Aggregate shall be fine and coarse and conform to ASTM C33. Maximum size of aggregate shall be 0.9525 cm (3/8 in.).
Polyethylene liner	Ultra-Lock ^a 33-5 or approved equivalent (an approved equivalent is Mobil ^b NRP-135 polyethylene ground pellets). Two pieces, welded together. (Applies to body and lid).
Reinforcing	Welded wire fabric, ASTM A497, D16 x 6 x 6, grade 75. Reinforcing bars, ASTM A615, grade 60.
Lid plug	A 2.54-cm (1-in.) NPT carbon steel square-head plug. Plug inserts into a 2.54-cm (1-in.) NPT carbon steel 90° street ell Schedule 40, that is connected to a 2.54-cm (1-in.) NPT carbon steel 90° ell, that is connected to a 2.54-cm NPT by 6.35-cm long (1-in. NPT by 2.5-in. long), carbon steel Schedule 40 nipple.

Materials/Method of Construction (sheet 2 of 2)

Item	Description
Lid washers	Six Carbon steel, ASTM A36, 0.3175 cm (1/8 in.) thick by 7.62 cm (3 in.) by 7.62 cm (3 in.).
Lid bolts	Six 2.54-cm by 15.24-cm (1-in. by 6-in.) coil bolts, B-14, heavy, ASTM A325, Dayton Superior ^c .
Body drains	Two plugged drains, located underneath the container body, consisting of two 2.54-cm (1-in.) Schedule 40 by 5.08-cm (2-in.) long nipples, two 2.54-cm (1-in.) ball valves, and two 2.54-cm (1-in.) NPT countersunk plugs. Access to the ball valves is obtained by removing two additional 3.81-cm (1.5-in.) NPT countersunk plugs located on the side of the container body. Two 5.08-cm (2-in.) Schedule 160S, Type 304, ASTM A312 pipe sleeves are contoured to fit the valve body and tack welded into place.
Lifting anchors	Four 15.24-cm by 15.24-cm by 0.635-cm (6-in. by 6-in. by 1/4-in.) thick ASTM A36 plate welded onto ASTM A36 pipe.
Gasket	Astro-Foam ^d , 1.27-cm (0.5-in.) thick polyethylene foam, Density of 1.8-1.9, Material Code No. 350-48, Federal Specification PPP-C-1752D.
Glue	Weldwood Contact Cement ^e , "The Original, Fast Dry Formula."
Top impact limiter-optional	Douglas Fir, Commercial Grade #2, 20.32 cm by 20.32 cm (8 in. by 8 in.) (nominal). Overall finished size is 165.1 cm (65 in.) wide by 287.02 cm (113 in.) long. Four corner braces consist of 1.27-cm (0.5-in.) carbon steel plate, ASTM A36, with spikes.

ASTM = American Society for Testing and Materials.

^aUltra-Lock is a trademark of UltraTech International, Inc.

^bMobil is a trademark of Mobil Chemical Company.

^cDayton Superior is a trademark of the Dayton Superior Corporation.

^dAstro-Foam is a trademark of Astro-Valcour, Inc.

^eWeldwood Contact Cement is a trademark of United States Plywood Corporation.

8.10.2 Authorized Contents

The shipper must determine that the actual contents are closely simulated by the payload used during testing (see Section 8.10.2.4). If they are not, testing or analysis must be conducted and documented to demonstrate DOT-7A compliance with the actual contents.

8.10.2.1 Physical Form.

8.10.2.1.1 Solids Only. Three forms are authorized. Each shipper must determine the most appropriate form for his particular contents, as follows:

- Material Form Number 1: Solids--any particle size
- Material Form Number 2: Solids--large particle size only (e.g., sand, concrete, debris, soil)
- Material Form Number 3: Solids--objects with no removable or dispersible contamination. (For definition, see 49 CFR 173.443, "Contamination Control.")

NOTE: Refer to Section 8.10.3, "Restrictions/Specifications," for items fitting the previous descriptions that could result in highly localized forces.

8.10.2.1.1 Maximum Gross Weight

Weight

Description	Weight kg (lb)
Container lid	816.5 (1,800) - approximate
Container body	3,629 (8,000) - approximate
Empty packaging (without top impact limiter)	4,445 (9,800) - approximate
Content weight (dry)	5,443 (12,000) - maximum
Top impact limiter	340 (750) - approximate
Packaging shipping weight without top impact limiter	9,888 (21,800) - maximum gross
Packaging shipping weight with top impact limiter	10,228.5 (22,550) - maximum gross
Design weight of lifted package (includes 1,724 kg (3,800 lb) of water temporarily in box)	11,703 (25,800) - approximate

8.10.2.2 Chemical Form. The shipper must evaluate and ensure chemical compatibility of the material to be shipped with the materials of the packaging in contact with the payload.

8.10.2.3 Radiological. 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. See Appendix D, Table D-19, for details of damage to the package during drop testing.

8.10.2.4 Simulated Payload. The simulated payload used during testing was sand and soil, stainless steel ingots (45.72-cm diameter by 38.1-cm long and/or 45.72-cm diameter by 101.6-cm long [18-in. diameter by 15 in.-long and/or 18-in. diameter by 40-in. long]), and lead bricks. Bracing was used to protect the bottom, sides, and top of the inside of the container. Bracing consisted of plywood sheets, wooden 2 x 4s, and railroad ties. Refer to Figure 8-12 for a diagram of the placement of the payload and bracing during testing.

8.10.3 Restrictions/Specifications

1. Cracks in the polyethylene liner (body and lid) are not acceptable. Weld seam on sealing surface of body and lid liner will be even and smooth, and free from cracks.
2. Clean sealing surfaces prior to lid installation.
3. Apply the polyethylene foam gasket to the container lid according to drawing numbers 445862 and 446074. The gasket in the as-tested configuration consisted of two parts (booster and main gasket), and each part being one continuous piece. Check the gasket to ensure a minimum of 0.9525-cm (3/8-in.) loft. If the loft is less than 0.9525 cm (3/8 in.), a new gasket shall be installed. The gasket shall not be installed until time of permanent container sealing.
4. The shipper shall ensure that the radiation level at any surface would not increase by more than 20%.
5. The user is responsible for ensuring that the packaging does not contain small, highly radioactive materials that could become lodged inside the drain/vent lines that could result in a significant radiation change in the surface of the packaging.
6. To ensure that the bolts seat properly, remove the lid from the Mark III Concrete Container body, and install bolts. Bolts should thread down to within 2.54 cm (1 in.) of the body rim.
7. The vent plug on the lid of the container will be removed prior to installation of the lid due to air pressure being trapped within the container.

8. Lid bolts shall be torqued to 135.58 N-m (100 ft-lbs) in 33.89-N-m (25-ft-lb) increments, and in the pattern specified by the sponsor's instructions.
9. Prior to shipment, verify that valves are closed and that the two drains are closed and that all five plugs are installed.
10. For heavy, bulky materials (e.g., concrete chunks, motors, pumps); 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.
11. When the packaging is loaded underwater, the user must ensure that all water has been removed before shipment.

8.10.4 49 CFR 178.350 Regulatory Requirements

Regulatory Compliance Assessment

Regulatory requirements	Testing/analysis results
49 CFR 173.24, Standard requirements for all packages (pre-HM-181)	Meets applicable requirements. See Appendix A, Table A-7.
49 CFR 173.411, General design requirements	Meets applicable requirements. See Appendix B, Table B-7.
49 CFR 173.412, Additional requirements for Type A packages	Meets applicable requirements. See Appendix C, Table C-13.
49 CFR 173.465, Type A packaging tests Water spray Free drop 0.6 m (2 ft) Compression Penetration	Meets applicable requirements. <u>Pass.</u> This test was conducted, and there was no inleakage of water; there was no significant affect on the performance of the wooden top impact limiter. See Appendix D, Table D-9. <u>Pass.</u> Drop tests were conducted with and without the top wooden impact limiter, in several orientations, and with no release of contents. See Appendix D, Table D-19. <u>Pass.</u> The test was conducted for over a 24-hr period by applying a load of 53,369.681 kg (117,660 lb). There was no cracking or bulging on the interior or exterior of the packaging and no loss of contents. See Appendix D, Table D-29. <u>Pass.</u> The test was conducted to hit the vent plug located on the lid of the container, with no significant effect. See Appendix D, Table D-36.

8.10.5 Quality Control

Packaging/Acceptance/Use Criteria

Critical	Major	Acceptance/pre-use/ inspection criteria*
Lid/body interface	Vendor qualification and experience	Functional: • Mating surfaces flat and smooth, no foreign matter • Geometry as specified • Size, material, and geometry as specified • Lack of dust, dents, nicks, cracks • Surface must be smooth and even
Gasket		
Sealing surfaces		
	Weld Seams	Acceptable conditions: • Continuous welds, no cracks • Lack of dents, no deformations of mating surfaces • Verify that bolts fit down properly into container body for tightening purposes
Lid coil bolts		
Body		Lot tests/inspections as appropriate by shipper

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

8.10.6 Additional Information

Evaluation and testing of the subject packaging took place at Westinghouse Hanford Company in 1994 as Docket Number 92-33-7A. A complete test report is available upon request from one of the DOT-7A Program technical contacts listed in Section 1.1.2.

8.10.6.1 Primary Users

<u>Site/Contact/Phone</u>	<u>Address</u>
INEL W. D. Richins (208) 526-0522	Lockheed Idaho Technologies Company (LITCO) P.O. Box 1625 Idaho Falls, Idaho 83415
H. D. Welch (208) 526-0530	
B. C. Spaulding (208) 526-8633	

APPENDIX A**COMPLIANCE WITH STANDARD REQUIREMENTS
FOR ALL PACKAGES (49 CFR 173.24)****Pre-HM-181 (pre-October 1994)**

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Table C-1. Steel Drums---Compliance with Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--steel drums
(m) When subjected to the tests specified in §173.465 or evaluated against these tests by any of the methods authorized by §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; (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 §173.466 or evaluated against these tests by any of the methods authorized by §173.461(a);	<u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table C-1. Steel Drums--Compliance with Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--steel drums
(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	<u>Designer</u> , <u>tester</u> , and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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	<u>Designer</u> , <u>tester</u> , and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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	<u>Designer</u> , <u>tester</u> , and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table C-1. Steel Drums--Compliance with Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--steel drums
(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 §173.461(a).	Designer, tester, and evaluator to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

*Celotex is a trademark of the Celotex Corporation.

C1.0 SUMMARY OF PRESSURE TESTS ON EVALUATED STEEL DRUMS

Paragraph 173.412(i) in effect requires a pressure differential of 0.75 atm (11.2 psig) across the surfaces of the containment system acting from the inside to the outside. In all of the steel drum packagings, the containment system is defined as the drum itself. To achieve the pressure differential, the inside of the packaging was pressurized to 11.2 psig using compressed air and held for approximately 5 min. The pass/fail criteria were as follows:

1. No release of contents as determined by the absence of any detectable air flow or fluorescein after the test.
2. The retention of pressure, 11.2 ± 0.3 psig. This was held for approximately 5 min.
3. No structural distortion which would cause an increase exceeding 20% in the dose rate at the surface of the package as compared to the dose rate prior to beginning the test.

The 17C 55-gal drums with vent clips and with high-efficiency filters installed in the lids were tested. In this case the criteria became just containment (no release of contents) since the packaging will not hold pressure. This last statement is technically correct; however, in the instance above (vent clips and filters in lid), the pressure was raised to 11.2 psig and held for 5 min. by adjusting the inward flow to equal the loss through the vent clip and/or filter. This was over-testing because there are no realistic conditions of normal transport in which a pressure differential of this magnitude could arise in a matter of seconds. In the unlikely event of such a pressure change over longer periods of time, the vent clip or filter would allow the pressures to equilibrate before differentials approaching 11.2 psig could be reached. The table below provides detailed information concerning the testing of the steel drums and the results.

Table C-3. Steel Boxes--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--steel boxes
(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;	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. None of these packagings have valves.	None of these packagings have valves.
(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 shield shall be securely closed or, by way of packaging design, ensure against escape of a containment component. One example is a package with cellotex on top of a lead shield with a press-fit lid in which closure of the cellotex holds the lid in place. the shipper must make sure that under the tests prescribed in 49 CFR 173.465, there will be no rearrangement of the original containment/shield orientation. <u>Designer, tester, and evaluator</u> to do and <u>shipper</u> responsibility to ensure.	None of these packagings have shielding as described.
(l) Failure of any tie-down attachment on the packaging under excessive load will not impair the ability of the package to meet other requirements of this subpart.	<u>Designer, tester, and evaluator</u> to do and <u>shipper</u> responsibility to ensure.	None of these packagings have tie-down attachments as described.

Table C-3. Steel Boxes--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--steel boxes
(m) When subjected to the tests specified in §173.465 or evaluated against these tests by any of the methods authorized by §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; (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 §173.466 or evaluated against these tests by any of the methods authorized by §173.461(a);	<u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table C-3. Steel Boxes--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--steel boxes
(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	<u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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	<u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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	<u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table C-3. Steel Boxes--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--steel boxes
(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 §173.461(a).	<u>Designer</u> , <u>tester</u> , and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table C-5. Wooden Boxes---Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--wooden boxes
(m) When subjected to the tests specified in §173.465 or evaluated against these tests by any of the methods authorized by §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; (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 §173.466 or evaluated against these tests by any of the methods authorized by §173.461(a);	<u>Designer</u>, <u>tester</u>, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Designer</u>, <u>tester</u>, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Designer</u>, <u>tester</u>, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table C-5. Wooden Boxes--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--wooden boxes
(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	<u>Designer</u> , <u>tester</u> , and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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	<u>Designer</u> , <u>tester</u> , and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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	<u>Designer</u> , <u>tester</u> , and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table C-5. Wooden Boxes--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--wooden boxes
(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 §173.461(a).	<u>Designer</u> , <u>tester</u> , and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

C3.0 SUMMARY OF PRESSURE TESTS ON EVALUATED WOODEN BOXES

This test method, raising the internal pressure to 9 to 11 psi and maintaining it for several minutes, is very conservative. This is because, in transport, any pressure differential encountered would be equilibrated very slowly, and the strong driving force encountered in this test would not exist.

Table C-7. Fiberboard Containers--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--fiberboard containers
(m) When subjected to the tests specified in §173.465 or evaluated against these tests by any of the methods authorized by §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; (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 §173.466 or evaluated against these tests by any of the methods authorized by §173.461(a);	<u>Designer</u>, <u>tester</u>, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Designer</u>, <u>tester</u>, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Designer</u>, <u>tester</u>, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table C-7. Fiberboard Containers--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--fiberboard containers
(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	<u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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	<u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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	<u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table C-7. Fiberboard Containers--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--fiberboard containers
(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 §173.461(a).	<u>Designer</u> , <u>tester</u> , and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

LLNL = Lawrence Livermore National Laboratory.

Table C-8. UF₆ Cylinders--Compliance With Additional Design Requirements for Type A Packages (49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--UF ₆ cylinders
In addition to meeting the general design requirements prescribed in §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); (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; (c) As far as practicable, the external surfaces are free from protrusions and are designed so that they can be easily decontaminated;	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. For this requirement, the package designer may need to be skilled and creative. This is especially true for packages such as fiberboard cartons and wooden boxes. A padlock is not effective as a security seal. It is not possible with most types of padlocks to ascertain if they have been illicitly opened. One acceptable approach toward meeting this requirement is serially numbered lead-wire seals, or, in the case of fiberboard packages, a tape of sufficient adhesive strength to damage the fiberboard upon removal. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. The intent is to minimize the number of protrusions by consideration during design and/or as a result of any modifications to the packaging. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	As shown in the figures and as given in the packaging descriptions in Section 6.0, all packagings meet this requirement. There are acceptable approaches to compliance for all evaluated packagings. It is the <u>shipper's</u> responsibility to ensure compliance with this requirement. All evaluated packages meet this requirement.

Table C-8. UF₆ Cylinders--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--UF ₆ cylinders
(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;	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	Each valve is protected against damage, sealed against unauthorized operation, and capped to retain any leakage.
(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 shield shall be securely closed or, by way of packaging design, ensure against escape of a containment component. One example is a package with a cellotex on top of a lead shield with a press-fit lid in which closure of the cellotex holds the lid in place. The shipper must make sure that under the tests prescribed in 49 CFR 173.465, there will be no rearrangement of the original containment/shield orientation. <u>Designer, tester, and evaluator</u> to do and <u>shipper</u> responsibility to ensure.	None of these packagings have shielding as described.
(l) Failure of any tie-down attachment on the packaging under excessive load will not impair the ability of the package to meet other requirements of this subpart;	<u>Designer, tester, and evaluator</u> to do and <u>shipper</u> responsibility to ensure.	Only one configuration (48-in. cylinder) uses/incorporates tie-down attachments. Table C-9 shows the calculated safety factors and the failure mode analyses. In all cases, it was demonstrated that the lug would fail, not the cylinder. Thus, the integrity of the cylinder would not be impaired.

Table C-8. UF₆ Cylinders--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--UF ₆ cylinders
(m) When subjected to the tests specified in §173.465 or evaluated against these tests by any of the methods authorized by §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; (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 §173.466 or evaluated against these tests by any of the methods authorized by §173.461(a);	Designer, <u>tester</u>, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure. Designer, <u>tester</u>, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure. Designer, <u>tester</u>, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table C-8. UF₆ Cylinders---Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--UF ₆ cylinders
(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	<u>Designer, tester, and evaluator to do; shipper responsibility to ensure.</u>	<u>Shipper responsibility to ensure.</u>
(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	<u>Designer, tester, and evaluator to do; shipper responsibility to ensure.</u>	<u>Shipper responsibility to ensure.</u>
(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	<u>Designer, tester, and evaluator to do; shipper responsibility to ensure.</u>	<u>Shipper responsibility to ensure.</u>

Table C-8. UF₆ Cylinders--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--UF ₆ cylinders
(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 §173.461(a).	Designer, tester, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table C-10. Liquid and Gas Packagings---Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category---liquid and gas packagings
(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;	<u>Designer to do and shipper responsibility to ensure.</u>	Five packagings in this category have valves as described below: (1) <u>LLNL Gas Cylinders</u>: These cylinders are packaged in a 17H 114-L (30-gal) steel drum, which provides the physical protection and protects against unauthorized operation. The 17H 114-L (30-gal) drum also provides an enclosure to retain any leakage. More positively, each valve outlet is capped to retain any leakage. (2) <u>ORNL Gas Cylinders</u>: Each cylinder has a threaded protective cap and is sealed against unauthorized operation. The threaded caps also retain any leakage. (3) <u>EG&G Mound Commercial Tritium Cylinders</u>: The inner valves meet this requirement. (4) <u>WHC Grout Sample Packaging</u>: The 417-L (110-gal) overpack provides protection against damage and unauthorized operation of the secondary container valve. Unauthorized operation of the valve also is prevented by use of safety wire.

Table C-10. Liquid and Gas Packagings--Compliance With Additional Design Requirements for Type A Packages (49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--liquid and gas packagings
(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; (l) Failure of any tie-down attachment on the packaging under excessive load will not impair the ability of the package to meet other requirements of this subpart; (m) When subjected to the tests specified in §173.465 or evaluated against these tests by any of the methods authorized by §173.461(a), the packaging will prevent: (1) Loss or dispersal of the radioactive contents; and	The shield shall be securely closed or, by way of packaging design, ensure against escape of a containment component. One example is a package with cellotex on top of a lead shield with a press-fit lid in which closure of the cellotex holds the lid in place. The shipper must make sure that under the tests prescribed in 49 CFR 173.465, there will be no rearrangement of the original containment/shield orientation. <u>Designer, tester, and evaluator</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer, tester, and evaluator</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure.	(5) <u>EG&G Mound Lewis Gas Packaging</u>: The VCR cap provides the required enclosure. The valves are protected by the metal drum and polyurethane cushioning. The packagings meeting this criterion are discussed in Table C-12. None of the packagings have tie-down attachments as described. <u>Shipper</u> responsibility to ensure.

Table C-10. Liquid and Gas Packagings--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--liquid and gas packagings
(2) Any significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test; (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 §173.466 or evaluated against these tests by any of the methods authorized by §173.461(a);	<u>Designer</u>, <u>tester</u>, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Designer</u>, <u>tester</u>, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.
(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	<u>Designer</u>, <u>tester</u>, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table C-10. Liquid and Gas Packagings--Compliance With Additional Design Requirements for Type A Packages (49 CFR 173.412). (9 pages total)

Regulatory requirement	Action required/by whom	Packaging category--liquid and gas packagings
(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 (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 §173.461(a).	<u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

LLNL = Lawrence Livermore National Laboratory
 ORNL = Oak Ridge National Laboratory.

Table C-11. Liquid and Gas Packagings--"Reduced Pressure" Tests Summary. (4 pages total)

Packaging/ Principal User	Model/Size	Containment System	Test/Analysis	Results
Lovelace	MS-24347-7	Glass bottle with screw cap	Two of the glass bottles with caps screwed on by hand were inverted in a beaker of water, and a vacuum was drawn (3.6 psi). After 5 min. there was no evidence of leakage (bubbles in the water). Also, the metal drum itself passed the reduced pressure test, so the tests on the bottles would not have been required.	Pass
LANL	Fiberboard box with inner lead container	Inner lead container with screw-top cap and O-ring seal	The inner lead container was inverted in a beaker of water, and a vacuum was drawn (3.6 psi). After 5 min., there was no evidence of leakage (bubbles in the water).	Pass
LLNL	3A-1800 3E-1800	Steel drum Gas cylinders	Each of the cylinders was pressurized before being sent to Mound. The pressure was measured in each one upon receipt and averaged approximately 92 psig per cylinder. These data and the fact that the surface pressure was ambient (1 atm) indicate compliance with the 11.2 psi requirements.	Pass
ORNL	Fiberboard box for liquids and solids	Glass bottles with plastic screw-top caps: 15 mL - 6 tested 25 mL - 6 tested 50 mL - 5 tested 100 mL - 4 tested	Four to six bottles of each size were inverted in a glass beaker of water in a bell jar. The pressure was reduced (vacuum drawn) to 3.6 psig and held for 5 min. There was no leakage (bubbles in the water) in any case.	Pass

Table C-11. Liquid and Gas Packagings--"Reduced Pressure" Tests Summary. (4 pages total)

Packaging/ Principal User	Model/Size	Containment System	Test/Analysis	Results
ORNL	Fiberboard box for gases	Glass ampules: 2 cc - 4 tested 5 cc - 4 tested 10 cc - 4 tested 20 cc - 4 tested	Four ampules of each size were immersed in water in glass beaker in a bell jar. The pressure was reduced (vacuum drawn) to 3.6 psig and held for 5 min. There was no leakage (bubbles in the water) in any case.	Pass
ORNL	Fiberboard box for liquids and solids	Glass bottles with plastic screw-top caps	Four to six bottles of each size were inverted in a glass beaker of water in a bell jar. The pressure was reduced (vacuum drawn) to 3.6 psig and held for 5 min.	Pass
ORNL	Aluminum clad wood box (returnable)	Glass bottles with plastic screw-top caps	Four to six bottles of each size were inverted in a glass beaker of water in a bell jar. The pressure was reduced (vacuum drawn) to 3.6 psig and held for 5 min. There was no leakage (bubbles in the water) in any case.	Pass
ORNL	Gas cylinders in returnable plastic boxes	Gas cylinders as listed in Figures 7-9, 7-10, and 7-11	Each of these cylinders is designed for and tested at pressures well above 11.2 psi.	Pass
LANL	LANL-2	Combination outer steel drum with inner shielded container (pig)	Qualified based on previous testing of DOT-17C 55-gal steel drums.	Pass
HF	WHC Liquid Sample Packaging	Combination outer steel drum with inner polyethylene bottle	RTV silicone rubber sealant was applied to the drum gasket for the test. [Docket 90-14-7A]	Pass
Rocky Flats	RF Container Model LWS-1	Containment plus twice the absorbent required	10 vials containing 5 ml of RC-77 Fluorescent Penetrant each. [Docket 91-25-7A]	Pass

Table C-11. Liquid and Gas Packagings--"Reduced Pressure" Tests Summary. (4 pages total)

Packaging/ Principal User	Model/Size	Containment System	Test/Analysis	Results
EG&G Mound Applied Technology	EG&G Mound Commercial Tritium Packaging	Gas cylinders as listed in Figure 7-18	These cylinders were tested at pressure differentials well above the required 77.2 kPa (11.2 psi). Note: All shipments will be at less than 1 atm.	Pass
WHC	WHC Grout Sample Packaging	Combination inner shielded canister with outer steel container	Inner shielded canister filled with water in a bell jar. The pressure was reduced (vacuum drawn) to 24.1 kPa (3.5 psia) and held for 15 min. There was no leakage. Outer steel container filled with water. The pressure was increased to 77.2 kPa (11.2 psig) for 15 min and then to 345 kPa (50 psig) for another 15 min. There was no leakage.	Pass
EG&G Mound Applied Technology	EG&G Mound Lewis Gas Packaging	Gas cylinders as listed in Figure 7-20	In this packaging, the containment system is defined as the stainless steel inner cylinder. This cylinder is rated for up to 310 kPa (45 psi) at 93 °C (200 °F), thus meeting the requirement. In addition, the test cylinder was subjected to the reduced pressure test per 173.412 (i) and passed.	Pass

Table C-11. Liquid and Gas Packagings--"Reduced Pressure" Tests Summary. (4 pages total)

Packaging/ Principal User	Model/Size	Containment System	Test/Analysis	Results
WHC	WHC Hedgehog Container			
	1-L version:	Primary: PVC-coated glass bottle with Teflon-lined, phenolic lid. Secondary: SafeSend container.	The SafeSend ^a container is the reduced pressure containment boundary. The SafeSend container was manufacturer-tested by the 3M Company to an internal pressure of 100 kPa (14.5 psig) with no adverse effects.	Pass
	30-, 125-, and 250-mL versions:	Primary: Type 304 ss assembly(ies). Secondary: SafeSend container.	The SafeSend container is the reduced pressure containment boundary. In addition to the above- noted testing conducted by the 3M Company, the ss pig assemblies for the 30-mL and 250-mL versions underwent a reduced external pressure test. A vacuum of 20.68 kPa (3.0 psia) was drawn and held for 15 minutes (a pressure differential of 11.49 psi was achieved) with no leakage of simulated contents. The 125-mL version was not tested but was evaluated to pass this test due to it similarity in design with the 30- mL and 250-mL versions.	Pass

^aSafeSend is a trademark of 3M Company.

HF = Hanford, Richland, Washington.

LANL = Los Alamos National Laboratory.

LLNL = Lawrence Livermore National Laboratory.

Mound = Mound Laboratory.

ORNL = Oak Ridge National Laboratory.

WHC = Westinghouse Hanford Company.

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Table C-12. Packages Meeting 49 CFR 173.412(k) Criterion. (2 pages total)

Packaging	Containment System	Analysis	Results
LANL fiberboard box with inner lead shielded containers	Inner lead container [5.08-cm (2-in.) outside diameter] with screw-cap and O-ring seal	The inner container is held in place by a lid with three bolts. Thus the outer shield is securely closed. There was no rearrangement during the tests specified in 49 CFR 173.465.	Pass
ORNL fiberboard boxes with shielded inner containers	Glass ampule or bottle with screw cap and a sealed metal can	The packaging components are firmly held in place by the sealed metal can.	Pass
ORNL aluminum clad wood box	Glass bottle and the 2R containers	The 2R container is held in place by the bolt closure lid of the stainless-steel-clad lead carrier.	Pass
ORNL gas cylinder	The cylinder itself	The lead shielding, when used, fills the void between the inner and outer wall and prevents escape.	Pass
LANL-2 drum with inner container	The inner container	The tubing, valves and shielding are securely held in place by the upper and lower shell, which is bolted in place.	Pass
WHC Grout Sample Packaging	Inner shielded canister; outer steel container	The inner shielded canister is held in place by the outer steel container, which is secured by means of a bayonet cover and two locking screws.	Pass

Table C-12. Packages Meeting 49 CFR 173.412(k) Criterion. (2 pages total)

Packaging	Containment System	Analysis	Results
WHC Hedgehog Container	I-L version: Primary: PVC-coated glass bottle with Teflon^a-lined phenolic lid. Secondary: SafeSend^b container. 30-, 125-, 250-mL versions: Primary: Type 304 stainless steel assembly(ies). Secondary: SafeSend container.	I-L version uses no shielding material. The bottle is held within the SafeSend container. The SafeSend container has a self-locking mechanism located on the lid that engages to the proper torque when the lid is screwed on. The SafeSend retains the primary containment. The ss assemblies are held together with 8-32 screws. There is an O-ring in the base and lid of each assembly. The assemblies act as both shielding and containment. The assemblies, when serving as a shield, retain the inner container shield. The SafeSend container has a self-locking mechanism located on the lid that engages to the proper torque when the lid is screwed on. The SafeSend retains the shielding and primary containment.	Pass

^aTeflon is a trademark of E. I. du Pont de Nemours & Company.

^bSafeSend is a trademark of 3M Company.

LANL = Los Alamos National Laboratory.

ORNL = Oak Ridge National Laboratory.

WHC = Westinghouse Hanford Company.

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Table C-13. Miscellaneous Packagings--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirements	Action required/by whom	Package category--miscellaneous packagings
(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 containment system is defined as the components intended to retain the radioactive contents during transportation. Thus, one starts by identifying the containment system. The radioactive contents must be completely retained in the containment system if the package is subjected to reduced pressure. A filtered packaging is possible as long as it can be demonstrated that the filtered package will retain the contents and that the filter is not susceptible to damage from any other tests. Caution should be exercised to ensure that the contents and internal packaging components (e.g., plastic boxes, etc.) will not effectively seal the filter during normal use. In cases where a pressure differential will not build up because of the free-flow through a filter, the requirement of demonstrating the retention of contents must still be met. For a package that breathes [does not hold 77.2 kPa (11.2 psi)], such as a wooden box, one must demonstrate that, even with breathing, the contents will be retained. Otherwise, a separate inner containment capable of meeting the reduced pressure requirement is required. <u>Designer, tester, and evaluator to do and shipper responsibility to ensure.</u>	See Table C-14.

Table C-13. Miscellaneous Packagings--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirements	Action required/by whom	Package category--miscellaneous packagings
(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;	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	The only packaging meeting this criterion are as follows: <u>SNL Tritium Waste Package</u>. The 17H 114-L (30-gal) drum provides the physical protection against unauthorized operation. The asphalt which surrounds the entire inner packaging and the 17H steel drum will retain any contents. <u>INEL Mark III Concrete Container</u>. Two valves exist on the lower body of the container. Both valves are cast in the concrete within one layer of welded wire fabric for protection from damage. The valves are sealed after loading of the packaging. Leakage would be retained in plugged lines.
(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 shield shall be securely closed or, by way of packaging design, ensure against escape of a containment component. One example is a package with cellox on top of a lead shield with a press-fit lid in which closure of the cellox holds the lid in place. The shipper must make sure that under the tests prescribed in 49 CFR 173.465, there will be no rearrangement of the original containment/shield orientation. <u>Designer, tester, and evaluator</u> to do and shipper responsibility to ensure.	The only packaging meeting this criterion is the LLNL (Spec. 55) container. The packaging/shield is one piece, so it is obviously the containment system also. Since the containment system and the radiation shield are all the same, they cannot escape/separate.

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Regulatory requirements	Action required/by whom	Package category--miscellaneous packagings
(1) Failure of any tie-down attachment on the packaging under excessive load will not impair the ability of the package to meet other requirements of this subpart.	<u>Designer</u> , <u>tester</u> , and <u>evaluator</u> to do and <u>shipper</u> responsibility to ensure.	The only packaging in this category that has a tie-down attachment as described is the INEL Mark III Concrete Container. Tie-down points are located on the four upper corners of the body and lid. The lifting ring hardware has a safety factor of 5. Should a failure occur, the lid and body consist of substantial concrete, welded wire fabric, liner material, and a gasket, and will prevent release of hazardous material.
(m) When subjected to the tests specified in §173.465 or evaluated against these tests by any of the methods authorized by §173.461(a), the packaging will prevent:	<u>Designer</u> , <u>tester</u> , and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(1) Loss or dispersal of the radioactive contents; and	<u>Designer</u> , <u>tester</u> , and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(2) Any significant increase in the radiation levels recorded or calculated at the external surfaces for the condition before the test;	<u>Designer</u> , <u>tester</u> , and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table C-13. Miscellaneous Packagings--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirements	Action required/by whom	Package category---miscellaneous packagings
(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 §173.466 or evaluated against these tests by any of the methods authorized by §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	<u>Designer</u>, <u>tester</u>, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Designer</u>, <u>tester</u>, and <u>evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table C-13. Miscellaneous Packagings--Compliance With Additional Design Requirements for Type A Packages
(49 CFR 173.412). (9 pages total)

Regulatory requirements	Action required/by whom	Package category--miscellaneous packagings
(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 (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 §173.461(a).	<u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

LLNL = Lawrence Livermore National Laboratory
SNL = Sandia National Laboratory.

Table C-14. Miscellaneous Packagings Containment System Analysis. (3 pages total)

Packaging/ Principal User	Model/Size	Containment System	Test/Analysis	Results
LLNL	Spec 55	There is only one packaging component, so this obviously is the containment.	The cavity of this packaging was filled with a water-fluorescein solution. The package was inverted in a bell jar and subjected to a reduced pressure of 3.6 psi for 5 min. Upon completion of the test there was no visible loss of contents and no loss found with a black light.	Pass
ORNL	ORNL-TRU	Because the contents are restricted to Special Form [49CFR 173.403(z)], Form [49CFR 173.403(z)], this provides the containment system.	This test has little meaning since there is no loose contamination available for dispersion or transfer. This test was not conducted, but obviously would meet the criterion, if tested, of "No Loss of Contents."	Pass
FEMA	FEMA Source Overpack	Because the contents are restricted to Special Form [49CFR 173.403(z)], Form [49CFR 173.403(z)], this provides the containment system.	This test has little meaning since there is no loose contamination available for dispersion or transfer. This test was not conducted, but obviously would meet the criterion, if tested, of "No Loss of Contents."	Pass
LLNL	SNL Tritium Waste Package	Modified DOT 5C-304 15-gal stainless steel drum.	The inner container was subjected to a hydrostatic pressure of 80 psi for 5 min., with no leakage.	Pass
LANL	LANL-1 Aluminum Packaging	Form No. 3 Material (self-contained)	The material form of the contents would prevent dispersal when the package was exposed to the reduced pressure conditions. Testing was not needed.	Pass

Table C-14. Miscellaneous Packagings Containment System Analysis. (3 pages total)

Packaging/ Principal User	Model/Size	Containment System	Test/Analysis	Results
WIPP	RH-TRU Canister	Steel Cylinder, Welded Construction, NucFil ^a Filter	The NucFil filter would prevent pressure differentials. Testing was not needed. [Docket 89-03-7A]	Pass
Grand Junction	Special Form Neutron Source	Special Form Material	The authorized contents are restricted to special form material. Testing was not needed. [Docket 91-26-7A]	Pass
WIPP	TRUPACT II Ten-Drum Overpack	Cylindrical body; lid; capscrews; carbon filters; pipe plugs	Because this packaging has multiple filters, a pressure differential of this magnitude could not be achieved. This packaging was tested with 10 filters installed. An analysis showed that if the contents of the TDOP have the potential to generate flammable gas, then nine filters are sufficient to maintain the flammable gas concentration. The analysis also showed that if the contents of the TDOP do not have the potential for flammable gas generation, a minimum of one filter may be installed and the unused filter ports sealed with pipe plugs. [Docket 90-16-7A]	Pass

Table C-14. Miscellaneous Packagings Containment System Analysis. (3 pages total)

Packaging/ Principal User	Model/Size	Containment System	Test/Analysis	Results
INEL	MARK III Concrete Container	Concrete body and lid; polyethylene liner; polyethylene foam gasket; six coil bolts and washers; a lid vent plug; four bottom drain plugs; and two valves	A containment boundary verification was performed by conducting a hydrostatic pressure test using the polyethylene foam gasket material. Test unit 33-TU-04 was filled with water and pressurized to 77.22 kPa (11.2 psig) and held for 15 min.	Pass

^a

NucFil is a trademark of Nuclear Filter Technology, Inc.

DOT = U.S. Department of Transportation.

FEMA = Federal Emergency Management Agency.

INEL = Idaho National Engineering Laboratory.

LANL = Los Alamos National Laboratory.

LLNL = Lawrence Livermore National Laboratory.

ORNL = Oak Ridge National Laboratory.

RH = Remotely handled.

SNL = Sandia National Laboratory.

TRU = Transuranic.

TRUPACT = Transuranic package transporter.

WHC = Westinghouse Hanford Company

WIPP = Waste Isolation Pilot Plant.

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D1.2 PACKAGING CATEGORY--STEEL DRUMS

In evaluating steel drums against this requirement, one would consider the following:

- The effect the water spray would have on the ability of the steel drums to meet the other Specification 7A performance requirements
- The potential for inleakage of water with the subsequent potential for transport of the radioactive contents out of the packagings
- Because these same packagings are air-leak tight, prevention of the inleakage of water under such passive conditions as a water spray (rain) is expected.

As shown in Table D-1, nine different types of steel drums (a total of 26 different packagings) were subjected to this test. In all cases, as one would expect based on materials and methods of construction, closure mechanisms, gaskets, and the painted surfaces, the water spray had no effect that could possibly be interpreted as decreasing the ability of the steel drums to meet all Specification 7A performance criteria. This is not surprising since there are years of experience demonstrating that lengthy exposures to rain have not had a negative effect on containment integrity. In addition, in each of the 26 individual tests, a careful inspection demonstrated there was no inleakage of water as a result of these tests. Because these same packagings are air-leak tight, one would also expect them to prevent the inleakage of water under such passive conditions as a water spray (rain).

As a final point of mainly academic discussion, because the steel drums are air-leak tight to begin with, in the unlikely event of an inleakage of water, it would be equally unlikely that this expected minute quantity of water would leak out. Thus, based on the test data below and after comparison of the similarity in materials and methods of construction of the untested steel drums, one can readily conclude that these steel drums meet this requirement.

Table D-1. Water Spray Test Results for Steel Drums. (3 pages total)

STEEL DRUMS

Specific packaging	Test/Analysis Results
DOT-6C, 5-gal	By comparison, this drum would meet this requirement.
DOT-6C, 10-gal	By comparison, this drum would meet this requirement.
DOT-17C, 5-gal	By comparison, this drum would meet this requirement.
DOT-17C, 30-gal	By comparison, this drum would meet this requirement.
DOT-17C, 35-gal	Three loaded and three empty drums were tested and passed.
DOT-17C 55-gal	Three drums were subjected to this test and passed (Configuration RF-1).
DOT-17C, 55-gal w/pressure relief device	Three lids with the Nucfil ^a filters were subjected to the water spray test and no water passed through the filter (Configurations HF-1 and RF-2).
DOT-17C, 55-gal w/HDPE liner	The same data shown for the 17C 55-gal drum would apply here (Configurations HF-2, LL-1, MD-1 and RF-3).
DOT-17C, 55-gal w/HDPE vented liner	One test unit package was subjected to the test conditions and passed (Configurations RF-4 through RF-8). [Dockets 89-13-7A and 90-18-7A]
DOT-17H, 30-gal	Three drums were subjected to this test and passed (Configuration OR-1).
DOT-17H, 30-gal w/filter	One test unit package was subjected to the test conditions and passed (Configurations AW-1 and FM-1). [Dockets 90-17-7A and 90-20-7A]
DOT-17H, 55-gal	Three drums were subjected to this test and passed.
MS-24347-1 ^b	By comparison, this drum would meet this requirement.
MS-24347-7 ^b	Two drums were subjected to this test and passed.
MS-27684-1 ^b	By comparison, this drum would meet this requirement.
MS-27684-2 ^b	By comparison, this drum would meet this requirement.
MS-27684-3 ^b	Three drums were subjected to this test and passed.
MS-27684-6 ^b	By comparison, this drum would meet this requirement.
MS-27684-8 ^b	Three drums were subjected to this test and passed.
MS-27683-7 ^b	Three drums were subjected to this test and passed.
MS-27683-13 ^b	By comparison, this drum would meet this requirement.
MS-24683-21 ^b	Three drums were subjected to this test and passed.

Table D-1. Water Spray Test Results for Steel Drums. (3 pages total)

PACKAGING SPECIALTIES, SQUARE STEEL DRUMS				
Specific packaging	No. tested	Contents	Results	Comments
Style 1A	1	Flour and fluorescein	Pass	The drum was opened upon completion of the test and the 2-hr waiting period. An inspection demonstrated that there had been no inleakage of water.
	2	Cement in a plastic liner inside the steel drum	Pass	One drum was dropped (angle) on both the top and the bottom (same drum). The drum passed the drop test with no effect apparent from the water spray test. A second drum was dropped flat on its side and again it passed the drop test with no effect from the water spray test.
		Flour and fluorescein were placed between the plastic liner and the wall of the steel drum.		
Style 1B	1	Empty	Pass	The drum was opened upon completion of the test and the 2-hr waiting period. An inspection demonstrated that there had been no inleakage of water.
	2	Flour and fluorescein on top and bottom	Pass	One drum was dropped (angle) on both the top and the bottom (same drum). The drum passed the drop test with no effect apparent from the water spray test. A second drum was dropped flat on its side and again it passed the drop test with no effect from the water spray test.
		Sand and metal weights as required for weight		
		Plastic cover between sand and flour, top and bottom		

Table D-1. Water Spray Test Results for Steel Drums. (3 pages total)

PACKAGING SPECIALTIES, SQUARE STEEL DRUMS				
Specific packaging	No. tested	Contents	Results	Comments
Style 2	1	Empty	Pass	The drum was opened upon completion of the test and the 2-hr waiting period. An inspection demonstrated that there had been no leakage of water.
	2	Flour and fluorescein on top and bottom	Pass	One drum was dropped (angle) on both the top and the bottom (same drum). The drum passed the drop test with no effect apparent from the water spray test. A second drum was dropped flat on its side and again it passed the drop test with no effect from the water spray test.
		Sand and metal weights as required for weight		
Style 3		Plastic cover between sand and flour, top and bottom		
	1	Empty	Pass	The drum was opened upon completion of the test and the 2-hr waiting period. An inspection demonstrated that there had been no leakage of water.
	2	Flour and fluorescein on top and bottom	Pass	One drum was dropped (angle) on both the top and bottom (same drum). The drum passed the drop test. A second drum was dropped flat on its side and again it passed the drop test with no effect from the water spray test.
		Sand and metal weights as required for weight		
		Plastic cover between sand and flour, top and bottom		

^aNucfil is a trademark of Nuclear Filter Technology, Inc.^bDrum assembly numbers.

AW = Argonne National Laboratory - West
 DOT = U.S. Department of Transportation
 FM = Feed Materials Production Center
 HDPE = High-density polyethylene
 HF = Hanford, Richland, Washington

LL = Lawrence Livermore National Laboratory
 MD = Mound Laboratory
 MS = Military specification
 OR = Oak Ridge National Laboratory
 RF = Rocky Flats.

Table D-8. Water Spray Test Results for Liquid and Gas Packagings. (2 pages total)

Specific packaging	Test/analysis results
WHC Grout Sample Packaging	The water spray test was performed immediately prior to the compression test. No water spray was applied to the package prior to any further testing, as the strength of the steel drum will not be affected by the application of water. (See discussions in Introduction, D1.2 Packaging Category--Steel Drums, and Table of Requirements, D-1 Water Spray Test.
EG&G Mound Lewis Gas Packaging	This test was conducted on each packaging before conducting the DOT-7A performance tests. Results: Pass. This test had no significant effect on the packaging.
	This test also was conducted on an empty packaging (metal drum) to ensure that there would be no inleakage of water. Results: Pass. Upon completion of the test, the drum was opened and it was confirmed that there had been no inleakage of water.
WHC Hedgehog Container	This test was conducted on an empty packaging (39-TU-02) before conducting the DOT-7A performance tests and after the vibration standards test. Water collected on the top exterior of the Hardigg Case ^a as it would normally sit during transportation. There was no in-leakage of water. There was no damage to the exterior or interior of the packaging. Results: Pass.

^aHardigg Case is a trademark of Hardigg Industries, Inc.

ANL-W = Argonne National Laboratory - West.

LLNL = Lawrence Livermore National Laboratory.

MS = Military specifications.

ORNL = Oak Ridge National Laboratory.

WHC = Westinghouse Hanford Company.

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Requirement D-2. Free Drop Test. (2 pages total)

49 CFR 173.465	Discussion
(c) <u>Free Drop Test</u> 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:	<u>Major Points</u> (1) 4-ft drop (2) Manner to cause maximum damage <u>Comments</u> (1) The orientation causing maximum damage may not be readily apparent. Typically, the following guidelines should be considered: (a) Drums - side drop with bolt closure ring (BCR) at impact point; - angle drop (approximately 45° on BCR and on bottom at intersection of chime and side seam); (b) Boxes - Top (lid) corner near features, such as lifting rings and filters, if any exist; (c) Approximate center of gravity over impact point. (2) A quick release device is required to ensure no change in package orientation. Straightforward

Requirement D-2. Free Drop Test. (2 pages total)

Table 11. Free-fall distance for packaging weighing more than 5,000 kilograms.			Comments
Packaging weight		Free-fall distance	Designer, tester, and evaluator to do and shipper responsibility to ensure. For packagings to be used for Fissile Class II shipments, further testing and evaluation per subparagraph (3) are required. Designer, tester, evaluator to do and shipper responsibility to ensure. Designer, tester, evaluator to do and shipper responsibility to ensure. As a rule of thumb, an essentially nonyielding surface is one at least five times the mass of the impacting object. Tester and evaluator to do and shipper responsibility to ensure.
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	
>15,000	>33,000	1 0.3	
(3) For Fissile Class II packagings, the free drop specified in subparagraph (1) or (2) of this paragraph shall be preceded by a free drop from a height of .3 meter (1 foot) on each corner. For cylindrical packagings, the .3 meter (1 foot) drop shall be onto each of the quarters of each rim. (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 .3 meters (1 foot). (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 .3 meters (1 foot). (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.			

Table D-10. Free Drop Test Results for Steel Drums. (13 pages total)

Specific packaging	Weight ^a (lb)	Contents	RTV/ liner	45° Top ^b		45° Bottom ^c		Side ^{d,e}	
				No. tested	Results	No. tested	Results	No. tested	Results
DOT-6C (5-gal)	80	F/F/S/Pb ^f	RTV	2	2 pass	2	2 pass	1	1 pass
DOT-6C (10-gal)	160	F/F/S/Pb	RTV	2	2 pass	2	2 pass	1	1 pass
DOT-17C (5-gal)	100	F/F/S/Pb	RTV	1	1 pass	1	1 pass	1	1 pass
DOT-17C (30-gal)	400	(Form 1)		Tests were not done on the 17C (30-gal). This evaluation is based on testing of the 17H (30-gal) drum, which has structural integrity equal to the 17C drum.					
	500	(Form 2)	None						
DOT-17C (55-gal)	900	(Form 1)	Liner ^g	5	5 pass	5	5 pass	7	7 pass
(Config. RF-1)	1,000	F/F/S/Pb	None	5	5 pass	5	5 pass	6	6 pass
		S/Pb ^h							
Flat on top and bottom									
DOT-17C (55-gal)	900	F/F/S/Pb	--	3	3 pass	3	3 pass	--	--
(Config. RF-1)									
DOT-17C (55-gal) with Pressure Relief Device - Vent Clip	900	F/F/S/Pb	Liner	4	4 pass	2	2 pass	2	2 pass
(Config. HF-1)	1,000	S ⁱ	None	--	--	--	--	--	--
DOT-17C (55-gal) with Pressure Relief Device - Filter	900	F/F/S/Pb	None	3	3 pass	--	--	3	3 pass
(Config. RF-2)									
Flat on top									
DOT-17C (55-gal)	900	F/F/S/Pb	None	3	3 pass	--	--	--	--
- Filter Installed									
(Config. RF-2)									
DOT-17C (55-gal) with 90-mil HDPE Liners	900	F/F/S/Pb	HDPE liner	5	5 pass	5	5 pass	5	5 pass
(Configs. HF-2, LL-1, MD-1, RF-3)	900	F/F/S/Pb	HDPE liner	5	5 pass	5	5 pass	5	5 pass
	900	F/F/S/Pb	HDPE liner	2	2 pass	2	2 pass	3	3 pass

Table D-10. Free Drop Test Results for Steel Drums. (13 pages total)

Specific packaging	Weight (lb)	Contents	RTV/ liner	Orientation	No. tested	Results
DOT-17C (55-gal) HDPE Liner (Configs. RF-4, RF-5 thru RF-8) [Dockets 89-13-7A, 90-18-7A]	950	F/F/S/Pb	HDPE liner	CG over bolt Flat on bottom	1	1 pass
	1,025	S/Pb	HDPE liner	CG over bolt Flat on bottom	1	1 pass
	935	F/F/S/Pb	HDPE liner	Side flat on bolt CG over bottom rim Flat on top	1	1 pass
	1,050	S/Pb	HDPE liner	Side flat on bolt CG over bottom rim Flat on top	1	1 pass
DOT-17C (UN1A2) (55-gal) NucFil-013 Filtered drum, open Type IV HDPE 110-mil liner, 3.5-mil polyethylene bag (Config. LL-2) [Docket 94-37-7A]	900	F/F/S/Pb	HDPE liner	Side flat on bolt CG at bolt location	1	1 pass
	1,000	S/Pb	HDPE liner	Side flat on bolt CG at bolt location	1	1 pass
DOT-17C (30-gal) Filtered drum with bag liner (Configs. AW-1, FM-1) [Dockets 90-17-7A, 90-20-7A]	900	F/F/S ^j	Bag liner	Flat on top Flat on bottom CG over top CG over bottom	1	1 pass
	420	F/F/S	Bag liner	CG over top on bolt CG over bottom	1	1 pass

Table D-10. Free Drop Test Results for Steel Drums. (13 pages total)

Specific packaging	Weight ^a (lb)	Contents	RTV/ liner	45° Top ^b		45° Bottom ^c		Side ^{d,e}	
				No. tested	Results	No. tested	Results	No. tested	Results
DOT-17H (30-gal) (Config. OR-1)	400	F/F/S/Pb	RTV	2	2 pass	1	1 pass	2	2 pass
	400	F/F/S/Pb	4-mil	2	2 pass	2	2 pass	2	2 pass
	400	F/F/S/Pb	None	1	1 pass	1	1 pass	1	1 pass
	500	S/Pb	None	2	2 pass	2	2 pass	2	2 pass
DOT-17H (55-gal)	1,000	S/Pb	None	8	8 pass	8	8 pass	4	4 pass
Flat on Top and Bottom									
DOT-17H (55-gal)	1,000	S/Pb	None	5	5 pass	5	5 pass	--	--
DOT-17H	900	F/F/S/Pb	4-mil	5	5 pass	5	5 pass	--	--
	900	F/F/S/Pb	None	6	6 pass	--	--	7	2 pass 5 fail
MS-24347-1 (0.25-gal)*	900	F/F/S/Pb	4-mil	8	8 pass	2	2 pass	11	11 pass
	900	F/F/S/Pb	RTV	5	5 pass	5	5 pass	5	5 pass
	10	F/F/S/Pb	None	2	2 fail	--	--	3	2 pass 1 fail
MS-24347-7 (1.25-gal)*	10	F/F/S/Pb	4-mil	2	2 pass	--	--	2	2 pass
	35	F/F/S/Pb	None	1	1 fail	--	--	1	1 fail
	60	F/F/S/Pb	4-mil	3	3 pass	--	--	3	3 pass
MS-27684-1 (3-gal)*	60	F/F/S/Pb	4-mil	3	3 pass	--	--	1	1 pass
	110	S/Pb	None	--	--	--	--	1	1 pass
MS-27684-2 (4-gal)*	110	F/F/S/Pb	None	4	4 pass	4	4 pass	4	4 pass

Table D-10. Free Drop Test Results for Steel Drums. (13 pages total)

Specific packaging	Weight ^a (lb)	Contents	RTV/ liner	45° Top ^b		45° Bottom ^c		Side ^{d,e}	
				No. tested	Results	No. tested	Results	No. tested	Results
MS-27684-2 (4-gal)*	110	F/F/S/Pb	None	4	4 pass	4	4 pass	---	--
MS-27684-3 (6-gal)*	80	F/F/S/Pb S/Pb	4-mil None	3	3 pass	k k	--	1	1 pass
MS-27684-6 (8-gal)*	80	F/F/S/Pb	None	3	3 pass	k	--	1	1 pass
MS-27684-8 (12-gal)*	200 200	F/F/S/Pb S/Pb	4-mil None	2 1	2 pass 1 pass	k k	--	1	1 pass
MS-27683-13 (30-gal)*	400 400	F/F/S/Pb S/Pb	4-mil None	2 1	2 pass 1 pass	k k	--	1	1 pass
MS-27683-13 (45-gal)*	500	F/F/S/Pb	4-mil Liner	3	3 pass	k	--	2	2 pass
MS-27683-21 (85-gal)*	800	F/F/S/Pb	None	---	--	k	--	1	1 pass
		F/F/S/Pb	RTV	2	2 pass	k	--	2	2 pass

Table D-10. Free Drop Test Results for Steel Drums. (13 pages total)

Test unit	Authorized gross weight (lb)	Weight (lb)	Test contents	RTV/liner	No. tested	Orientation	Results	Comments
DOT-17C (35-gal)	400	>400	S/F/F ¹	RTV	5	Top Edge ^m	5 pass	The only result was a minor dent at the point of impact. The largest dent was 1 1/8 in. during the drop test on the top edge.
DOT-17C (35-gal)	400	>400	S/F/F	RTV	5	Bottom Edge	5 pass	The only result was a minor dent at the point of impact. The largest dent was 1/2 in.
DOT-17C (35-gal)	400	>400	S/F/F	RTV	3	Flat on Side	3 pass	The only result was a minor dent at the point of impact. The largest dent was 3/4 in. at the top of one drum.
DOT-17C (35-gal)	400	>400	S/F/F	RTV	1	Flat on Top and Bottom	1 pass	There was no effect.

Table D-10. Free Drop Test Results for Steel Drums. (13 pages total)

Specific packaging	No. tested	Results	Contents and weight	Drop orientation	Comments
PACKAGING SPECIALTIES SQUARE STEEL DRUMS					
Style 1A ^{n,o}	1	1 pass	Concrete matrix with pieces of steel F/F ^p between liner and bottom of drum F/F on top of concrete (1,370 lb)	Flat on top of the drum	Monitoring for fluorescein in each case below demonstrated "no release of contents." Decreased height ~5/16 in.
	1	1 pass	Same as above (1,370 lb--same drum)	Flat on bottom	Overall height did not change
	1	1 pass	Same as above (1,368 lb)	Flat on side edge closest to bung	1/4-in. dent, top and bottom
	1	1 pass	Same as above (1,366 lb)	Flat on side closest to bung	Rolling hoops dented 1/4 in.
	1	1 pass	Same as above (1,380 lb)	Flat on side with weld seam	Rolling hoops dented 1/4 in.
ANGLE DROPS					
	1	1 pass	Same as above (1,356 lb)	Top corner near bung	Dent of 3 in.
	1	1 pass	Same as above (1,360 lb--same drum)	Bottom corner at weld seam	Dent of 1 3/4 in.
	1	1 pass	Same as above (1,360 lb)	Top corner at bung	Dent of 4 in.
	1	1 pass	Same as above (1,360 lb)	Bottom corner closest to weld seam	Dent of 1 3/4 in.
	1	1 pass	Same as above (1,380 lb)	Flat on top long edge nearest weld seam	Dent of 2 1/4 in.
	1	1 pass	Same as above (1,380 lb)	Flat on long edge of bottom nearest weld seam	Dent of 1 in.

Table D-10. Free Drop Test Results for Steel Drums. (13 pages total)

Specific packaging	No. tested	Results	Contents and weight	Drop orientation	Comments
PACKAGING SPECIALTIES SQUARE STEEL DRUMS					
Style 1B	1	1 pass	Same as above (1,372 lb)	Top corner nearest weld seam	Dent of 3 1/4 in.
	1	1 pass	Same as above (1,372 lb)	Bottom corner nearest weld seam	Dent of 1 7/8 in.
	1	1 pass	Same as above (1,364 lb)	Top corner at weld seam	Dent of 3 1/2 in.
	1	1 pass	Same as above (1,364 lb)	Flat on bottom edge containing weld seam	Dent of 1 in.
	1	1 pass	Sand and steel weight F/F on top and bottom (1,394 lb)	Top corner nearest bung	Dent of 3 1/2 in.
	1	1 pass	Same as above (1,394 lb)	Bottom corner nearest weld seam	Dent of 4 in.
	1	1 pass	Same as above (1,356 lb)	Top corner nearest bung	Dent of 3 in.
	1	1 pass	Same as above (1,356 lb)	Bottom corner nearest weld seam	Dent of 3 1/2 in.
	1	1 pass	Same as above (1,392 lb)	Top corner nearest bung	Dent of 3 1/4 in.
	1	1 pass	Same as above (1,392 lb)	Bottom corner opposite the weld seam	Dent of 3 1/2 in.
	1	1 pass	Same as above (1,390 lb)	Top corner nearest weld seam	Dent of 3 7/8 in.
	1	1 pass	Same as above (1,390 lb)	Bottom corner opposite the weld seam	Dent of 3 3/8 in.

Table D-10. Free Drop Test Results for Steel Drums. (13 pages total)

Specific packaging	No. tested	Results	Contents and weight	Drop orientation	Comments
PACKAGING SPECIALTIES SQUARE STEEL DRUMS					
	1	1 pass	Same as above (1,352 lb)	Flat on long edge nearest bung	Dent of 1 3/4 in.
	1	1 pass	Same as above (1,352 lb)	Flat on long edge nearest weld seam (bottom)	Dent of 2 in.
	1	1 pass	Cement with F/F (1,384 lb)	Top corner nearest bung at top and bottom of drum ^a	Dent of 3 1/4 in.
	1	1 pass	Same as above (1,384 lb)	Bottom corner nearest weld seam	Dent of 2 1/4 in.
	1	1 pass	Same as above (1,368 lb)	Top corner nearest bung	Dent of 3 1/8 in.
	1	1 pass	Same as above (1,368 lb)	Bottom corner nearest weld seam	Dent of 1 7/8 in.
SLIDE DROPS					
	1	1 pass	Same as above (1,354 lb)	Flat on side - long edge nearest bung	Dent of 1 in. - top Dent of 1 in. - bottom
	1	1 pass	Same as above (1,382 lb)	Flat on side nearest bung	Dent of 0 in. - top Dent of 1/8 in. - bottom
	1	1 pass	Same as above (1,354 lb)	Flat on side with weld (nearest bung)	Dent of 0 in. - top Dent of 1/8 in. - bottom
	1	1 pass	Same as above (1,366 lb)	Flat on top	No effect
	1	1 pass	Same as above (1,366 lb)	Flat on bottom	No effect

Table D-10. Free Drop Test Results for Steel Drums. (13 pages total)

Specific packaging	No. tested	Results	Contents and weight		Drop orientation	Comments
			PACKAGING SPECIALTIES			
Style 2	1	1 pass	Sand and steel weights F/F top and bottom (1,414 lb)	Top corner at lugs	Dent of 3 3/4 in.	
	1	1 pass	Same as above (1,414 lb)	Bottom corner nearest weld seam	Dent of 3 5/8 in.	
	1	1 pass	Same as above (1,354 lb)	Top corner nearest lugs and weld seam	Dent of 3 1/4 in.	
	1	1 pass	Same drum (1,354 lb)	Bottom corner nearest weld seam	Dent of 3 1/4 in.	
	1	1 pass	Same as above (1,352 lb)	Top corner nearest lugs	Dent of 3 1/2 in.	
	1	1 pass	Same drum (1,352 lb)	Flat on long edge of bottom nearest weld seam	Dent of 1 1/2 in.	
Style 2	1	1 pass	Same as above (1,356 lb)	Top corner nearest bung	Dent of 3 1/2 in.	
	1	1 pass	Same drum (1,356 lb)	Bottom corner opposite welded seam	Dent of 3 1/4 in.	
	1	1 pass	Same as above (1,354 lb)	Flat on long edge nearest lugs and weld seam	Dent of 1 1/2 in.	
	1	1 pass	Same drum	Bottom corner nearest weld seams	Dent of 3 1/8 in.	
	1	1 pass	Same as above (1,382 lb)	Top corner nearest lugs and weld seam	Dent of 3 in.	
	1	1 pass	Same drum	Bottom corner nearest weld	Dent of 3 3/4 in.	

Table D-10. Free Drop Test Results for Steel Drums. (13 pages total)

Specific packaging	No. tested	Results	Contents and weight	Drop orientation	Comments
PACKAGING SPECIALTIES SQUARE STEEL DRUMS					
	1	1 pass	Same as above (1,374 lb)	Top corner nearest bung and weld seam	Dent of 3 in.
	1	1 pass	Same drum	Bottom corner nearest weld seam	Dent of 3 1/4 in.
Style 2	1	1 pass	Cement with F/F at top and bottom (1,390 lb)	Top corner nearest lugs and weld seam	Dent of 1 7/8 in.
	1	1 pass	Same drum	Bottom corner nearest weld seam	Dent of 2 in.
	1	1 pass	Same as above (1,386 lb)	Top corner nearest bung	Dent of 3 in.
	1	1 pass	Same drum	Bottom corner nearest weld seam	Dent of 2 in.
SIDE DROPS					
	1	1 pass	Sand and steel weights F/F top and bottom (1,356 lb)	Flat on long edge nearest lugs	Dent of 3/4 in. - top Dent of 3/4 in. - bottom
	1	1 pass	Same as above (1,358 lb)	Flat on side nearest bung	Dent of 0 in. - top Dent of 3/16 in. - bottom
	1	1 pass	Same as above (1,358 lb)	Flat on side nearest lugs, bung and weld seam	Dent of 0 in. - top Dent of 1/8 in. - bottom

Table D-10. Free Drop Test Results for Steel Drums. (13 pages total)

Specific packaging	No. tested	Results	Contents and weight	Drop orientation	Comments
PACKAGING SPECIALTIES SQUARE STEEL DRUMS					
<u>END DROP</u>					
Style 2	1	1 pass	Same as above (1,352 lb)	Flat on top and bottom ends	No significant effect
Style 3	1	1 pass	Sand and steel weights F/F at top and bottom (1,386 lb)	Top corner nearest bung	Dent of 3 3/4 in.
	1	1 pass	Same as above	Bottom corner nearest weld seam	Dent of 4 in.
	1	1 pass	Same as above (1,386 lb)	Top corner nearest bung	Dent of 3 5/8 in.
	1	1 pass	Same as above	Bottom corner nearest weld seam	Dent of 4 1/2 in.
	1	1 pass	Same as above (1,358 lb)	Top corner nearest weld seam	Dent of 3 in.
	1	1 pass	Same as above (1,386 lb)	Top corner nearest weld seam	Dent of 3 1/2 in.
	1	1 pass	Same drum	Bottom corner opposite weld seam	Dent of 4 in.
	1	1 pass	Same as above (1,378 lb)	Flat on top long edge nearest bung and weld seam	Dent of 1 1/4 in.
	1	1 pass	Same drum	Flat on bottom long edge nearest weld seam	Dent of 1 1/2 in.

Table D-10. Free Drop Test Results for Steel Drums. (13 pages total)

Specific packaging	No. tested	Results	Contents and weight	Drop orientation	Comments
<u>PACKAGING SPECIALTIES SQUARE STEEL DRUMS</u>					
Style 3	1	1 pass	Cement with F/F at top and bottom (1,408 lb)	Top corner nearest bung and weld seam	Dent of 2 in. Dent of 2 in.
	1	1 pass	Same drum	Bottom corner nearest weld seam	Dent of 2 in.
	1	1 pass	Same as above (1,418 lb)	Top corner nearest weld seam	Dent of 2 in.
	1	1 pass	Same drum	Bottom corner nearest weld seam	Dent of 2 1/8 in.
<u>SIDE DROPS WITH SAND AND STEEL</u>					
	1	1 pass	Sand and steel weights F/F at top and bottom (1,362 lb)	Flat on long edge nearest to bung	Dent of 1 3/8 in. - top Dent of 1 3/8 in. - bottom
	1	1 pass	Same as above (1,388 lb)	Flat on side with weld seam	Dent of 1/2 in. - top Dent of 3/8 in. - bottom
	1	1 pass	Same as above (1,394 lb)	Flat on side with weld seam and nearest bung	Dent of 1/2 in. - top Dent of 3/8 in. - bottom

Table D-10. Free Drop Test Results for Steel Drums. (13 pages total)

Specific packaging	No. tested	Results	Contents and weight	Drop orientation	Comments
PACKAGING SPECIALTIES SQUARE STEEL DRUMS					
END DROP WITH SAND AND STEEL					
	1	1 pass	Same as above (1,380 1b)	Flat on top and bottom	No effect

^aThis is the authorized gross weight. In each case, the actual test weights exceeded this value.

^bApproximately a 45° angle with the package impacting on the bolt of the bolt closure ring.

^cApproximately a 45° angle with the package impacting on the bottom chime.

^dOriented so that the bolt is at the point of impact.

^e4-ft drops flat on the top and flat on the bottom were conducted on the DOT-17H and DOT-17C 55-gal steel drums, but were not deemed necessary for other drums because of the almost total lack of effect.

^fFlour, fluorescein, sand, and lead, as required to achieve desired weight.

^g4-mil polyethylene bag, not the 90-mil high-density polyethylene (HDPE) liner discussed later.

^hSand and lead, as required to achieve desired weight.

ⁱSand, as required to achieve desired weight.

^jFlour, fluorescein, and sand, as required to achieve desired weight.

^kNo tests were conducted because these were one-piece structures with no seals or chimes to test.

^lSand, flour, fluorescein and weights as needed.

^mThe top and bottom edge drops were done at about a 45° angle. The bolt was oriented at the point of impact during the side drops.

ⁿAfter all the tests on Style 1A packagings, a hole was drilled at the point of impact to ensure the presence of F/F between the liner and the drum.

^oAfter all the tests on Style 1A packagings, the bung on the top was removed to verify the presence of F/F.

^pFlour and fluorescein mixture.

^qPlastic sheet (4 mil) was used to separate F/F from the concrete.

^{*}Drum assembly numbers.

DOT = U.S. Department of Transportation.

MS = Military specification.

-- = Not applicable.

Table D-11. Free Drop Test Results for Steel Boxes.^a (10 pages total)

Specific packaging Manufacturer	Weight (lb)	Contents	Results	Comments
Capital Industries S-0510-0823	7,000	F/F/S ^b	Pass	Angle drop on top corner. No loss of contents or significant change in package geometry. Authorized for Form No. 1, No. 2, and No. 3 materials.
V-0510-0823	7,000	F/F/S	Pass	Angle drop on top corner. No loss of contents or significant change in package geometry. Authorized for Form No. 1, No. 2, and No. 3 materials.
S-0840-1440	22,700	F/F/S	Pass	Angle drop on top corner. No loss of contents or significant change in package geometry. Authorized for Form No. 1, No. 2, and No. 3 materials.
S-0730-1006	10,400	F/F/S	Pass	Angle drop on top corner. No loss of contents or significant change in package geometry. Authorized for Form No. 1, No. 2, and No. 3 materials.
S-0730-00846	8,700	Not tested	Pass	Evaluated by analysis and comparison (lid, lid reinforcing angle, bolt size, bolt spacing, container flange, and materials) to packaging S-0730-1006, which was tested and evaluated. All materials and methods of construction were equal to or better than the evaluated packaging, and the authorized gross weight was 1,700 lb less than that for the evaluated packaging. Authorized for Form No. 1, No. 2, and No. 3 materials.

Table D-11. Free Drop Test Results for Steel Boxes.^a (10 pages total)

Specific packaging	Weight (lb)	Contents	Results	Comments
Capital Industries S-0480-0906	6,120	Not tested	Pass	Evaluated by analysis and comparison (lid, lid reinforcing angle, bolt size, bolt spacing, container flange, and materials) to packaging S-0510-0823, which was tested and evaluated. All materials and methods of construction were equal to or better than the evaluated packaging, and the authorized gross weight was 820 lb less than that for the evaluated packaging. Authorized for Form No. 1, No. 2, and No. 3 materials.
S-0450-0846	5,240	Not tested	Pass	Evaluated by analysis and comparison (lid, lid reinforcing angle, bolt size, bolt spacing, container flange, and materials) to packaging S-0510-0823, which was tested and evaluated. All materials and methods of construction were equal to or better than the evaluated packaging, and the authorized gross weight was 1,760 lb less than that for the evaluated packaging. Authorized for Form No. 1, No. 2, and No. 3 materials.
S-0240-0906	3,672	Not tested	Pass	Evaluated by analysis and comparison (lid, lid reinforcing angle, bolt size, bolt spacing, container flange, and materials) to packaging S-0510-0823, which was tested and evaluated. All materials and methods of construction were equal to or better than the evaluated packaging, and the authorized gross weight was 3,328 lb less than that for the evaluated packaging. Authorized for Form No. 1, No. 2, and No. 3 materials.

Table D-11. Free Drop Test Results for Steel Boxes.^a (10 pages total)

Specific packaging	Weight (lb)	Contents	Results	Comments
Capital Industries S-0480-1376	9,295	Not tested	Pass	Evaluated by analysis and comparison (lid, lid reinforcing angle, bolt size, bolt spacing, container flange, and materials) to packaging S-0730-1006, which was tested and evaluated. All materials and methods of construction were equal to or better than the evaluated packaging, and the authorized gross weight was 1,105 lb less than that for the evaluated packaging. Authorized for Form No. 1, No. 2, and No. 3 materials.
Container Products Corp.				
B-12-44-4-S/L FD Drawing No. 01-3100-1-00 Rev. B	4,625	F/F/S	Pass	Angle drop on top corner. Authorized for Form No. 1, No. 2, and No. 3 materials.
B-25-4-S/L FD Drawing No. 01-2800-1-00 Rev. C	4,820	Not tested	Pass	Evaluated by analysis and comparison to tests of B-96-5 S/L FD, which has identical lid seal characteristics. In addition, this package was tested using just sand with no loss of contents. Authorized for Form No. 1, No. 2, and No. 3 materials.
B-52-4-S/L FD Drawing No. 04-1000-1-00 Rev. F	4,775	Not tested	Pass	Evaluated by analysis and comparison to tests of B-96-5 S/L FD, which has identical lid seal characteristics. In addition, this package was tested using just sand with no loss of contents. Authorized for Form No. 1, No. 2, and No. 3 materials.

Table D-11. Free Drop Test Results for Steel Boxes.^a (10 pages total)

Specific packaging	Weight (lb)	Contents	Results	Comments
Container Products Corp.				
B-82-6-S/L FD Drawing No. 01-2300-1-00 Rev. D	6,775	Not tested	Pass	Evaluated by analysis and comparison to tests of B-96-5 S/L FD, which has identical lid seal characteristics. In addition, this package was tested using just sand with no loss of contents. Authorized for Form No. 1, No. 2, and No. 3 materials.
B-87-6-S/L FD Drawing No. 04-1300-1-00 Rev. B	6,970	Not tested	Pass	Evaluated by analysis and comparison to tests of B-96-5 S/L FD, which has identical lid seal characteristics. Authorized for Form No. 1, No. 2, and No. 3 materials.
B-96-6-S/L FD Drawing No. 04-1200-1-00 Rev. 0	7,000	Not tested	Pass	Evaluated by analysis and comparison to tests of B-96-8 S/L FD, which has identical lid seal design. By analysis, the six side drive clips are comparable to the eight side drive clips for the B-96-8 S/L FD considering the difference of 2,000 lb in authorized gross weight. Authorized for Form No. 1, No. 2, and No. 3 materials.
B-96-8-S/L FD Drawing No. 04-1200-2-00 Rev. 0	9,100	F/F/S	Pass	Angle drop on top corner. Authorized for Form No. 1, No. 2, and No. 3 materials.
B-96-5-S/L FD Drawing No. 01-2101-1-00 Rev. 0	6,050	F/F/S	Pass	Angle drop on top corner. Authorized for Form No. 1, No. 2, and No. 3 materials.

Table D-11. Free Drop Test Results for Steel Boxes.^a (10 pages total)

Specific packaging	Weight (lb)	Contents	Results	Comments
Container Products Corp.				
B-96-5-S/L RA Drawing No. 01-1901-1-00 Rev. 0	6,800	Not tested	Pass	Identical to B-96-5-S/L FD (except for strength members added to meet reduced pressure test), which was tested and passed. Authorized for Form No. 1, No. 2, and No. 3 materials.
B-96-5-RA B Drawing No. 01-2201-1-01 Rev. 0	6,500	Not tested	Pass	Identical to B-96-5-S/L FD (except there is no filter), which was tested and passed. Authorized for Form No. 1, No. 2, and No. 3 materials.
467-C-S/L FD Drawing No. 01-3700-1-00 Rev. C	4,000	Not tested	Pass	Evaluated by analysis and comparison to tests of B-96-5 S/L FD, which has identical lid seal characteristics. In addition, tests have been completed using just sand with no loss of contents. Authorized for Form No. 1, No. 2, and No. 3 materials.
B-96-5 FD B Drawing No. 01-2301-1-01 Rev. 0	6,500	F/F/S	Pass	Angle drop on top corner. Authorized for Form No. 1, No. 2, and No. 3 materials.

Table D-11. Free Drop Test Results for Steel Boxes.^a (10 pages total)

Specific packaging	Weight (lb)	Contents	Results	Comments
RoGar Chemical and Nuclear Services				
Model R-1	7,750	Not tested	Pass	Evaluated by analysis and comparison (lids, lid reinforcing angle, bolt size, bolt spacing, container flange, materials of construction, etc.) to Model R-3. All materials and methods of construction were equal to or better than the test packaging, the dimensions were substantially less, and the authorized gross weight was 170 lb less than that for the test packaging.
Model R-2	7,820	Not tested	Pass	Evaluated by analysis and comparison (lids, lid reinforcing angle, bolt size, bolt spacing, container flange, materials of construction, etc.) to Model R-3. All materials and methods of construction were equal to or better than the test packaging, the dimensions were substantially less, and the authorized gross weight was 100 lb less than that for the test packaging.

Table D-11. Free Drop Test Results for Steel Boxes.^a (10 pages total)

Specific packaging	Weight (lb)	Contents	Results	Comments
RoGar Chemical and Nuclear Services				
Model R-3	7,920	F/F/S	Pass	This package was dropped 4 ft on a top (lid) corner. There was no loss of contents or significant change in package geometry. Authorized for Form No. 1, No. 2, and No. 3 materials.
Model R-4	7,920	Not tested	Pass	Evaluated by analysis and comparison (lids, lid reinforcing angle, bolt size, bolt spacing, container flange, materials of construction, etc.) to Model R-3. All materials and methods of construction were equal to or better than the test packaging, the dimensions were substantially less, and the gross weight remained the same.
Rocky Flats SAND Box				
Style 1	7,000	Gravel and water	Pass	A number of tests were conducted at different orientations (45° on top, 45° on bottom, etc.) for each packaging. After each test, the packagings were successfully air-leak tested to 0.5 psi. The use of water and gravel was more conservative than the use of flour and fluorescein to simulate the contents. Authorized for Form No. 1, No. 2, and No. 3 materials.

Table D-11. Free Drop Test Results for Steel Boxes.^a (10 pages total)

Specific packaging	Weight (lb)	Contents	Results	Comments
Rocky Flats SAND Box				
Style 2	6,000	Gravel and water	Pass	A number of tests were conducted at different orientations (45° on top, 45° on bottom, etc.) for each packaging. After each test, the packagings were successfully air-leak tested to 0.5 psi. The use of water and gravel was more conservative than the use of flour and fluorescein to simulate the contents. Authorized for Form No. 1, No. 2, and No. 3 materials.
Style 3	6,000	Gravel and water	Pass	A number of tests were conducted at different orientations (45° on top, 45° on bottom, etc.) for each packaging. After each test, the packagings were successfully air-leak tested to 0.5 psi. The use of water and gravel was more conservative than the use of flour and fluorescein to simulate the contents. Authorized for Form No. 1, No. 2 and No. 3 materials.
Style 4	6,000	Gravel and water	Pass	A number of tests were conducted at different orientations (45° on top, 45° on bottom, etc.) for each packaging. After each test, the packagings were successfully air-leak tested to 0.5 psi. The use of water and gravel was more conservative than the use of flour and fluorescein to simulate the contents. Authorized for Form No. 1, No. 2 and No. 3 materials.

Table D-11. Free Drop Test Results for Steel Boxes.^a (10 pages total)

Specific packaging	Weight (lb)	Contents	Results	Comments
Argonne M-4 Bin	3,000 ^c	Four 55-gal drums filled with sand, two 5-gal pails, and approx. 300 lb of loose sand.	Pass	Dropped on one of the bottom corners. Previous analysis had shown this orientation to be most vulnerable to damage. After the drop the bin was filled with 24 in. of water, 18 in. above the damage area. The bin was leak-tight. Authorized for Forms No. 1, No. 2, and No. 3 materials.
ANL-W 7A-960	960	Solid pieces of lead	Pass	Dropped on top corner of lid. There was no loss of contents and no significant pathways created by which contents could escape. Authorized only for Form No. 3 materials.
ORNL Low-Level Waste Container [Docket 89-04-7A]	8,150	Misc. Debris F/F/S	Pass	Test unit package no. 7V-90-0003 was subjected to four different 4-ft drop tests in different orientations and passed.
Nonvented	10,230	Misc. Debris F/F/S	Pass	Test unit package no. 7NV-90-0003 was subjected to three different 4-ft drop tests in different orientations and passed.

Table D-11. Free Drop Test Results for Steel Boxes.^a (10 pages total)FOUR-FT FREE DROP TEST RESULTS FOR TRUPACT-II STANDARD WASTE BOX (SWB)^d

Test unit	Authorized gross weight (lb)	Test weight (lb)	Contents	Form	No. tested	Orientation	Results	Comments
TU-1A	4,000	4,040	F/F/S	1 & 2	1	Top corner	1 pass	The only result was a minor dent at the point of impact. The largest dent was 1/2 in. during the drop test on the bottom corner.
TU-1B	4,000	4,100	F/F/S	1 & 2	2 ^e	Bottom corner	2 pass	Dent of 4 in.
TU-2	4,000	4,092	Debris ^f	3 & 4	1	Flat on end	1 pass	The only results were minor dents on the end surface.
TU-3B	4,000	4,100	Four loaded steel drums ^g	5	1	Top corner	1 pass	The only results were minor dents at the point of impact due to the drums.
TU-3B(1B) ^h	4,000	4,100	Four loaded steel drums ^g	5	1	Top corner	1 pass	Same as above.

^aGeneral Comments: The primary drop orientation was inverting the box (lid down) with a corner as the point of impact. When filters were used, they were typically placed in an end, and the corner chosen for the impact point was the corner closest to the filter location.

^bFlour, fluorescein, and sand.

^cThe authorized gross weight is 3,000 lb; however, the actual gross weight for testing was 3,215 lb.

^dGeneral Comments: These drops were conducted on top corners, bottom corners, and flat on the end of the box. In each case there was no loss of contents and the box is authorized for the contents as specified in this table.

The water spray test was conducted prior to the free drop test for TU-1, and the packaging was allowed to set for 2 hr prior to the drop test.

^eSame packaging was dropped twice.

^fDebris represents motors, pipes, steel plates, concrete blocks, etc. which would represent Form No. 3. To provide Form No. 1 contents, F/F was added. The pass/fail criteria then becomes no release of F/F.

^gF/F was placed on top of the drums.

^hTest Unit 1B was emptied and refilled with Form No. 5 contents.

ANL-W = Argonne National Laboratory - West

ORNL = Oak Ridge National Laboratory.

Table D-12. Free Drop Test Results for ANL and LLNL Wooden Boxes.

Specific packaging	Weight (lb)	Contents	Results	Comments
<u>ANL-W</u>				
7A-217	217	Solid materials simulating Form No. 3 materials were used for all tests.	Pass	Packagings were dropped on a top corner, which included the lid. In all cases the packaging met the requirements for Form No. 3 materials. Authorized only for Form No. 3 materials.
7A-375	375			
7A-880	880			
7A-995	995			
7A-1315	1,315			
7A-670	670	55-gal drum filled with soil placed inside the wooden box.	Pass	Packaging was dropped on a top corner, which included the lid. In all cases, the packaging met the requirement for Form No. 3 materials. Authorized only for Form No. 3 materials.
<u>LLNL</u>				
Flush Panel	2,500	Dryorb 75% by weight; Microsel-E 25% by weight	Pass	Packaging was dropped on a top corner, which included the lid. There was no release of contents and the packaging was authorized for Form No. 2 and No. 3 materials.

ANL-W = Argonne National Laboratory - West
 LLNL = Lawrence Livermore National Laboratory
 ORNL = Oak Ridge National Laboratory.

Table D-13. Free Drop Test Results for Wooden Boxes.^a (5 pages total)

Specific packaging	Weight (lb)	Contents	No. tested	Results	Comments
<u>Mound Wooden Boxes - Configuration A</u>					
MA-1	40	S/Pb ^b	2	2 pass	Authorized only for Form No. 2 and No. 3 materials.
MA-2	100	S/Pb	2	2 pass	
MA-3	100	S/Pb	1	1 pass	
		F/F/S/Pb ^c	1	1 pass	
MA-4	100	S/Pb	1	1 pass	
		F/F/S/Pb	1	1 pass	
<u>Mound Wooden Boxes - Configuration B</u>					
MB-1	150	F/F/S/Pb	2	2 pass	Authorized only for Form No. 2 and No. 3 materials.
MB-2	150	F/F/S/Pb	2	2 pass	
MB-3	200	F/F/S/Pb	2	2 pass	
MB-4	150	F/F/S/Pb	2	2 pass	
MB-5	150	F/F/S/Pb	2	2 pass	
MB-6	200	F/F/S/Pb	1	1 pass	

Table D-13. Free Drop Test Results for Wooden Boxes.^a (5 pages total)

Specific packaging	Weight (lb)	Contents	No. tested	Results	Comments
<u>Mound Wooden Boxes - Configuration C</u>					
MC-1	150	F/F/S/Pb S	1 1	1 pass 1 pass	Authorized only for Form No. 2 and No. 3 materials
MC-2	300	F/F/S/Pb S/Pb	1 1	1 pass 1 pass	
MC-3	250	F/F/S/Pb S/Pb	1 1	1 pass 1 pass	
MC-4	100	F/F/S/Pb S	1 1	1 pass 1 pass	
MC-5	150	F/F/S	1	1 pass	
<u>Mound Wooden Boxes - Configuration D</u>					
MD-1	200	F/F/S/Pb	2	2 pass	Authorized only for Form No. 2 and No. 3 materials
MD-2	300	F/F/S/Pb	1	1 pass	
MD-3	250	F/F/S	2	2 pass	
MD-4	250	F/F/S	2	2 pass	
MD-5	200	F/F/S/Pb	2	2 pass	
MD-6	200	F/F/S/Pb	2	2 pass	

Table D-13. Free Drop Test Results for Wooden Boxes.^a (5 pages total)

Specific packaging	Weight (lb)	Contents	No. tested	Results	Comments
<u>Mound Wooden Boxes - Configuration E</u>					
ME-1	150	S	1	1 pass	Authorized only for Form No. 2 and No. 3 materials.
ME-2	150	S	2	2 pass	
ME-3	150	F/F/S	1	1 pass	
<u>Y-12 B-Series Wooden Boxes</u>					
B-1	400	S/Pb	2	2 pass	Authorized only for Form No. 3 materials.
B-2	400	S/Pb	2	2 pass	
B-3	400	S/Pb	2	2 pass	
B-4	400	S/Pb	2	2 pass	
B-5	400	S/Pb	2	2 pass	
B-6	400	S/Pb	2	2 pass	
B-7	400	S/Pb	2	2 pass	
B-8	400	S/Pb	2	2 pass	

Table D-13. Free Drop Test Results for Wooden Boxes.^a (5 pages total)

Specific packaging	Weight (lb)	Contents	No. tested	Results	Comments
<u>Y-12 Picture Frame</u>					
<u>Boxes Picture Frame</u>					
PF-1	500	S/Pb	1	1 pass	Authorized only for Form No. 3 materials.
PF-2	750	Pb	2	2 pass	
PF-3	1,000	Pb	2	2 pass	
PF-4	500	Pb	2	2 pass	
PF-5	750	S/Pb	2	2 pass	
PF-6	1,000	Pb	2	2 pass	
PF-7	750	Pb	2	2 pass	
PF-8	1,000	Pb	2	2 pass	
PF-10	2,500	S/Pb	1	1 pass	
<u>Rocky Flats</u>					
<u>RA Series</u>					
Configuration 1	900	Solid material	1	1 pass	Authorized only for Form No. 3 materials.
Configuration 2	1,250	Solid material	1	1 pass	
<u>ORNL Y-12 Series</u>					
Docket 89-01-7A					
C-1	1,190	Concrete block	1	1 pass	Authorized only for Form No. 3 materials.
	1,181	Concrete cyl.	1	1 pass	Authorized only for Form No. 3 materials.
C-2	1,804	Concrete block	1	1 pass	Authorized only for Form No. 3 materials.
	1,735	Concrete cyl. and lead	1	1 pass	Authorized only for Form No. 3 materials.
C-3	2,326	Concrete block	1	1 pass	Authorized only for Form No. 3 materials.
	2,260	Concrete cyl. and lead	1	1 pass	Authorized only for Form No. 3 materials.

Table D-13. Free Drop Test Results for Wooden Boxes.^a (5 pages total)

Specific packaging	Weight (lb)	Contents	No. tested	Orientation	Results	Comments
C-280 (1) (3/8-in. bands)	>280	S/Pb	1	Top corner	Pass	Authorized only for Form No. 3 materials.
C-280 (2) (3/8-in. bands)	>280	S/Pb	1	Bottom corner	Pass	Authorized only for Form No. 3 materials.
C-400 (1) (3/4-in. bands)	>400	S/Pb	1	Top corner	Pass	Authorized only for Form No. 3 materials.
C-400 (2) (3/4-in. bands)	>400	S/Pb	1	Bottom corner	Pass	Authorized only for Form No. 3 materials.
C-600 (2) (3/4-in. bands)	606	S/Pb	1	Bottom corner	Pass	Authorized only for Form No. 3 materials.
C-600 (2) (3/4-in. bands)	606	S/Pb	1	Top corner	Pass	Authorized only for Form No. 3 materials.
C-600 (1) (3/4-in. bands)	608	S/Pb	1	Top corner	Pass	Authorized only for Form No. 3 materials.
C-600 (1) (3/4-in. bands)	608	S/Pb	1	Bottom corner	Pass	Authorized only for Form No. 3 materials.
C-1000 (1) (3/4-in. bands)	1,004	S/Pb	1	Top corner	Pass	Authorized only for Form No. 3 materials.
C-1000 (1) (3/4-in. bands)	1,004	S/Pb	1	Bottom corner	Pass	Authorized only for Form No. 3 materials.
C-1000 (2) (3/4-in. bands)	1,008	S/Pb	1	Top corner	Pass	Authorized only for Form No. 3 materials.
C-1000 (2) (3/4-in. bands)	1,008	S/Pb	1	Bottom corner	Pass	Authorized only for Form No. 3 materials.

^aGeneral Comments: All drops were conducted on a top corner of the lid. There was no loss of contents and the packagings were authorized for Form No. 2 and No. 3 materials.

^bSand and lead.

^cFlour, fluorescein, sand, and lead.

ORNL = Oak Ridge National Laboratory.

Table D-14. Free Drop Test Results for NLO Family of Banded Wooden Boxes.^a

Specific packaging	Weight (lb)	Results	Orientation	Comments
G-4214	1,805	Pass	All drops were conducted on a top corner of lid. In several instances these packagings survived drops of 30 ft (7.5 times the prescribed distance) with no release of contents.	Authorized only for Form No. 3 materials.
G-4245	250	Pass		
G-4255	1,500	Pass		
G-4273	3,250	Pass		
G-4292	852	Pass		
WMC0 Banded Wooden Boxes				
G-4214-1A	1,264	Pass	Drop on top corner of lid and opposite bottom corner. Both at ~45°	Authorized only for Form No. 3 materials. [Docket 89-09-7A]
G-4214-1B	1,256	Pass	Drop on top corner of lid at 45° and flat on opposite end	
G-4245-3A	225	Pass	Drop on top corner of lid and opposite bottom corner. Both at ~45°	
G-4245-3B	201	Pass	Drop on top corner of lid at 45° and flat on opposite end	
G-4255-4A	1,448	Pass	Drop on lid top corner at 45°	
G-4255-4B	1,474	Pass	Drop on bottom corner at 45°	
G-4273-5A	3,035	Pass	Drop on lid top corner at 45°	
G-4273-5B	2,960	Pass	Drop on bottom corner at 45°	
G-4273-6A	3,646	Pass	Drop on bottom corner at 45°	
G-4273-6B	3,649	Pass	Drop on top corner at 45°	
G-4292-2A	1,334	Pass	Drop on lid top corner at 45°	
G-4292-2B	1,331	Pass	Drop on bottom corner at 45°	

^aGeneral Comments: All drops were conducted on a top corner of the lid. There was no loss of contents and the packagings were authorized for Form No. 3 materials.

WMC0 = Westinghouse Materials Company of Ohio.

Table D-15. Free Drop Test Results for Fiberboard Boxes.^a

Specific packaging	Weight (lb)	Contents	No. tested	Results	Comments
<u>12B-65 Fiberboard Boxes</u>					
1	65	Pb ^b	2	2 pass	Authorized only for Form No. 3 materials.
2	65	Pb	3	3 pass	
3	65	Pb	1	1 pass	
4	65	Pb ^c	2	2 pass	
5	65	S	2	2 pass	Authorized only for Form No. 3 materials.
6	65	S	1	1 pass	
7	65	S	2	2 pass	
8	65	S	2	2 pass	
9	65	S	2	2 pass	Authorized for Form No. 1, No. 2, and No. 3 materials. Inner can was air-leak tested after each test.
10	65	S	2	2 pass	
11	65	S	1	1 pass	
12	65	S	2	2 pass	
13	65	S	2	2 pass	
LLNL 12B-10 with inner metal can ^d	10	Inner metal can filled with rocks	3	3 pass	
Tri-Wall Fiberboard Box	350	Sand in plastic bags	2	2 pass	Authorized only for Form No. 3 materials.

^aGeneral Comments: All drops were conducted on a top corner of the lid. There was no loss of contents and the packaging were authorized for Form No. 3 materials.

^bLead

^cSand

^dThe inner metal can was removed after each test and leak checked in a bell jar under water.

LLNL = Lawrence Livermore National Laboratory.

Table D-16. Free Drop Test Results for DOT-21C Fiberboard Drums.

Specific packaging	Weight kg (lb)	Contents	45° Top		45° Bottom		Comments
			No. tested	Results	No. tested	Results	
1	52.21 (115)	F/F/S ^a	1	1 pass	1	1 pass	Authorized only for Form No. 3 materials. ^c
2	52.21 (115)	F/F/S/Pb ^b	1	1 pass	1	1 pass	
3	52.21 (115)	F/F/S	1	1 pass	1	1 pass	
4	52.21 (115)	F/F/S/Pb	1	1 pass	1	1 pass	
5	52.21 (115)	F/F/S	1	1 pass	1	1 pass	
6	52.21 (115)	F/F/S	1	1 pass	1	1 pass	

^aFlour, fluorescein, and sand.^cFlour, fluorescein, sand, and lead.

^bEven though these packagings passed the drop test without release of the flour and fluorescein, they were authorized only for Form No. 3 materials because their performance in the penetration test was sporadic.

Table D-17. Free Drop Test Results for UF₆ Cylinders.

Specific packaging	Weight kg (lb)	Orientation	Comments
1S	0.9 (2)	This category of packagings was evaluated based on numerous drop tests conducted on Models 5A, 8A, 12B, 30B, and 48X cylinders. These tests included the 1.2-m (4-ft) drop (side and angle), the much more severe 9-m (30-ft) drop (side and angle), and the 1.2-m (4-ft) drop onto the bar (puncture test). In all of these tests, there was no loss of contents. When analyses were performed, data such as materials of construction, dimensions, authorized gross weight, and effects of testing were used to verify that the cylinders not tested meet the Specification 7A requirements.	These packagings are authorized for Form No. 1, No. 2, and No. 3 materials (recognizing that Form No. 2 and No. 3 are not really appropriate).
2S	4.3 (9.5)		
5A	50 (110)		
8A	170 (375)		
12A	293 (645)		
12B	295 (650)		
30A	2,883 (6,350)		
30B	2,915 (6,420)		
48G	13,892 (30,600)		
48H	13,688 (30,150)		
48HX	13,688 (30,150)		
48X	11,591 (25,530)		
48Y	14,873 (32,760)		
Modified			

Four test units were subjected to 1.2-m (4-ft) drop tests with different orientations with no adverse affects.

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Table D-18. Additional Free Drop Test Results for Liquid and Gas Packagings. (12 pages total)

Specific packaging	Weight kg (lb)	Contents	Results/Comments
Steel Drum MS-24347-7	2.7 (6)	Water	Top (45°): No. tested - 3; Results - 3 pass Flat on Top: No. tested - 1; Results - 1 pass Bottom (45°): No. tested - 3; Results - 3 pass Side: No. tested - 2; Results - 2 pass Three 9-m (30-ft) drops were done consecutively on the same package. The inner containment vessel (glass bottle) was removed and inverted for 10 min to determine if there had been any loss of contents. After nine 9-m (30-ft) drops, there was no evidence of leakage, and the package was evaluated as meeting all requirements.
LANL 12B-62 Fiberboard Box	28 (62)	Water	One 9-m (30-ft) drop was done on this packaging. The impact point was a top corner (package was inverted). After completion of the test, the inner containment vessel (glass ampule) was removed and inverted for 10 min to determine if there had been any loss of contents. There was no loss of contents. In addition, after an additional 9-m (30-ft) drop, the 5.08-cm- (2-in-) diameter inner shield container with the threaded cap and O-ring seal was air-leak tested and passed. Thus, this packaging meets all requirements with any appropriate inner containment.
LANL Steel Drums with Gas Cylinders			A 9-m (30-ft) drop test was conducted on both configurations. After each drop test, it was determined that there had been no loss of contents (by comparison of pre-test pressure to post-test pressure) from any of the seven test cylinders. Thus, there was no loss of contents, and this package meets all requirements.
3A 1800	31 (68)	Air	
3E 1800	27 (60)	Air	

Table D-18. Additional Free Drop Test Results for Liquid and Gas Packagings. (12 pages total)

Specific packaging	Weight kg (lb)	Contents	Results/Comments
LANL-2	225 (495)		Top (45°): No. tested - 3; Results - 3 pass Three 9-m (30-ft) drops were conducted using the same inner container (Fenton Hill Pig) and the same Celotex^a disks placed in new 17C 208-L (55-gal) steel drums. The drops orientations were all on the top, at approximately a 45° angle and positioned so that the bolt of the bolt closure ring was at the point of impact.

Drop No.	Maximum dent cm (in.)	Effect on lid	Movement of inner container	Results/Comments
1	10.16 (4)	Separated on sides away from impact point	Minimal [<2.54 cm (<1 in.)]	After each drop test the inner container was removed, the cover taken off, and the container inverted over paper for at least 10 min, looking for evidence of leakage. None was found. All pass.
2	12.06 (4.75)	Same as above	Same as above	
3	10.16 (4)	Same as above	Same as above	

Table D-18. Additional Free Drop Test Results for Liquid and Gas Packagings. (12 pages total)

Specific packaging	Weight kg (lb)	Contents	Results/Comments
ORNL Fiberboard Box Liquids and Solids	15 (33)	Water	A 9-m (30-ft) drop test was conducted on this packaging. The impact was on the bottom edge of the cardboard box. There was no evidence of loss of contents, and this packaging meets all requirements.
ORNL Fiberboard Box Gases	15 (33)	Water	A 9-m (30-ft) drop test was conducted on this packaging. The impact was on the bottom edge of the cardboard box. There was no evidence of loss of contents, and this packaging meets all requirements.
ORNL Fiberboard Box Liquids and Solids with Shielding	15 (33)	Water	A 9-m (30-ft) drop test was conducted on this packaging. The impact was on the bottom edge of the cardboard box. There was no evidence of loss of contents, and this packaging meets all requirements.
ORNL Wooden Box Returnable, Shielded	96 (212)	Water	Two 9-m (30-ft) drops were conducted: one with the entire packaging assembly and one with just the stainless steel clad lead shield by itself (without the wooden box). The second drop indicated that this inner assembly could withstand the 9-m (30-ft) drop test by itself. After both tests, the glass inner container was removed and examined. There was no loss of contents (leakage of water), and this packaging meets all requirements.
ORNL Gas Cylinder Returnable (Hoke Cylinders)			
HOH-50	4.1 (9)		
HOXe-50	6.8 (15)		
HOKr-50	6.8 (15)		
HOH-150	5.0 (11)		
HOXe-1150	15.9 (35)		
HOKr-150	15.9 (35)		
HOH-300	5.5 (12)		
HOKr-300	16.3 (36)		
HOH-500	6.8 (15)		
HOKr-500	23 (50)		

Nine-m (30-ft) drop tests were conducted on the 1,000-ml (34-oz) (not currently used) and 500-ml (17 oz) gas shipping cylinders. The test packages were dropped with the valve cover down. There was no loss of contents, and these packagings meet this requirement. These two tests subjected the packaging to maximum stress, so, after consideration of material of construction, thickness of materials, package weights, etc., the analysis demonstrated that all listed packagings meet all requirements.

Table D-18. Additional Free Drop Test Results for Liquid and Gas Packagings. (12 pages total)

Specific packaging	Weight kg (lb)	Contents	Results/Comments
ORNL Gas Cylinder Returnable (J. L. Shephard)			
Cylinder 1	11 (24)		A 9-m (30-ft) drop test was conducted on a J. L. Shephard Model 394-500-L gas shipping cylinder. The cylinder landed on its top. Helium leak testing before and after the testing demonstrated that there was no loss of contents, and this packaging meets this requirement. Because this packaging would be subject to the greatest stress, all smaller packagings also meet all requirements.
Cylinder 2	18 (40)		
Cylinder 3	27 (60)		
WHC Liquid Sample Packaging	21 (46.75)	Saturated salt water, colored water	The package was subjected to 9-m (30-ft) drops. Two drop orientations were used: (1) package oriented to strike on the side, and (2) package oriented with the center of gravity over top rim positioned to strike on the closure bolt area.
	20 (43.25)	Saturated salt water, colored water	The damage observed from the drop for orientation was (1) the side of the package flattened approximately 0.635 cm (0.25 in.) for orientation and (2) the rim and drum edge were pushed down 3.175 cm (1.25 in.). In both cases, the packaging passed the test.
SRP Process Water Sample Packaging	54 (118)	Water	The package was subjected to 1.2-m (4-ft) and 9-m (30-ft) drop tests with varying orientations. In all cases, the packaging passed the tests.

Table D-18. Additional Free Drop Test Results for Liquid and Gas Packagings. (12 pages total)

Specific packaging	Weight kg (lb)	Contents	Results/Comments
RF Container Model LWS-1	5.5 (12)	Fluorescent penetrant	The package was subjected to 1.2-m (4-ft) and 9-m (30-ft) drops. Three drop orientations were used: (1) package oriented with the center of gravity over top rim positioned to strike on the closure bolt area, (2) package oriented to drop directly onto the bottom, and (3) package oriented to drop flat on the side. The damage observed from the drop for orientation was (1) the rim being driven inward about 2.54 cm (1 in.), (2) the bottom rim was driven up even with the bottom of the drum, and (3) the side of the packaging was flattened along the height of the drum side and was pushed in about 2.54 cm (1 in.) from the original position. In all three cases, the packaging passed the test. The inner packaging moves within the space provided in the foam. The movement could influence the radiation readings.
EG&G Mound Applied Technologies Commercial Tritium Packaging	4.67 (10.29) 4.84 (10.66) 5.13 (11.29) 5.37 (11.83) 5.78 (12.72)	Air Air Air Air Air	See specific drop test information listed below. In one instance [500 cc (3.17 lb)], there was movement of the inner cylinder of 3.81 cm (1½ in.), and the maximum dent in the outer packaging was 1.27 cm (½ in.). In all cases, the packaging passed the tests.

Table D-18. Additional Free Drop Test Results for Liquid and Gas Packagings. (12 pages total)

Packaging/cylinder	Number of drops	Orientation	Result	Comments
EG&G Mound Applied Technologies Commercial Tritium Packaging (cont.)				
Case and 10 cc (0.74 lb)	1	End - top of cylinder	Pass	Package split about 5.08 cm (2 in.) from top front corner, 7.62-cm (3-in.) length [note final 500-cc (3.17-lb) drop test].
Case and 50 cc (1.11 lb)	2	45° on back top left cylinder	Pass	Pushed corner in 0.317 cm (1/8 in.).
	1	End drop on top of cylinder	Pass	No visible damage.
	2	45° on front	Pass	No visible damage, but one latch came loose. ^b
		Right corner (whole)		
Case and 150 cc (1.74 lb)	1	45° on top back right corner	Pass	No visible damage, but one latch came loose.
	2	45° on top back left corner	Pass	No visible damage.
	3	Side at latches	Pass	No visible damage, but both latches came loose.
	4	Flat on top	Pass	No visible damage, but both latches came loose.
Case and 300 cc (2.28 lb)	1	Flat on top	Pass	Both latches came loose, but no other visible effect.
	2	Side at hinge	Pass	No visible damage.
Case and 500 cc (3.17 lb)	1	Flat on bottom	Pass	No visible damage, but one latch came loose.
	2	45° on bottom front right corner	Pass	Pushed corner in 1.27 cm (½ in.).
	3	End at top of cylinder	Pass	No visible damage. ^c

Table D-18. Additional Free Drop Test Results for Liquid and Gas Packagings. (12 pages total)

Specific packaging	Weight kg (lb)	Contents	Results/Comments
WHC Grout Sample Packaging	178 (391)	Water, lead shot, fluorescent penetrant	Three drop orientations were used: (1) package oriented to drop flat on the bottom, (2) package oriented to drop flat on the top, (3) package oriented to drop flat on the side with bolt down. The damage observed from the drop for each orientation from 9 m (30 ft) was as follows: (1) overall height compressed from 109.22 cm (43 in.) to 106.997 cm (42 1/8 in.); (2) overall height compressed to 106.36 cm (41 7/8 in.), and (3) the side of the packaging was flattened along the height of the drum side and was pushed in about 3.969 cm (1 9/16 in.) from the original position. In all three cases, the packaging passed the test.
EG&G Mound Lewis Gas Packaging	9.49 (20.875)	Air	See specific test information listed below. There was no loss of contents after any of these tests, and the packaging passed the test.

Table D-18. Additional Free Drop Test Results for Liquid and Gas Packagings. (12 pages total)

Packaging/cylinder	Number of drops	Orientation	Result	Comments
EG&G Mound Lewis Gas Packaging (cont.)				
Package #1	1	45° angle on bolt closure	Pass ^d	Dent of approximately 2.54 cm (1 in.) at point of impact.
Package #2	1	45° angle on bolt closure	Pass	Dent of approximately 2.858 cm (1 1/8 in.) at point of impact.
Package #3	2	Flat on side (bolt at point of impact)	Pass	Dent of approximately 2.54 cm (1 in.) at point of impact.

Table D-18. Additional Free Drop Test Results for Liquid and Gas Packagings. (12 pages total)

Specific Packaging	Weight kg (1b)	Contents	Results/Comments
WHC Hedgehog Container:			
30-mL version	28.6 (63)	steel shot, water, and fluorescein	Although damage to the internal foam on the case lid resulted in crevices of varying depth and slight shifting of the foam pieces, there was no significant movement of the SafeSend ^e container within the cavity area of the Hardigg Case. See specific test information listed below for both versions. Packaging passed test.
1-L version	18.1 (40)	steel shot, water, and fluorescein	
Number of drops			
Orientation			
39-TU-01 (30-mL)	1	Flat onto lid of packaging	Pass Internal foam on the lid of the Hardigg Case received a crevice 1.19-cm (0.47-in.) and 1.42-cm (0.558-in.) deep from the impact of the top and bottom of SafeSend. The foam located in the internal cavity shifted outward, away from the cavity 1.10 cm (0.435 in.) and 1.89 cm (0.745 in.). No further damage.
39-TU-01 (30-mL)	1	Impact top corner of lid, latch side, CG (45° angle)	Pass The external, impacted corner of the Hardigg Case indented 3.81 to 3.96 cm (1.5 to 1.562 in.). The case pushed outward, near the indented area 1.27 cm (0.5 in.). Internal foam on the lid of the case received a crevice 1.46-cm (0.575-in.) and 1.35-cm (0.532-in.) deep from the impact of the top and bottom of the SafeSend. The maximum compressed area on the lid foam, from the impact of the SafeSend, measured 0.70 cm (0.275 in.). No further damage.

Table D-18. Additional Drop Test Results for Liquid and Gas Packagings. (12 pages total)

	Number of drops	Orientation	Result	Comments
WHC Hedgehog Container (cont.)				Although damage to the internal foam on the case lid resulted in crevices of varying depth, and slight shifting of the foam pieces, there was no significant movement of the SafeSend container within the cavity area of the Hardigg Case.
39-TU-01 (30-mL)	1	Flat onto top of packaging	Pass	The top, center foam piece of the Hardigg Case cavity shifted upward at each end, a distance of 0.64 cm (0.25 in.) and 1.27 cm (0.50 in.) on the left and right sides. The wooden spacer bent 0.16 cm (0.063 in.) around the top of and touching the SafeSend container. This spacer could not be used during further testing. No further damage resulted.
39-TU-01 (30-mL)	1	Flat onto bottom of packaging	Pass	The ABS load spacer was bent 0.54 cm (0.25 in.) in two locations around the bottom of the SafeSend container. No further damage resulted.
39-TU-03 (1-L)	1	Flat onto the lid of the packaging	Pass	No damage resulted. No leakage or discharge of contents from internal bottle.

Table D-18. Additional Drop Test Results for Liquid and Gas Packagings. (12 pages total)

	Number of drops	Orientation	Result	Comments
WHC Hedgehog Container (cont.)				Although damage to the internal foam on the case lid resulted in crevices of varying depth and slight shifting of the foam pieces, there was no significant movement of the SafeSend container within the cavity area of the Hardigg Case.
39-TU-03 (1-L)	2	Flat onto top of packaging	Pass	During the first drop, a slight discharge of simulated contents was noted around the bottle lid (about eight drops). A few drops of water and fluorescein was indicated on the foam spacer closest to the lid. No damage resulted. There was no loss of material from the package. The SafeSend and internal bottle were changed out, and the packaging was dropped a second time at this orientation. Slight discharge (about five drops) was indicated around the bottle lid. A few drops of water and fluorescein were indicated on the foam spacer closest to the bottle lid. No damage resulted. There was no loss of material from the package.

Table D-18. Additional Drop Test Results for Liquid and Gas Packagings. (12 pages total)

	Number of drops	Orientation	Result	Comments
WHC Hedgehog Container (cont.)				Although damage to the internal foam on the case lid resulted in crevices of varying depth and slight shifting of the foam pieces, there was no significant movement of the SafeSend container within the cavity area of the Hardigg Case.
39-TU-03 (1-L)	1	Flat onto bottom of packaging	Pass	No damage resulted. No leakage or discharge of contents from internal bottle.

^aCelotex is a trademark of the Celotex Corporation.

^bPackage remained closed because a bolt is required on one side of the handle.

^cAt the end of the 500-cc (3.17-lb) package tests, the cylinder had moved 3.81 cm (1½ in.).

^dDetermined by comparing the pressure after the test with the measured pressure before the test. In each case, the measurement was made for 20 minutes. In each instance there was no decrease in pressure or any other indication of a leak. Also, for package No. 3, after two 9-m (30-ft) drops had been made on the same packaging, the inner gas container was placed under water for 2 minutes and again no leakage was detected. This was in addition to the measurement of pressure before and after testing.

^eSafesend is a trademark of 3M Company.

Hardigg Case is a trademark of Hardigg Industries, Inc.

LANL = Los Alamos National Laboratory.

ORNL = Oak Ridge National Laboratory.

RF = Rocky Flats.

SRP = Savannah River Plant.

WHC = Westinghouse Hanford Company.

Table D-18a. Free Drop Test Results for Liquid and Gas Packagings. (6 pages total)

Specific Packaging	Weight kg (lb)	Contents	Results/Comments	
EG&G Mound Applied Technologies Commercial Tritium Packaging	4.67 (10.29)	Air	See specific drop test information listed below. No loss of contents.	
	4.84 (10.55)	Air		
	5.13 (11.29)	Air		
	5.37 (11.83)	Air		
	5.78 (12.72)	Air		
	Number of drops	Orientation	Result	Comments
Case and 50 cc (1.11 lb)	1	End, near top of cylinder	Pass	No visible damage.
	2	45° top right corner	Pass	No visible damage.
	8	One drop on each corner	Pass	No visible damage.
Case and 50 cc (1.11 lb)				
Specific packaging	Weight kg (lb)	Contents	Results/Comments	
WHC Grout Sample Packaging	178 (391)	Water, lead shot, fluorescent penetrant	Three drop orientations were used: (1) package oriented to drop flat on the bottom, (2) package oriented to drop flat on the top, (3) package oriented to drop flat on the side with bolt down. The damage observed from the drop for each orientation from 1.2 m (4 ft) was as follows: (1) bottom lid of drum bowed out 0.635 cm (1/4 in.), (2) top lid of drum bowed out 0.635 cm (1/4 in.), (3) 0.952-cm (3/8-in.) dent in bolt area. In all three cases, the packaging passed the test.	

Table D-18a. Free Drop Test Results for Liquid and Gas Packagings. (6 pages total)

Specific Packaging	Weight kg (lb)	Contents	Results/Comments
EG&G Mound Lewis Gas Packaging	9.49 (20.875)	Air	See specific test information listed below. Packaging passed test.
Package #1	Number of drops	Orientation	Result
	1	45° angle on top [opposite impact point of the 9-m (30-ft) drop conducted just before this test--without opening the packaging]	Pass No significant effect determined.

Table D-18a. Free Drop Test Results for Liquid and Gas Packagings. (6 pages total)

Specific Packaging	Weight kg (lb)	Contents	Results/Comments
WHC Hedgehog Container			
30-mL version	28.6 (63)	Steel shot, water, and fluorescein	Although damage to the internal foam on the case lid resulted in crevices of varying depth, and slight shifting of the foam pieces, there was no significant movement of the SafeSend ^a container within the cavity area of the Hardigg Case. ^b See specific test information listed below for both versions. Packaging passed test.
1-L version	18.1 (40)	Steel shot, water, and fluorescein	
Number of drops	Orientation	Result	Comments
1	Flat onto lid of packaging	Pass	Internal foam on the lid of the Hardigg Case received a crevice 1.87-cm (0.735-in.) to 1.46-cm (0.575-in.) deep from the impact of the top and bottom of the SafeSend. The lid foam also compressed from the weight of the SafeSend 0.65 to 0.90 cm (0.255 to 0.335 in.) from center to bottom. The top, center foam piece, located in the cavity area of the case, shifted downward into the cavity a distance of 0.239 to 0.475 cm (0.094 to 0.187 in.) from left to right. No further damage.

39-TU-01
(30-mL)
D-60j

Table D-18a. Free Drop Test Results for Liquid and Gas Packagings. (6 pages total)

	Number of drops	Orientation	Result	Comments
WHC Hedgehog Container (cont.)				Although damage to the internal foam on the case lid resulted in crevices of varying depth, and slight shifting of the foam pieces, there was no significant movement of the SafeSend container within the cavity area of the Hardigg Case.
39-TU-01 (30-mL)	1	Impact top corner of lid, Tatch side, CG (45° angle)	Pass	Internal foam on the lid of the Hardigg Case received a crevice 1.78-cm (0.70-in.) to 1.29-cm (0.509-in.) deep from the impact of the left and right side of the SafeSend. A crevice 1.37-cm (0.54-in.) deep resulted from the impact of the bottom of the SafeSend. The lid foam also compressed from the weight of the SafeSend 0.66 to 0.82 cm (0.260 to 0.322 in.) from center to bottom. The top center foam section located in the cavity area shifted outward a distance of 0.56 to 0.47 cm (0.219 to 0.187 in.) from the left to right side. No further damage.

Table D-18a. Free Drop Test Results for Liquid and Gas Packagings. (6 pages total)

	Number of drops	Orientation	Result	Comments
WHC Hedgehog Container (cont.)				Although damage to the internal foam on the case lid resulted in crevices of varying depth, and slight shifting of the foam pieces, there was no significant movement of the SafeSend container within the cavity area of the Hardigg Case.
39-TU-01 (30-mL)	1	Flat onto top of packaging	Pass	Internal foam on the lid of the Hardigg Case received a crevice 1.84-cm (0.725-in.) to 1.52-cm (0.60-in.) deep from the impact of the left side and bottom of the SafeSend. The lid foam also compressed from the weight of the SafeSend 0.787 to 0.729 cm (0.310 to 0.287 in.) (center) to 0.709 cm (0.279 in.) (bottom). No further damage.
39-TU-03 (1-L)	1	Flat onto lid of packaging	Pass	The butterfly latch came unlatched at the base of package as it would normally sit during transportation. Internal foam on the lid of the Hardigg Case received a crevice 1.01-cm (0.40-in.) deep from the impact of the top of the SafeSend. The lid foam also compressed from the weight of the SafeSend 0.315 to 0.335 cm (0.124 to 0.132 in.) from top to bottom. No further damage.

Table D-18a. Free Drop Test Results for Liquid and Gas Packagings. (6 pages total)

	Number of drops	Orientation	Result	Comments
WHC Hedgehog Container (cont.)				Although damage to the internal foam on the case lid resulted in crevices of varying depth, and slight shifting of the foam pieces, there was no significant movement of the SafeSend container within the cavity area of the Hardigg Case.
39-TU-03 (1-L)	1	Flat onto top of packaging	Pass	Internal foam on the lid of the Hardigg Case received a crevice 1.0-cm (0.397-in.) deep. No further damage.
39-TU-03 (1-L)	1	Flat onto bottom of packaging	Pass	After five drops with this case, the rivets on bottom latch began to loosen. Internal foam on the lid of the Hardigg Case received a crevice 1.0-cm (0.397-in.) deep from the impact of the top of the SafeSend. No further damage.

^aSafeSend is a trademark of 3M Company.^bHardigg Case is a trademark of Hardigg Industries, Inc.

WHC = Westinghouse Hanford Company.

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Table D-19. Free Drop Test Results for Miscellaneous Packagings. (8 pages total)

Specific packaging	Weight kg (lb)	Comments
LLNL-01d Spec 55	23 (50)	Two of these packagings were filled with a water/fluorescein solution, sealed, and dropped on a lid edge. There was no loss of contents, even with these conservative contents. Thus, this packaging meets all requirements.
ORNL TRU Shipping Container	1,701 (3,750)	Because this packaging is certified only for Special Form [49 CFR 173.403(z)] contents, this test has little meaning from a loss of contents standpoint. However, the test was conducted on the top edge with no significant effect on the packaging. Thus, the packaging plus the Special Form contents meet all requirements.
FEMA Source Overpack	91 (200)	Because this package is authorized only for Special Form [49 CFR 173.403(z)] contents, this test has little meaning from a loss of contents standpoint. However, the test was conducted on the top edge with no significant effect on the packaging. Thus, the packaging plus the Special Form contents meet all requirements.
SNL Tritium Waste Package	91 (200)	The inner container was dropped 6 ft on a chime and 4 ft on a protected valve, and the entire package was dropped 4 ft on the top bolt closure ring, all with no loss of contents. The packaging meets all requirements.
LANL Aluminum Packaging (LANL-1)	77 (170)	The same packaging was dropped three times: on the top cover at approximately a 45° angle; flat on a side flange; and flat on an end flange. There were no significant effects on the packaging; there were no significant dents or indents; and there was no movement of the inner contents.
WIPP RH-TRU Canister	2,712 (5,980)	Test Unit LA01 was subjected to three drop tests with varying orientations with no adverse affects.
	2,381 (5,250)	Test Unit LA02 was subjected to three drop tests with varying orientations, also with no adverse affects. [Docket 89-03-7A]

Table D-19. Free Drop Test Results for Miscellaneous Packagings. (8 pages total)

Specific packaging	Weight kg (lb)	Comments
Packaging for Special Form Neutron Source	261 (576)	Test Unit 26-TU-1 was subjected to one 4-ft drop test. The access tube protrusion was pushed into the center of the package by 0.875 in. (maximum). The weld holding the access tube to the container end piece fractured, but it did not fail completely. [Docket 91-26-7A] The package plus the special form material meet all requirements.
TRUPACT II Ten-Drum Overpack	3,129 (6,900)	Test Unit 16-TU-01 was subjected to a drop test at a 48° angle, center-of-gravity over top rim, impact point at a filter location. At the point of impact, the lid flange pushed inward 0.91 cm (0.360 in.). The damage tapered off in both directions from the impact point resulting in a crease across the lid with a 61-cm (24-in.) chord. The lid uplifted 1.87 cm (0.735 in.), measured from a distance of 79 cm (31 in.) from the center of the lid, and with the chord of 61 cm (24 in.). The shape of the uplifting of the lid is similar to that of a parabolic curve. There was minor flattening along the side of the overpack at the point of impact. Passed with no leakage of contents. [Tested 10/28/93, Docket 90-16-7A]

Table D-19. Free Drop Test Results for Miscellaneous Packagings. (8 pages total)

Specific packaging	Weight kg (lb)	Comments
TRUPACT II Ten-Drum Overpack (cont.)	3,093 (6,820)	Test Unit 16-TU-02 was subjected to a drop test, flat on side, near lift handle on opposite side of the welded seam. The lift handle pushed against the external side of the TDOP with no resulting damage to the TDOP wall at the point of impact. All four bumpers received minor damage, with the most damage occurring to bumper #4, which dented 3.49 cm (1 3/8 in.) inward with a 53.98-cm (21 1/4-in.) chord. The sides of the overpack near the dented bumpers also received minor damage, with the most damage occurring on the side near bumper #4, which indented 3.49 cm (1 3/8 in.). The bottom portion of the overpack side panel dented inward approximately 2.70 cm (1 1/16 in.) with a chord of 40.6 cm (16 in.). The area of damage to this test package also had a parabolic curve. Damage was minimal at the top of the package, with an increase in the damage occurring more at the bottom of the overpack. Passed with no leakage of contents. [Tested 10/28/93, Docket 90-16-7A]
	3,129 (6,900)	Test Unit 16-TU-03 was subjected to a drop test at a 48° angle, center-of-gravity over bottom rim, impact point at the welded seam. All four bumpers received minor damage, with the most damage occurring to bumper #1 which indented 2.06 cm (13/16 in.) and with a 28-cm (11-in.) chord. The sides of the overpack near the dented bumpers also received minor damage, with the most damage occurring to the side near bumper #1 which indented 1.59 cm (5/8 in.). The damage showed a similar shaped parabolic curve as 16-TU-02; however, the bumpers did not flatten as much. The bottom side wall under bumper #4 dented inward 4 cm (1.573 in.). The bottom pan of the overpack buckled up from the underside and into the overpack, resulting in a dent approximately 5.4 cm (2-1/8 in.) and with a chord of 27.5 cm (1 ft 10 in.). Passed with no leakage of contents. [Tested 10/28/93, Docket 90-16-7A]

Table D-19. Free Drop Test Results for Miscellaneous Packagings. (8 pages total)

Specific packaging	Weight kg (1b)	Contents	Results/comments
INEL Mark III Concrete Container	Varied--see specific info noted below	Except where noted below, the simulated contents were sand, soil, stainless steel ingots, and lead bricks. Bracing was also added to protect the bottom, sides, and top of the inside of the container. Bracing consisted of plywood sheets, wooden 2 x 4s, and railroad ties. A mixture of flour and fluorescein was added for leak detection purposes.	Except where noted below, a 0.6-m (2-ft) drop test was conducted. Cracking and the breaking off of the exterior concrete, and cracking of the internal polyethylene liner resulted from drop tests conducted. See specific test information listed below. The packaging passed testing with and without the use of the top impact limiter, as indicated below.
33-TU-01	4,581.28 (10,100)	Container was filled with 30.28 L (8 gal) of water; fluorescein added for leak detection purposes.	This packaging did not include the top impact limiter. This packaging was subjected to a 1.4-m (4.6-ft) drop test to confirm the integrity and performance of the drain valve and plugs.
33-TU-02	10,477.98 (23,100)		This packaging included the top impact limiter.
33-TU-04	10,409.95 (22,950)		This packaging did not include the top impact limiter.
33-TU-05	10,455.30 (23,050)		This packaging included the top impact limiter.
33-TU-05	10,115.11 (22,300)		This packaging was dropped a second time without the top impact limiter.

Table D-19. Free Drop Test Results for Miscellaneous Packagings. (8 pages total)

	Number of drops	Orientation	Result	Comments
INEL Mark III Concrete Container				
33-TU-01	1	Center of gravity to impact the drain valve and plugs located on the side and bottom of the container body.	Pass	The two drain plugs located on the side of the container body indented symmetrically 0.635 cm (0.25 in.) across the 3.81-cm (1.5-in.) wide plug/valve area. The drain plugs located on the bottom of the container body were not affected.
33-TU-02	1	Flat onto the top of the lid.	Pass	Minimal damage noted to the top impact limiter. External damage to the concrete container was evident only in the lid. Cracking of the concrete occurred in a wave-like pattern along a lengthwise side of the lid and measured a total length of 114.3 cm (45 in.). The concrete lifted outward about 0.3175 cm (0.125 in.) along portions of this crack. Damage noted on the opposite side of the lid consisted of concrete chipping off in chunks 17.78-cm (7-in.) long and 13.97-cm (5.5-in.) long. The polyethylene liner of the lid cracked along a chamfer edge of the lengthwise portion of the lid. The crack was in a wave-like pattern and measured 179.07-cm (70.5-in.) long.

Table D-19. Free Drop Test Results for Miscellaneous Packagings. (8 pages total)

	Number of drops	Orientation	Result	Comments
INEL, Mark III Concrete Container	33-TU-04	1	Center of gravity to impact lengthwise edge of lid.	Pass
				There was no top impact limiter, and the lid shifted 0.635 cm (0.25-in.) from the initial point of impact toward the side of the slap down. Exterior damage resulted in the concrete breaking off along one edge of the lid a length of 25.4 cm (10 in.) and a depth of 7.62 to 5.08 cm (3 to 2 in.). Rebar was exposed across the exterior of the lid along this area. Cracking of the concrete occurred at a bolt location in the lid. The concrete raised upward 0.3175 cm (0.125 in.) along this crack. Rebar was exposed on the exterior of the lid between two lid bolts. A crack 36.83-cm (14.5-in.) long pushed outward about 0.1588 cm (0.0625 in.) from the concrete container body. The interior lid liner cracked 15.24 cm (6 in.) along one end. Cracks were also noted in the lid liner around two bolt locations. The body of the liner cracked along the location where the outer edge of the concrete container had pushed out 0.1588 cm (0.0625 in.). This crack ran diagonal along the interior of the container for a length of 38.1 cm (15 in.).

Table D-19. Free Drop Test Results for Miscellaneous Packagings. (8 pages total)

	Number of drops	Orientation	Result	Comments
INEL, Mark III Concrete Container				
33-TU-05	1	Flat onto short, butt-end to impact top impact limiter, and slap down onto container bottom.	Pass	The top impact limiter cracked and broke up; wood split up. A crack measured 39.37-cm (15.5-in.) long, and pushed outward about 0.635 cm (0.25 in.) along one side of the exterior concrete body. A hole measuring 41.91-cm (16.5-in.) across, 27.94-cm (11-in.) high, and 5.08-cm (2-in.) deep occurred in the body of the concrete container. On the underside of the body, concrete was broken out 2.54 cm (1 in.) toward the reinforced plate for the lifting eyes and measured 21.59 by 27.94 cm (8.5 by 11 in.). On the opposite edge, the concrete was broken out 19.05 cm (7.5 in.) from the edge. The bottom of the container body hit the clevis hook (from the lifting straps used) during the slap down onto the test pad. Damage resulting from the hook measured 27.94-cm (11-in.) long and 5.08-cm (2-in.) deep. Internal damage noted to the polyethylene liner body at this location resulted in a crack 60.96-cm (24-in.) long intersecting a second crack that was 50.8-cm (20-in.) long (cross-shaped). The liner raised up about 5.08 cm (2 in.).

Table D-19. Free Drop Test Results for Miscellaneous Packagings. (8 pages total)

Number of drops	Orientation	Result	Comments
INEL, Mark III Concrete Container			
33-TU-05	1 Flat onto top of lid.	Pass	This was the second drop with this test unit. The top impact limiter was removed. Damage resulting to the lid included a crack 17.79-cm (7-in.) long along one edge. Additional cracks to the lid measured 49.53-cm (19.5-in.) long and 1.905-cm (0.75-in.) deep; 50.8-cm (20-in.) long and 1.905- to 2.54-cm (0.75- to 1-in.) deep; and 49.53-cm (19.5-in.) long and 4.445-cm (1.75-in.) deep. Rebar showed where all concrete was broken out as described. No further damage resulted to this test unit during this drop.

FEMA = Federal Emergency Management Agency.
INEL = Idaho National Engineering Laboratory.
LANL = Los Alamos National Laboratory.
LLNL = Lawrence Livermore National Laboratory.
ORNL = Oak Ridge National Laboratory.
RH = Remotely handled.
SNL = Sandia National Laboratory.
TRU = Transuranic.
WIPP = Waste Isolation Pilot Plant.

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Table D-20. Corner Free Drop Test Results for Wooden Boxes.^a (2 pages total)

Specific packaging	Weight (lb)	Contents	No. tested	Results	Comments
<u>Mound Wooden Boxes - Configuration A</u>					
MA-1	40	S/Pb ^b	1	1 pass	0.25-in. indent
MA-2	100	S/Pb	1	1 pass	0.25-in. indent
MA-3	100	S/Pb	1	1 pass	0.375-in. indent
MA-4	100	S/Pb	1	1 pass	0.25-in. indent
<u>Mound Wooden Boxes - Configuration B</u>					
MB-1	150	F/F/S/Pb ^c	1	1 pass	0.25-in. indent
MB-2	150	F/F/S/Pb	1	1 pass	0.375-in. indent
MB-3	200	F/F/S/Pb	1	1 pass	0.375-in. indent
MB-4	150	F/F/S/Pb	1	1 pass	0.375-in. indent
MB-5	150	F/F/S/Pb	1	1 pass	0.375-in. indent
MB-6	200	F/F/S/Pb	1	1 pass	0.375-in. indent
<u>Mound Wooden Boxes - Configuration C</u>					
MC-1	150	S/Pb	1	1 pass	0.5-in. indent
MC-2	300	S ^d	1	1 pass	0.25-in. indent
MC-3	250	S/Pb	1	1 pass	0.5-in. indent
MC-4	100	S/Pb	1	1 pass	0.25-in. indent
MC-5	150	S	1	1 pass	0.25-in. indent
<u>Mound Wooden Boxes - Configuration D</u>					
MD-1	200	F/F/S/Pb	1	1 pass	0.25-in. indent
MD-2	200	F/F/S/Pb	1	1 pass	0.25-in. indent
MD-3	250	F/F/S ^e	1	1 pass	0.25-in. indent
MD-4	250	F/F/S	1	1 pass	0.375-in. indent
MD-5	200	F/F/S/Pb	1	1 pass	0.25-in. indent
MD-6	200	F/F/S/Pb	1	1 pass	0.25-in. indent

Table D-23. Compression Test Results for Steel Drums. (2 pages total)

Specific packaging	Authorized gross weight (lb)	Compression test weight (lb)	Test duration (hr)	Test/analysis data and results		Comments
				No. tested	Results	
DOT-6C 5-gal	80	500	>24	1	1 pass	No detectable effect.
DOT-6C 10-gal	160	928	>24	1	1 pass	No detectable effect.
DOT-17C 5-gal	100	520	>24	1	1 pass	No detectable effect.
DOT-17C 30-gal	500	Not tested ^a	--	--	--	Pass, based on testing of DOT-17H 30-gal drum.
DOT-17C 35-gal	400	2,060	>24	1	1 pass	No detectable effect.
DOT-17C 55-gal	1,000	Not tested ^b	--	--	--	Pass, based on testing of DOT-17H 55-gal drum. ^c
DOT-17C 55-gal with pressure relief devices	1,000	Not tested ^c	--	--	--	Pass, based on testing of DOT-17H 55-gal drum. ^c
DOT-17C 55-gal with HDPE liner	1,000	5,525	>24	1	1 pass	Passed. [Dockets 89-13-7A and 90-18-7A]
DOT-17H 30-gal	500 400	2,700 2,069	>24 >24	1 1	1 pass 1 pass	No detectable effect. No detectable effect. [Dockets 90-17-7A and 90-20-7A]
DOT-17H 55-gal	1,000	5,100	>24	1	1 pass	No detectable effect.
MS-24347-1 ^d	10	100	48	1	1 pass	No detectable effect.
MS-24347-7 ^d	35	200	48	1	1 pass	No detectable effect.
MS-24684-1 ^d	60	300	>24	1	1 pass	No detectable effect.
MS-27684-2 ^d	110	Not tested	--	--	--	Pass, based on comparison to test data on comparable drum.
MS-27684-3 ^d	80	401	>24	1	1 pass	No detectable effect.

Table D-23. Compression Test Results for Steel Drums. (2 pages total)

Specific packaging	Authorized gross weight (lb)	Compression test weight (lb)	Test duration (hr)	Test/analysis data and results		Comments
				No. tested	Results	
MS-27684-5 ^d	80	500	>24	1	1 pass	No detectable effect.
MS-27684-8 ^d	200	1,000	>24	1	1 pass	No detectable effect.
MS-27683-7 ^d	400	2,072	>24	1	1 pass	No detectable effect.
MS-27683-13 ^d	500	2,752	>24	1	1 pass	No detectable effect.
MS-27683-21 ^d	800	5,500	>24	1	1 pass	No detectable effect.
PACKAGING SPECIALTIES SQUARE STEEL DRUMS						
Style 1A	1,350	7,506	>24	1	1 pass	The test had no effect on the drum.
Style 1B	1,350	7,492	>24	1	1 pass	The test had no effect on the drum.
Style 2	1,350	7,508	>24	1	1 pass	The test had no effect on the drum.
Style 3	1,350	7,486	>24	1	1 pass	The test had no effect on the drum.

^aThe test data for the DOT-17H 30-gal drum are directly applicable because the construction specifications for these two drums (DOT-17H 30-gal and DOT-17C 30-gal) are essentially the same.

^bA DOT-17C 55-gal drum filled with concrete was tested to 8,142 lb (for 24 hr) and passed.

^cThe test data for the DOT-17H 55-gal drum are directly applicable (although conservative), because the only major difference between the DOT-17H and the DOT-17C 55-gal drums is the thickness of the body sheet. The DOT-17H body sheet is 18 gauge, and the DOT-17C is 16 gauge.

^dDrum assembly numbers.

DOT = U.S. Department of Transportation

HDPE = High-density polyethylene

MS = Military specification

-- = Not applicable.

Table D-27. Compression Test Results for UF₆ Cylinders.

Packaging	Calculated no. of packages required for stress leading to failure	Results	Comments
1S	60	Pass	Two methods of analysis were used to evaluate the containers: (1) A linear elastic stress and buckling analysis using shell of revolution program BOSOR; and (2) A linear elastic buckling analysis and a nonlinear elastic-plastic collapses analysis using the finite element program NASTRAN.^a
2S	>100	Pass	
5A	21	Pass	
8A	15	Pass	
12A	>100	Pass	
12B	>100	Pass	
30A	12	Pass	
30B	12	Pass	
48G	9	Pass	
48H	9	Pass	
48HX	12	Pass	
48X	12	Pass	
48Y	9	Pass	
Modified			
5A	--	Pass	
5B			

^aNASTRAN is a trademark of the National Aeronautics and Space Administration.

-- = Not applicable.

Table D-28. Compression Test Results for Liquid and Gas Packagings. (5 pages total)

Specific packaging	Authorized gross weight kg (lb)	Compression test weight kg (lb)	Test duration (hr)	Test/analysis data and results		Comments
				No. tested	Results	
Steel Drum MS-24347-7	10	Not tested	--	--	--	Pass, see Table D-22 of this addendum for test results on this drum.
LANL 12B-62 Fiberboard Box	62	328	>24	1	1 pass	No detectable effect.
LLNL Steel Drums with Gas Cylinders	--	Not tested	--	--	--	Pass, see Table D-23 for test results on 17H 30-gal steel drums.
ORNL Fiberboard Box - Liquids and Solids	33	165	>24	1	1 pass	Deformation of up to 1 in. on all four sides and less than 0.5 in. on the top end button.
ORNL Fiberboard Box - Gases	33	165	>24	1	1 pass	Deformation of up to 1 in. on all four sides and less than 0.5 in. on the top end button.
ORNL Fiberboard Box - Liquids and Solids with Shielding	33	165	>24	1	1 pass	Deformation of up to 1 in. on all four sides and less than 0.5 in. on the top end button.
ORNL Wooden Box - Returnable, Shielded	212	1,040	>24	1	1 pass	Tests on a slightly smaller packaging at a slightly less compressive load demonstrated that this packaging would be expected to meet this requirement.

Table D-28. Compression Test Results for Liquid and Gas Packagings. (5 pages total)

Specific packaging	Authorized gross weight kg (lb)	Compression test weight kg (lb)	Test duration (hr)	Test/analysis data and results		Comments
				No. tested	Results	
ORNL Gas Cylinder Returnable (Hoke Cylinders)	212	1,060	>24	1	1 pass	No damage to the packaging.
HOH-50	9	Not tested	--	--	--	Pass, based on comparison to test data on heaviest cylinder, HOKr-500, shown below.
HOXe-50	15	Not tested	--	--	--	Pass, based on comparison to test data on heaviest cylinder, HOKr-500, shown below.
HOKr-50	15	Not tested	--	--	--	Pass, based on comparison to test data on heaviest cylinder, HOKr-500, shown below.
HOH-150	11	Not tested	--	--	--	Pass, based on comparison to test data on heaviest cylinder, HOKr-500, shown below.
HOXe-150	35	Not tested	--	--	--	Pass, based on comparison to test data on heaviest cylinder, HOKr-500, shown below.
HOKr-150	35	Not tested	--	--	--	Pass, based on comparison to test data on heaviest cylinder, HOKr-500, shown below.
HOH-300	12	Not tested	--	--	--	Pass, based on comparison to test data on heaviest cylinder, HOKr-500, shown below.
HOKr-300	36	Not tested	--	--	--	Pass, based on comparison to test data on heaviest cylinder, HOKr-500, shown below.

Table D-28. Compression Test Results for Liquid and Gas Packagings. (5 pages total)

Specific packaging	Authorized gross weight kg (1b)	Compression test weight kg (1b)	Test duration (hr)	Test/analysis data and results		Comments
				No. tested	Results	
H0H-500	15	Not tested	--	--	--	Pass, based on comparison to test data on heaviest cylinder, HOKr-500, shown below.
HOKr-500	50	285	24	1	1 pass	No damage to the packaging.
Tests were also conducted with a 1,000-ml container in which a compressive load of 580 lb was applied for 24 hr. There was no damage to the package. Because these cylinders are all identical in construction except for size and weight, the testing of the two heaviest packagings represents the worst possible cases. Thus, all of the above cylinders would pass this test.						
ORNL Gas Cylinder Returnable (J. L. Shephard)						
Cylinder 1	24	--	--	--	--	Pass, based on evaluation; based on letter describing testing conducted by ORNL, subject "J. L. Shephard Gas Cylinder," D. M. Ferren/D. A. Edling, April 30, 1985.
Cylinder 2	40	--	--	--	--	
Cylinder 3	60	--	--	--	--	

Table D-28. Compression Test Results for Liquid and Gas Packagings. (5 pages total)

Specific packaging	Authorized gross weight kg (lb)	Compression test weight kg (lb)	Test duration (hr)	Test/analysis data and results		Comments
				No. tested	Results	
WHC Liquid Sample Packaging	21 (46 3/4)	150 (331)	24	1	1 pass	Pass. This test was conducted with 150 kg (331 lb) for 24 hr with no adverse effects on the package.
SRP Process Water Sample Packaging	54 (118)	911 (2,006)	24	1	1 pass	Pass. This test was conducted with 911 kg (2,006 lb) for 24 hr with no adverse effects on the package.
RF Container Model LWS-1	5.4 (12)	91 (200)	24	1	1 pass	Pass. This test was conducted with 91 kg (200 lb) for 24 hr with no adverse effects on the package.
EG&G Mound Applied Technologies Commercial Tritium Packaging 10, 50, 150, 300 and 500 cc	5.8 (12.72) Max	227 (500)	>24	1	1 pass	Pass. This test was conducted to 227 kg (500 lb) or well above the required weight.
WHC Grout Sample Packaging	178 (391)	1,388 (3,058)	27	1	1 pass	Pass. This test was conducted with 1,388 kg (3,058 lb) for 27 hr with no adverse effects on the package.
EG&G Mound Lewis Gas Packaging	9.49 (20.875)	56.75 (125)	>24	1	1 pass	Pass. This test was conducted with 57 kg (125 lb) for >24 hr with no detectable effect.

Table D-28. Compression Test Results for Liquid and Gas Packagings. (5 pages total)

Specific packaging	Authorized gross weight kg (lb)	Compression test weight kg (lb)	Test duration (hr)	Test/analysis data and results		Comments
				No. tested	Results	
WHC Hedgehog Container	28.6 (63)	318 (700)	24	1	1 pass	This test was conducted on test unit 39-TU-02 (empty case). The compressive load was applied with no adverse effects on the package.

LANL = Los Alamos National Laboratory SRP = Savannah River Plant
 LLNL = Lawrence Livermore National Laboratory WHC = Westinghouse Hanford Company
 ORNL = Oak Ridge National Laboratory -- = Not applicable.
 RF = Rocky Flats

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Table D-29. Compression Test Results for Miscellaneous Packagings. (2 pages total)

Specific packaging	Authorized gross weight kg (lb)	Compression test weight kg (lb)	Test duration (hr)	Test/analysis data and results		Comments
				No. tested	Results	
LLNL Old Spec 55	23 (50)	136 (300)	>24	1	1 pass	No detectable effect.
ORNL TRU Shipping Container	1,680 (3,700)	Not tested	--	--	--	Analysis demonstrates that even 22,700 kg (50,000 lb), a severe over-test, would not have a significant effect.
FEMA Source Overpack	91 (200)	486 (1,070)	>24	1	1 pass	No detectable effect.
SNL Tritium Waste Package	91 (200)	Not tested	--	--	--	Pass, see Table D-23 of this document for test data on the DOT-17H 114-L (30-gal) drum.
LANL-1	77 (170)	Not tested	--	--	--	This test was not conducted because a comparison to other metal packagings demonstrates that this test would have no effect. In addition, the configuration of this package would make stacking of similar packagings impossible and the application of a compressive load very difficult.
WIPP RH-TRU Canister	2,715 (5,980) 2,384 (5,250)	13,638 (30,040)	24	1	1 pass	No detectable effect. [Docket 89-03-7A]
Packaging for Special Form Neutron Source	262 (576)	1,337 (2,945)	>24	1	1 pass	No detectable effect. [Docket 91-26-7A]

Table D-29. Compression Test Results for Miscellaneous Packagings. (2 pages total)

Specific packaging	Authorized gross weight kg (lb)	Compression test weight kg (lb)	Test duration (hr)	Test/analysis data and results		Comments
				No. tested	Results	
TRUPACT II Ten-Drum Overpack	3,039 (6,700)	16,757 (36,950)	24	1	Pass	No detectable effect was observed on Test Package #130409 (tested 7/31/90). Further testing was not necessary for the tests conducted on 10/28/93 as it was determined that the design modifications would not have any negative effect on the testing previously conducted. [Docket 90-16-7A]
INEL Mark III Concrete Container	Without impact limiter = 9,888 (21,800) With impact limiter = 10,338.5 (22,550)	53,369.681 (117,660)	24	1	Pass	No detectable effect was observed on test unit 33-TU-04. There was no cracking or bulging noted on the exterior or interior surfaces of the container. [Docket 92-33-7A]

DOT = U.S. Department of Transportation.
 FEMA = Federal Emergency Management Agency.
 INEL = Idaho National Engineering Laboratory.
 LANL = Los Alamos National Laboratory.
 LLNL = Lawrence Livermore National Laboratory.
 ORNL = Oak Ridge National Laboratory.
 RH-TRU = Remotely handled transuranic.
 SNL = Sandia National Laboratory.
 TRU = Transuranic.
 TRUPACT = Transuranic package transporter.
 WIPP = Waste Isolation Pilot Plant.
 -- = Not applicable.

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Requirement D-4. Penetration Test.	49 CFR 173.465	Discussion
(e) <u>Penetration Test</u> 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 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).	<u>Major Points</u> (1) 13-1b bar (2) 1 m (3.3 ft) (3) Most vulnerable point <u>Comments</u> Penetration of the outer packaging(s) is not necessarily a cause for failure. The question is, "Did the test result in a loss of contents?" For outer packaging components not meeting this requirement, one could specify an inner component(s) that will meet the requirement or design protective devices to ensure that the bar cannot reach the primary containment system. <u>Tester and evaluator</u> to do and <u>shipper responsibility</u> to ensure.

Table D-30. Penetration Test Results for Steel Drums. (3 pages total)

Test/analysis results				
Specific packaging	No. tested	Location	Results	Comments
DOT-6C (5-gal)	1	Lid at center	1 pass	0.50-in. dent
	1	Side at seam	1 pass	1.00-in. dent
	1	Lid near closure ring	1 pass	0.25-in. dent
DOT-6C (10-gal)	1	Lid at center	1 pass	0.50-in. dent
	1	Side at seam	1 pass	0.75-in. dent
	1	Lid near closure ring	1 pass	0.50-in. dent
DOT-17C (5-gal)	Not tested	--	--	Pass, based on test data shown for comparable or lesser gauge steels.
DOT-17C (30-gal)	Not tested	--	--	Pass, based on test data shown for comparable or lesser gauge steels.
DOT-17C (35-gal)	1	Lid near center	1 pass	0.625-in. dent
	2	Lid near edge	2 pass	0.500-in. dent max.
	1	Side near seam	1 pass	0.250-in. dent
DOT-17C (55-gal)	Not tested	--	--	Pass, based on test data shown for comparable or lesser gauge steels.
DOT-17C (55-gal) Pressure Relief Device Nucfil ^a Filter	3	Center of filter	3 pass	Air flow was established after each test with flour/fluorescein as contents. There was no visible evidence of loss of contents, and no loss of contents was detected under a black light.
	1	Lid center	1 pass	Minor damage
	1	Side	1 pass	Same result
DOT-17C (55-gal) with HDPE Liners	1	Bottom	1 pass	Same result
	1	Filter	1 pass	Minor damage [Dockets 89-13-7A and 90-18-7A]
	1	Lid at center	1 pass	0.125-in. dent
DOT-17H (30-gal)	1	Side at seam	1 pass	0.125-in. dent
	1	Lid near closure ring	1 pass	0.055-in. dent
	1	Lid	1 pass	0.230-in. dent
	1	Bottom	1 pass	0.320-in. dent
	1	Side	1 pass	0.300-in. dent
				[Dockets 90-17-7A and 90-20-7A] [Dockets 90-17-7A and 90-20-7A] [Dockets 90-17-7A and 90-20-7A]

Table D-30. Penetration Test Results for Steel Drums. (3 pages total)

Test/analysis results				
Specific packaging	No. tested	Location	Results	Comments
DOT-17H (55-gal)	1	Lid at center	1 pass	0.125-in. dent
	1	Side at seam	1 pass	0.125-in. dent
	1	Lid near closure ring	1 pass	0.055-in. dent
MS-24347-1 (0.25-gal) ^b	1	Lid at middle	1 pass	0.075-in. dent
	1	Side at seam	1 pass	1.250-in. dent
MS-24347-7 (1.25-gal) ^b	1	Lid at middle	1 pass	0.500-in. dent
	1	Side at seam	1 pass	1.250-in. dent
	1	Lid near closure ring	1 pass	0.125-in. dent
MS-27684-1 (3-gal) ^b	1	Lid at middle	1 pass	0.75-in. dent
	1	Side at seam	1 pass	1.00-in. dent
MS-27684-2 (4-gal) ^b	Not tested	--	--	Pass, based on test data shown for drums of lesser gauge and size.
MS-27684-3 (6-gal) ^b	1	Lid at middle	1 pass	1.00-in. dent
	1	Side at seam	1 pass	0.50-in. dent
MS-27684-6 (8-gal) ^b	1	Lid at middle	1 pass	0.125-in. dent
	1	Side at seam	1 pass	1.000-in. dent
MS-27684-8 (12-gal) ^b	1	Lid at middle	1 pass	1.000-in. dent
	1	Side at seam	1 pass	0.562-in. dent
MS-27683-7 (30-gal) ^b	1	Lid at middle	1 pass	1.000-in. dent
	1	Side at seam	1 pass	0.562-in. dent
MS-27683-13 (45-gal) ^b	1	Lid at middle	1 pass	0.125-in. dent
	1	Side at seam	1 pass	0.125-in. dent
MS-27683-21 (85-gal) ^b	Not tested	--	--	Pass, based on test data shown for drums of lesser gauge and size.

Table D-30. Penetration Test Results for Steel Drums. (3 pages total)

Test/analysis results			
Specific packaging	No. tested	Location	Results
PACKAGING SPECIALTIES SQUARE STEEL DRUMS			
Style 1A	1	Center of cover	1 pass
	1	Center of bung	1 pass
Style 1B	1	Center of cover	1 pass
	1	Center of bung	1 pass
Style 2	1	Center of cover	1 pass
	1	Center of bung	1 pass
	1	On lug closure	1 pass
Style 3	1	Center of cover	1 pass
	1	Center of bung	1 pass
	1	On lug closure	1 pass

Only effect was a dent of approximately 0.25 in.
 Only effect was a dent of approximately 0.25 in.
 Only effect was a dent of approximately 0.25 in.
 Only effect was a minor scrape (no dent)
 Only effect was a dent of approximately 0.0625 in.
 Only effect was a minor scrape (no dent)
 No effect
 Only effect was a dent of approximately 0.25 in.
 No effect
 No effect

^aNucfil is a trademark of Nuclear Filter Technology, Inc.
^bDrum assembly numbers.

DOT = U.S. Department of Transportation
 HDPE = High-density polyethylene
 MS = Military specifications
 -- = Not applicable.

Table D-35. Penetration Test Results for Liquid and Gas Packagings. (4 pages total)

Specific packaging	Test/analysis results			Comments
	No. tested	Location	Results	
Steel Drum MS-24347-7	--	--	--	Pass, based on test data shown on Table D-30.
LANL 12B-62 Fiberboard Box	1 1	Top Side	1 pass 1 pass	There was penetration in both tests, but the bar did not contact the inner container in either case.
LLNL Steel Drums with Gas Cylinders	--	--	--	Pass, based on test data shown on Table D-30.
ORNL Fiberboard Box - Liquids and Solids	1	Top (center)	1 pass	A nonpenetrating deformation of the wet cardboard box and a 0.55-in.-deep by 0.75-in.-diameter indentation in the top of the inner metal can.
ORNL Fiberboard Box - Gases	1	Top (center)	1 pass	A nonpenetrating deformation of the wet cardboard box and a 0.55-in.-deep by 0.75-in.-diameter indentation in the top of the inner can.
ORNL Fiberboard Box - Liquids and Solids	1	Top (center)	1 pass	A nonpenetrating deformation of the wet cardboard box and a 0.55-in.-deep by 0.75-in.-diameter indentation in the top of the inner metal can.
ORNL Wooden Box Returnable, Shielded	1	Top (center)	1 pass	Minor, nonpenetrating dent.

Table D-35. Penetration Test Results for Liquid and Gas Packagings. (4 pages total)

Specific packaging	Test/analysis results			Comments
	No. tested	Location	Results	
ORNL Gas Cylinder Returnable (Hoke Cylinders)				
HOH-50	1	Top (center of protective valve cap)	1 pass	This test was conducted on the HOKr 1000-mL cylinder (which is not listed), but the results can be used to evaluate the smaller packagings.
HOXe-50				
HOKr-50				
HOH-150				
HOXe-150				
HOKr-150				
HOH-300				
HOKr-300				
HOH-500				
HPKr-500				
ORNL Gas Cylinder Returnable (J. L. Shephard)				
Cylinder 1	--	--	Pass	Evaluated based on testing conducted by ORNL, letter dated April 30, 1985, D. M. Ferren/D. A. Edling.
Cylinder 2				
Cylinder 3				
LLNL Old Spec 55	2	Lid bolts	2 pass	No detectable effect other than a scratch.
ORNL TRU Shipping Container	1	Top	1 pass	Only effect was a minor dent in each case.
	1	Side	1 pass	
FEMA Source Overpack	1	Top	1 pass	Only effect was a minor scratch.
LANL-2	1	Lid at Center	1 pass	0.125-in. dent
	1	Side at Seam	1 pass	
	1	Lid near closure ring	1 pass	

Table D-35. Penetration Test Results for Liquid and Gas Packagings. (4 pages total)

Test/analysis results					Comments
Specific packaging	No. tested	Location	Results		
WHC Liquid Sample	1	Top	1 pass		Movement of surface inward was less than 1.27 cm (1/2 in.).
		Side	1 pass		Movement of surface inward was less than 1.6 cm (5/8 in.).
SRP Process Water Packaging	1	Top center	1 pass		No significant distortion.
RF Container Model	1	Top center	1 pass		Movement of surface inward was less than 2.54 cm (1 in.).
		Side	1 pass		Movement of surface inward was less than 2.54 cm (1 in.).
EG&G Mound Applied Technologies Commercial Tritium Packaging 10, 50, 150, 300 and 500 cc	4	Top center	Pass		Only effect was a mark, not measurable.
		Left hatch	Pass		Dent in latch.
		Bottom of hinge/back side	Pass		Dent, nonmeasurable.
		Top of hinge/back side	Pass		Dent, nonmeasurable.
	4	Top 5.08 cm (2 in.) from back	Pass		Package split and bar entered, but did not contact cylinder because of foam.
		Left latch	Pass		Dent in latch.
		Hinge in back	Pass		Dent, nonmeasurable.
		On valve	Pass		Bent valve slightly.
WHC Grout Sample Packaging	1	Bottom center	1 pass		Movement of surface inward was less than 0.635 cm (1/4 in.).
	1	Side	1 pass		Movement of surface inward was less than 0.397 cm (5/32 in.).
EG&G Mound Lewis Gas Packaging	2	Impact at center of drum lid	1 pass		Only effect was a 0.635-cm (1/4-in.) dent at point of impact.
		Impact at middle of side of drum	1 pass		Only effect was a 2.54-cm (1-in.) dent at point of impact.

Table D-35. Penetration Test Results for Liquid and Gas Packagings. (4 pages total)

Test/analysis results				
Specific packaging	No. tested	Location	Results	Comments
WHC Hedgehog Container				
1-m (3.3 ft)	1	Between center and edge bumper of lid of Hardigg Case ^a	Pass	No significant distortion. Indented 0.594-cm (0.234-in.) deep and 1.9-cm (0.75-in.) across at point of impact.
1.7-m (5.5 ft)	1	Between center and edge bumper of lid of Hardigg Case	Pass	No significant distortion. Indented 0.879-cm (0.346-in.) deep and 1.9-cm (0.75-in.) across at point of impact.
^a Hardigg Case is a trademark of Hardigg Industries, Inc. FEMA = Federal Emergency Management Agency. LANL = Los Alamos National Laboratory. LLNL = Lawrence Livermore National Laboratory. ORNL = Oak Ridge National Laboratory. RF = Rocky Flats. TRU = Transuranic. SRP = Savannah River Plant. WHC = Westinghouse Hanford Company. -- = Not applicable.				

Table D-36. Penetration Test Results for Miscellaneous Packagings. (2 pages total)

Test/analysis results				Comments
Specific packaging	No. tested	Location	Results	
SNL Tritium Waste Package	--	--	--	Pass, based on test data shown on Table D-30.
LANL Aluminum Packaging (LANL-1)	1	Top of cover	Pass	There was no measurable dent.
	1	Flange	Pass	There was no measurable dent.
	1	Eyebolt	Pass	There was no measurable dent.
WIPP RH-TRU Canister	1	Top center	Pass	Slight depression.
	1	Side center	Pass	Slight depression. [Docket 89-03-7A]
Packaging for Special Form Neutron Source	1	End piece	Pass	Slight depression. [Docket 91-26-7A]
TRUPACT II Ten-Drum Overpack	1	Top center	Pass	Slight depression. Further testing was not necessary for tests conducted on 10/28/93 as it was determined that the design modifications would not have any negative effect on testing conducted previously. [Test Package 130408, tested 7/27/90, Docket 90-16-7A]
	1	Side	Pass	Slight depression. Further testing was not necessary for tests conducted on 10/28/93 as it was determined that the design modifications would not have any negative effect on testing conducted previously. [Test Package 130408, tested 7/27/90, Docket 90-16-7A]

Table D-36. Penetration Test Results for Miscellaneous Packagings. (2 pages total)

Test/analysis results				
Specific packaging	No. tested	Location	Results	Comments
INEL Mark III Concrete Container	1	Vent plug in lid	Pass	There was no measurable damage. [Docket 92-33-7A]
INEL = Idaho National Engineering Laboratory. LANL = Los Alamos National Laboratory. RH-TRU = Remotely handled transuranic. SNL = Sandia National Laboratory. TRUPACT = Transuranic package transporter. WIPP = Waste Isolation Pilot Plant. -- = Not applicable.				

APPENDIX E

**COMPLIANCE WITH VIBRATION STANDARDS
(49 CFR 178.608)**

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NOTE: Compliance information will be added for the above-noted packaging types upon completion of testing for a particular packaging type.

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E1.0 INTRODUCTION

The purpose of this section is to provide more details concerning the packaging tests that were conducted for compliance with the vibration standard for testing packages (49 CFR 178.608).

This vibration test standard is being applied to Type A packages to demonstrate compliance with 49 CFR 173.412 (e), which states:

". . . each Type A packaging shall be designed so that . . .
(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."

This test, test method, and determination of pass/fail criteria are discussed in Section 1.0.

Requirement E-1. Vibration Test. (2 pages total)

49 CFR 178.608	Discussion
(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, selected at random, 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) 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 Materials Safety.	<u>Major Points</u> (1) Three sample packagings. (2) Vibrating platform has vertical or rotary double-amplitude of one inch. (3) Packagings free to move vertically, bounce, and rotate. (4) One-hour duration. (5) Pass a piece of material 1.6-mm (0.063-in.) thick between package and the platform.

Requirement E-1. Vibration Test. (2 pages total)

49 CFR 178.608	Discussion
(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.	<u>Manufacturer and shipper</u> responsible to ensure that package is capable of passing test.

Table E-1. Steel Drums--Compliance With Vibration Standard (49 CFR 178.608).

Specific packaging	No. tested	Weight (lb)	Contents	Results	Comments
Packagings for dockets in this category that are pre-HM-181 are considered to be acceptable based on evaluation and/or by comparison with similar packagings.					
	2	1,000	Sand and lead bricks	2 pass	Drums were observed for leakage at filter location, ring and bolt location, and bottom of drum; nothing was detected.
	1	900	Flour/fluorescein sand, lead bricks	1 pass	Drums were observed for leakage at filter location, ring and bolt location, and bottom of drum; nothing was detected.

Table E-2. Steel Boxes--Compliance With Vibration Standard (49 CFR 178-608).

Specific packaging	No. tested	Weight (lb)	Contents	Results	Comments
Packagings for dockets in this category that are pre-HM-181 are considered to be acceptable based on evaluation and/or by comparison with similar packagings.					

Table E-3. Wooden Boxes--Compliance With Vibration Standard (49 CFR 178-608).

Specific packaging	No. tested	Weight (lb)	Contents	Results	Comments
Packagings for dockets in this category that are pre-HM-181 are considered to be acceptable based on evaluation and/or by comparison with similar packagings.					

Table E-4. Fiberboard Containers---Compliance With Vibration Standard (49 CFR 178-608).

Specific packaging	No. tested	Weight (lb)	Contents	Results	Comments
Packagings for dockets in this category that are pre-HM-181 are considered to be acceptable based on evaluation and/or by comparison with similar packagings.					

Table E-5. UF₆ Cylinders--Compliance With Vibration Standard (49 CFR 178-608).

Specific packaging	No. tested	Weight (1b)	Contents	Results	Comments
Packagings for docket in this category that are pre-HM-181 are considered to be acceptable based on evaluation and/or by comparison with similar packagings.					

Table E-6. Liquid and Gas Packagings--Compliance With Vibration Standard (49 CFR 178-608).

Specific packaging	No. tested	Weight kg (lb)	Contents	Results	Comments
Packagings for dockets in this category that are pre-HM-181 are considered to be acceptable based on evaluation and/or by comparison with similar packagings.					
WHC Hedgehog Container					
1-L version	1	18.1 (40)	Steel shot, water, and fluorescein	Pass	No loosening of lids or component parts. Slight indication of rubbing on interior foam on Hardigg Case ^a lid. No significant damage and no loss of material.
250 mL-version	1	24.0 (53)	Steel shot, water, and fluorescein	Pass	No loosening of lids or component parts. Slight indication of rubbing on interior foam on Hardigg Case lid. No significant damage and no loss of material.
30-mL version	1	28.6 (63)	Steel shot, water, and fluorescein	Pass	No loosening of lids or component parts. Slight indication of rubbing on interior foam on Hardigg Case lid. No significant damage and no loss of material. The 125-mL version was not tested due to its similarity with the 30- and 250-mL versions. Based on evaluation, no significant damage and no loss of material should occur.

^aHardigg Case is a trademark of Hardigg Industries, Inc.

Table E-7. Miscellaneous Packagings--Compliance With Vibration Standard (49 CFR 178-608).

Specific packaging	No. tested	Weight (1b)	Contents	Results	Comments
Packagings for dockets in this category that are pre-HM-181 are considered to be acceptable based on evaluation and/or by comparison with similar packagings.					

APPENDIX F

**COMPLIANCE WITH GENERAL REQUIREMENTS FOR
PACKAGES AND PACKAGING (49 CFR 173.24)**

Post-HM-181 (post-October 1994)

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Table F-1. Steel Drums--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- steel drums
(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 that are reused; and (3) Specification and non-specification packagings. (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--	To be considered during package design evaluation. Shipper responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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;	To be considered during package design evaluation. Shipper responsibility to ensure. To be considered during package design evaluation. Shipper responsibility to ensure. One aspect for strong consideration is effect of contents on packaging effectiveness.	

Table F-1. Steel Drums--Compliance with General Requirements for Packages and Packaging
(49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- steel drums
(3) There will be no mixture of gases or vapors in the package that could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging. (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 the 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 chapter.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure that packagings used are in compliance with the design.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-1. Steel Drums--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- steel drums
(d) 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.	<u>Shipper</u> responsibility to ensure that packagings used are in compliance with the design.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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 so significant chemical or galvanic reaction between the materials and contents of the package.	<u>Shipper</u> responsibility to ensure.	

Table F-1. Steel Drums--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- steel drums
(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 that 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--	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-1. Steel Drums--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- steel drums
(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. (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.	<u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- steel drums
(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.	<u>Shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	

Table F-1. Steel Drums--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- steel drums
(g) Venting. Venting of packagings, to reduce internal pressure that 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- steel drums
(h) Outage and filling limits-- (1) <i>General</i>. 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 sections 173.24a(d) and 173.24b(a), respectively. (2) <i>Compressed gases and cryogenic liquids</i>. 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

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Table F-2. Steel Boxes--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- steel boxes
(3) There will be no mixture of gases or vapors in the package that could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging. (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 the 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 chapter.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure that packagings used are in compliance with the design.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-2. Steel Boxes--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category--- steel boxes
(d) 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. (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 so significant chemical or galvanic reaction between the materials and contents of the package.	<u>Shipper</u> responsibility to ensure that packagings used are in compliance with the design. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-2. Steel Boxes--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- steel boxes
(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 that 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--	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packing category-- steel boxes
(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.	Designer, tester, and evaluator to do; <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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.	<u>Shipper</u> responsibility to ensure.	
(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--	<u>Shipper</u> responsibility to ensure.	
(i) Combustion or dangerous evolution of heat; (ii) Evolution of flammable or poisonous gases; or (iii) Formation of unstable or corrosive materials.		

Table F-2. Steel Boxes--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- steel boxes
(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. (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.	<u>Shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-2. Steel Boxes--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- steel boxes
(g) Venting. Venting of packagings, to reduce internal pressure that 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

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DOT = U.S. Department of Transportation.
UN = United Nations.

Table F-3. Wooden Boxes--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- wooden boxes
(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 that are reused; and (3) Specification and non-specification packagings. (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--	To be considered during package design evaluation. <u>Shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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;	To be considered during package design evaluation. <u>Shipper</u> responsibility to ensure. To be considered during package design evaluation. <u>Shipper</u> responsibility to ensure. One aspect for strong consideration is effect of contents on packaging effectiveness.	

Table F-3. Wooden Boxes--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- wooden boxes
(3) There will be no mixture of gases or vapors in the package that could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging. (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 chapter.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure that packagings used are in compliance with the design.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-3. Wooden Boxes--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- wooden boxes
(d) 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.	<u>Shipper</u> responsibility to ensure that packagings used are in compliance with the design.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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 so significant chemical or galvanic reaction between the materials and contents of the package.	<u>Shipper</u> responsibility to ensure.	

Table F-3. Wooden Boxes--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- wooden boxes
(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 that 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--	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-3. Wooden Boxes--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- wooden boxes
(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. (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.	Designer, tester, and evaluator to do; <u>shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-3. Wooden Boxes--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- wooden boxes
(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. (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.	<u>Shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-3. Wooden Boxes--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- wooden boxes
(g) Venting. Venting of packagings, to reduce internal pressure that 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.	<u>Designer to do and shipper responsibility to ensure.</u>	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- wooden boxes
(h) Outage and filling limits-- (1) <i>General</i>. 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 sections 173.24a(d) and 173.24b(a), respectively. (2) <i>Compressed gases and cryogenic liquids</i>. 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

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Table F-4. Fiberboard Containers--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- fiberboard containers
(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 that are reused; and (3) Specification and non-specification packagings. (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--	To be considered during package design evaluation. <u>Shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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;	To be considered during package design evaluation. <u>Shipper</u> responsibility to ensure. To be considered during package design evaluation. <u>Shipper</u> responsibility to ensure. One aspect for strong consideration is effect of contents on packaging effectiveness.	

Table F-4. Fiberboard Containers--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- fiberboard containers
(3) There will be no mixture of gases or vapors in the package that could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging. (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 chapter.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure that packagings used are in compliance with the design.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-4. Fiberboard Containers--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- fiberboard containers
(d) 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.	Shipper responsibility to ensure that packagings used are in compliance with the design.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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 so significant chemical or galvanic reaction between the materials and contents of the package.	Shipper responsibility to ensure.	

Table F-4. Fiberboard Containers--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- fiberboard containers
(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 that 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--	Designer to do and <u>shipper</u> responsibility to ensure.	NOTE: Packaging category will be added for this packaging type upon completion of testing for this packaging type.

Table F-4. Fiberboard Containers--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- fiberboard containers
(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. (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.	<u>Designer, tester; and evaluator</u> to do; <u>shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- fiberboard containers
(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.	Shipper responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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.	Designer to do and shipper responsibility to ensure. Designer to do and shipper responsibility to ensure.	

Table F-4. Fiberboard Containers---Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- fiberboard containers
(g) Venting. Venting of packagings, to reduce internal pressure that 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-4. Fiberboard Containers--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- fiberboard containers
(h) Outage and filling limits-- (1) <i>General</i>. 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 sections 173.24a(d) and 173.24b(a), respectively. (2) <i>Compressed gases and cryogenic liquids</i>. 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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.		

DOT = U.S. Department of Transportation.
UN = United Nations.

Table F-5. UF₆--Compliance with General Requirements for Packages and Packaging
(49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category--UF ₆
(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 that are reused; and (3) Specification and non-specification packagings. (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--	To be considered during package design evaluation. Shipper responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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;	To be considered during package design evaluation. Shipper responsibility to ensure. To be considered during package design evaluation. Shipper responsibility to ensure. One aspect for strong consideration is effect of contents on packaging effectiveness.	

Table F-5. UF₆--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category--UF ₆
(3) There will be no mixture of gases or vapors in the package that could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging. (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 chapter.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure that packagings used are in compliance with the design.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-5. UF₆--Compliance with General Requirements for Packages and Packaging
(49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category--UF ₆
(d) 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. (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 so significant chemical or galvanic reaction between the materials and contents of the package.	<u>Shipper</u> responsibility to ensure that packagings used are in compliance with the design. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-5. UF₆--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category--UF ₆
(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 that 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--	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-5. UF₆--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category--UF ₆
(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.	<u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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.	<u>Shipper</u> responsibility to ensure.	
(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.	<u>Shipper</u> responsibility to ensure.	

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category--UF ₆
(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.	<u>Shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	
	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	

Table F-5. UF₆--Compliance with General Requirements for Packages and Packaging
(49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category--UF ₆
(g) Venting. Venting of packagings, to reduce internal pressure that 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-5. UF₆--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Table F-6. Liquid and Gas Packagings--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (9 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- liquid and gas
(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 that are reused; and (3) Specification and non-specification packagings. (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--	To be considered during package design evaluation. <u>Shipper</u> responsibility to ensure.	All packagings described have been tested and/or evaluated and meet DOT-7A Type A packaging criteria.
(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;	To be considered during package design evaluation. <u>Shipper</u> responsibility to ensure.	All packagings met 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 Section 2.0 and Appendices B, C, and D.

Table F-6. Liquid and Gas Packagings--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (9 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- liquid and gas
(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;	To be considered during package design evaluation. <u>Shipper</u> responsibility to ensure. One aspect for strong consideration is effect of contents on packaging effectiveness.	All packagings met 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 Section 2.0 and Appendices B, C, and D.
(3) There will be no mixture of gases or vapors in the package that could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging.	<u>Shipper</u> responsibility to ensure.	Note: <u>Shipper</u> responsibility to consider and evaluate, if necessary, the effect of the contents. <u>Shipper</u> responsibility to ensure.

Table F-6. Liquid and Gas Packagings--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (9 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- liquid and gas
(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 chapter.	Shipper responsibility to ensure that packagings used are in compliance with the design.	All packagings described have been qualified to meet Specification 7A packaging requirements in accordance with 49 CFR 178.350.

Table F-6. Liquid and Gas Packagings--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (9 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- liquid and gas
(d) 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. (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 so significant chemical or galvanic reaction between the materials and contents of the package.	<u>Shipper</u> responsibility to ensure that packagings used are in compliance with the design.	All packagings described have been qualified to meet Specification 7A packaging requirements in accordance with 49 CFR 178.350.
(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.	<u>Shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(2) Packaging materials and contents must be such that there will be so significant chemical or galvanic reaction between the materials and contents of the package.	<u>Shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table F-6. Liquid and Gas Packagings--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (9 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- liquid and gas
(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 that 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--	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table F-6. Liquid and Gas Packagings--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (9 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- liquid and gas
(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.	<u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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.	<u>Shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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.	<u>Shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- liquid and gas
(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.	<u>Shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table F-6. Liquid and Gas Packagings--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (9 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- liquid and gas
(g) Venting. Venting of packagings, to reduce internal pressure that 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table F-7. Miscellaneous Packagings--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- miscellaneous
(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 that are reused; and (3) Specification and non-specification packagings. (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; (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;	To be considered during package design evaluation. <u>Shipper</u> responsibility to ensure. To be considered during package design evaluation. <u>Shipper</u> responsibility to ensure. To be considered during package design evaluation. <u>Shipper</u> responsibility to ensure. One aspect for strong consideration is effect of contents on packaging effectiveness.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-7. Miscellaneous Packagings--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category--miscellaneous
(3) There will be no mixture of gases or vapors in the package that could, through any credible spontaneous increase of heat or pressure, significantly reduce the effectiveness of the packaging. (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 chapter.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure that packagings used are in compliance with the design.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- miscellaneous
(d) 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. (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 so significant chemical or galvanic reaction between the materials and contents of the package.	Shipper responsibility to ensure that packagings used are in compliance with the design. Shipper responsibility to ensure. Shipper responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Table F-7. Miscellaneous Packagings--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category--miscellaneous
(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 that 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--	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- miscellaneous
(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.	<u>Designer, tester, and evaluator</u> to do; <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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.	<u>Shipper</u> responsibility to ensure.	
(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.	<u>Shipper</u> responsibility to ensure.	

Table F-7. Miscellaneous Packagings--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category--- miscellaneous
(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.	<u>Shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.
(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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	

Table F-7. Miscellaneous Packagings--Compliance with General Requirements for Packages and Packaging (49 CFR 173.24). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24	Action required/by whom	Packaging category-- miscellaneous
(g) Venting. Venting of packagings, to reduce internal pressure that 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	NOTE: Packaging category compliance information will be added for this packaging type upon completion of testing for this packaging type.

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APPENDIX G

**COMPLIANCE WITH ADDITIONAL GENERAL REQUIREMENTS
FOR NON-BULK PACKAGING AND PACKAGES (49 CFR 173.24a)**

Post-HM-181 (post-October 1994)

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Table G-1. Steel Drums--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- steel drums
(a) Packaging design. Except as provided in section 172.312 of this subchapter: (1) <i>Inner packaging closures.</i> A combination packaging containing liquid hazardous materials must be packed so that closures on inner packagings are upright. (2) <i>Friction.</i> 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) <i>Securing and cushioning.</i> Inner packagings or 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table G-1. Steel Drums--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--steel drums
(4) <i>Metallic devices.</i> 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) <i>Vibration.</i> 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. (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:	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure that the material being shipped falls within the envelope of acceptable materials based on design and testing. Type A packagings are not required to be marked with specific gravity.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. For specific vibration test data, refer to Appendix E. <u>Shipper</u> responsibility to ensure.

Table G-1. Steel Drums--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--- steel drums
(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;	This is not applicable as a Type A packaging does not incorporate packing groups.	
(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	This is not applicable as a Type A packaging does not incorporate packing groups.	
(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 as a Type A packaging does not incorporate packing groups.	

Table G-1. Steel Drums--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- steel drums
(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 that 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 that 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.	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. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure that the material being shipped falls within the envelope of acceptable materials based on design and testing. This not applicable to Type A packagings as Type A packagings do not incorporate packing groups.	<u>Shipper</u> responsibility to ensure.

Table G-1. Steel Drums--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- steel drums
(ii) A single or composite non-bulk packaging that 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 that 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 Type A packagings as Type A packagings do not incorporate packing groups. This is not applicable to Type A packagings as Type A packagings do not incorporate packing groups.	

Table G-1. Steel Drums--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- steel drums
(4) Packagings tested as prescribed in section 178.605 or 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 confirms 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	This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations.	<u>Shipper</u> responsibility to ensure.

Table G-1. Steel Drums--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- steel drums
(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). (5) No hazardous material may remain on the outside of a package after filling. (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;	This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is modified for a Type A packaging (see 49 CFR 173.443). <u>Shipper</u> responsibility to ensure. For entire subsection (c), <u>designer</u> to do and <u>shipper</u> responsibility to ensure. For Type A packagings that are to contain other nonradioactive material, the package must meet both Type A and the required performance requirements.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table G-1. Steel Drums--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--steel drums
(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. (d) Liquids must not completely fill a receptacle at a temperature of 55 °C (131 °F) or less.		<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table G-2. Steel Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- steel boxes
(a) Packaging design. Except as provided in section 172.312 of this subchapter: (1) <i>Inner packaging closures.</i> A combination packaging containing liquid hazardous materials must be packed so that closures on inner packagings are upright. (2) <i>Friction.</i> 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) <i>Securing and cushioning.</i> Inner packagings or 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table G-2. Steel Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--steel boxes
(4) <i>Metallic devices.</i> 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) <i>Vibration.</i> 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. (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:	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure that the material being shipped falls within the envelope of acceptable materials based on design and testing. Type A packagings are not required to be marked with specific gravity.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. For specific vibration test data, refer to Appendix E. <u>Shipper</u> responsibility to ensure.

Table G-2. Steel Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- steel boxes
(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;	This is not applicable as a Type A packaging does not incorporate packing groups.	
(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	This is not applicable as a Type A packaging does not incorporate packing groups.	
(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 as a Type A packaging does not incorporate packing groups.	

Table G-2. Steel Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- steel boxes
(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 that 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; (i) A single or composite non-bulk packaging that 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.	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. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure that the material being shipped falls within the envelope of acceptable materials based on design and testing. This not applicable to Type A packagings as Type A packagings do not incorporate packing groups.	<u>Shipper</u> responsibility to ensure.

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category---steel boxes
(ii) A single or composite non-bulk packaging that 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.	This is not applicable to Type A packagings as Type A packagings do not incorporate packing groups.	
(iii) A single or composite non-bulk packaging that 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 Type A packagings as Type A packagings do not incorporate packing groups.	

Table G-2. Steel Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--steel boxes
(4) Packagings tested as prescribed in section 178.605 or 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 confirms 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	This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations.	<u>Shipper</u> responsibility to ensure.

Table G-2. Steel Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- steel boxes
(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). (5) No hazardous material may remain on the outside of a package after filling. (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;	This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is modified for a Type A packaging (see 49 CFR 173.443). <u>Shipper</u> responsibility to ensure. For entire subsection (c), <u>designer</u> to do and <u>shipper</u> responsibility to ensure. For Type A packagings that are to contain other nonradioactive material, the package must meet both Type A and the required performance requirements.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table G-2. Steel Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--steel boxes
(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. (d) Liquids must not completely fill a receptacle at a temperature of 55 °C (131 °F) or less.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table G-3. Wooden Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- wooden boxes
(a) Packaging design. Except as provided in section 172.312 of this subchapter: (1) <i>Inner packaging closures.</i> A combination packaging containing liquid hazardous materials must be packed so that closures on inner packagings are upright. (2) <i>Friction.</i> 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) <i>Securing and cushioning.</i> Inner packagings or 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table G-3. Wooden Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- wooden boxes
(4) <i>Metallic devices.</i> 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) <i>Vibration.</i> 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. (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:	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure that the material being shipped falls within the envelope of acceptable materials based on design and testing. Type A packagings are not required to be marked with specific gravity.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. For specific vibration test data, refer to Appendix E. <u>Shipper</u> responsibility to ensure.

Table G-3. Wooden Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- wooden boxes
(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 as a Type A packaging does not incorporate packing groups. This is not applicable as a Type A packaging does not incorporate packing groups. This is not applicable as a Type A packaging does not incorporate packing groups.	

Table G-3. Wooden Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- wooden boxes
(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 that 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; (i) A single or composite non-bulk packaging that 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.	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. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure that the material being shipped falls within the envelope of acceptable materials based on design and testing. This not applicable to Type A packagings as Type A packagings do not incorporate packing groups.	<u>Shipper</u> responsibility to ensure.

Table G-3. Wooden Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- wooden boxes
(ii) A single or composite non-bulk packaging that 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 that 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 Type A packagings as Type A packagings do not incorporate packing groups. This is not applicable to Type A packagings as Type A packagings do not incorporate packing groups.	

Table G-3. Wooden Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- wooden boxes
(4) Packagings tested as prescribed in section 178.605 or 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 confirms 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	This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations.	<u>Shipper</u> responsibility to ensure.

Table G-3. Wooden Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- wooden boxes
(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). (5) No hazardous material may remain on the outside of a package after filling. (c) Mixed contents. (1) An outer non-bulk packaging may contain more than one hazardous material only when--	This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is modified for a Type A packaging (see 49 CFR 173.443). <u>Shipper</u> responsibility to ensure. For entire subsection (c), <u>designer</u> to do and <u>shipper</u> responsibility to ensure. For Type A packagings that are to contain other nonradioactive material, the package must meet both Type A and the required performance requirements.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.
(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;		

Table G-3. Wooden Boxes--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- wooden boxes
(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;		<u>Shipper</u> responsibility to ensure.
(iii) Corrosive materials (except ORM-D) in bottles are further packed in securely closed inner receptacles before packing in outer packagings; and		<u>Shipper</u> responsibility to ensure.
(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.		<u>Shipper</u> responsibility to ensure.
(2) A packaging containing inner packagings of Division 6.2 materials may not contain other hazardous materials, except dry ice.	<u>Shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(d) Liquids must not completely fill a receptacle at a temperature of 55 °C (131 °F) or less.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table G-4. Fiberboard Containers--Compliance with Additional General Requirements
for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post HM-181
(Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- fiberboard containers
(a) Packaging design. Except as provided in section 172.312 of this subchapter: (1) <i>Inner packaging closures.</i> A combination packaging containing liquid hazardous materials must be packed so that closures on inner packagings are upright. (2) <i>Friction.</i> 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) <i>Securing and cushioning.</i> Inner packagings or 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table G-4. Fiberboard Containers--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- fiberboard containers
(4) <i>Metallic devices</i>. 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) <i>Vibration</i>. 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. (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:	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure that the material being shipped falls within the envelope of acceptable materials based on design and testing. Type A packagings are not required to be marked with specific gravity.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. For specific vibration test data, refer to Appendix E. <u>Shipper</u> responsibility to ensure.

Table G-4. Fiberboard Containers--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- fiberboard containers
(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;	This is not applicable as a Type A packaging does not incorporate packing groups.	
(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	This is not applicable as a Type A packaging does not incorporate packing groups.	
(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 as a Type A packaging does not incorporate packing groups.	

Table G-4. Fiberboard Containers--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- fiberboard containers
(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 that 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 that 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.	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. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure that the material being shipped falls within the envelope of acceptable materials based on design and testing. This is not applicable to Type A packagings as Type A packagings do not incorporate packing groups.	<u>Shipper</u> responsibility to ensure.

Table G-4. Fiberboard Containers---Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--- fiberboard containers
(ii) A single or composite non-bulk packaging that 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.	This is not applicable to Type A packagings as Type A packagings do not incorporate packing groups.	
(iii) A single or composite non-bulk packaging that 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 Type A packagings as Type A packagings do not incorporate packing groups.	

Table G-4. Fiberboard Containers--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- fiberboard containers
(4) Packagings tested as prescribed in section 178.605 or 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 confirms 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	This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations.	<u>Shipper</u> responsibility to ensure.

Table G-4. Fiberboard Containers--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- fiberboard containers
(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). (5) No hazardous material may remain on the outside of a package after filling. (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;	This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is modified for a Type A packaging (see 49 CFR 173.443). <u>Shipper</u> responsibility to ensure. For entire subsection (c), <u>designer</u> to do and <u>shipper</u> responsibility to ensure. For Type A packagings that are to contain other nonradioactive material, the package must meet both Type A and the required performance requirements.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table G-4. Fiberboard Containers--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- fiberboard containers
(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;		<u>Shipper</u> responsibility to ensure.
(iii) Corrosive materials (except ORM-D) in bottles are further packed in securely closed inner receptacles before packing in outer packagings; and		<u>Shipper</u> responsibility to ensure.
(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.		<u>Shipper</u> responsibility to ensure.
(2) A packaging containing inner packagings of Division 6.2 materials may not contain other hazardous materials, except dry ice.	<u>Shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(d) Liquids must not completely fill a receptacle at a temperature of 55 °C (131 °F) or less.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table G-5. UF₆--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--UF ₆
(a) Packaging design. Except as provided in section 172.312 of this subchapter: (1) <i>Inner packaging closures.</i> A combination packaging containing liquid hazardous materials must be packed so that closures on inner packagings are upright. (2) <i>Friction.</i> 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) <i>Securing and cushioning.</i> Inner packagings or 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table G-5. UF₆--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--UF ₆
(4) <i>Metallic devices.</i> 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) <i>Vibration.</i> 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. (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:	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure that the material being shipped falls within the envelope of acceptable materials based on design and testing. Type A packagings are not required to be marked with specific gravity.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. For specific vibration test data, refer to Appendix E. <u>Shipper</u> responsibility to ensure.

Table G-5. UF₆--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--UF ₆
(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 as a Type A packaging does not incorporate packing groups. This is not applicable as a Type A packaging does not incorporate packing groups. This is not applicable as a Type A packaging does not incorporate packing groups.	

Table G-5. UF₆--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--UF ₆
(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 that 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 that 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.	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. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure that the material being shipped falls within the envelope of acceptable materials based on design and testing. This not applicable to Type A packagings as Type A packagings do not incorporate packing groups.	<u>Shipper</u> responsibility to ensure.

Table G-5. UF₆--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--UF ₆
(ii) A single or composite non-bulk packaging that 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.	This is not applicable to Type A packagings as Type A packagings do not incorporate packing groups.	
(iii) A single or composite non-bulk packaging that 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 Type A packagings as Type A packagings do not incorporate packing groups.	

Table G-5. UF_6 --Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- UF_6
(4) Packagings tested as prescribed in section 178.605 or 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 confirms 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	This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations.	<u>Shipper</u> responsibility to ensure.

Table G-5. UF₆--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--UF ₆
(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). (5) No hazardous material may remain on the outside of a package after filling.	This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is modified for a Type A packaging (see 49 CFR 173.443). <u>Shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(c) Mixed contents. (1) An outer non-bulk packaging may contain more than one hazardous material only when--	For entire subsection (c), designer to do and <u>shipper</u> responsibility to ensure. For Type A packagings that are to contain other nonradioactive material, the package must meet both Type A and the required performance requirements.	<u>Shipper</u> responsibility to ensure.
(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;		<u>Shipper</u> responsibility to ensure.

Table G-5. UF₆--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a). Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--UF ₆
(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;		<u>Shipper</u> responsibility to ensure.
(iii) Corrosive materials (except ORM-D) in bottles are further packed in securely closed inner receptacles before packing in outer packagings; and		<u>Shipper</u> responsibility to ensure.
(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.	<u>Shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(2) A packaging containing inner packagings of Division 6.2 materials may not contain other hazardous materials, except dry ice.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(d) Liquids must not completely fill a receptacle at a temperature of 55 °C (131 °F) or less.		

Table G-6. Liquid and Gas Packagings--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- liquids and gas
(a) Packaging design. Except as provided in section 172.312 of this subchapter: (1) <i>Inner packaging closures.</i> A combination packaging containing liquid hazardous materials must be packed so that closures on inner packagings are upright. (2) <i>Friction.</i> 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) <i>Securing and cushioning.</i> Inner packagings or 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table G-6. Liquid and Gas Packagings--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--liquids and gas
(4) <i>Metallic devices.</i> 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) <i>Vibration.</i> 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. (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:	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure that the material being shipped falls within the envelope of acceptable materials based on design and testing. Type A packagings are not required to be marked with specific gravity.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. For specific vibration test data, refer to Appendix E. <u>Shipper</u> responsibility to ensure.

Table G-6. Liquid and Gas Packagings--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- liquids and gas
(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 as a Type A packaging does not incorporate packing groups. This is not applicable as a Type A packaging does not incorporate packing groups. This is not applicable as a Type A packaging does not incorporate packing groups.	

Table G-6. Liquid and Gas Packagings--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--- liquids and gas
(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 that 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 that 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.	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. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure that the material being shipped falls within the envelope of acceptable materials based on design and testing. This not applicable to Type A packagings as Type A packagings do not incorporate packing groups.	<u>Shipper</u> responsibility to ensure.

Table G-6. Liquid and Gas Packagings--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- liquids and gas
(ii) A single or composite non-bulk packaging that 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 that 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 Type A packagings as Type A packagings do not incorporate packing groups. This is not applicable to Type A packagings as Type A packagings do not incorporate packing groups.	

Table G-6. Liquid and Gas Packagings--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- liquids and gas
(4) Packagings tested as prescribed in section 178.605 or 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 confirms 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	This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations.	<u>Shipper</u> responsibility to ensure.

Table G-6. Liquid and Gas Packagings--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- liquids and gas
(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). (5) No hazardous material may remain on the outside of a package after filling. (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;	This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is modified for a Type A packaging (see 49 CFR 173.443). <u>Shipper</u> responsibility to ensure. For entire subsection (c), <u>designer</u> to do and <u>shipper</u> responsibility to ensure. For Type A packagings that are to contain other nonradioactive material, the package must meet both Type A and the required performance requirements.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- liquids and gas
(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.		<u>Shipper</u> responsibility to ensure.
(2) A packaging containing inner packagings of Division 6.2 materials may not contain other hazardous materials, except dry ice.	<u>Shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(d) Liquids must not completely fill a receptacle at a temperature of 55 °C (131 °F) or less.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table G-7. Miscellaneous Packagings--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- miscellaneous
(a) Packaging design. Except as provided in section 172.312 of this subchapter: (1) <i>Inner packaging closures.</i> A combination packaging containing liquid hazardous materials must be packed so that closures on inner packagings are upright. (2) <i>Friction.</i> 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) <i>Securing and cushioning.</i> Inner packagings or 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table G-7. Miscellaneous Packagings--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--miscellaneous
(4) <i>Metallic devices.</i> 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) <i>Vibration.</i> 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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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:	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. For specific vibration test data, refer to Appendix E.	<u>Shipper</u> responsibility to ensure.
	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. Type A packagings are not required to be marked with specific gravity.	<u>Shipper</u> responsibility to ensure.

Table G-7. Miscellaneous Packagings---Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- miscellaneous
(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 as a Type A packaging does not incorporate packing groups. This is not applicable as a Type A packaging does not incorporate packing groups. This is not applicable as a Type A packaging does not incorporate packing groups.	

Table G-7. Miscellaneous Packagings--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- miscellaneous
(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 that 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 that 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.	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. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure that the material being shipped falls within the envelope of acceptable materials based on design and testing. This not applicable to Type A packagings as Type A packagings do not incorporate packing groups.	<u>Shipper</u> responsibility to ensure.

Table G-7. Miscellaneous Packagings--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category-- miscellaneous
(ii) A single or composite non-bulk packaging that 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 that 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 Type A packagings as Type A packagings do not incorporate packing groups. This is not applicable to Type A packagings as Type A packagings do not incorporate packing groups.	

Table G-7. Miscellaneous Packagings--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category---miscellaneous
(4) Packagings tested as prescribed in section 178.605 or 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 confirms 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	This is not applicable to Type A packaging. Shipper responsibility to ensure that the Type A packaging is used with the designed limitations. This is not applicable to Type A packaging. Shipper responsibility to ensure that the Type A packaging is used with the designed limitations. This is not applicable to Type A packaging. Shipper responsibility to ensure that the Type A packaging is used with the designed limitations.	Shipper responsibility to ensure.

Table G-7. Miscellaneous Packagings--Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category--- miscellaneous
(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). (5) No hazardous material may remain on the outside of a package after filling. (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;	This is not applicable to Type A packaging. <u>Shipper</u> responsibility to ensure that the Type A packaging is used with the designed limitations. This is modified for a Type A packaging (see 49 CFR 173.443). <u>Shipper</u> responsibility to ensure. For entire subsection (c), <u>designer</u> to do and <u>shipper</u> responsibility to ensure. For Type A packagings that are to contain other nonradioactive material, the package must meet both Type A and the required performance requirements.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table G-7. Miscellaneous Packagings---Compliance with Additional General Requirements for Non-Bulk Packaging and Packages (49 CFR 173.24a).
Post-HM-181 (Post-October 1994). (8 pages total)

Regulatory requirement: 49 CFR 173.24a	Action required/by whom	Packaging category---miscellaneous
(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. (d) Liquids must not completely fill a receptacle at a temperature of 55 °C (131 °F) or less.	Shipper responsibility to ensure. Shipper responsibility to ensure. Shipper responsibility to ensure. Shipper responsibility to ensure. Shipper responsibility to ensure. Shipper responsibility to ensure.	Shipper responsibility to ensure. Shipper responsibility to ensure. Shipper responsibility to ensure. Shipper responsibility to ensure. Shipper responsibility to ensure. Shipper responsibility to ensure.

APPENDIX H

COMPLIANCE WITH ADDITIONAL GENERAL REQUIREMENTS FOR BULK PACKAGINGS (49 CFR 173.24b)

Post-HM-181 (post-October 1994)

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Table H-1. Steel Drums---Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category---steel drums
(a) <i>Outage and filling limits.</i> (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 that meets the definition of poisonous by inhalation (see section 178.1 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 (105 °F) for insulated tanks.	Designer to do and shipper responsibility to ensure. Designer to do and shipper responsibility to ensure. Designer to do and shipper responsibility to ensure.	Shipper responsibility to ensure. Shipper responsibility to ensure. Shipper responsibility to ensure.

Table H-1. Steel Drums--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category-- steel drums
(b) <i>Equivalent steel</i>. 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, in special provision B30), the minimum thickness for the steel must be obtained from one of the following formulas, as appropriate: <u>Formula for metric units:</u> $e_1 = (12.74e_0) / (Rm_1 A_1)^{1/3}$ <u>Formula for non-metric units:</u> $e_1 = (144.2e_0) / (Rm_1 A_1)^{1/3}$ 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-in. test specimen.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table H-1. Steel Drums--Compliance with Additional General Requirements
for Bulk Packagings (49 CFR 173.24b). Post-HM-181
(Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category-- steel drums
(c) Air pressure in excess of ambient atmospheric pressure may not be used to load or unload any lading that may create an air-enriched mixture within the flammability range of the lading in the vapor space of the tank. (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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table H-2. Steel Boxes--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category-- steel boxes
(a) <i>Outage and filling limits.</i> (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 that meets the definition of poisonous by inhalation (see section 178.1 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 (105 °F) for insulated tanks.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table H-2. Steel Boxes---Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category---steel boxes
(b) <i>Equivalent steel</i>. 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: <u>Formula for metric units:</u> $e_1 = (12.74e_0) / (Rm_1A_1)^{1/3}$ <u>Formula for non-metric units:</u> $e_1 = (144.2e_0) / (Rm_1A_1)^{1/3}$ 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-in. test specimen.	Designer to do and shipper responsibility to ensure.	Shipper responsibility to ensure.

Table H-2. Steel Boxes--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category--steel boxes
(c) Air pressure in excess of ambient atmospheric pressure may not be used to load or unload any lading that may create an air-enriched mixture within the flammability range of the lading in the vapor space of the tank.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table H-3. Wooden Boxes--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (4 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category-- wooden boxes
(a) <i>Outage and filling limits.</i> (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 that meets the definition of poisonous by inhalation (see section 178.1 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 (105 °F) for insulated tanks.	Designer to do and <u>shipper</u> responsibility to ensure. Designer to do and <u>shipper</u> responsibility to ensure. Designer to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table H-3. Wooden Boxes--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (4 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category-- wooden boxes
(b) <i>Equivalent steel</i>. 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: <u>Formula for metric units:</u> $e_1 = (12.74e_0) / (Rm_1 A_1)^{1/3}$ <u>Formula for non-metric units:</u> $e_1 = (144.2e_0) / (Rm_1 A_1)^{1/3}$ 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-in. test specimen.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table H-3. Wooden Boxes--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (4 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category-- wooden boxes
(c) Air pressure in excess of ambient atmospheric pressure may not be used to load or unload any lading that may create an air-enriched mixture within the flammability range of the lading in the vapor space of the tank. (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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table H-4. Fiberboard Containers--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category-- fiberboard containers
(a) <i>Outage and filling limits.</i> (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 that meets the definition of poisonous by inhalation (see section 178.1 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 (105 °F) for insulated tanks.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table H-4. Fiberboard Containers--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category--- fiberboard containers
(b) <i>Equivalent steel.</i> 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: <u>Formula for metric units:</u> $e_1 = (12.74e_0) / (Rm_1 A_1)^{1/3}$ <u>Formula for non-metric units:</u> $e_1 = (144.2e_0) / (Rm_1 A_1)^{1/3}$ 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-in. test specimen.	Designer to do and shipper responsibility to ensure.	Shipper responsibility to ensure.

Table H-4. Fiberboard Containers--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category-- fiberboard containers
(c) Air pressure in excess of ambient atmospheric pressure may not be used to load or unload any lading that may create an air-enriched mixture within the flammability range of the lading in the vapor space of the tank.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table H-5. UF₆---Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category--UF ₆
(a) <i>Outage and filling limits.</i> (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 that meets the definition of poisonous by inhalation (see section 178.1 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 (105 °F) for insulated tanks.	Designer to do and <u>shipper</u> responsibility to ensure. Designer to do and <u>shipper</u> responsibility to ensure. Designer to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table H-5. UF₆--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement; 49 CFR 173.24b	Action required/by whom	Packaging category--UF ₆
(b) <i>Equivalent steel</i>. 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: <u>Formula for metric units:</u> $e_1 = (12.74e_0) / (Rm_1 A_1)^{1/3}$ <u>Formula for non-metric units:</u> $e_1 = (144.2e_0) / (Rm_1 A_1)^{1/3}$ 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-in. test specimen.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table H-5. UF₆---Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category--UF ₆
(c) Air pressure in excess of ambient atmospheric pressure may not be used to load or unload any lading that may create an air-enriched mixture within the flammability range of the lading in the vapor space of the tank.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table H-6. Liquid and Gas Packagings--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category-- liquids and gas
(a) <i>Outage and filling limits.</i> (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 that meets the definition of poisonous by inhalation (see section 178.1 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 (105 °F) for insulated tanks.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table H-6. Liquid and Gas Packagings--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category-- liquids and gas
(b) <i>Equivalent steel</i>. 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: <u>Formula for metric units:</u> $e_1 = (12.74e_0) / (R_m A_1)^{1/3}$ <u>Formula for non-metric units:</u> $e_1 = (144.2e_0) / (R_m A_1)^{1/3}$ 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; 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-in. test specimen.	Designer to do and shipper responsibility to ensure.	Shipper responsibility to ensure.

Table H-6. Liquid and Gas Packagings--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category-- Liquids and gas
(c) Air pressure in excess of ambient atmospheric pressure may not be used to load or unload any lading that may create an air-enriched mixture within the flammability range of the lading in the vapor space of the tank.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.
(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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packing category-- miscellaneous
(a) <i>Outage and filling limits.</i> (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 that meets the definition of poisonous by inhalation (see section 178.1 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 (105 °F) for insulated tanks.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

Table H-7. Miscellaneous Packagings--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category-- miscellaneous
(b) <i>Equivalent steel</i>. 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: <u>Formula for metric units:</u> $e_1 = (12.74e_0) / (Rm_1 A_1)^{1/3}$ <u>Formula for non-metric units:</u> $e_1 = (144.2e_0) / (Rm_1 A_1)^{1/3}$ 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-in. test specimen.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure.

Table H-7. Miscellaneous Packagings--Compliance with Additional General Requirements for Bulk Packagings (49 CFR 173.24b). Post-HM-181 (Post-October 1994) (3 pages total)

Regulatory requirement: 49 CFR 173.24b	Action required/by whom	Packaging category--- miscellaneous
(c) Air pressure in excess of ambient atmospheric pressure may not be used to load or unload any lading that may create an air-enriched mixture within the flammability range of the lading in the vapor space of the tank. (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.	<u>Designer</u> to do and <u>shipper</u> responsibility to ensure. <u>Designer</u> to do and <u>shipper</u> responsibility to ensure.	<u>Shipper</u> responsibility to ensure. <u>Shipper</u> responsibility to ensure.

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APPENDIX I

**U.S. DEPARTMENT OF TRANSPORTATION
LETTER OF CONCURRENCE**

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Figure I-1. U.S. Department of Transportation Letter of Concurrence.



U.S. Department
of Transportation

Research and
Special Programs
Administration

400 Seventh Street, S.W.
Washington, D.C. 20590

APR 21 1992

Michael E. Wangler, Director
Transportation and Packaging Safety Division
EH-33.3
U.S. Department of Energy
Washington, DC 20585

Dear Mr. Wangler:

This letter refers to your request for our review of the revision to your document entitled "Test and Evaluation Document for DOT Specification 7A Type A Packagings" DOE/DP/00052-H1. This document is intended to assist shippers in satisfying some of the requirements for documenting the results of testing of DOT Specification 7A packaging.

We have reviewed the subject document and concur with its purpose and contents. The document will provide DOE contractors and other radioactive materials shippers with information about the types of packaging components that can be used with various DOT specification packagings, the results of tests performed on the various packaging configurations, and quality control requirements for using the packagings. This information is essential for a program that offers a broad range of Type A packages for radioactive materials transported by a number of shippers.

We continue to concur with the restrictions that you place on using the document. Historically, some shippers have assumed that this type of document, as extracted or by itself, provides the complete documentation required by 49 CFR 173.415 for offering a Type A package for transportation. You emphasize that in addition to having this report, the shipper must also maintain documentation on other aspects of the shipment. These aspects include a comparison of the physical properties of the actual content of the package to those surrogate materials used for testing, and the implementation of a quality control program to ensure that package use complies with the applicable DOE and DOT requirements. This documentation is required for shippers to meet DOT requirements.

Thank you for the opportunity to review your document.

Sincerely,

A handwritten signature in dark ink, appearing to read "Alan I. Roberts".

Alan I. Roberts
Associate Administrator for
Hazardous Materials Safety

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