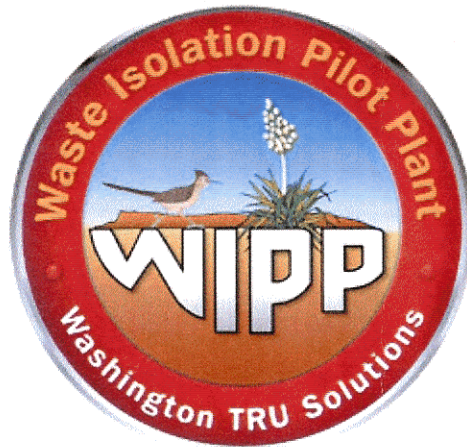


Shielded Container Type A Evaluation Report


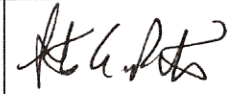
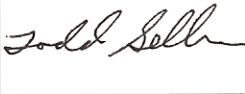


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Preparer		Reviewer		Manager	
Sign	Date	Sign	Date	Sign	Date
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TERMS

Bulk Packaging¹ - a packaging, other than a vessel or a barge, including a transport vehicle or freight container, in which hazardous materials are loaded with no intermediate form of containment and which has: (1) A maximum capacity greater than 450 L (119 gallons) as a receptacle for a liquid; (2) A maximum net mass greater than 400 kg (882 pounds) and a maximum capacity greater than 450 L (119 gallons) as a receptacle for a solid; or (3) A water capacity greater than 454 kg (1000 pounds) as a receptacle for a gas as defined in 49 CFR §173.115.

Non-bulk Packaging¹ - a packaging which has: (1) A maximum capacity of 450 L (119 gallons) or less as a receptacle for a liquid; (2) A maximum net mass of 400 kg (882 pounds) or less and a maximum capacity of 450 L (119 gallons) or less as a receptacle for a solid; or (3) A water capacity of 454 kg (1000 pounds) or less as a receptacle for a gas as defined in 49 CFR §173.115.

Package¹ - a packaging plus its contents.

Packaging¹ - a receptacle and any other components or materials necessary for the receptacle to perform its containment function in conformance with the minimum packing requirements of 49 CFR.

Specification Packaging¹ - a packaging conforming to one of the specifications or standards for packagings in part 178 or part 179 of 49 CFR.

Type A package² - packaging that, together with its radioactive contents limited to A₁ or A₂ as appropriate, meets the requirements of §§173.410 and 173.412 and is designed to retain the integrity of containment and shielding under normal conditions of transport as demonstrated by the tests set forth in §173.465 or §173.466 of 49 CFR, as appropriate.

¹ Title 49, Code of Federal Regulations, Part 171 (49 CFR §171), General information, regulations, and definitions, 10-01-07 Edition.

² Title 49, Code of Federal Regulations, Part 173 (49 CFR §173), Shippers--general requirements for shipments and packagings, 10-01-07 Edition.

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1.0 INTRODUCTION

This Type A Evaluation Report (TAER) documents the U.S. Department of Transportation Specification 7A (DOT 7A) Type A compliance test and evaluation results for the Shielded Container per the requirements of 49 CFR §178.350.³

The Shielded Container is a vented carbon steel and lead cylindrical structure with a removable lid designed as a payload container to package and transport transuranic waste with gamma-emitting radiation as contact-handled (CH) waste within the HalfPACT Type B packaging.⁴ Although not required for use of the Shielded Container as an authorized payload container in the HalfPACT packaging, the demonstration of the design of the payload container to the requirements of DOT 7A Type A is required by the Transuranic Waste Acceptance Criteria (WAC) for the Waste Isolation Pilot Plant (WIPP).⁵

1.1 Purpose and Scope

This report identifies the analyses, tests, and evaluations performed on the Shielded Container to demonstrate compliance of the packaging design with the applicable requirements of 49 CFR §178.350. Use of the Shielded Container as a standalone DOT 7A Type A packaging requires the shipper to document compliance with all requirements stipulated in the regulations, within this document and its appendix, and in the drawing, specification, and handling and operation manual referenced within this document.

1.2 Summary

The Shielded Container is evaluated for use as a standalone DOT 7A Type A packaging. As such, the Shielded Container is designed for and intended to ship Type A solid, radioactive materials of normal form. The Shielded Container is a specification packaging.

The Shielded Container may also be utilized within the HalfPACT packaging (Type B). This evaluation report does not address the use of the Shielded Container with the HalfPACT packaging.

All DOT 7A Type A requirements of 49 CFR are addressed in this report whether or not the requirement is applicable to the evaluated package configurations. As summarized in Table 1-1, the Shielded Container design was evaluated and found to meet the requirements applicable for use as a DOT 7A Type A packaging. The Shielded Container is demonstrated by test to meet the confinement and shielding requirements for the regulatory 4 ft drop tests. Based on the materials of construction and design, it was determined by evaluation that the Shielded Container would not be significantly affected by the water spray test, or due to acceleration, vibration, or vibration resonance resulting from normal conditions of transportation. Based on the materials of

³ Title 49, Code of Federal Regulations, Part 178 (49 CFR §178), Specifications for Packagings, 10-01-07 Edition.

⁴ U.S. Department of Energy (DOE), *HalfPACT Shipping Package Safety Analysis Report*, current revision, USNRC Certificate of Compliance 71-9279, U.S. Department of Energy, Carlsbad Field Office, Carlsbad, New Mexico.

⁵ U.S. Department of Energy (DOE), *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, current revision, DOE/WIPP 02-3122, U.S. Department of Energy, Carlsbad Field Office, Carlsbad, New Mexico.

construction and design, it was demonstrated by analysis that the Shielded Container meets requirements of the stacking test and penetration test.

Table 1-1 – Summary of Evaluation Results

Evaluation	Result
Water Spray – per 49 CFR §173.465(b)	Pass by evaluation (see Section 4.2.1).
Free Drop – 4 ft per 49 CFR §173.465(c) <ul style="list-style-type: none"> • Top-down center of gravity-over-corner drop • Bottom-down end drop • Top-down near-vertical drop • Side drop 	Pass by testing (see Section 4.2.2)
Stacking – per 49 CFR §173.465(d)	Pass by analysis (see Section 4.2.3)
Penetration – per 49 CFR §173.465(e)	Pass by analysis (see Section 4.2.4)
Vibration – per 49 CFR §178.608	Pass by evaluation (see Section 4.2.5)

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

DOT Specification 7A (see §178.350 of this subchapter) Type A general packaging. Each offeror of a Specification 7A package must maintain on file for at least one year after the latest shipment, and shall provide to DOT on request, complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification.

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

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

2.0 PACKAGING DESCRIPTION

The Shielded Container, approximately the same size as a standard 55-gallon drum, consists of a twin-shelled, carbon steel cylindrical structure and a lid. Nominally, 1 inch of lead shielding is contained between the 7-gauge inner shell and 11-gauge outer shell. The shells are welded to an upper flange and a 3-inch thick solid steel bottom. The 3-inch thick solid steel lid integrates a silicone rubber gasket, fifteen 1/2-inch alloy steel closure bolts (flange hex head cap screw), two alignment pins to facilitate remote assembly, and a lead-shielded filter port. The lead-shielded filter port is comprised of a 7/8-inch thick lead filter shield plug and a 7-gauge carbon steel filter shield cap. Three threaded holes in the lid are available to interface with a lifting fixture for lifting and handling the Shielded Container. One threaded hole in the bottom (base) is available for lifting and handling the Shielded Container during fabrication but subsequently plugged with a 1/2-inch alloy steel socket set screw. The Shielded Container is designed to carry its authorized contents inside of one vented 30-gallon payload drum. A partially exploded view of the Shielded Container, including its 30-gallon payload drum, is provided in Figure 2-1. In addition to the 30-gallon payload drum, the Shielded Container may optionally contain a mesh “bag” to facilitate remote installation of the 30-gallon payload drum into the Shielded Container.

The detailed dimensions, weights, materials of construction, and associated manufacturing requirements are provided in WTS Drawing 165-F-026.⁶ The Shielded Container is fabricated in accordance with the WTS Fabrication Specification E-I-478.⁷ A high-level summary of the dimensions, weights, and materials of construction of the Shielded Container are provided in Table 2-1, Table 2-2, Table 2-3, respectively.

2.1 Authorized Configurations

The authorized configuration of the Shielded Container is as specified in WTS Drawing 165-F-026⁶ when fitted with an approved gasketed filter vent that is compatible with the filter vent port.⁸

2.2 Containment and Shielding Systems

The Shielded Container provides containment and shielding for the authorized payloads. The containment system is comprised of the lid, body inner shell, body flange, body base, closure bolts, gasket, and filter vent. The shielding system is comprised of the lid (including the filter shield plug and filter shield cap) and body (including the inner shell, annular lead, outer shell, and base).

⁶Washington TRU Solutions, *Shielded Container Assembly*, Drawing 165-F-026-W1 thru W5, Revision B, June 2008.

⁷ Washington TRU Solutions, *Specification for Fabrication of a Shielded Container Assembly*, Specification E-I-478, Revision 0, June 2008.

⁸ U.S. Department of Energy (DOE), *Waste Isolation Pilot Plant Approved Filter Vents*, current revision, DOE/WIPP 08-3384, U.S. Department of Energy, Carlsbad Field Office, Carlsbad, New Mexico.

2.3 Authorized Contents

The authorized contents of the Shielded Container is for Type A solid, radioactive materials, normal form, with material form numbers 1, 2, and 3 as defined in Table 2-4. All contents shall be contained within a vented 30-gallon payload drum (optionally contained within a mesh “bag” to facilitate loading) that is overpacked into the Shielded Container in compliance with the maximum contents and maximum gross weight limits specified in Table 2-2.

2.4 Loading, Assembly, and Closure

The Shielded Container is to be loaded, assembled, and closed in accordance with the WTS Handling and Operation Manual WP 08-PT.16.⁹

⁹ Washington TRU Solutions, *Shielded Container Assembly Handling and Operation Manual*, WP 08-PT.16, Revision 0, June 2008.

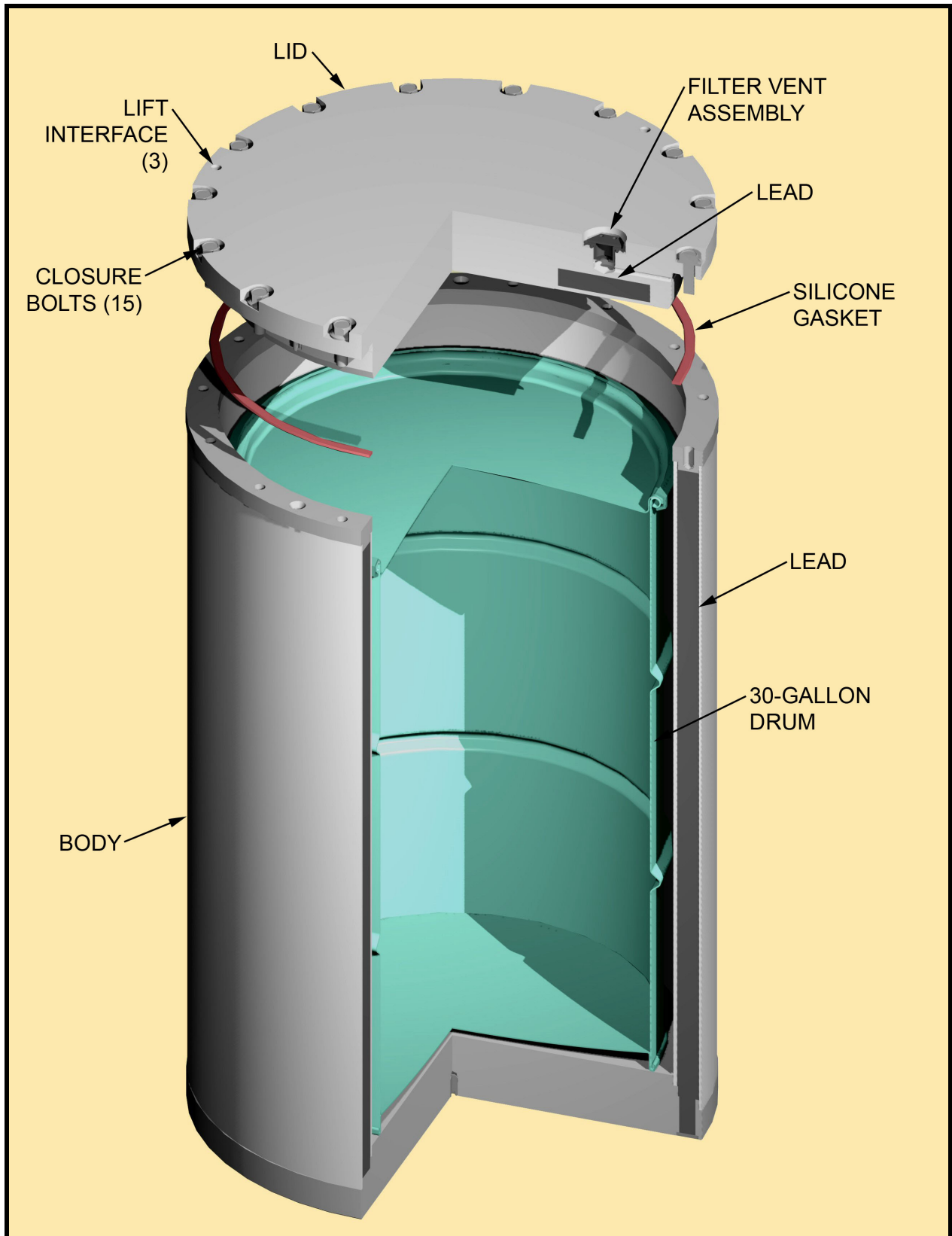


Figure 2-1 – Shielded Container Features

Table 2-1 – Shielded Container Dimensions

Dimension	Approximate Measurement (inches)	
	Inside Dimension (in.)	Outside Dimension (in.)
Height	29 ³ / ₄	35 ³ / ₄
Diameter	20 ³ / ₈	23

Table 2-2 – Shielded Container Weights

Component	Weight (pounds)		
	Approximate Empty	Maximum Contents	Maximum Gross
Shielded Container Assembly	1,726	450	2,260
Shielded Container Body	1,426	N/A	N/A
Shielded Container Lid	300	N/A	N/A

Table 2-3 – Shielded Container Materials of Construction

Shielded Container Component	Material	Temperature Range (°F)
Lid, base, flange, inner shell, outer shell, alignment pins, filter shield cap	Carbon steel	-40 to 2750
Body annular lead and filter shield plug	Lead	<620
Closure bolts and socket set screw	Alloy steel	-40 to 2750
Gasket	Silicone rubber	-65 to 400

Table 2-4 – Shielded Container: Material Content Forms Authorized for Transport

Form Number	Description ^①
1	Direct load: Solids, any particle size (e.g., fine powder or inorganic particulates)
2	Direct load: Solids, large particle size (e.g., sand, concrete, or debris)
3	Direct load: Solids, large objects (e.g., metal cans containing waste)

① each form contained within a vented 30-gallon payload drum

3.0 EVALUATION CRITERIA

3.1 Test and Evaluation Criteria

As required by 49 CFR §173.412(j), when evaluated against the performance requirements of this section and the tests specified in §173.465 or using any of the methods authorized by §173.461(a), the packaging will prevent the following:

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

Guidance from international regulations (IAEA 2005, Paragraph 646) is provided as follows:¹⁰

646. A package shall be so designed that, if it were subjected to the tests specified in paras 719–724, it would prevent:

(a) Loss or dispersal of the radioactive contents; and

(b) More than a 20% increase in the maximum radiation level at the external surface of the package.

Determination of the response of a point radiation source subject to movement within the package and any associated effects on radiation levels are not provided in this document. Drop test damage information is provided in Section 4.2.2 for use by the shipper in determining whether a significant change in radiation level would result for a specific payload.

Refer to Section 4.0 and Appendix A for detailed test and evaluation information.

3.2 Pass/Fail Criteria

For all tests, except where otherwise indicated, the packages tested were considered to fail if there was significant damage to the packaging and/or loss of the simulated load. Rupture of, or leakage from, the package as a result of the test constitutes failure. Damage information is provided to assist the shipper in evaluating the possible dose rate changes at the surface of the package for the intended payloads to be shipped.

¹⁰ International Atomic Energy Agency, *Regulations for the Safe Transport of Radioactive Material*, IAEA Safety Standards Series No. TS-R-1, Vienna, 2005.

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4.0 PACKAGING EVALUATION

Referring to Table 4-1, a list of the primary sections of 49 CFR applicable to DOT 7A Type A packaging is provided along with an indication of whether the section is addressed by the evaluations provided herein. It is the responsibility of the user of the package to ensure compliance with the regulations not evaluated herein and with the parts identified within Appendix A as being the responsibility of the shipper.

Table 4-1 – Regulations and Responsibilities

49 CFR	Title	Addressed Herein or Responsible Party
§173.24	General Requirements for Packagings and Packages	Yes
§173.24a	Additional General Requirements for Non-bulk Packagings and Packages	Yes
§173.24b	Additional General Requirements for Bulk Packagings	Yes
§173.27	General Requirements for Transportation by Aircraft	Yes
§173.410	General Design Requirements	Yes
§173.412	Additional Design Requirements for Type A Packages	Yes
§173.415(a)	Authorized Type A Packages	Shipper
§173.442	Thermal Limitations	Shipper
§173.461	Demonstration of Compliance with Tests	Yes
§173.462	Preparation of Specimens for Testing	Yes
§173.465	Type A Packaging Tests	Yes
§173.466	Additional Tests for Type A Packaging Designed for Liquids and Gases	Yes
§173.474	Quality Control for Construction of Packaging	Shipper
§173.475	Quality Control Requirements Prior to Each Shipment of Class 7 (Radioactive) Materials	Shipper
§178.2(c)	Notification	Yes
§178.3	Marking of Packagings	Yes
§178.350	Specification 7A; General Packaging, Type A	Shipper

4.1 Design Change Evaluation

The Shielded Containers utilized in the DOT 7A Type A testing (i.e., test units SCA-1 and SCA-2) were fabricated to the original revision of WTS Drawing 165-F-026.¹¹ Table 4-2 provides a listing of the deviations of the test articles from the original drawing requirements. In addition, the impact of all subsequent revisions are evaluated with respect to the test articles utilized for certification.

Table 4-2 – Summary of Revision Changes and Evaluations

Document	Change Description	Evaluation
Test Article Variances from Rev. NEW		
AR/VR 408363-5	Test Unit #1 lid plate thickness was found to be 0.016 in. less than the minimum thickness allowed by the stock material callout (ref. Drawing 165-F-026-W2, Rev. NEW, Detail 4).	Use-as-is disposition was approved because the effect of reduced lid plate thickness was structurally conservative and the determination of reduction in shielding effectiveness could be made by a post-test damage inspection of the known thickness plate.
AR/VR 408363-5	Test Unit #1 and #2 lid plates displayed surface pit imperfections from the mill ranging in depth from 0.017 – 0.040 in. (ref. Drawing 165-F-026-W2, Rev. NEW, Detail 4)	Use-as-is disposition was approved because the determination of reduction in shielding effectiveness could be made by a post-test damage inspection of the known condition plate.
AR/VR 408363-6	Test Unit #1 and #2 body flange inside diameter in the machined and welded state was found at most to be 0.011 in. greater than the maximum diameter and 0.020 in. less than the minimum diameter; the part was oval (ref. Drawing 165-F-026-W3, Rev. NEW, Detail 8).	Use-as-is disposition was approved because the amount of lateral shift of the lid and interaction with the body flange as a shear lip was conservatively accounted for in the oval condition.

¹¹ Washington TRU Solutions, *Shielded Container Assembly*, Drawing 165-F-026-W1 thru W5, Revision NEW, August 2007.

Document	Change Description	Evaluation
AR/VR 408363-6	Test Unit #1 and #2 body flange outside diameter in the machined and welded state was found to be 0.001 in. less than the minimum diameter and 0.003 in. greater than the maximum diameter, respectively (ref. Drawing 165-F-026-W5, Rev. NEW, Detail 14).	Use-as-is disposition was approved because the body flange outside diameter deviations did not significantly effect the required body shell welds or other critical function of the part.
AR/VR 408363-6	Test Unit #1 and #2 body inner shell inside diameter in the welded state was found at most to be 0.013 in. greater than the maximum inside diameter (ref. Drawing 165-F-026-W3, Rev. NEW, Section H-H).	Use-as-is disposition was approved because the larger inner shell inside diameter would not preclude the ability to adequately assess the reduction in shielding effectiveness resulting from the free drop.
AR/VR 408363-6	Test Unit #1 and #2 body flange closure bolt threaded holes were found to be at most 0.154 in. less than the minimum required thread depth (ref. Drawing 165-F-026-W3, Rev. NEW, Detail 8).	Use-as-is disposition was approved because provided thread depth was sufficient to tighten the closure bolts to the required torque without bottoming out in the flange.

Document	Change Description	Evaluation
Drawing Changes from Rev. NEW to Rev. A		
ECO 11834 Addendum 1	Revised Item 15, flange hex head cap screw from 1-1/4 in. long to 1-1/2 in. long (ref. Drawing 165-F-026-W1, Rev. A, Zone C-2).	Lengthening of closure bolt was to accommodate lid thickness increase. Change does not affect certification basis because the slightly increased bolt length results in equivalent strain under equivalent loads. Slight additional increase in elastic bolt stretch due to increased grip length is inconsequential to the silicon gasket compression of approximately 50%.
ECO 11834 Addendum 1	Revised weight note from "ESTIMATED FINAL ASSEMBLY WEIGHT: 1667 LB." to "NOMINAL ASSEMBLY WEIGHT: 1726 LB." (ref. Drawing 165-F-026-W1, Rev. A, Zone C-3).	Weight was revised to accommodate 1/4 in. lid and base thickness increase. Both lid and base weight increased by approximately 30 lb. each. Minimum contents weight in free drop testing was 491 lb. or 41 lb greater than the maximum authorized contents weight of 450 lb. Through comparative evaluation against the original certification test weights, it is concluded that the increase in tare weight of the package would not significantly affect the performance of the packaging since the additional weight is associated with thickening and strengthening the lid and base components. Loads applied to the closure interface are largely unaffected by the increased lid and base weights and offset by the excess contents weight employed in the testing. The slight increase in columnar buckling loads applied to the body shield is of no consequence considering the capacity of the side shield and shells in resisting buckling.

Document	Change Description	Evaluation
ECO 11834 Addendum 1	Revised G/N 4 from "... GR 36, SS ..." to "... GR 45, SS (STRUCTURAL STEEL) ..." material callout (ref. Drawing 165-F-026-W1, Rev. A, Zone C-2).	Change was editorial only as test units utilized material meeting the minimum strength requirements of GR 45 even though they were purchased to GR 36 requirements. No impact on certification basis.
ECO 11834 Addendum 1	Revised G/N 10 to change nominal tare weight from "1,667 LB." to "1,726 LB." and maximum gross weight from "2,200 LB." to "2,260 LB." (ref. Drawing 165-F-026-W1, Rev. A, Zone B-2).	Tare weight increase evaluation provided above. The maximum gross weight value was revised to accommodate the tare weight increase and to accommodate additional weight due to tolerance stack-up of the components that would increase the tare weight of the package above the nominal. Through comparative evaluation against the original certification test weights, it is concluded that the increase in gross weight of the package would not significantly affect the performance of the packaging since increases in lead thickness (due to extreme minimum inside shell and extreme maximum outside shell tolerance conditions) would tend to further stiffen the robust side shield. The increased weight would be of no consequence to the original certification testing which accommodated a contents test weight that bounded the 450 lb. authorized contents weight.
ECO 11834 Addendum 1	Revised F/N 13 from "3/4 THK." to "1 IN. THK" (ref. Drawing 165-F-026-W1, Rev. A, Zone B-2).	Revision was editorial to callout suggested thickness of material needed to fill vent port lead cavity and associated lid thickness increase. No impact to certification basis.
ECO 11834 Addendum 1	Revised overall height reference dimension from "(35-1/4)" to "(35-3/4)" (ref. Drawing 165-F-026-W1, Rev. A, Section A-A).	Revision was editorial to accommodate lid and base thickness increase. No impact to certification basis.

Document	Change Description	Evaluation
ECO 11834 Addendum 1	Revised lid to filter shield cap weld to add grind flush requirement (ref. Drawing165-F-026-W2, Rev. A, Detail 7).	Revision was for consistency with all other welds that might interact with mating components or payload to preclude interference. No impact to safety basis as ground flush weld is structurally equivalent and additionally protected from impact.
ECO 11834 Addendum 1	Removed “OR 3/16 STK” option from filter shield cap material thickness callout (ref. Drawing165-F-026-W2, Rev. A, Zone D-1).	Revision was to consistently utilize sheet stock gauge thickness material vs sheet stock fractional thickness material. No impact to safety basis as material thickness is nearly identical.
ECO 11834 Addendum 1	Revised filter shield plug thickness from “0.687” to “0.875”(ref. Drawing165-F-026-W2, Rev. A, Zone D-3).	Revision was to accommodate lid thickness increase and provide sufficient lead shielding for equivalency with lid steel thickness where the gamma energy and intensity of Cs-137 defined the “equivalence”. No impact to certification basis as thickness of lead below filter port remains at a ratio to ensure the lead provides equivalent shielding to the steel not present in the filter port recess.
ECO 11834 Addendum 1	Revised lid thickness from “2.75 STK” to “3.00 STK” (ref. Drawing165-F-026-W2, Rev. A, Detail 4).	Revision was to provide equivalent steel shielding for the axial orientation as that provided by the steel/lead/steel body shield in the radial orientation. Revision does not affect the certification basis for the packaging because the thicker steel lid is more structurally robust in bending, is equivalent in tension/compression at the closure bolt locations, and provides increased shielding.
ECO 11834 Addendum 1	Revised filter port vent hole location from “1.250” to “1.500” and lid flange thickness reference dimension from “(1.00)” to “(1.25)” (ref. Drawing165-F-026-W2, Rev. A, Detail 4).	Revision was to accommodate increased lid plate thickness and does not impact certification basis. Increased thickness of lid flange is more structurally robust than original design.

Document	Change Description	Evaluation
ECO 11834 Addendum 1	Revised filter shield plug counterbore from "0.687 MAX" to "0.875 MAX" (ref. Drawing 165-F-026-W2, Rev. A, Detail 4).	Revision was to accommodate lid thickness increase and associated lead shield plug thickness. No impact to certification basis.
ECO 11834 Addendum 1	Revised filter shield cap counterbore from "0.188" to "0.197" (ref. Drawing 165-F-026-W2, Rev. A, Detail 4).	Revision was to ensure that the filter shield cap is mounted so not to protrude from the underside of the lid and preclude direct impact of the payload with the shield cap. No impact to certification basis.
ECO 11834 Addendum 1	Removed "OR 3/16 STK" option from plug material thickness callout (ref. Drawing 165-F-026-W3, Rev. A, Zone B-3).	Revision was to consistently utilize sheet stock gauge thickness material vs sheet stock fractional thickness material. No impact to safety basis as material thickness is nearly identical.
ECO 11834 Addendum 1	Revised plug counterbore from "0.228" to "0.197" (ref. Drawing 165-F-026-W3, Rev. A, Zone A-5).	Revision was to ensure that the plug is mounted so not to protrude from the underside of the base and preclude direct impact on the plug. Revision was also to accommodate the plug thickness at extreme tolerance. No impact to certification basis.
ECO 11834 Addendum 1	Removed "OR 3/16 STK" option from inner shell thickness callout (ref. Drawing 165-F-026-W5, Rev. A, Zone D-5).	Revision was to consistently utilize sheet stock gauge thickness material vs sheet stock fractional thickness material. No impact to safety basis as material thickness is nearly identical.
ECO 11834 Addendum 1	Removed "OR 1/8 STK" option from outer shell thickness callout (ref. Drawing 165-F-026-W5, Rev. A, Zone D-7).	Revision was to consistently utilize sheet stock gauge thickness material vs sheet stock fractional thickness material. No impact to safety basis as material thickness is nearly identical.

Document	Change Description	Evaluation
ECO 11834 Addendum 1	Revised body flange outside diameter from “23.14” to “23.09” and body flange inside land diameter from “20.896” to “20.834” with associated reference dimension changes (ref. Drawing165-F-026-W5, Rev. A, Detail 14).	Revision accommodated the tighter material thickness tolerancing invoked by the revised shell material gauge thickness specification. Changes simply ensure that shell diameter and thickness tolerances are consistent with body flange land diameters to achieve full thickness assembly welds. No impact to certification basis as structurally the two configurations are nearly identical and ensure achievement of original design intent.
ECO 11834 Addendum 1	Revised base outside diameter from “23.14” to “23.09” and base inside land diameter from “20.896” to “20.834” with associated reference dimension changes (ref. Drawing165-F-026-W5, Rev. A, Detail 13).	Revision accommodated the tighter material thickness tolerancing invoked by the revised shell material gauge thickness specification. Changes simply ensure that shell diameter and thickness tolerances are consistent with base land diameters to achieve full thickness assembly welds. No impact to certification basis as structurally the two configurations are nearly identical and ensure achievement of original design intent.
ECO 11834 Addendum 1	Revised base thickness from “2.75 STK” to “3.00 STK” (ref. Drawing165-F-026-W5, Rev. A, Detail 13).	Revision was to provide equivalent steel shielding for the axial orientation as that provided by the steel/lead/steel body shield in the radial orientation. Revision does not affect the certification basis for the packaging because the thicker steel base is more structurally robust in bending and provides increased shielding.
ECO 11834 Addendum 1	Revised base shelf thickness dimension from “1.75)” to “2.00” (ref. Drawing165-F-026-W2, Rev. A, Detail 13).	Revision was to accommodate increased base plate thickness and does not impact certification basis. Increased thickness of base shelf is more structurally robust than original design.

Document	Change Description	Evaluation
Drawing Changes from Rev. A to Rev. B		
ECO 11834 Addendum 2	Removed “PROTOTYPE FABRICATION ONLY” stamp (ref. Drawing 165-F-026-W1 thru W5, Rev. B).	Removal of stamp indicates the design is validated and available for full-production and intended use.
ECO 11834 Addendum 2	Revised Suppliers Note B to add “(SS20)” (ref. Drawing 165-F-026-W1, Rev. B, Zone C-2).	The “SS20” callout was moved from G/N 3 because it is specific to the recommended supplier (i.e., IPOTEC). No impact to certification basis.
ECO 11834 Addendum 2	Replaced G/N 1 with “ALL WELDS SHALL CONFORM TO AND BE VISUALLY INSPECTED TO THE REQUIREMENTS OF AWS D1.1. SHELL MATERIALS MAY BE JOINED FROM ONE OR MORE PIECES UTILIZING COMPLETE JOINT PENETRATION (CJP) WELDS AND SHALL BE MADE AND VISUALLY INSPECTED PER THE ABOVE REQUIREMENTS” (ref. Drawing 165-F-026-W1, Rev. B, Zone C-1/2).	Welding requirements under previous drawing revision were imposed through purchasing documents in the Statement of Work. It was deemed more appropriate to impose weld requirements as a drawing note. Previous G/N 1 deburring requirement is addressed in the fabrication specification. No impact to certification basis.
ECO 11834 Addendum 2	Revised G/N 3 to remove the “(SS20)” callout (ref. Drawing 165-F-026-W1, Rev. B, Zone C-1/2).	The “SS20” callout is specific to IPOTEC, so it was moved to Suppliers Note B. No impact to certification basis.
ECO 11834 Addendum 2	Revised G/N 3 from "...SILICONE ADHESIVE ONE SIDE..." to "...ADHESIVE ONE SIDE..." (ref. Drawing 165-F-026-W1, Rev. B, Zone C-1/2).	Revised callout is editorial to clarify that gasket requires adhesive on one side, but not a specific silicone adhesive. No impact to certification basis.

Document	Change Description	Evaluation
ECO 11834 Addendum 2	Revise G/N 4 to remove “OR ASTM A-36”; add the following optional materials specific to Items 3 and 4: ASTM A333, Grade 9 ASTM A501, Grade B ASTM A714, Class 2, Grade I (ref. Drawing 165-F-026-W1, Rev. B, Zone C-1/2).	Revision was to remove allowance for use of ASTM A36 material as it does not meet the minimum requirements of the as-tested configuration. Optional pipe materials meeting the minimum requirements of ASTM A1011, Grade 45, have been added to enhance fabrication options. No impact to certification basis.
ECO 11834 Addendum 2	Replaced F/N 8 with a G/N stating: “CONTAINER SHALL BE EQUIPPED WITH ONE USER-SUPPLIED FILTER VENT PER DOE/WIPP 08-3384 IN ACCORDANCE WITH SECTION 2.5 OF THE CH-TRAMPAC” (ref. Drawing 165-F-026-W1, Rev. B, Zone B-1/2).	F/N 8 previously supplemented the Flange (Item 5) to indicate pre-lead to post-lead condition dimensional requirements. Previous note was redundant to imposed post-lead pour dimensional requirements, so it was removed. Filter vent requirements are provided by the new note and met by the filters utilized in the certification test units. No impact to certification basis.
ECO 11834 Addendum 2	Revised G/N 10 to add “- ARROW MARKS (3X, OPTIONAL).” (ref. Drawing 165-F-026-W1, Rev. B, Zone B-1/2).	Revision was to allow the optional stenciling of arrows that indicate location of lift interface holes. No impact to certification basis.
ECO 11834 Addendum 2	Revised F/N 13 from “MACHINED FROM 1 IN. THK LEAD PLATE.” to “MACHINED FROM LEAD PLATE.” (ref. Drawing 165-F-026-W1, Rev. B, Zone B-1/2).	Revision removed unnecessary detail as any thickness of lead plate may be used as stock providing that the minimum thickness meets the finished part dimensional requirements. No impact to certification basis.

Document	Change Description	Evaluation
ECO 11834 Addendum 2	Replace F/N 14 with G/N stating: "FABRICATE IN ACCORDANCE WITH WASHINGTON TRU SOLUTIONS SPECIFICATION E-I-478. USE IN ACCORDANCE WITH WP 08-PT.16." (ref. Drawing 165-F-026-W1, Rev. B, Zone A/B-1/2).	F/N 14 previously provided a fabrication option to match drill lid and flange. The hole configurations are easily attained using geometric tolerances (as achieved with the test units) rather than through a match-drilling process. Use of a referenced fabrication specification was desired for consistency with other DOT 7A Type A packages and special processes for lead pour (including the use of contaminated lead), shielding integrity testing, sampling, etc., that are not efficiently called out on the drawing. Detailed handling and operating requirements are specified by WP 08-PT.16, consistent with that used for the certification test units. No impact to certification basis.
ECO 11834 Addendum 2	Revised the material standard callout for Items 8 and 9 from "ASTM B29" to "SEE NOTE 21" (ref. Drawing 165-F-026-W1, Rev. B, Zone D-1).	Revision was to accommodate the use of radioactively-contaminated (recycled) lead meeting the properties of ASTM B29 to ensure structural equivalency and no impact to certification basis.
ECO 11834 Addendum 2	Removed Items 14 & 15 from List Of Materials and field of drawing with Items 16 & 17 renumbered to become Items 14 & 15, respectively (ref. Drawing 165-F-026-W1, Rev. B, Zone D-1/2/3, D-4, D-6, B-6).	Removed eyebolt and heavy hex nut. Handling and operating manual specifies the use of a specific lift assembly that bolts directly into the lid. Also, shipping each container with a set of eyebolts/nuts that may be damaged in shipment and handling is unnecessary. No impact to certification basis as eyebolts were for handling purposes only and to be removed prior to shipment.

Document	Change Description	Evaluation
ECO 11834 Addendum 2	<p>Added "PROTECTIVE PLUG, 1/2 PIPE PRESS-FIT" for Item 16 to the List of Materials for use in the three 1/2-13UNC threaded lift interface holes in the lid.</p> <p>Added "3" to the quantity column.</p> <p>Added "A" to the note column.</p> <p>Added "4491K42" to the part number column.</p> <p>Added "LDPE" to the material column.</p> <p>(ref. Drawing 165-F-026-W1, Rev. B, Zone D-1/2/3, B-6)</p>	The plastic pipe plugs are added to protect the threaded lift interface holes. No impact to certification basis.
ECO 11834 Addendum 2	<p>Added marking requirements (lid and body) with F/N 23 attachment and the following text:</p> <p>"USA DOT 7A TYPE A MFG. NAME/ADDRESS S/N: XXXXXX"</p> <p>(ref. Drawing 165-F-026-W1, Rev. B, Zone C/D-7/8 and Zone B-3/4).</p>	Added requirement to mark the packaging per DOT 7A Type A requirements. No impact to certification basis.
ECO 11834 Addendum 2	Deleted reference note "(EYEBOLTS REMOVED FOR CLARITY)" (ref. Drawing 165-F-026-W1, Rev. B, Zone A-7/8).	Due to the removal of the 3 eyebolts and heavy hex nuts, the reference note is no longer applicable. No impact to certification basis.
ECO 11834 Addendum 2	Deleted Item 15 supplier and part number reference in List of Materials (ref. Drawing 165-F-026-W1, Rev. B, Zone D-2).	Supplier is no longer suggested due to their inability to meet CMTR requirement for hex head cap screw fasteners. Remaining material specification and std/number callout fully defines all applicable requirements. No impact to certification basis.

Document	Change Description	Evaluation
ECO 11834 Addendum 2	Revised F/N 15 from “TIGHTEN CLOSURE BOLTS (ITEM 17) TO” to “TIGHTEN CAP SCREWS (ITEM 15) TO” (ref. Drawing 165-F-026-W2, Rev. B, Zone B-1/2).	Revised to consistently utilize part nomenclature and to revise for consistency with applicable Item Number. No impact to certification basis.
ECO 11834 Addendum 2	Revised F/N 16 to replace “IT IS RECOMMENDED THAT SEAL (ITEM 7) BE” with “SEAL (ITEM 7) SHALL BE” (ref. Drawing 165-F-026-W2, Rev. B, Zone B-1/2).	Revision requires, rather than recommends, the use of a monolithic seal since spliced seals were not qualified via test. No impact to certification basis.
ECO 11834 Addendum 2	Added G/N 18 as “CAUTION: FOR USE OF THREADED LIFT INTERFACE HOLES IN THE LID, ENSURE THREADED FASTENERS OF LIFT ATTACHMENT DO NOT PROTRUDE BEYOND THE BOTTOM FACE OF THE LID FLANGE DURING ASSEMBLY.” (ref. Drawing 165-F-026-W2, Rev. B, Zone B-1/2).	Added G/N ensures that the lid-to-body interface is metal-to-metal and not interfered by protruding lifting attachments to facilitate correct bolt torque and proper flange sealing. No impact to certification basis.
ECO 11834 Addendum 2	Added F/N 19 as “RESTRAINED OR PI-TAPE MEASUREMENT PERMITTED FOR VERIFICATION.” (ref. Drawing 165-F-026-W2, Rev. B, Zone B-1/2).	Added F/N allows a restrained or pi-tape measurement of the inner and outer shells at the piece-part level. Post lead-pour dimensional requirements ensures completed assembly lead thickness and no impact to certification basis.
ECO 11834 Addendum 2	Cleaned-up Section E-E to resolve the spurious text that was behind the GD&T control block (ref. Drawing 165-F-026-W2, Rev. B, Zone D-5).	The spurious text confused the callout and is considered an administrative change and not clouded. No impact to certification basis.
ECO 11834 Addendum 2	Revised the “.875 MAX” dimension to be “.885” for Detail 4 of Item 6 (ref. Drawing 165-F-026-W2, Rev. B, Zone A-7/8).	The depth of the 4-1/4 in. diameter hole was revised to specify a ± 0.010 -inch tolerance to ensure that Item 9 is fully contained within the counterbore and Item 10 can be properly seated prior to weld-out. No impact to certification basis.

Document	Change Description	Evaluation
ECO 11834 Addendum 2	Revised "7 GA. (.179)" to be ".179 ±.008 (7 GA.)" for Item 10 (ref. Drawing 165-F-026-W2, Rev. B, Zone D-1).	Revision specifies the required material thickness tolerance to remove ambiguity implied in the ASTM standard. No impact to certification basis.
ECO 11834 Addendum 2	Deleted F/N 14 next to Item 6 callout (ref. Drawing 165-F-026-W2, Rev. B, Zone C-8).	Match-drill option previously allowed by G/N 14 is no longer applicable. No impact to certification basis.
ECO 11834 Addendum 2	Added F/N 20 as "SEAM WELD APPLICABLE TO ROLLED AND WELDED PLATE ONLY." (ref. Drawing 165-F-026-W3, Rev. B, Zone B-1/2).	Pipe standard material options for shells rendered longitudinal seam weld callout not applicable. Added F/N clarifies applicability. No impact to certification basis.
ECO 11834 Addendum 2	Added G/N 21 as "ASTM B29. OPTIONALLY UTILIZE RADIOACTIVELY-CONTAMINATED (RECYCLED) LEAD MEETING THE MINIMUM STRUCTURAL REQUIREMENTS OF ASTM B29" (ref. Drawing 165-F-026-W3, Rev. B, Zone B-1/2).	Addition was to specify lead material requirements. The use of radioactively-contaminated (recycled) lead meeting the properties of ASTM B29 ensures structural equivalency and no impact to certification basis.
ECO 11834 Addendum 2	Added F/N 22 as "OPTIONAL: CONICAL TAPER CUP DESIGN OR USE OF BELL REDUCER(S) ARE ALLOWED IN LIEU OF CYLINDRICAL CUP CONFIGURATION AS SHOWN" (ref. Drawing 165-F-026-W3, Rev. B, Zone B-1/2).	Addition allows optional cup design to facilitate lead pour operations. No impact to certification basis.

Document	Change Description	Evaluation
ECO 11834 Addendum 2	Added F/N 23 as “MARK AS SHOWN USING 1/2 IN. MIN. HIGH CHARACTERS, RAISED OR INDENTED BY FORGING OR DIE-STAMPING INTO THE SURFACE. UNIQUE 6-DIGIT SERIAL NUMBER SHALL BE MATCHED TO BODY AND LID ASSEMBLY. BODY OPTION: WELD-ON STAMPED TAG OR STENCIL WITH HIGH-VISIBILITY PAINT.” (ref. Drawing 165-F-026-W3, Rev. B, Zone B-1/2).	Added requirement to mark the packaging per DOT 7A Type A requirements. No impact to certification basis.
ECO 11834 Addendum 2	Added a dimension for the outer shell on Section H-H that specifies the post-lead pour dimensional requirements of “23.056 +/- .060 O.D. (ITEM 3)” (ref. Drawing 165-F-026-W3, Rev. B, Zone C-7).	Added dimension controls the lead thickness in the sidewall and controls shell dimensional changes due to the lead pour operation. No impact to certification basis.
ECO 11834 Addendum 2	Revised dimension for the inner shell on Section H-H that specifies the post-lead pour dimensional requirements of “20.43 +/- .06 I.D. (ITEM 4)” to “20.446 +/- .080 I.D. (ITEM 4)” (ref. Drawing 165-F-026-W3, Rev. B, Zone C-7).	Revised dimension controls the lead thickness in the sidewall and controls shell dimensional changes due to the lead pour operation. No impact to certification basis.
ECO 11834 Addendum 2	Revised “7 GA. (.179)” to be “.179 ±.008 (7 GA.)” for Item 11 (ref. Drawing 165-F-026-W3, Rev. B, Zone B-3).	Revision specifies the required material thickness tolerance to remove ambiguity implied in the ASTM standard. No impact to certification basis.
ECO 11834 Addendum 2	Delete F/N 14 on SECTION H-H (ref. Drawing 165-F-026-W3, Rev. B, Zone A-8).	Match-drill option previously allowed by G/N 14 is no longer applicable. No impact to certification basis.
ECO 11834 Addendum 2	Revised the cup to add minimum wall thickness as “3/16 THK MIN” (ref. Drawing 165-F-026-W4, Rev. B, Zone D-2/3).	Thicker material is superior in retaining heat during the lead pour process. No impact to certification basis.

Document	Change Description	Evaluation
ECO 11834 Addendum 2	Revised the cup to add reference to F/N 22 (ref. Drawing 165-F-026-W4, Rev. B, Zone D-2/3).	Addition allows optional cup design to facilitate lead pour operations. No impact to certification basis.
ECO 11834 Addendum 2	Revised the Riser Pipe from "SCH. 40 (.113 WALL)" to "SCH. 80 (.154 WALL)" (ref. Drawing 165-F-026-W4, Rev. B, Zone C-1).	Increased wall thickness is superior in retaining heat during the lead pour process. No impact to certification basis.
ECO 11834 Addendum 2	Added "2X" to riser callout (ref. Drawing 165-F-026-W4, Rev. B, Zone C-1).	Addition is editorial to account for application to both risers.
ECO 11834 Addendum 2	Revised "SCH. 40 (.113 WALL)" to "SCH. 80 (.154 WALL)" (ref. Drawing 165-F-026-W4, Rev. B, Zone C-8).	Increased wall thickness is superior in retaining heat during the lead pour process. No impact to certification basis.
ECO 11834 Addendum 2	Revised "22.77 +.06 -.00 I.D." dimension for Item 3 to be "23.086 +.000/-.060 O.D." dimension; added F/N 19 to specifically allow restrained or pi-tape measurement for verification (ref. Drawing 165-F-026-W5, Rev. B, Zone D-7).	Final dimensions are being held at the assembly level such that the circularity of flexible component at the subassembly level is not required. The necessary requirement is to have the proper overall diameter that is achieved in the restrained condition. Also, pi-tape measurements are more easily achieved as an OD rather than ID. No impact to certification basis.
ECO 11834 Addendum 2	Revised "20.40 +.06 -.00 I.D." dimension for Item 4 to be "20.834 +.000/-.060 O.D." dimension; added F/N 19 to specifically allow restrained or pi-tape measurement for verification (ref. Drawing 165-F-026-W5, Rev. B, Zone D-5).	Final dimensions are being held at the assembly level such that the circularity of flexible component at the subassembly level is not required. The necessary requirement is to have the proper overall diameter that is achieved in the restrained condition. Also, pi-tape measurements are more easily achieved as an OD rather than ID. No impact to certification basis.
ECO 11834 Addendum 2	Deleted F/N 8 next to Item 5 callout (ref. Drawing 165-F-026-W5, Rev. B, Zone C-2).	Reference to F/N 8 is no longer applicable as post-lead pour dimensional requirements are explicitly applied. No impact to certification basis.

Document	Change Description	Evaluation
ECO 11834 Addendum 2	Revised "11 GA. (.120)" to be ".120 ±.008 (11 GA.)" for Item 3 (ref. Drawing 165-F-026-W5, Rev. B, Zone D-7).	Revision specifies the required material thickness tolerance to remove ambiguity implied in the ASTM standard. No impact to certification basis.
ECO 11834 Addendum 2	Revised "7 GA. (.179)" to be ".179 ±.008 (7 GA.)" for Item 4 (ref. Drawing 165-F-026-W5, Rev. B, Zone D-5).	Revision specifies the required material thickness tolerance to remove ambiguity implied in the ASTM standard. No impact to certification basis.
ECO 11834 Addendum 2	Added F/N 20 to Items 3 & 4 (ref. Drawing 165-F-026-W5, Rev. B, Zone C-4, C-7).	Longitudinal seam weld applies only to rolled and welded plate. No impact to certification basis.

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4.2 DOT 7A Type A Packaging Tests

4.2.1 Water Spray

The Shielded Container was not subject to a water spray test per 49 CFR §173.465(b) prior to each of the free drop tests as the packaging was shown to be bubble leak tight when properly assembled and closed.¹² Additionally, soaking the Shielded Container with water for 1 hour is of no consequence to other DOT 7A Type A evaluation criteria since it is fabricated entirely of metallic and non-water soluble materials.

4.2.2 Free Drop

Two Shielded Container test units were fabricated, assembled, and each subjected to two successive free drop orientations from a distance of 4 ft onto an essentially unyielding surface per the requirements of 49 CFR §173.465(c).¹² The essentially unyielding surface had a 27,781 lb load capacity and consisted of a 12 ft reinforced concrete cube with a grouted 1-³/₄ in. thick steel cap. The contents, tare, and gross weight of each test unit is provided in Table 4-3. The test units were each fitted with an UltraTech 9400 rad waste filter installed per the manufacturer's instructions.

4.2.2.1 Test Contents

The simulated contents in each test unit was a prototypic 30-gallon steel drum filled with concrete, the center displaced by a 27-inch long, 10-inch nominal inside diameter Sonotube® concrete form, as shown in Figure 4-1. The 30-gallon drums utilized an internal lever-lok closure ring and were each fitted with an UltraTech 9400 rad waste filter installed per the manufacturer's instructions. In addition to the 30-gallon payload drum, 100 g of flourescein well-mixed with ¹/₂ lb of flour was placed inside the Shielded Container (outside of the 30-gallon payload drum) as a fine particulate containment indicator. Each test unit was rotated on its side and rolled prior to the initiation of drop testing to disperse the indicator throughout the package. Again, the contents weight for each test unit is provided in Table 4-3.

4.2.2.2 Test Orientations

Temporary lift attachments were welded onto the test units, as required and in a manner to not interfere with the package performance, to facilitate rigging the package for specific drop test orientations. Test unit SCA-1 was subject to a top-down, center of gravity-over-corner drop orientation (33-¹/₂° from vertical) followed by a bottom-down, end drop orientation (0° from vertical) as shown in Figure 4-2. Test unit SCA-2 was subject to a top-down, near vertical end drop orientation (10° from vertical) followed by a side drop orientation (90° from vertical) as shown in Figure 4-3.

¹² Engineered Products Department, *Manufacturing Quality Planning Traveler*, 2570-TEST ASM.1, ASM.2, and ASM.4, Washington Group International, October 2007.

The free drop test orientations were selected as bounding for the design based on the following:

Top-Down, Center of Gravity-Over-Corner Drop Test

- results in the worst-case corner damage corresponding to the greatest potential for a radiation shine path, and
- results in the worst-case corner damage corresponding to possible seal leakage.

Bottom-Down End Drop Test

- results in the worst-case axial acceleration to the lead column corresponding to the greatest amount of lead slump,
- results in the worst-case axial force corresponding to the greatest buckling loads on the inner and outer steel shells, and
- results in the worst-case axial acceleration of the filter shield plug and possible deformation of the filter shield cap corresponding to the greatest potential for a radiation shine path.

Top-Down, Near-Vertical End Drop Test

- results in the worst-case closure bolt tensile load (maximum prying load to lid), and
- results in the worst-case closure bolt stretch corresponding to possible seal leakage.

Side Drop Test

- results in the worst-case closure bolt shear and bending load (due to lateral shift), and
- results in the worst-case lateral deformation of the lead shielding and side shells.

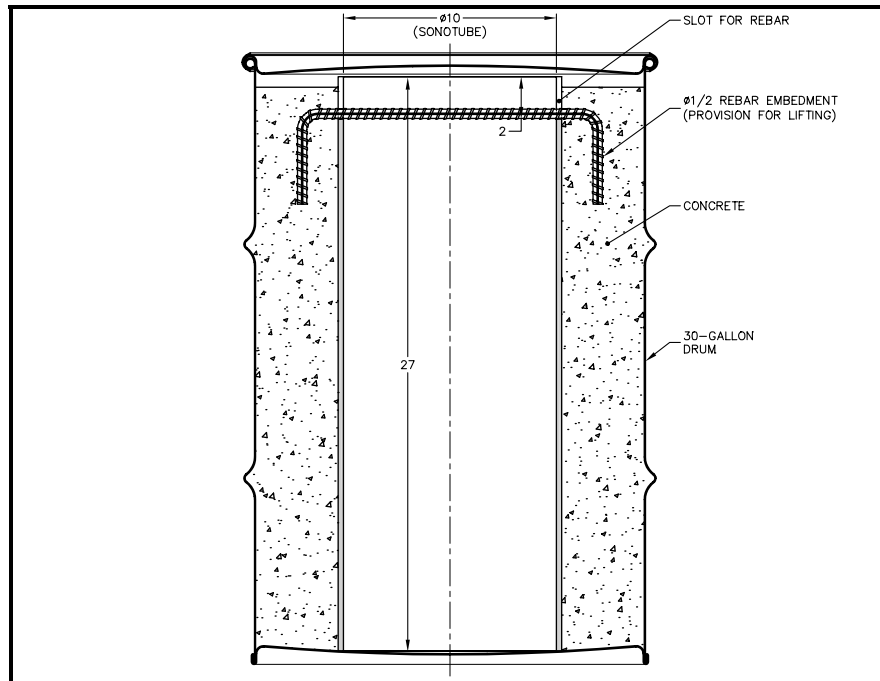


Figure 4-1 – 30-Gallon Payload Drum Filled with Concrete

Table 4-3 – Test Article Weights

Test Article	Contents Weight (lb)	Tare Weight (lb)	Total Gross Weight ^{①②} (lb)
SCA-1	492	1628.5	2117.0
SCA-2	491	1641.5	2128.5

- ① Each weight determined by measurement using calibrated load cell such that Contents Weight plus Tare Weight doesn't exactly equal Total Gross Weight due to measurement error.¹²
- ② The Authorized Maximum Gross Weight of the loaded package (2,260 lb per Table 2-2) is slightly greater than the as-tested Total Gross Weight; an evaluation of and justification for the design change is provided in Table 4-2.

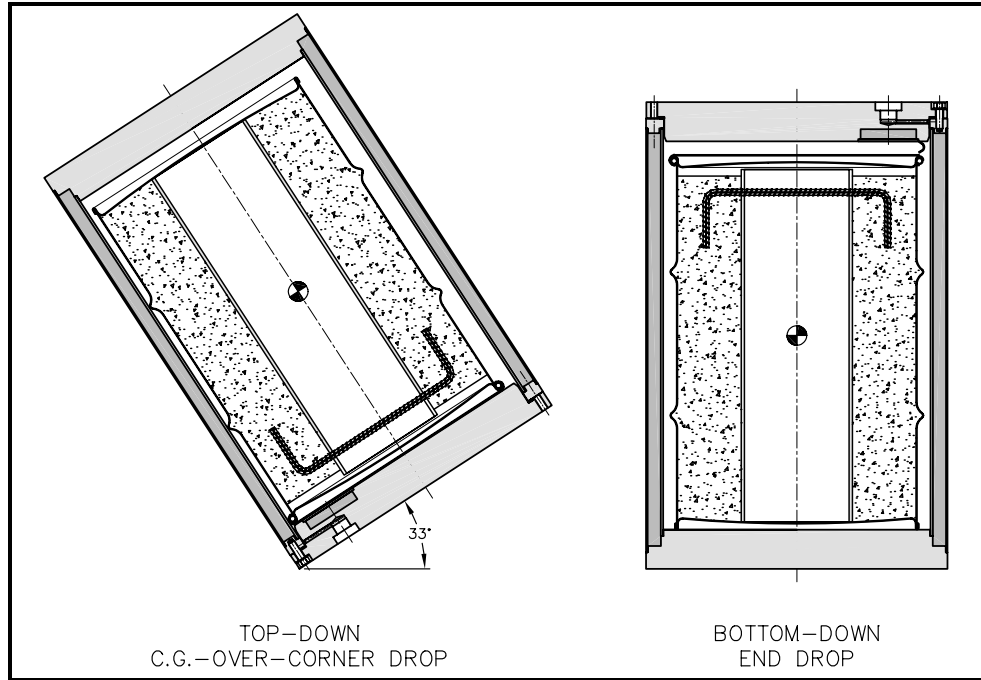


Figure 4-2 – SCA-1 Free Drop Test Orientations

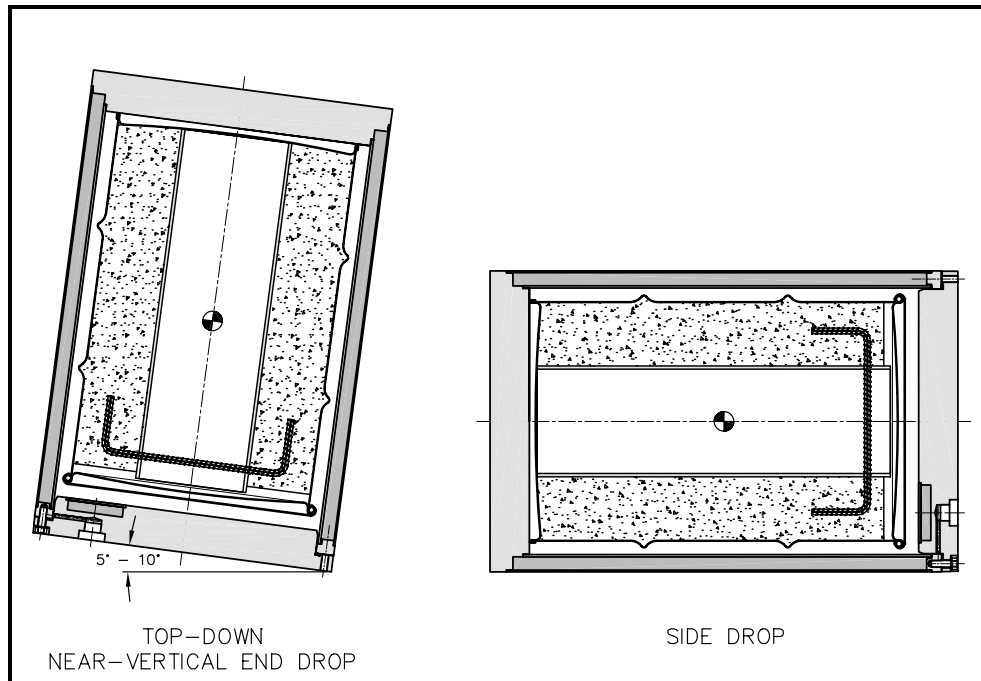


Figure 4-3 – SCA-2 Free Drop Test Orientations

4.2.2.3 Containment

Following each drop test, the test unit was visually inspected with the aid of an ultraviolet light source (minimum intensity of 1,200 $\mu\text{W}/\text{cm}^2$ at 15 in.) in a darkened area with no more than 5 foot candles of ambient white light. No release of the simulated payload was discovered upon visual inspection.¹² The following provides a summary of package damage resulting from each of the free drop tests conducted:

Top-Down, Center of Gravity-Over-Corner Drop Test (SCA-1, 1st drop)

- approximately 7 in. long by 1 in. wide flat on the lid with slight flattening of the corner of one closure bolt head due to the primary impact (see Figure 4-4), and
- slight flattening (approximately 1- $\frac{3}{4}$ in. wide) of the body outer shell to end plate weld cap due to secondary impact (see Figure 4-5).

Bottom-Down End Drop Test (SCA-1, 2nd drop)

- approximately 20% of the circumference of the body outer shell, near the shell to base plate attachment weld, experienced a slight radial bulging in-line with the side of the base plate that contacted the test pad first (i.e., the bottom-end drop experienced a slight rotation during free fall) (see Figure 4-6 and Figure 4-7).

Top-Down, Near-Vertical End Drop Test (SCA-2, 1st drop)

- approximately 10 in. long by 1 in. wide flat on the lid due to the primary impact (see Figure 4-8 and Figure 4-9).

Side Drop Test (SCA-2, 2nd drop)

- approximately 2 in. wide flat over the length of the body due to the primary impact (see Figure 4-10 and Figure 4-11).

In summary, both test units underwent two successive 4-ft drop tests in orientations previously identified such that cumulative damage was recorded during testing, and therefore considered within this evaluation. During testing, it was observed that no significant damage to the package was sustained. After each drop test it was observed that there was no release of the simulated contents (i.e., solids, representing fine powder/particulates, large particulates, and large bulky objects).



Figure 4-4 – SCA-1 Lid Damage, Top-Down, Center of Gravity-Over-Corner Drop Test



Figure 4-5 – SCA-1 Body Damage, Top-Down, Center of Gravity-Over-Corner Drop Test



Figure 4-6 – SCA-1 Body Damage Top View, Bottom-Down End Drop Test



Figure 4-7 – SCA-1 Body Damage Side View, Bottom-Down End Drop Test



Figure 4-8 – SCA-2 Lid Damage Front View, Top-Down, Near-Vertical End Drop Test



Figure 4-9 – SCA-2 Lid Damage Side View, Top-Down, Near-Vertical End Drop Test



Figure 4-10 – SCA-2 Body Damage Overall, Side Drop Test

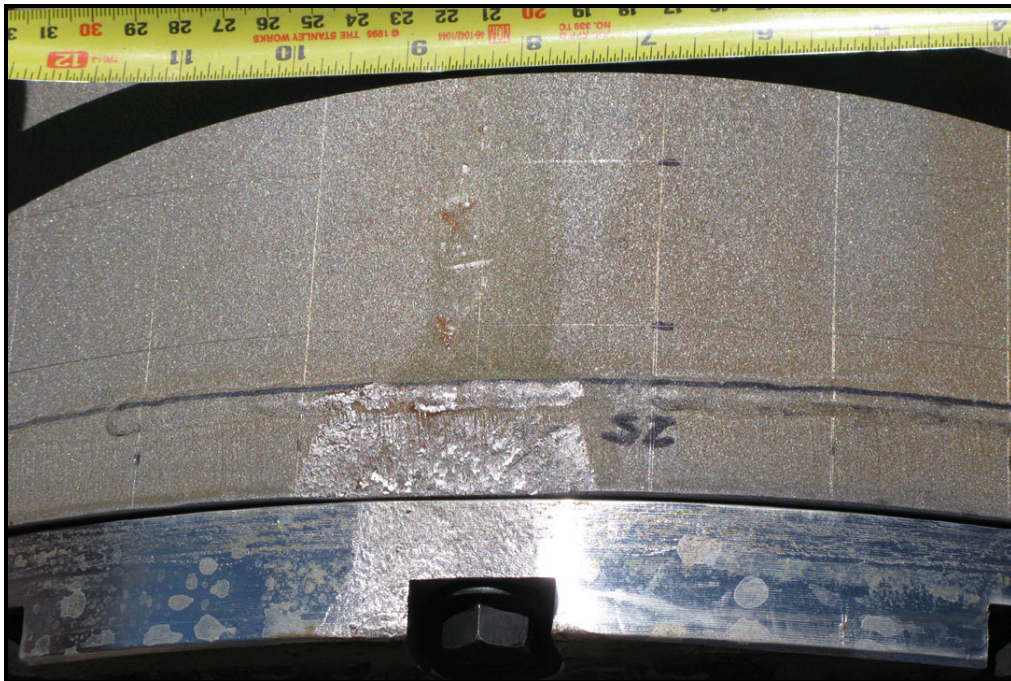


Figure 4-11 – SCA-2 Body Damage Close-up, Side Drop Test

4.2.2.4 Shielding

Prior to and upon conclusion of the two drop tests conducted on test units SCA-1 and SCA-2, the body of each test unit was subjected to a gamma scan. The gamma scan consisted of evaluating the measured dose rate at grid points, spaced approximately every 1-½ in., axially and circumferentially, about the outer shell and through the steel/lead/steel wall of the packaging. The gamma scans were conducted using a calibrated meter and 10 µCi Co-60 source.¹³ The gamma scan data obtained provides additional information that was used to evaluate the potential for loss of shielding effectiveness due to the sustained damage observed for each test unit. The grid map utilized in the pre- and post-test gamma scans is provided in Figure 4-12. A comparison of pre- and post-drop dose rate measurements for each test unit was performed and provided in the form of percentage change plots (Figure 4-13 and Figure 4-14).

At the lowermost axial grid locations for both test units, a lack of setup repeatability in the pre- and post-drop test gamma scans produced erroneous gamma scan readings. The lack of setup repeatability was primarily influenced by the inability to directly align the dose detector and the source at the axial 0, -1, and -2 grid locations. The low activity of the source and amount of base steel material contributing to dose attenuation at the lowermost axial grid locations was problematic in achieving accurate measurements. With the exception of two anomalous readings on SCA-2 (one location indicating an approximately 20% increase in shielding effectiveness and a second indicating an approximately 20% decrease in shielding effectiveness), the straight-line through-wall (axial locations 1 thru 21) gamma scan readings in the body of the container demonstrated less than 20% change in shielding effectiveness as a result of the drop tests for SCA-1 and SCA-2. The two anomalous readings for SCA-2 (located at axial location 5 and circumferential locations 41 and 46) were not selected for further investigation through sectioning or considered significant because they do not correspond to a physical location where shielding damage would be expected to occur and they are surrounded by grid locations that showed a small change in shielding effectiveness.

Post-test visual inspection and sectioning of the test articles served as the primary evaluation of the potential for loss of shielding effectiveness of the package. Neither of the test units experienced gross buckling or significant damage to the lid, base, body shells, or annular lead that would reduce the shielding effectiveness of the package. The minor bulging in the body outer shell resulting from the bottom end drop orientation (SCA-1) was localized and simply resulted in a separation of the outer shell away from the annular lead column where the lead did not flow or otherwise slump into the protruded bulge. No visual damage was discernible in the lid with the exception of the steel that flowed directly as a result of contact of the lid with the target in the top-down center of gravity-over-corner (SCA-1) and top-down near-vertical end drop (SCA-2) orientations. Additionally, the filter shield cap was undisturbed such that the filter shield plug shielding effectiveness was unchanged for both test units. There was no indication from the sectioned articles of lead slump or lead movement as a result of the free drop tests.

Full axial sections of the SCA-1 and SCA-2 test units are shown in Figure 4-15, Figure 4-16, and Figure 4-17. SCA-1 was sectioned in the area of greatest outer shell bulging associated with the

¹³ Engineered Products Department, *Shielding Integrity Summary for Type A Tests*, Task Order No. 408510 - Task 2, Washington Group International, April 2008.

bottom end drop (circumferential grid location #8, see Figure 4-13). SCA-2 was sectioned in the area of axial contact with the target in the side drop (circumferential grid location #24, see Figure 4-14). From inspection of the sections, no lead movement, slump, or damage resulted from the drop tests of either test article. Note that the pear-shaped feature in SCA-2 (Figure 4-16) is related to the section being taken from a lead production pour access location and the apparent localized freezing of lead in the fill tube during lead pouring. Process controls and gamma scan verification of subsequent test and production units has remedied the issue. The process related voids have no affect on the DOT 7A Type A certification testing because they were inconsequential to the shielding effectiveness (percentage change) determination and did not represent a reduction in shielding effectiveness resulting from damage experienced in the drop tests.

To confirm that the areas indicating greater than 20% reduction in shielding effectiveness were anomalous and due to measurement error, additional (lower) axial grid sections were taken from the test units at locations indicating the largest percentage reduction in shielding effectiveness. As shown in Figure 4-18, the area of largest measured change in SCA-1 (circumferential grid location #21, see Figure 4-13) is shown to have experienced no loss of effective shielding due to lead slump, cracking, or related damage. As with the full axial SCA-2 section, the lower SCA-1 section cut shown in Figure 4-18 was located near a lead production pour access location that exposed a small void apparently resulting from localized freezing of lead in the fill tube during lead pouring. As shown in Figure 4-19, the area of largest measured change in SCA-2 (circumferential grid location #20, see Figure 4-14) is shown to have experienced no loss of effective shielding due to lead slump, cracking, or related damage.

In summary, both test units underwent two successive 4-ft drop tests in orientations previously identified such that cumulative damage was recorded during testing, and therefore considered within this evaluation. During testing, it was observed that no significant damage to the package was sustained. After the conclusion of drop test activities, it was observed that there was no significant reduction in the shielding effectiveness of the package.

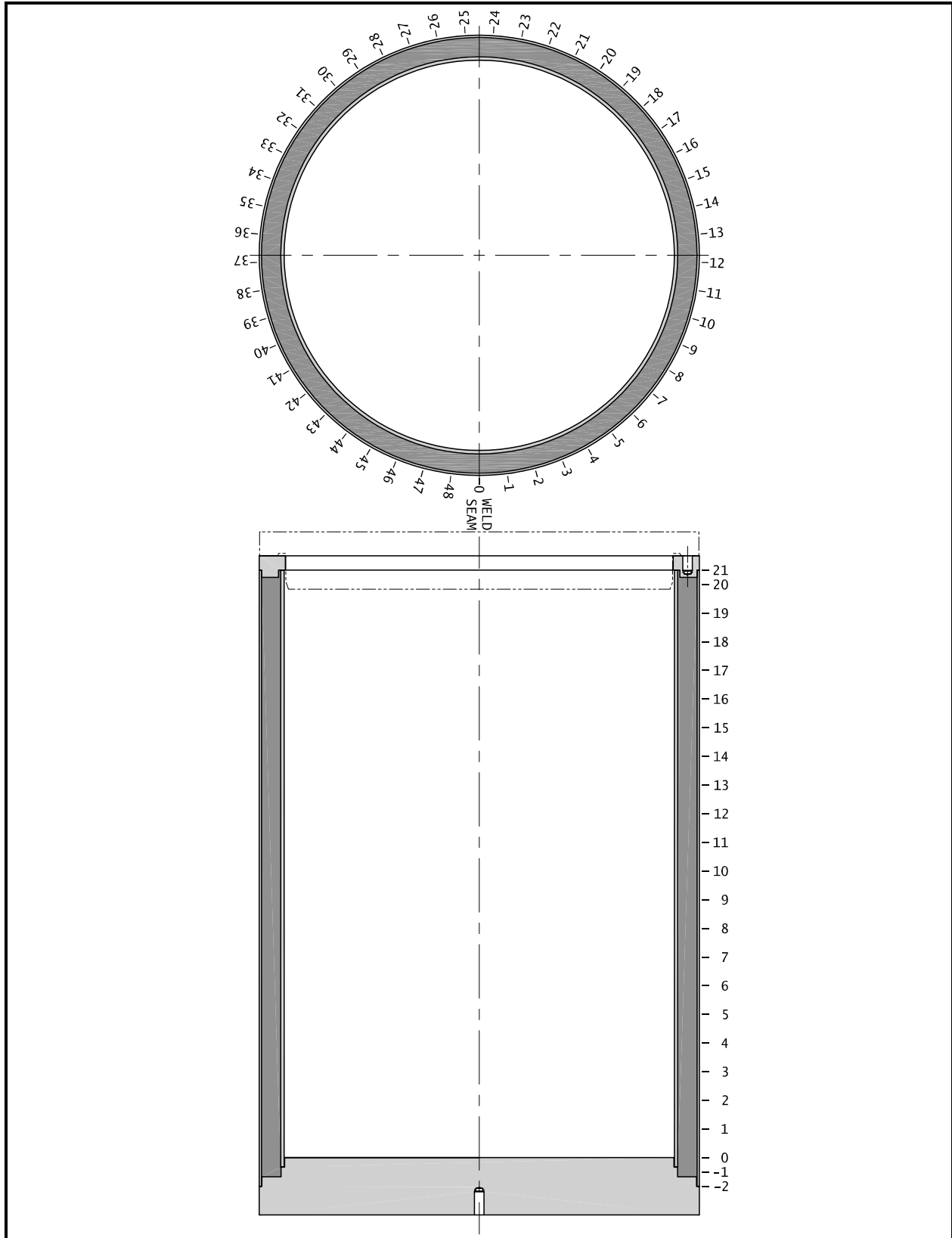


Figure 4-12 – Circumferential and Axial Gamma Scan Grid Map

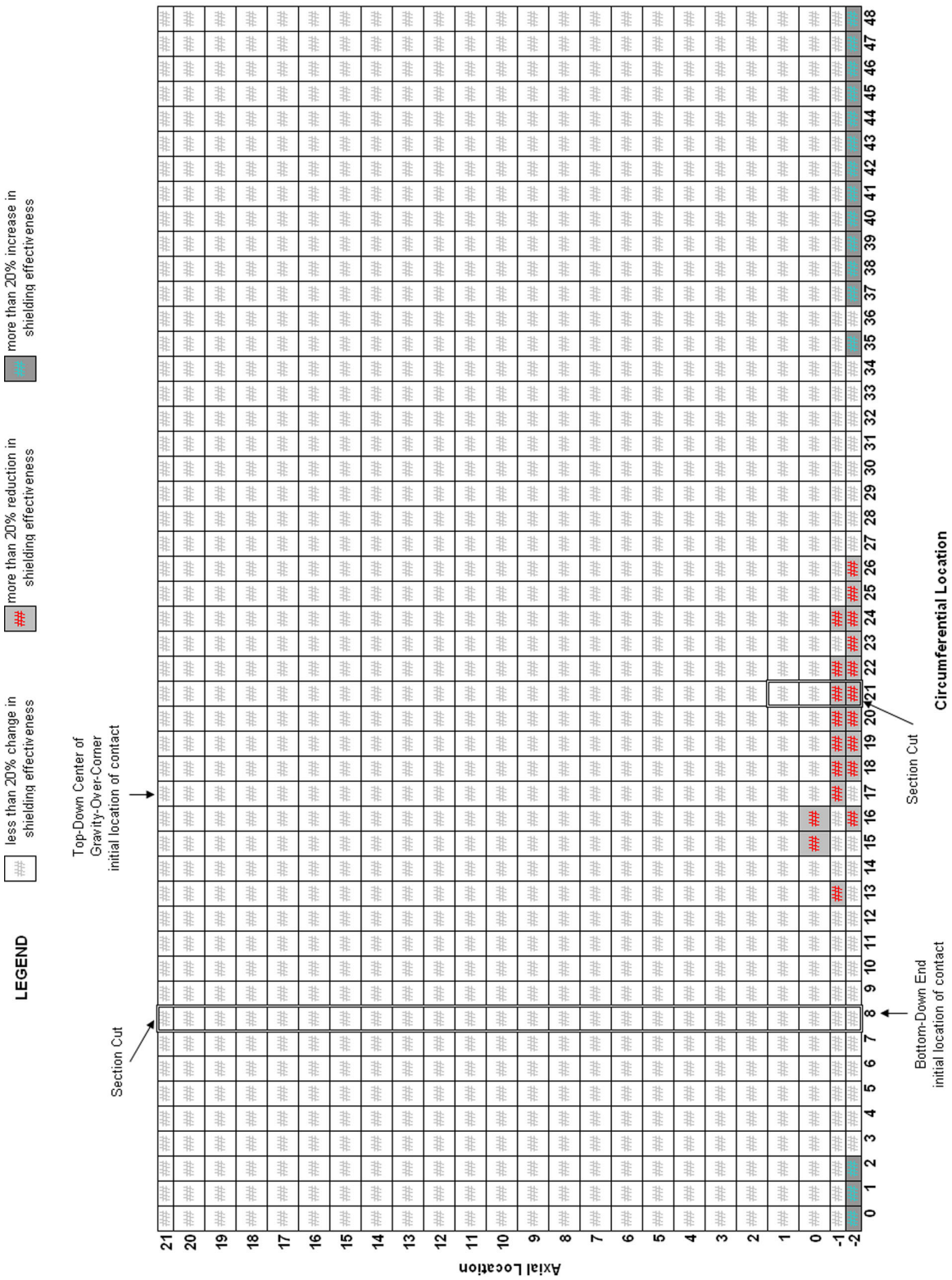


Figure 4-13 – SCA-1 Shielding Change Indicated by Measurement

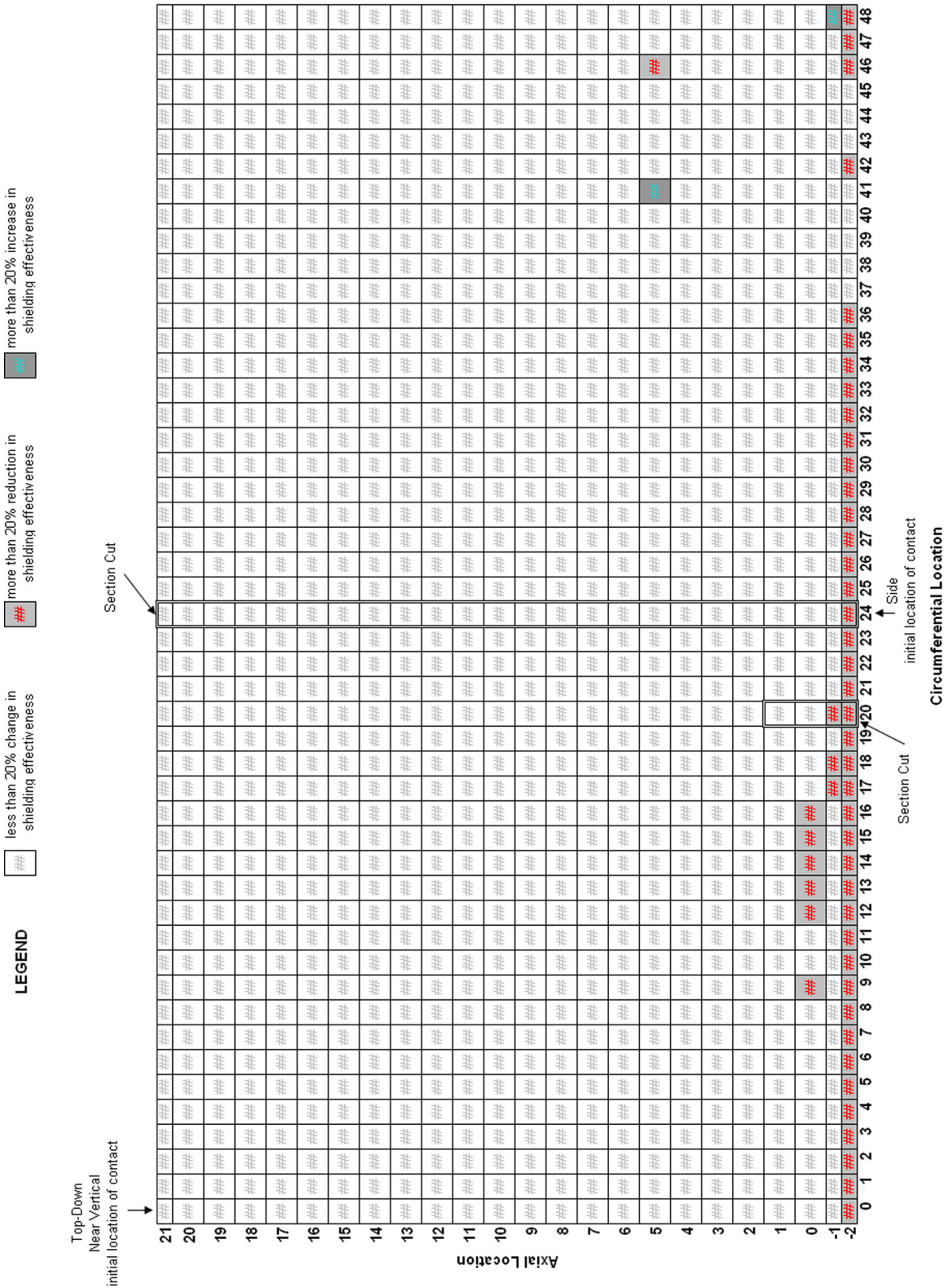


Figure 4-14 – SCA-2 Shielding Change Indicated by Measurement

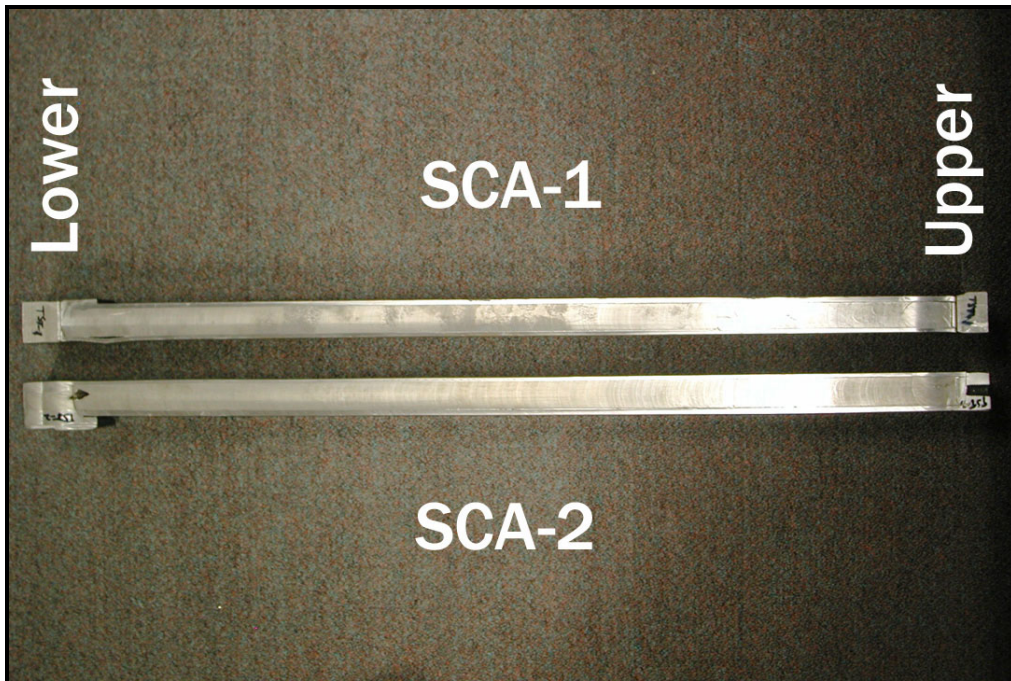


Figure 4-15 – SCA-1 (#8) and SCA-2 (#24) Full Section Cuts

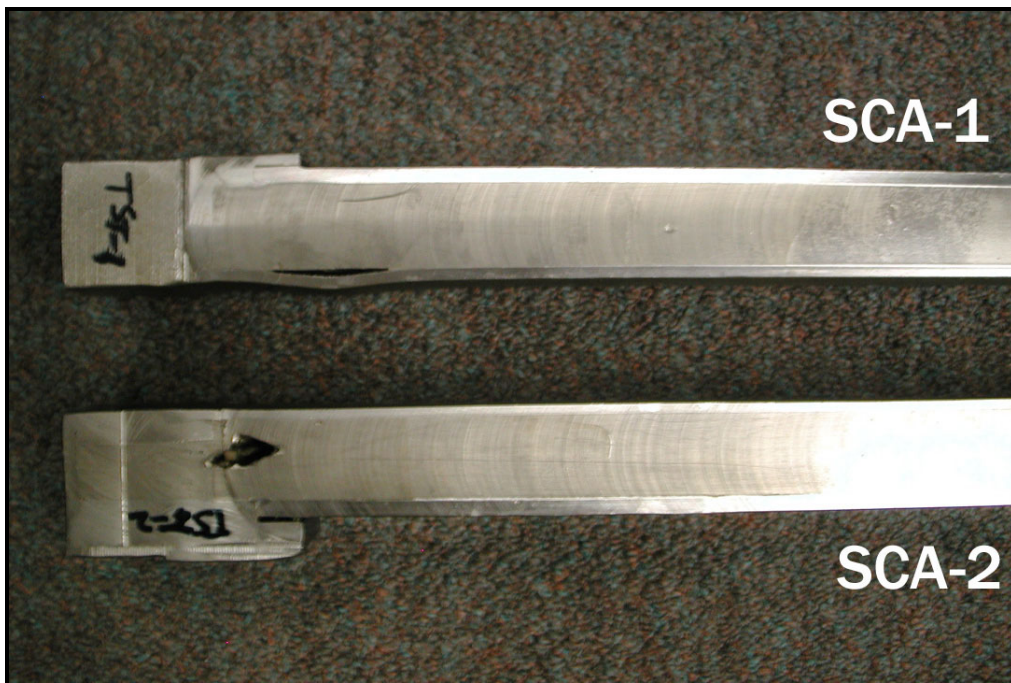


Figure 4-16 – SCA-1 (#8) and SCA-2 (#24) Full Section Cuts, Lower End Close-up

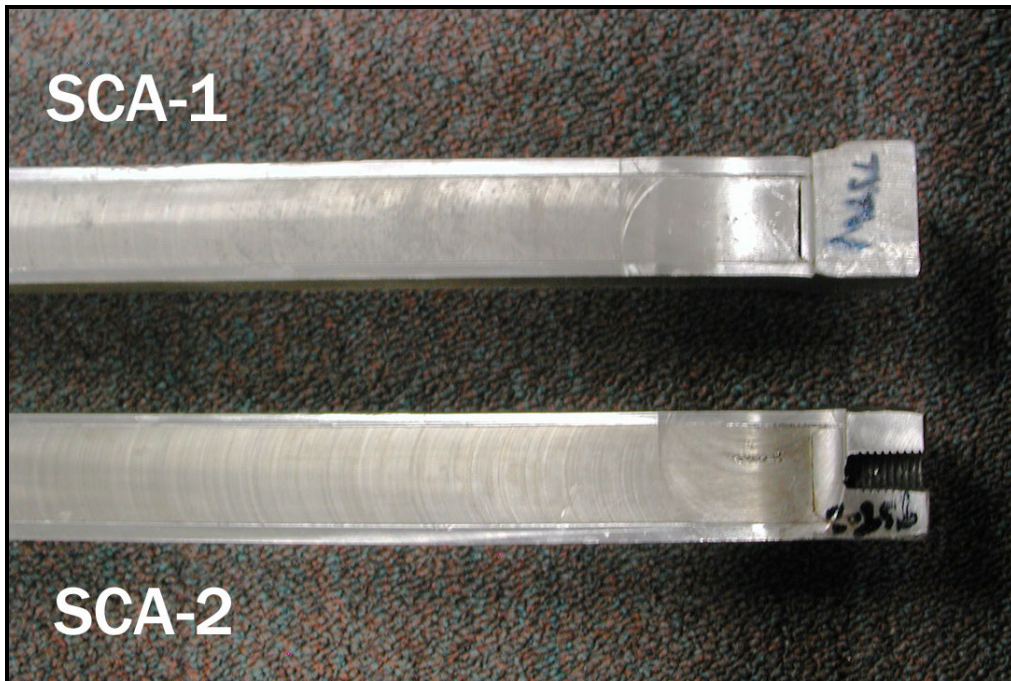


Figure 4-17 - SCA-1 (#8) and SCA-2 (#24) Full Section Cuts, Upper End Close-up

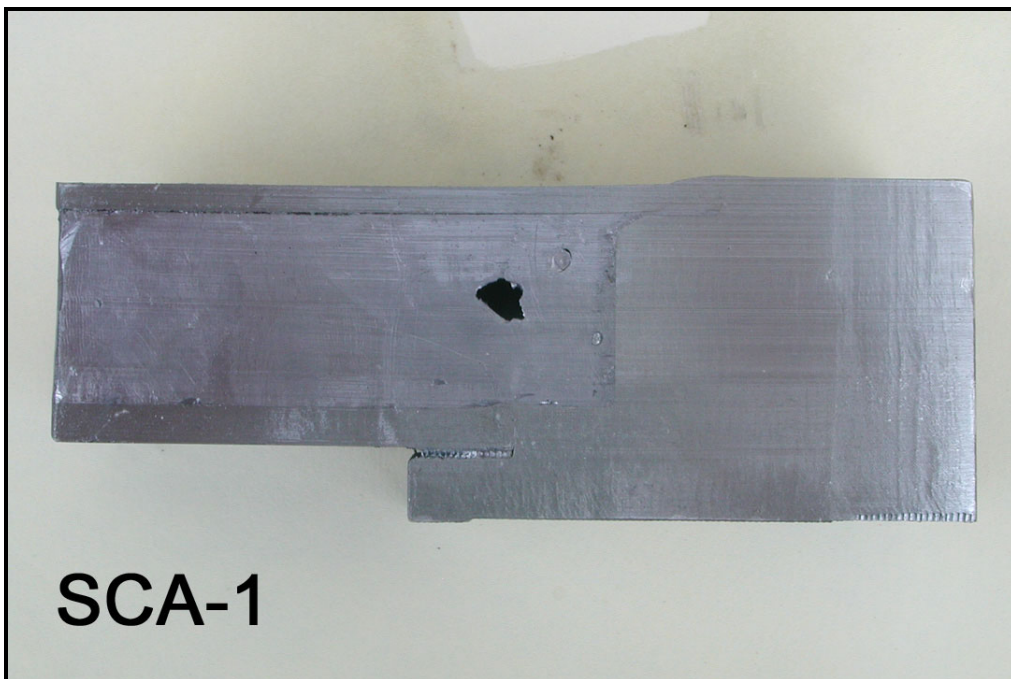


Figure 4-18 – SCA-1 (#21) Lower Section Cut

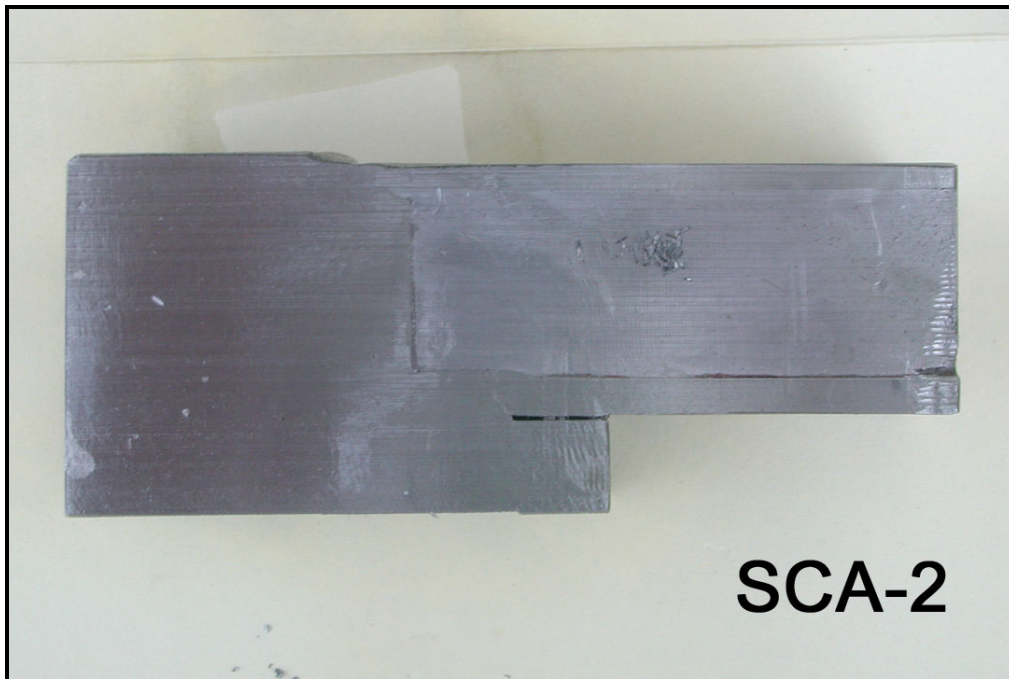


Figure 4-19 – SCA-2 (#20) Lower Section Cut

4.2.3 Stacking

Determination of compliance with packaging stacking requirements of 49 CFR §173.465(d) was achieved through an analytical evaluation to determine that the Shielded Container structure will not buckle under the regulatorily required stacking load (i.e., the greater of 5 times the weight of the package [11,300 lb] or 13 kPa times the vertically projected area of the package [783 lb]).

Each Shielded Container weighs a maximum of 2,260 pounds, fully loaded. Assuming a bounding configuration of six payload containers that exceeds the regulatory stacking requirements, the axial load on the shells, $P = 6(2,260) = 13,560$ pounds. It is also conservatively assumed that all the load is carried by the inner shell. The inner shell's geometry and material properties are as follows:

- Shell Thickness, $t = 0.1793$ inches
- Inner Diameter, $D_i = 20.3750$ inches
- Outer Diameter, $D_o = D_i + 2t = 20.7336$ inches
- Shell Length, $L = 31.2500$ inches
- Yield Strength, $\sigma_y = 45,000$ psi at 70 °F for ASTM A1011, Grade 45, structural steel
- Elastic Modulus, $E = 29(10)^6$ psi at 70 °F for structural steel

The ASME Code Case N-284-1 is utilized for the inner shell buckling calculation.¹⁴ Based on the above geometry, the following geometry constants are determined:

- Nominal Radius, $R = 10.2772$ inches
- Shell Thickness, $t = 0.1793$ inches
- $R/t = 57.32$
- $\ell_\phi = 31.25$ inches
- $\ell_\theta = 64.57$ inches
- $M_\phi = 23.02$
- $M_\theta = 47.57$
- $M = 23.02$ (minimum of M_ϕ or M_θ)

Based on an axial load of 13,560 pounds, the axial stress in the inner shell, σ_ϕ , is:

$$\sigma_\phi = \frac{P}{A} = \frac{13,560}{(\pi/4)[(20.7336)^2 - (20.3750)^2]} = 1,171 \text{ psi}$$

As seen in Table 4-4, all interaction checks are well below unity. Thus, buckling of the inner (or outer) shell will not occur and the stacking test requirement of 49 CFR §173.465(d) is evaluated to be met.

¹⁴ ASME Boiler and Pressure Code Case N-284-1, *Metal Containment Shell Buckling Design Methods*, March 14, 1995 version.

Table 4-4 – Inner Shell Buckling Summary for a 13,560-lb Axial Load

Condition	Inner Shell	Remarks
Capacity Reduction Factors (-1511)		
$\alpha_{\phi L} =$	0.4325	
$\alpha_{\theta L} =$	0.8000	
$\alpha_{\phi\theta L} =$	0.8000	
Plasticity Reduction Factors (-1610)		
$\eta_{\phi} =$	0.2989	
$\eta_{\theta} =$	1.0000	
$\eta_{\phi\theta} =$	0.4073	
Theoretical Buckling Values (-1712.1.1)		
$C_{\phi} =$	0.6050	
$\sigma_{\phi eL} =$	306,098 psi	
$C_{\theta r} =$	0.0421	
$\sigma_{\theta eL} = \sigma_{reL} =$	21,302 psi	
$C_{\theta h} =$	0.0411	
$\sigma_{\theta eL} = \sigma_{heL} =$	20,794 psi	
$C_{\theta h} =$	0.1556	
$\sigma_{\phi\theta eL} =$	78,711 psi	
Elastic Interaction Equations (-1713.1.1)		
$\sigma_{xa} =$	66,196 psi	
$\sigma_{ra} =$	8,521 psi	
$\sigma_{ha} =$	8,318 psi	
$\sigma_{\tau a} =$	31,484 psi	
Axial + Hoop \Rightarrow Checks (a) & (b):	<i>N/A</i>	<1 ∴ OK
Axial + Shear \Rightarrow Check (c):	0.0177	<1 ∴ OK
Hoop + Shear \Rightarrow Check (d):	0.0000	<1 ∴ OK
Axial + Hoop + Shear \Rightarrow Check (e):	<i>N/A</i>	<1 ∴ OK
Inelastic Interaction Equations (-1713.2.1)		
$\sigma_{xc} =$	19,783 psi	
$\sigma_{rc} =$	8,521 psi	
$\sigma_{\tau c} =$	12,823 psi	
Axial or Hoop \Rightarrow Check (a):	0.0592	<1 ∴ OK
Axial + Shear \Rightarrow Check (b):	0.0592	<1 ∴ OK
Hoop + Shear \Rightarrow Check (c):	0.0000	<1 ∴ OK

4.2.4 Penetration

Determination of compliance with packaging penetration requirements of 49 CFR §173.465(e) was achieved through an analytical evaluation to demonstrate that the Shielded Container structure would not be compromised by the regulatorily required puncture load. The outer shell of the Shielded Container is the most vulnerable external feature that could be subject to penetration.

Due to the robustness of the Shielded Container's outer shell, the effect of dropping a 13.2-pound, Ø1.25 hemispherically-ended penetration bar from a height of 1-meter is negligible, as demonstrated by using the BRL penetration formula¹⁵ to calculate the required steel thickness, t , to resist puncture from the bar:

$$t = \frac{(0.5 \times m \times v^2)^{\frac{2}{3}}}{672 \times D} = \frac{(0.5 \times 0.41 \times 14.6^2)^{\frac{2}{3}}}{672 \times 1.25} = 0.015 \text{ in}$$

where the penetration bar mass, $m = 0.41$ slugs, the impact velocity, $v = 14.6$ ft/sec², and the bar diameter, $D = 1.25$ in. Since the Shielded Container's outer shell is 11-gauge material (0.120 inches thick), the shell will not puncture as the minimum thickness to resist penetration of the bar is eight times less than that provided by the packaging. Thus, the penetration requirement of 49 CFR §173.465(e) is evaluated to be met.

4.2.5 Vibration

The design of the shielded container, due to the robustness and mass required to provide sufficient levels of gamma shielding, is such that normal transport condition vibrations and/or accelerations per 49 CFR §178.608 are of no significance to the package. The stiffness of the 3 in. thick lid and base, and the greater than 1 in. thick steel/lead/steel body sidewall is such that resonant frequencies would not be encountered during normal condition transport. The 15 closure bolts, when preloaded to the torque requirements referenced herein, would not loosen or otherwise be significantly affected by vibration conditions. Other miscellaneous components are either welded, press-fit, or otherwise secured in place and not significantly affected by vibration conditions and/or not critical components serving a containment or shielding function in the package. Thus, the vibration requirements of 49 CFR §173.24(b)(2) and 49 CFR §173.24(f) are evaluated to be met.

¹⁵ M.K. Singhall, J.C. Walls, *Evaluation of Wind/Tornado-Generated Missile Impact*, Oak Ridge National Laboratory & Martin Marietta Energy System, Inc., Oak Ridge Tennessee.

4.3 Lifting and Handling

Compliance with the requirements of 49 CFR §173.410(b) and 49 CFR §173.412(i) can be shown to be met by simple comparison. The Shielded Container lid utilizes fifteen closure bolts (Grade 8 flange hex head cap screws) for attachment to the Shielded Container body. The lower ultimate strength and 5X greater average load at the three lid lift interface holes would require failure of the lift interface holes prior to the 15 closure bolts that attach the lid to the body and therefore not impair the ability of the package to maintain containment under an overstressed lifting configuration.

Grade 8 flange hex head cap screws have a minimum yield strength of 130,000 psi. The 1/2-13UNC screw thread has a minimum tensile stress area of

$$A_t = \pi \left[\frac{E_{smin}}{2} - \frac{0.16238}{n} \right]^2,$$

where $E_{smin} = 0.4435 \text{ in}^2$ and $n = 13$, so that

$$A_t = \pi \left[\frac{0.4435}{2} - \frac{0.16238}{13} \right]^2 = 0.1376 \text{ in}^2.$$

Therefore, the tensile stress in each of the 15 closure bolt as a result of lifting the 2,260 lb max gross weight of the package is as follows:

$$\sigma_t = \frac{2,260 \text{ lb}}{15 \times 0.1376 \text{ in}^2} = 1,095 \text{ psi}$$

The factor of safety against yield of the lid closure bolts in lifting is much greater than the regulatory requirement of 3:1, as shown below:

$$FS_t = \frac{130,000 \text{ psi}}{1,095 \text{ psi}} = 119$$

Sufficient factor of safety against yield of the lift interface holes in the lid of the packaging can be ensured by utilizing a lift fixture with a working load limit greater than 753 lb each and at least ½ in. of thread engagement. The shipper is responsible for ensuring the lift interface holes are fitted with the appropriately sized lift fixture device.

A tie-down device that utilized a threaded attachment with the lid lift interface holes would fail prior to the closure bolts and therefore not impair the ability of the package to maintain containment under an overstressed tie-down configuration. Tensile loads on a tie-down device would yield the lid lift interface holes prior to the closure bolts as shown above. Shear loads would yield the tie-down device at the point of the threaded connection with the lid unless the tie-down device had a material yield strength 5X greater than that of the closure bolts (650 ksi yield), which is not possible. The shipper is responsible for ensuring the lift interface holes are fitted with the appropriately sized tie-down device.

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5.0 CONCLUSION

When loaded as described in this report (refer to Section 2.3 and Section 2.4), the evaluation and testing indicates that the Shielded Container configurations (as described in Section 2.0, Section 4.0, and Appendix A) meet applicable DOT 7A Type A design and compliance test requirements. Deviations from the approved, as-tested packaging configurations will require retesting and/or evaluation.

5.1 Restrictions/Specifications

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

The shipper assumes the responsibilities of the manufacturer to ensure the requirements of 49 CFR §178.3(a), (b), and (c) are met. The manufacturer (shipper) of the packaging described herein is responsible for using the packaging fabrication materials, processes, and controls that are equivalent to those used in the fabrication of the approved as-tested and evaluated packaging.

The following additional restrictions/specifications shall be observed:

1. The packaging shall be constructed in accordance with the latest revision of the drawings and specification as referenced herein.
2. The packaging shall be operated in accordance with the latest revision of the handling and operation manual as referenced herein.
3. The packaging shall be fitted with an approved gasketed filter vent that is compatible with the filter port and installed per the filter manufacturer's instructions.
4. The contents shall be securely fastened/positioned within the 30-gal drum internal payload container in a manner to prevent damage within the packaging. This includes heavy, bulky materials (e.g., concrete chunks, motors, pumps), equipment or materials with sharp corners or protrusions, or material /equipment geometries that could result in highly localized forces.
5. The contents shall be securely fastened/positioned within the 30-gal drum internal payload container in a manner to prevent a significant increase in the amount of radiation at the external surface of the package.

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6.0 QUALITY ASSURANCE PROGRAM

It is essential that controls are in place to ensure that the packaging used complies with the specifications given for the packaging as tested, described, and evaluated in this document. When packaging is used by U.S. Department of Energy (DOE) contractors, each shipper must have a documented quality assurance (QA) program, per DOE Order 414.1C¹⁶, that describes how compliance is achieved, and the degree of its certainty, in addition to providing documentation (audit trail) that demonstrates compliance.

The shipper's organization must implement a QA program that assures the shipment will comply with the regulations. In addition to implementing a QA program, the shipper is responsible for meeting the requirements identified in 49 CFR §173.474, "Quality control for construction of packaging," and §173.475, "Quality control requirements prior to each shipment of Class 7 (radioactive) materials."² These requirements provide the quality control elements that are applicable to DOT 7A Type A packagings.

¹⁶ U.S. Department of Energy (DOE), *Quality Assurance*, DOE Order 414.1C, U.S. Department of Energy, Washinton D.C..

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7.0 DESIGNER

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8.0 APPENDICES

APPENDIX A – DOT 7A TYPE A PACKAGING QUALIFICATION CHECKLIST

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A. DOT 7A TYPE A PACKAGING QUALIFICATION CHECKLIST

A1.0 Contents Characterization

A1.1 Radiological

In the following table identify the radionuclides present in the material. Identify the specific isotopes; for each isotope present identify the quantity in becquerel. If the material is special form, identify the A₁ value; if normal form, identify the A₂ value. Identify the weight in grams of the radionuclides present in the material when known. If nuclide is fissile, identify it as such. Identify the decay heat. Determine the total for each column.

RADIONUCLIDES	QUANTITY (per package)					DECAY HEAT
	Becquerel	A1	A2	Grams	Grams Fissile	Watts/gram
Totals						

(Use extra sheets if needed.)

Using the identified radionuclides determine the associated radiation types.

- Photons (X and gamma rays)
- Alpha particles
- Beta particles (includes positrons)
- Neutron particles
- Other important radiations. Identify.

It is the responsibility of the shipper to identify the radiological composition of the contents.

A1.2 Physical Form

A1.2.1 Weight/Density

Identify the total weight in grams for the material in which the radioactivity is distributed.

Total weight of the load _____ grams

Identify the density of the load.

Density of the load _____ (kg/m³)

It is the responsibility of the shipper to identify the weight and density of the contents and to ensure compliance with the maximum gross weight limit of the package. See Section 2.0 and Table 2-2.

A1.2.2 Phase Solid, Liquid, or Gas

Identify if material is special form or normal form. Determine the physical form of the material. Identify if it is a solid, liquid or gas. If the material is a solid, identify if it is considered form 1, 2, 3, or a heavy, bulky solid. For heavy, bulky materials (e.g., concrete chunks, motors, and pumps), equipment/materials with sharp corners or protrusions, or material/equipment geometries that could result in highly localized forces, ensure that the contents are securely fastened/positioned within the package to prevent damage to the packaging. Identify the density of the material. For liquids identify the specific gravity and viscosity. For gas identify the volume at standard temperature and pressure (STP). Indicate if a phase change(s) can occur over the required temperature range.

Form Category: Normal Special (see 49 CFR §173.469)

Physical Form: Solid Form 1 Form 2 Form 3

Heavy, bulky solid requiring dunnage.

Liquid Specific Gravity Viscosity

Gas

Volume

_____ (cm³ at STP)

Phase Change: Phase No Phase change

It is the responsibility of the shipper to identify the form category, physical form, and phase change of the contents to ensure compliance with the authorized contents for the packaging. The shipper is additionally responsible for identifying if a phase change can occur over the required temperature. See Section 2.0 and Table 2-4.

A1.3 Thermal

Using the information on decay heat identified in the radioisotope table above, determine the thermal load resulting from decay heat.

Total wattage from decay heat: _____ (watts/package)

Total wattage from other sources: _____ (watts/package)

Total wattage of contents: _____ (watts/package)

It is the responsibility of the shipper to identify the thermal load resulting from decay heat and to ensure that the decay heat does not result in exceeding the maximum operating temperature limits of the packaging materials. See Section 2.0 and Table 2-3.

A1.4 Chemical

Identify the chemical characteristics of the material that makes up the load. The basic chemical makeup of the contents being shipped must be understood to adequately design or select a packaging. Identify chemical properties that would make the packaging harmful to common packaging materials. Identify any materials that would be classed as hazardous materials if they were not radioactive. This would result in the identification of materials that were hazardous because they are explosive, flammable, poisonous, combustible, dangerous when wet, oxidizers, corrosives, irritants, or another hazard. It is suggested that the material be identified by the proper shipping name and identification number from the Hazardous Materials Table (49 CFR §172.101) it would have if it were not radioactive. Space is provided on the following table for the information. Identify the quantities of each material that will be in the load.

If the package will contain organic substances, identify them and the quantity expected to be present in a single package. Also, watch for materials that are pyrophoric or materials that react with air or water.

A1.4.1 Chemical Compatibility

List the chemical properties that may make the material being shipped incompatible with common packaging materials.

It is the responsibility of the shipper to list the chemical properties of the contents and to ensure compatibility within the contents and with the packaging materials. See Section 2.0 and Table 2-3.

A1.4.2 Hazardous Materials Proper Shipping Names

PROPER SHIPPING NAME	IDENTIFICATION NUMBER	EXPECTED QUANTITY (per package)		
		Solids (grams)	Liquids (ml)	Gases (cm ³ at STP)

(Use extra sheets if needed.)

It is the responsibility of the shipper to identify and list the proper shipping names.

A1.4.3 Organic Chemicals

NAME OF ORGANIC CHEMICALS	EXPECTED QUANTITY (per package)

(Use extra sheets if needed.)

It is the responsibility of the shipper to identify and list the organic chemicals.

A2.0 Classification of Contents

A2.1 Is the Material Radioactive?

Determine if material is radioactive for transportation per the requirements of 49 CFR §173.403.

For transportation, the material is classified as: Radioactive Nonradioactive

It is the responsibility of the shipper to determine whether the contents are radioactive.

A2.2 Is the Material Nonfissile or Fissile Exempt?

Are fissile nuclides present? If no, the material is nonfissile. If yes, can the material meet the conditions in 10 CFR §71.53? If yes, the material is fissile exempt. If no, the material is fissile and requires a certified packaging. Check the appropriate box.

Nonfissile Fissile Exempt Fissile (Certified Package Required)

It is the responsibility of the shipper to determine whether the contents are nonfissile or fissile exempt and compatible with the packaging. See Section 2.0.

A2.3 Can Type A Quantity Limits Be Met?

If more than one nuclide is present, determine the A_1 or A_2 value, as applicable, for the mixture. If only one nuclide is present, use the value from the table. Determine if the total activity to be placed in the package is less than or equal to a Type A quantity.

A_1 or A_2 value calculated or from table _____ TBq

Type A quantity present? Yes No

If yes, identify the proper shipping name from 49 CFR §172.101 Hazardous Materials Table.

For the identified proper shipping name, does the entry in column 8 (Packaging) identify 49 CFR §173.415?

49 CFR §173.415 referenced? Yes No

It is the responsibility of the shipper to determine whether the contents meet Type A quantity limits.

A3.0 Packaging Selection

A3.1 Authorized Type A Packaging Category Selected

The DOT authorizes four categories of packagings for use when shipping Type A quantities of radioactive material. Identify the category selected.

- Specification 7A, General Packaging, Type A. For packaging in this category, completion of this checklist will identify required documentation.
- Other Type A Packagings. When using other Type A packagings, be sure to register as a user and follow all conditions of use identified for the packaging.
- Type B Packagings. When using a Type B packaging, be sure to register as a user and follow all conditions of use identified for the packaging. If using a Type B packaging as a Type A packaging, conduct required evaluations. The documentation requirements identified in this document apply to a Type B packaging as a Type A packaging.
- Foreign-made Packagings. When using a foreign-made packaging, obtain the packaging's documentation and verify the packaging was used for import. While not directly applicable, this checklist provides some idea of the type of documentation that should be found.
 - Packaging meets the standards in International Atomic Energy Agency (IAEA) Regulations for the Safe Transport of Radioactive Material, 2005 Edition, Safety Standards Series No. TS-R-1 (IAEA 2005) and bears the marking "Type A."
 - Packaging was used for the import of Class 7 (radioactive) materials.
 - Possess the applicable documentation of tests and engineering evaluations and maintain the documentation on file in accordance with 49 CFR §173.415(a).

[It is the responsibility of the shipper to determine that the authorized packaging category is selected and compatible with the packaging. See Section 2.0.](#)

A3.2 Physical Characteristics of the Load

Selection of a proper packaging requires knowledge of the physical characteristics of the load. Space is provided in the following subsections to identify where the documentation for the radiological, physical, thermal, and chemical data for the load is found. The information is needed to document compatibility of the load with the packaging.

A3.2.1 Radiological Characteristics

If not provided in Section A1.0 of the checklist, identify where the documentation of radionuclides present in the load can be found.

[It is the responsibility of the shipper to determine the radiological characteristics of the contents in compliance with the packaging certification. See Section 2.0.](#)

A3.2.2 Physical Characteristics

If not provided in Section A1.0 of the checklist, identify where the documentation of physical characteristics of the load can be found.

<p>It is the responsibility of the shipper to determine the physical characteristics of the contents in compliance with the packaging certification. See Section 2.0.</p>

A3.2.3 Physical Phase, Solid, Liquid, or Gas

If not provided in Section A1.0 of the checklist, identify where the documentation of physical characteristics of the load can be found.

<p>It is the responsibility of the shipper to determine the physical phase of the contents in compliance with the packaging certification. See Section 2.0.</p>

A3.2.4 Gas Generation

If not provided in Section A1.0 of the checklist, identify where the documentation of gas generation by the load can be found.

<p>It is the responsibility of the shipper to determine the gas generation of the contents in compliance with the packaging certification. See Section 2.0.</p>

A3.2.5 Thermal

If not provided in Section A1.0 of the checklist, identify where the documentation on thermal characteristics of the load can be found.

<p>It is the responsibility of the shipper to determine the thermal characteristics of the contents in compliance with the packaging certification. See Section 2.0.</p>

A3.2.6 Chemical Characteristics

If not provided in Section A1.0 of the checklist, identify where the documentation of chemical characteristics of the load can be found.

<p>It is the responsibility of the shipper to determine the chemical characteristics of the contents in compliance with the packaging certification. See Section 2.0.</p>

A3.2.7 Transportation Mode Differences

Identify the mode of transportation.

Aircraft Highway, rail, vessel

If shipment is by aircraft, identify if the package contents are liquid, solid, or gas.

Liquid Solid Gas

If shipment is by air and is liquid, does the packaging meet the minimum pressure differential of 95 kPa (13.8 lb/in²).

Yes No, do not use packaging for shipment of liquid by aircraft

If liquid, do the contents require the ability to meet a higher differential pressure? If yes, identify the pressure required and documentation that shows the packaging meets the requirement.

--

Is the packaging vented?

No Yes, do not use packaging for shipment by aircraft

Are closures held securely in place and prevented from loosening due to vibration and temperature changes?

Yes No, do not use packaging for shipment by aircraft

<p>It is the responsibility of the shipper to determine that the authorized transportation mode is selected in compliance with the packaging certification. See Section 2.0.</p>
--

A4.0 Regulatory Requirements

A4.1 49 CFR §173.24 General Requirements for Packagings and Packages

A4.1.1 173.24(a) Applicability

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

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

All DOT 7A Type A packagings fall into one or more of the identified categories. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in:	<input checked="" type="checkbox"/> Drawing	<input type="checkbox"/> Analysis Report
	<input checked="" type="checkbox"/> Specification	<input checked="" type="checkbox"/> Test Report
	<input checked="" type="checkbox"/> Operating Instruction	<input checked="" type="checkbox"/> Other

Specify:

[See Section 2.0 and Section 4.0.](#)

A4.1.2 173.24(b) Containment

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

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

These requirements apply to DOT 7A Type A packagings. Documentation of the ability of the packaging to meet the more severe requirements of 49 CFR §173, Subpart I, can be used to document compliance. Indicate below the type of documentation that shows these requirements are met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

It is the responsibility of the shipper to determine that the above requirements are met. See Section 2.0 and Section 4.0.

A4.1.3 173.24(c) Authorized Packagings

(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 §172.101 table and conforms to applicable requirements in the special provisions of Column 7 of the §172.101 table and, for specification packagings (but not including UN standard packagings manufactured outside the United States), the specification requirements in parts 178 and 179 of this subchapter; or

(2) The packaging is permitted under, and conforms to, provisions contained in subparts B or C of part 171 of this subchapter or §§173.3, 173.4, 173.5, 173.5a, 173.6, 173.7, 173.8, 173.27, or §176.11 of this subchapter.

DOT 7A Type A packagings are authorized for packaging for Type A quantities of radioactive materials. Indicate below the type of documentation that shows the load is a Type A quantity and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

It is the responsibility of the shipper to determine that the above requirements are met. See Section 2.0 and Section 4.0.

A4.1.4 173.24(d) Specification Packagings and UN Standard Packagings Manufactured Outside the U.S.--

(d) *Specification packagings and UN standard packagings manufactured outside the U.S.--*

(1) *Specification packagings. A specification packaging, including a UN standard packaging manufactured in the United States, must conform in all details to the applicable specification or standard in part 178 or part 179 of this subchapter.*

A DOT 7A Type A packaging is a specification packaging. Documentation of the ability of the package to meet the packaging requirements identified in 49 CFR §173.415(a) will document compliance with this requirement. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[It is the responsibility of the shipper to determine that the above requirements are met. See Section 2.0 and Section 4.0.](#)

(2) *UN standard packagings manufactured outside the United States. A UN standard packaging manufactured outside the United States, in accordance with national or international regulations based on the UN Recommendations (IBR, see §171.7 of this subchapter), may be imported and used and is considered to be an authorized packaging under the provisions of paragraph (c)(1) of this section, subject to the following conditions and limitations:*

(i) *The packaging fully conforms to applicable provisions in the UN Recommendations and the requirements of this subpart, including reuse provisions;*

(ii) *The packaging is capable of passing the prescribed tests in part 178 of this subchapter applicable to that standard; and*

(iii) *The competent authority of the country of manufacture provides reciprocal treatment for UN standard packagings manufactured in the U.S.*

This requirement applies to DOT 7A Type A packagings manufactured outside the U.S. Indicate below if the requirement does or does not apply. If applicable, indicate below the form of documentation and where the documentation can be found.

- This requirement does not apply. The DOT 7A Type A packaging being used was manufactured in the U.S.
- This requirement applies as the packaging being used was manufactured outside the U.S.

Documentation of the packaging's ability to meet the more severe requirements of 49 CFR §173, Subpart I, can be used to document compliance.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, manufactured in U.S.

A4.1.5 173.24(e) Compatibility

(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.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows the lading is compatible with the packaging and identify where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

It is the responsibility of the shipper to determine that the above requirements are met. See Section 2.0 and Section 4.0.

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

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows there will be no significant chemical or galvanic reactions and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

It is the responsibility of the shipper to determine that the above requirements are met. See Section 2.0 and Section 4.0.

(3) Plastic packagings and receptacles.

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

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

(A) 18 °C (64 °F) for 180 days in accordance with Test Method 1 in appendix B of this part;

(B) 50 °C (122 °F) for 28 days in accordance with Test Method 2 in appendix B of this part; or

(C) 60 °C (140 °F) for 14 days in accordance with Test Method 3 in appendix B of this part.

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

This requirement applies to DOT 7A Type A packagings that use plastic containers to retain the load. Otherwise, the requirement does not apply. Remember to consider secondary hazards. Based on the materials of construction used for holding the load, indicate below if the requirement applies or does not apply. If the requirement applies, identify the documentation that shows compliance and identify where the documentation can be found.

This requirement:	<input checked="" type="checkbox"/> Does not apply.	<input type="checkbox"/> Applies; indicate the following.
Addressed in:	<input type="checkbox"/> Drawing	<input type="checkbox"/> Analysis Report
	<input type="checkbox"/> Specification	<input type="checkbox"/> Test Report
	<input type="checkbox"/> Operating Instruction	<input type="checkbox"/> Other

Specify:

N/A, no plastic components.

(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, poisonous, or asphyxiant gases; or*
- (iii) *Formation of unstable or corrosive materials.*

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

These requirements are applicable to DOT 7A Type A packagings. The requirements are load dependent. The primary hazards in a DOT 7A Type A packaging are not likely to result in the identified hazards. However, secondary hazards are commonly associated with the radioactivity and should be watched for the potential to produce the identified conditions. The potential for a phase change exists with radioactive materials. An evaluation of the potential for a phase change should be made and documented. Indicate below if the requirements apply or do not apply. If the requirements apply, identify the type documentation used to show compliance and where the documentation can be found.

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

Addressed in: Drawing Analysis Report

Specification Test Report

Operating Instruction Other

Specify:

[It is the responsibility of the shipper to determine that the above requirements are met. See Section 2.0 and Section 4.0.](#)

A4.1.6 173.24(f) Closures

(f) Closures.

(1) Closures on packagings shall be so designed and closed that under conditions (including the effects of temperature, pressure 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 leakproof and secured against loosening. For air transport, stoppers, corks or other such friction closures must be held in place by positive means.

(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 and must be closed in accordance with information, as applicable, provided by the manufacturer's notification required by §178.2 of this subchapter.

These requirements apply to DOT 7A Type A packagings. Indicate below the type of documentation that shows the requirements are met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

It is the responsibility of the shipper to determine that the above requirements are met. See Section 2.0 and Section 4.0.

A4.1.7 173.24(g) Venting

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

- (1) Transportation by aircraft is not involved;*
- (2) Except as otherwise provided in this subchapter, the evolved gases are not poisonous, likely to create a flammable mixture with air or be an asphyxiant under normal conditions of transportation;*
- (3) The packaging is designed so as to preclude an unintentional release of hazardous materials from the receptacle;*
- (4) For bulk packagings, other than IBCs, venting is authorized for the specific hazardous material by a special provision in the §172.101 table or by the applicable bulk packaging specification in part 178 of this subchapter; and*
- (5) Intermediate bulk packagings (IBCs) may be vented when required to reduce internal pressure that may develop by the evolution of gas subject to the requirements of paragraphs (g)(1) through (g)(3) of this section. The IBC must be of a type that has successfully passed (with the vent in place) the applicable design qualification tests with no release of hazardous material.*

These requirements apply to DOT 7A Type A packagings that are vented. The requirements are not applicable to nonvented DOT 7A Type A packagings. Based on the design, determine if the requirements apply or do not apply. If the requirements apply, indicate below the type of documentation that shows the requirements are met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

It is the responsibility of the shipper to determine that the above requirements are met. See Section 2.0 and Section 4.0.

A4.1.8 173.24(h) Outage and Filling Limits

(h) Outage and filling limits--

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

(2) *Compressed gases and cryogenic liquids. Filling limits for compressed gases and cryogenic liquids are specified in §§173.301 through 173.306 for cylinders and §§173.314 through 173.319 for bulk packagings.*

These requirements apply to DOT 7A Type A packagings used for the shipment of liquids and gases. The requirements are not applicable to DOT 7A Type A packagings used to ship solids. Based on the load, indicate if the requirements apply or do not apply. If the requirements apply, indicate below the type of documentation that shows the requirements are met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not authorized for liquids and gases.

A4.1.9 173.24(i) Air Transportation

(i) Air transportation. Except as provided in subpart C of part 171 of this subchapter, packages offered or intended for transportation by aircraft must conform to the general requirements for transportation by aircraft in §173.27.

This requirement applies to DOT 7A Type A packagings when used for transportation by aircraft. Otherwise, the requirement does not apply. Based on the mode of transportation, indicate if the requirement applies or does not apply. If the requirement applies, indicate below the type of documentation that shows the requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not authorized for air transport.

A4.2 49 CFR §173.24a Additional General Requirements for Non-bulk Packagings and Packages

A4.2.1 173.24a(a) Packaging design

(a) *Packaging design. Except as provided in §172.312 of this subchapter:*

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

This requirement applies to DOT 7A Type A packagings that meet the definition of a combination packaging and are used to ship liquids. The requirement does not apply to packagings used to ship nonliquids. Based on the packaging type and load, indicate if the requirement applies or does not apply. If the requirement applies, indicate below the type of documentation that shows the requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not authorized for liquids.

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

This requirement applies to non-bulk DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

Structural design of packaging is such that the friction would not compromise the containment boundary of the packaging. It is the responsibility of the shipper to determine that friction would not adversely affect the contents. See Section 2.0.

(3) *Securing and cushioning. Inner packagings of combination packagings must be so packed, secured and cushioned to prevent their breakage or leakage and to control their shifting 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 or having its protective properties significantly weakened in the event of leakage.

This requirement applies to DOT 7A Type A packagings that meet the definition of a combination packaging. The requirement does not apply to non-combination packagings. Based on the packaging type, indicate if the requirement applies or does not apply. If the requirement applies, indicate below the type of documentation that shows the requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not a combination packaging.

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

This requirement applies to DOT 7A Type A packagings that use devices that could protrude into the interior of the outer packaging. Based on the packaging design, indicate if the requirement applies or does not apply. If the requirement applies, indicate below the type of documentation that shows the requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, no use of interior protruding devices.

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

This requirement applies to non-bulk DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

Structural design of packaging is such that the vibration environment specified would not compromise the containment boundary of the packaging. See Section 4.2.5.

A4.2.2 173.24a(b) Non-bulk Packaging Filling Limits

(b) Non-bulk packaging filling limits.

(1) A single or composite non-bulk packaging may be filled with a liquid hazardous material only when the specific gravity of the material does not exceed that marked on the packaging, or a specific gravity of 1.2 if not marked, except as follows:

(i) A Packing Group I packaging may be used for a Packing Group II material with a specific gravity not exceeding the greater of 1.8, or 1.5 times the specific gravity marked on the packaging, provided all the performance criteria can still be met with the higher specific gravity material;

(ii) A Packing Group I packaging may be used for a Packing Group III material with a specific gravity not exceeding the greater of 2.7, or 2.25 times the specific gravity marked on the packaging, provided all the performance criteria can still be met with the higher specific gravity material; and

(iii) A Packing Group II packaging may be used for a Packing Group III material with a specific gravity not exceeding the greater of 1.8, or 1.5 times the specific gravity marked on the packaging, provided all the performance criteria can still be met with the higher specific gravity material.

N/A. DOT 7A Type A packagings do not incorporate Packing Groups.

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

It is the responsibility of the shipper to ensure that the packaging is loaded in compliance with its gross mass limits. See Section 2.0 and Table 2-2.

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

(i) A single or composite non-bulk packaging which is tested and marked for Packing Group I liquid hazardous materials may be filled with a solid Packing

Group II hazardous material to a gross mass, in kilograms, not exceeding the rated capacity of the packaging in liters, multiplied by 1.5, multiplied by the specific gravity marked on the packaging, or 1.2 if not marked.

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

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

N/A. Packing Groups are not applicable to radioactive material.

(4) Packagings tested as prescribed in §178.605 of this subchapter and marked with the hydrostatic test pressure as prescribed in §178.503(a)(5) of this subchapter may be used for liquids only when the vapor pressure of the liquid conforms to one of the following:

(i) The vapor pressure must be such that the total pressure in the packaging (i.e., the vapor pressure of the liquid plus the partial pressure of air or other inert gases, less 100 kPa (15 psia)) at 55 °C (131 °F), determined on the basis of a maximum degree of filling in accordance with paragraph (d) 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 psia); or

(iii) The vapor pressure at 55 °C (131 °F) must be less than two-thirds of the sum of the marked test pressure plus 100 kPa (15 psia).

N/A. 49 CFR §178.605 does not pertain to specification packagings.

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

N/A. For DOT 7A Type A packagings, the requirements of 49 CFR §173.443 override this requirement.

A4.2.3 173.24a(c) Mixed Contents

(c) Mixed contents.

(1) An outer non-bulk packaging may contain more than one hazardous material only when--

- (i) *The inner and outer packagings used for each hazardous material conform to the relevant packaging sections of this part applicable to that hazardous material;*
- (ii) *The package as prepared for shipment meets the performance tests prescribed in part 178 of this subchapter for the packing group indicating the highest order of hazard for the hazardous materials contained in the package;*
- (iii) *Corrosive materials (except ORM-D) in bottles are further packed in securely closed inner receptacles before packing in outer packagings; and*
- (iv) *For transportation by aircraft, the total net quantity does not exceed the lowest permitted maximum net quantity per package as shown in Column 9a or 9b, as appropriate, of the §172.101 table. The permitted maximum net quantity must be calculated in kilograms if a package contains both a liquid and a solid.*

Note this requirement only applies if the package is to carry both radioactive and nonradioactive hazardous materials. Based on the load, indicate if the requirement applies or does not apply. If the requirement applies, indicate below the type of documentation that shows the requirement is met and where the documentation can be found.

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

Addressed in: Drawing Analysis Report

Specification Test Report

Operating Instruction Other

Specify:

N/A, not a combination packaging.

(2) *A packaging containing inner packagings of Division 6.2 materials may not contain other hazardous materials except--*

- (i) *Refrigerants, such as dry ice or liquid nitrogen, as authorized under the HMR;*
- (ii) *Anticoagulants used to stabilize blood or plasma; or*
- (iii) *Small quantities of Class 3, Class 8, Class 9, or other materials in Packing Groups II or III used to stabilize or prevent degradation of the sample, provided the quantity of such materials does not exceed 30 mL (1 ounce) or 30 g (1 ounce) in each inner packaging. The maximum quantity in an outer package, including a hazardous material used to preserve or stabilize a sample, may not exceed 4 L (1 gallon) or 4 kg (8.8 pounds). Such preservatives are not subject to the requirements of this subchapter.*

This requirement does not apply to DOT 7A Type A packagings. The Class 7 packaging requirements will determine the packaging that applies.

A4.2.4 173.24a(d) Liquid Fill Level

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

This requirement applies to DOT 7A Type A packagings. Based on the load, indicate if the requirement applies or does not apply. If the requirement applies, indicate below the type of documentation that shows the requirement is met and where the documentation can be found.

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

Addressed in: Drawing Analysis Report

Specification Test Report

Operating Instruction Other

Specify:

N/A, not authorized for liquids.

A4.3 49 CFR §173.24b Additional General Requirements for Bulk Packagings

A4.3.1 173.24b(a) Outage and Filling Limits

(a) *Outage and filling limits.*

(1) *Except as otherwise provided in this subchapter, liquids and liquefied gases must be so loaded that the outage is at least five percent for materials poisonous by inhalation, or at least one percent for all other materials, of the total capacity of a cargo tank, portable tank, tank car (including dome capacity), multi-unit tank car tank, or any compartment thereof, at the following reference temperatures--*

(i) *46 °C (115 °F) for a noninsulated tank;*

(ii) *43 °C (110 °F) for a tank car having a thermal protection system, incorporating a metal jacket that provides an overall thermal conductance at 15.5 °C (60 °F) of no more than 10.22 kilojoules per hour per square meter per degree Celsius (0.5 Btu per hour/per square foot/ per degree F) temperature differential; or*

(iii) *41 °C (105 °F) for an insulated tank.*

(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.*

These requirements are not applicable to a DOT 7A Type A packaging unless it also meets the definition of a cargo tank; portable tank; tank car; or multi-unit tank car tank, or any compartment thereof, and is used to haul the identified liquids. Based on the packaging design, indicate if the requirements apply or do not apply. If the requirements apply, indicate below the type of documentation that shows the requirements are met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, does not meet definitions for cargo tank, portable tank, etc.

A4.3.2 173.24b(b) Stainless Steel Substitution

(b) *Equivalent steel. For the purposes of this section, the reference stainless steel is stainless 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 §172.102 of this subchapter, special provision B30), the minimum thickness for the steel must be obtained from one of the following formulas, as appropriate:

Formula for metric units:

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

Formula for non-metric units:

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

Where:

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

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

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

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

This requirement is not applicable to DOT 7A Type A packagings as no specific materials of construction are identified for the packaging.

A4.3.3 173.24b(c) Pressurized Loading

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

This requirement applies to DOT 7A Type A packagings that meet the definition of bulk packaging. Based on the packaging design and load, indicate if the requirement applies or does not apply. If the requirement applies, indicate below the type of documentation that shows the requirement is met and where the documentation can be found.

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

Addressed in: Drawing Analysis Report

Specification Test Report

Operating Instruction Other

Specify:

N/A, air pressure not used for loading or unloading.

A4.3.4 173.24b(d) Design Temperature Range/Weight

(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) *Except as otherwise provided in this subchapter, exceeds the maximum weight of lading marked on the specification plate.*

This requirement applies to a DOT 7A Type A packaging that also meets the definition of a bulk packaging. Based on the packaging design, indicate if the requirement applies or does not apply. If the requirement applies, indicate below the type of documentation that shows the requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not a bulk packaging.

A4.3.5 173.24b(e) UN Portable Tanks

(e) *UN portable tanks.*

(1) *A UN portable tank manufactured in the United States must conform in all details to the applicable requirements in parts 172, 173, 178 and 180 of this subchapter.*

(2) *UN portable tanks manufactured outside the United States. A UN portable tank manufactured outside the United States, in accordance with national or international regulations based on the UN Recommendations (IBR, see §171.7 of this subchapter), which is an authorized packaging under §173.24 of this subchapter, may be filled, offered and transported in the United States, if the §172.101 Table of this subchapter authorizes the hazardous material for transportation in the UN portable tank and it conforms to the applicable T codes, and tank provision codes, or other special provisions assigned to the hazardous material in Column (7) of the Table when manufactured in a country other than the United States. In addition, the portable tank must--*

- (i) *Conform to applicable provisions in the UN Recommendations (IBR, see §171.7 of this subchapter) and the requirements of this subpart;*
- (ii) *Be capable of passing the prescribed tests and inspections in part 180 of this subchapter applicable to the UN portable tank specification;*
- (iii) *Be designed and manufactured according to the ASME Code (IBR, see §171.7 of this subchapter) or a pressure vessel design code approved by the Associate Administrator;*

(iv) *Be approved by the Associate Administrator when the portable tank is designed and constructed under the provisions of an alternative arrangement (see §178.274(a)(2) of this subchapter); and*

(v) *The competent authority of the country of manufacture must provide reciprocal treatment for UN portable tanks manufactured in the United States.*

The requirements are intended to cover the use of specification packagings, such as portable tanks, and are not necessarily intended for DOT -7A Type A packagings. Consideration of the above restrictions should be given.

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

Addressed in: Drawing Analysis Report

Specification Test Report

Operating Instruction Other

Specify:

N/A, not a UN portable tank.

A4.4 49 CFR §173.27 General Requirements for Transportation by Aircraft

A4.4.1 173.27(a) Applicability

(a) The requirements of this section are in addition to the requirements in §173.24 and apply to packages offered or intended for transportation aboard aircraft. Except for materials not subject to performance packaging requirements in subpart E of this part, a packaging containing a Packing Group III material with a primary or subsidiary risk of Division 4.1, 4.2, 4.3, 5.1, or Class 8 must meet the Packing Group II performance level when offered or intended for transportation by aircraft.

This requirement is applicable to DOT 7A Type A packagings when transported by aircraft. Based on the mode of transportation, indicate if the requirement applies or does not apply. If the requirement applies, indicate below the type of documentation that shows the requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not authorized for air transport.

A4.4.2 173.27(b) Authorized Packages

(b) Packages authorized on board aircraft.

- (1) When Column 9a of the §172.101 table indicates that a material is "Forbidden", that material may not be offered for transportation or transported aboard passenger-carrying aircraft.*
- (2) When Column 9b of the §172.101 table indicates that a material is "Forbidden", that material may not be offered for transportation or transported aboard aircraft.*
- (3) The maximum quantity of hazardous material in a package that may be offered for transportation or transported aboard a passenger-carrying aircraft or cargo aircraft may not exceed that quantity prescribed for the material in Column 9a or 9b, respectively, of the §172.101 table.*
- (4) A package containing a hazardous material which is authorized aboard cargo aircraft but not aboard passenger aircraft must be labeled with the CARGO AIRCRAFT ONLY label required by §172.402(c) of this subchapter and may not be offered for transportation or transported aboard passenger-carrying aircraft.*

These requirements are applicable to DOT 7A Type A packagings when transported by aircraft. Based on the mode of transportation, indicate if the requirements apply or do not apply. If the requirements apply, indicate below the type of documentation that shows the requirements are met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not authorized for air transport.

A4.4.3 173.27(c) Pressure Requirements

(c) *Pressure requirements.*

(1) *Packagings must be designed and constructed to prevent leakage that may be caused by changes in altitude and temperature during transportation aboard aircraft.*

This requirement is applicable to DOT 7A Type A packagings when transported by aircraft. Based on the mode of transportation, indicate if the requirement applies or does not apply. If the requirement applies, indicate below the type of documentation that shows the requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not authorized for air transport.

(2) *Packagings for which retention of liquid is a basic function must be capable of withstanding without leakage the greater of--*

(i) *An internal pressure which produces a gauge pressure of not less than 75 kPa (11 psig) for liquids in Packing Group III of Class 3 or Division 6.1; or 95 kPa (14 psig) for other liquids; or*

(ii) *A pressure related to the vapor pressure of the liquid to be conveyed, determined by one of the following:*

(A) *The total gauge pressure measured in the receptacle (i.e., the vapor pressure of the material and the partial pressure of air or other inert gases, less 100 kPa (15 psia)) at 55 °C (131 °F), multiplied by a safety factor of 1.5; determined on the basis of a filling temperature of 15 °C (59 °F) and a degree of filling such that the receptacle is not completely liquid full at a temperature of 55 °C (131 °F) or less;*

(B) *1.75 times the vapor pressure at 50 °C (122 °F) less 100 kPa (15 psia); or*

(C) *1.5 times the vapor pressure at 55 °C (131 °) less 100 kPa (15 psia).*

This requirement is applicable to a DOT 7A Type A packaging when it is transported by aircraft and contains liquids. Based on the mode of transportation and content, indicate below if the requirement applies or does not apply. If the requirement applies, indicate the type of documentation that shows the requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not authorized for air transport.

(3) *Notwithstanding the provisions of paragraph (c)(2) of this section--*

(i) *Hazardous materials may be contained in an inner packaging which does not itself meet the pressure requirement provided that the inner packaging is packed within a supplementary packaging which does meet the pressure requirement and other applicable packaging requirements of this subchapter.*

(ii) *Packagings which are subject to the hydrostatic pressure test and marking requirements of §§178.605 and 178.503(a)(5), respectively, of this subchapter must have a marked test pressure of not less than 250 kPa (36 psig) for liquids in Packing Group I, 80 kPa (12 psig) for liquids in Packing Group III of Class 3 or Division 6.1, and 100 kPa (15 psig) for other liquids.*

These requirements are not applicable to DOT 7A Type A packagings. The first part clarifies that the packaging holding the load does not have to provide the pressure boundary. The second part is not applicable to DOT 7A Type A packagings as they are not subject to sections 49 CFR §178.605 or 178.503(a)(5) of the regulations.

A4.4.4 173.27(d) Closure Requirements

(d) Closures. Stoppers, corks or other such friction-type closures must be held securely, tightly and effectively in place by positive means. Each screw-type closure on any packaging must be secured to prevent closure from loosening due to vibration or substantial change in temperature.

This requirement is applicable to DOT 7A Type A packagings when transported by aircraft. Based on the mode of transportation, indicate below if the requirement applies or does not apply. If the requirement applies, indicate the type of documentation that shows the requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not authorized for air transport.

A4.4.5 173.27(e) Absorbent Materials

(e) Absorbent materials. Except as otherwise provided in this subchapter, liquid hazardous materials of Class 3, 4, or 8, or Division 5.1, 5.2 or 6.1 that are packaged and offered for transport in glass, earthenware, plastic or metal inner packagings must be packaged using absorbent material as follows:

- (1) Packing Group I liquids on passenger aircraft must be packaged using materials capable of absorbing the entire contents of the inner packagings.*
- (2) Packing Group I liquids on cargo aircraft, and Packing Group II liquids including Division 5.2 liquids on passenger and cargo aircraft, must be packaged using a sufficient quantity of absorbent material to absorb the entire contents of any one of the inner packagings containing such liquids. When the inner packagings are of different sizes and quantities, sufficient absorbent material must be used to absorb the entire contents of the inner packaging with the greatest volume of liquid.*
- (3) When absorbent materials are required and the outer packaging is not liquid tight, a means of containing the liquid in the event of a leakage must be provided in the form of a leakproof liner, plastic bag or other equally efficient means of containment.*
- (4) Absorbent material must not react dangerously with the liquid (see §§173.24 and 173.24a.).*
- (5) Absorbent material is not required if the inner packagings are so protected that they are unlikely to break and leak their contents from the outer packaging under normal conditions of transportation.*

These requirements are not applicable to DOT 7A Type A packagings. DOT 7A Type A

packagings are for transport of Class 7 (radioactive) materials.

A4.4.6 173.27(f) Combination Packagings

(f) Combination packagings. Unless otherwise specified in this part, or in §171.11 of this subchapter, when combination packagings are offered for transportation aboard aircraft, inner packagings must conform to the quantity limitations set forth in table 1 of this paragraph for transport aboard passenger-carrying aircraft and table 2 of this paragraph for transport aboard cargo aircraft only, as follows: ...

These requirements are not applicable to DOT 7A Type A packagings. DOT 7A Type A packagings are for transport of Class 7 (radioactive) materials.

A4.4.7 173.27(g) Cylinders

(g) Cylinders. For any cylinder containing hazardous materials and incorporating valves, sufficient protection must be provided to prevent operation of, and damage to, the valves during transportation, by one of the following methods:

- (1) By equipping each cylinder with securely attached valve caps or protective headrings; or*
- (2) By boxing or crating the cylinder.*

This requirement is not applicable to a DOT 7A Type A packaging unless it is a cylinder equipped with a valve(s) and is to be transported by aircraft. Based on the mode of transportation and packaging type, indicate below if the requirement applies or does not apply. If the requirement applies, indicate below the type of documentation that shows the requirement is met and where the documentation can be found.

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

Addressed in: Drawing Analysis Report

Specification Test Report

Operating Instruction Other

Specify:

N/A, not authorized for air transport.

A4.4.8 173.27(h) Tank Cars and Cargo Tanks

(h) Tank cars and cargo tanks. Any tank car or cargo tank containing a hazardous material may not be transported aboard aircraft.

This requirement is not applicable to a DOT 7A Type A packaging unless it is a tank car or cargo tank and is to be transported by aircraft. Based on the mode of transportation and packaging type, indicate below if the requirement applies or does not apply. If the requirement applies, indicate below the type of documentation that shows the requirement is met and where the documentation can be found.

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

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not authorized for air transport.

A4.4.9 173.27(i) Shipper's Certification for Air Transport

(i) Effective October 1, 2006, each person who offers a hazardous material for transportation by aircraft must include the certification statement specified in §172.204(c)(3).

This requirement is applicable to a DOT 7A packagings when transported by aircraft. Based on the mode of transportation, indicate below if the requirement applies or does not apply. If the requirement applies, indicate below the type of documentation that shows the requirement is met and where the documentation can be found.

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

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not authorized for air transport.

A4.5 49 CFR §173.410 General Design Requirements

A4.5.1 173.410(a) Handling and Securing

In addition to the requirements of subparts A and B of this part, each package used for the shipment of Class 7 (radioactive) materials must be designed so that--

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

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

See Section 2.0 and 4.3.

A4.5.2 173.410(b) Lifting Attachments

(b) Each lifting attachment that is a structural part of the package must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner, and it must be designed so that failure of any lifting attachment under excessive load would not impair the ability of the package to meet other requirements of this subpart. Any other structural part of the package which could be used to lift the package must be capable of being rendered inoperable for lifting the package during transport or must be designed with strength equivalent to that required for lifting attachments.

These requirements apply to DOT 7A Type A packagings. Indicate below the type of documentation that shows these requirements are met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

Analysis of fifteen closure bolts vs three lid lifting interface threaded holes of same size ensures lifting attachments will fail prior to lid to body connection or contents release. Maximum gross weight of the package can be lifted with required factor of safety using lifting interface. See Section 4.3. The shipper is responsible for ensuring the lift interface holes are fitted with the appropriately sized lift fixture device.

A4.5.3 173.410(c) External Surface Protrusions, Decontamination

(c) The external surface, as far as practicable, will be free from protruding features and will be easily decontaminated.

These requirements apply to DOT 7A Type A packagings. Indicate below the type of documentation that shows these requirements are met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[See Section 2.0.](#)

A4.5.4 173.410(d) Outer Layer - Pockets, Crevices (Water Collection)

(d) The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[See Section 2.0.](#)

A4.5.5 173.410(e) Features Added at Time of Transport

(e) Each feature that is added to the package will not reduce the safety of the package.

This requirement applies to DOT 7A Type A packagings that have features added at the time of shipment. Based on the packaging design, indicate below if the requirement applies or does not apply. If the requirement applies, indicate the type of documentation that shows this requirement is met and where the documentation can be found.

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

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

Shipper shall be responsible for securing a tamper indicating device and/or additional attachments required for tie-down during transport. See Section 2.0 and Section 4.3.

A4.5.6 173.410(f) Acceleration, Vibration

(f) The package will be capable of withstanding the effects of any acceleration, vibration or vibration resonance that may arise under normal conditions of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use (see §§173.24, 173.24a, and 173.24b).

These requirements apply to DOT 7A Type A packagings. Indicate below the type of documentation that shows these requirements are met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

See Section 4.2.5.

A4.5.7 173.410(g) Physical/Chemical Compatibility, Irradiation

(g) The materials of construction of the packaging and any components or structure will be physically and chemically compatible with each other and with the package contents. The behavior of the packaging and the package contents under irradiation will be taken into account.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[It is the responsibility of the shipper to determine that the above requirements are met. See Section 2.0 and Table 2-3.](#)

A4.5.8 173.410(h) Valves - Protection, Enclosure

(h) All valves through which the package contents could escape will be protected against unauthorized operation.

This requirement applies to DOT 7A Type A packagings that have valves. Based on the packaging design, determine if the requirement applies or does not apply. If the requirement applies, identify the type of documentation that shows this requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[N/A, no valves.](#)

A4.5.9 173.410(i) For Transport by Air--

(i) For transport by air--

- (1) The temperature of the accessible surfaces of the package will not exceed 50 °C (122 °F) at an ambient temperature of 38 °C (100 °F) with no account taken for insulation;*
- (2) The integrity of containment will not be impaired if the package is exposed to ambient temperatures ranging from -40 °C (-40 °F) to +55 °C (131 °F); and*
- (3) Packages containing liquid contents will be capable of withstanding, without leakage, an internal pressure that produces a pressure differential of not less than 95 kPa (13.8 lb/in²).*

These requirements apply to DOT 7A Type A packagings used for transport by aircraft. Based on the mode of transportation, indicate below if the requirements apply or do not apply. If the requirements apply, identify the type of documentation that shows these requirements are met and where the documentation can be found.

- This requirement: Does not apply. Applies; indicate the following.
- Addressed in: Drawing Analysis Report
- Specification Test Report
- Operating Instruction Other

Specify:

N/A, not authorized for air transport.

A4.6 49 CFR §173.412 Additional Design Requirements for Type A Packages

A4.6.1 173.412 Tamper Indication

In addition to meeting the general design requirements prescribed in §173.410, each Type A packaging must be designed so that--

(a) 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 closed transport vehicles in exclusive use, the cargo compartment, instead of the individual packages, may be sealed.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[It is the responsibility of the shipper to determine that the above requirements are met. See Section 2.0.](#)

A4.6.2 173.412(b) Smallest External Dimension

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

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[See Section 2.0.](#)

A4.6.3 173.412(c) Containment and Shielding

(c) Containment and shielding is maintained during transportation and storage in a temperature range of -40 °C (-40 °F) to 70 °C (158 °F). Special attention shall be given to liquid contents and to the potential degradation of the packaging materials within the temperature range.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

See Section 2.0 and 4.0. It is the responsibility of the shipper to determine that the contents are configured such that a significant increase in radiation at the external surface of the packaging is prevented. Not authorized for liquid contents.

A4.6.4 173.412(d) Secure Containment System

(d) The packaging must include a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form Class 7 (radioactive) material, as demonstrated in accordance with §173.469, may be considered as a component of the containment system. If the containment system forms a separate unit of the package, it must be securely closed by a positive fastening device that is independent of any other part of the package.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

See Section 2.0 and 4.0.

A4.6.5 173.412(e) Radiolytic Decomposition, Chemical Reaction, Radiolysis

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

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[It is the responsibility of the shipper to determine that the above requirements are met. See Section 2.0.](#)

A4.6.6 173.412(f) Reduction of Ambient Pressure

(f) The containment system will retain its radioactive contents under the reduction of ambient pressure to 25 kPa (3.6 psi).

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[Packaging incorporates a filter vent. It is the responsibility of the shipper to determine that the above requirements are met. See Section 2.0.](#)

A4.6.7 173.412(g) Valve - Protection, Enclosure

(g) Each valve, other than a pressure relief device, is provided with an enclosure to retain any leakage.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[N/A, no valves.](#)

A4.6.8 173.412(h) Shielding (Enclosure)

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

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

The shield is captured by positive means to surround the containment system. See Section 2.0 and 4.0.

A4.6.9 173.412(i) Tiedown (Failure)

(i) Failure of any tie-down attachment that is a structural part of the packaging, under both normal and accident conditions, must not impair the ability of the package to meet other requirements of this subpart.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

Analysis of fifteen closure bolts vs three lid lifting (or tiedown) interface threaded holes of same size ensures lifting (or tiedown) attachments will fail prior to lid to body connection or contents release. See Section 4.3. The shipper is responsible for ensuring the lift interface holes are fitted with the appropriately sized tie-down device.

A4.6.10 173.412(j) Evaluation and Testing

(j) When evaluated against the performance requirements of this section and the tests specified in §173.465 or using any of the methods authorized by §173.461(a), the packaging will prevent--

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

NOTE: A significant increase may be defined as, "More than a 20% increase in the maximum radiation level at the external surface of the package." (IAEA 2005, para. 646).

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[See Section 4.2.](#)

A4.6.11 173.412(k) Requirements for Liquid Packagings

(k) Each packaging designed for liquids will--

(1) Be designed to provide for ullage to accommodate variations in temperature of the contents, dynamic effects and filling dynamics;

(2) Meet the conditions prescribed in paragraph (j) 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); and

(3) Either--

(i) Have sufficient suitable absorbent material to absorb twice the volume of the liquid contents. The absorbent material must be compatible with the package contents and suitably positioned to contact the liquid in the event of leakage; 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 component in the event that the primary inner component leaks.

This requirement applies to DOT 7A Type A packagings for use in transporting liquids. Based on the packaging design, indicate below if the requirement applies or not. If the requirement applies, identify the type of documentation that shows this requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[N/A, not authorized for liquids.](#)

A4.6.12 173.412(l) Evaluation and Testing of Gas Packagings

(l) Each package designed for gases, other than tritium not exceeding 40 TBq (1080Ci) or noble gases not exceeding the A2 value appropriate for the noble gas, will be able to prevent loss or

dispersal 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).

This requirement applies to DOT 7A Type A packagings for use in transporting gases. Based on the packaging design, indicate below if the requirement applies or not. If the requirement applies, identify the type of documentation that shows this requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not authorized for gases.

A4.7 49 CFR §173.462 Preparation of Specimens for Testing

A4.7.1 173.462(a) Inspection

(a) Each specimen (i.e., sample, prototype or scale model) must be examined before testing to identify and record faults or damage, including:

- (1) Divergence from the specifications or drawings;
- (2) Defects in construction;
- (3) Corrosion or other deterioration; and
- (4) Distortion of features.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[See Section 4.1 and Table 4-2.](#)

A4.7.2 173.462(b) Correction

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

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[See Section 4.1 and Table 4-2.](#)

A4.7.3 173.462(c) Identify Containment System

(c) The containment system of the packaging must be clearly specified.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[See Section 2.2.](#)

A4.7.4 173.462(d) Identify External Features

(d) The external features of the specimen must be clearly identified so that reference may be made to any part of it.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[See Figure 2-1.](#)

A4.8 49 CFR §173.465 Type A Packaging Tests

A4.8.1 173.465(a) Packaging Tests

(a) The packaging, with contents, must be capable of withstanding the water spray, free drop, stacking and penetration tests prescribed in this section. One prototype may be used for all tests if the requirements of paragraph (b) of this section are met.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[See Section 4.2.](#)

A4.8.2 173.465(b) Water Spray

(b) Water spray test. The water spray test must precede each test or test sequence prescribed in this section. The water spray test must simulate exposure to rainfall of approximately 5 cm (2 inches) per hour for at least one hour. The time interval between the end of the water spray test and the beginning of the next test must be such that the water has soaked in to the maximum extent without appreciable drying of the exterior of the specimen. In the absence of evidence to the contrary, this interval may be assumed to be two hours if the water spray is applied from four different directions simultaneously. However, no time interval may elapse if the water spray is applied from each of the four directions consecutively.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[See Section 4.2.1.](#)

A4.8.3 173.465(c) Free Drop

(c) Free drop test. The specimen must drop onto the target so as to suffer maximum damage to the safety features being tested, and:

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

- Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[See Section 4.2.2.](#)

A4.8.4 173.465(c)(1) Free Drop

(1) The height of the drop measured from the lowest point of the specimen to the upper surface of the target may not be less than the distance specified in table 10, for the applicable package mass. The target must be as specified in §173.465(c)(5). Table 10 is as follows:

Table 10.-- Free Drop Distance for testing Packages to Normal Conditions of Transport	
Packaging mass kilograms (pounds)	Free drop distance Meters (feet)
< mass 5000 (11,000)	1.2 (4)
5000 (11000) mass to 10,000 (22,000)	0.9 (3)
10,000 (22,000) mass to 15,000 (33,000)	0.6 (2)
> 15,000 (33,000) mass	0.3 (1)

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

- Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[See Section 4.2.2.](#)

A4.8.5 173.465(c)(2) Free Drop

(2) For packages containing fissile material, the free drop test specified in paragraph (c)(1) of this section must be preceded by a free drop from a height of 0.3 m (1 foot) on each corner, or in the case of cylindrical packages, onto each of the quarters of each rim.

This requirement applies to DOT 7A Type A packagings for use in transporting fissile material. Based on the load, indicate below if the requirement applies or not. If the requirement applies, identify the type of documentation that shows this requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, only non-fissile or fissile exempt authorized.

A4.8.6 173.465(c)(3) Free Drop

(3) For fiberboard or wood rectangular packages with a mass of 50 kg (110 pounds) or less, a separate specimen must be subjected to a free drop onto each corner from a height of 0.3 m (1 foot).

This requirement applies to rectangular DOT 7A Type A packagings constructed of fiberboard or wood that have a gross weight of 50 kilograms (110 pounds) or less. Based on the materials of construction and the gross weight of the package, indicate below if the requirement applies or not. If the requirement applies, identify the type of documentation that shows this requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, no fiberboard or wood and gross weight is greater than required.

A4.8.7 173.465(c)(4) Free Drop

(4) For cylindrical fiberboard packages with a mass of 100 kg (220 pounds) or less, a separate specimen must be subjected to a free drop onto each of the quarters of each rim from a height of 0.3 m (1 foot).

This requirement applies to cylindrical DOT 7A Type A packagings constructed of fiberboard having a gross weight of 100 kilograms (220 pounds) or less. Based on the shape and the gross weight of the package, indicate below if the requirement applies or not. If the requirement applies, identify the type of documentation that shows this requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, no fiberboard and gross weight is greater than required.

A4.8.8 173.465(c)(5) Free Drop

(5) The target for the free drop test must be 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.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

See Section 4.2.2.

A4.8.9 173.465(d) Stacking Test

(d) Stacking test.

(1) The specimen must be subjected for a period of at least 24 hours to a compressive load equivalent to the greater of the following:

(i) Five times the mass of the actual package; or

(ii) *The equivalent of 13 kilopascals (1.9 psi) multiplied by the vertically projected area of the package.*

(2) *The compressive load must be applied uniformly to two opposite sides of the specimen, one of which must be the base on which the package would normally rest.*

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[See Section 4.2.3.](#)

A4.8.10 173.465(e) Penetration Test

(e) *Penetration test. For the penetration test, the specimen must be placed on a rigid, flat, horizontal surface that will not move significantly while the test is being performed.*

(1) *A bar of 3.2 cm (1.25 inches) in diameter with a hemispherical end and a mass of 6 kg (13.2 pounds) must be dropped and directed to fall with its longitudinal axis vertical, onto the center of the weakest part of the specimen, so that, if it penetrates far enough, it will hit the containment system. The bar may not be significantly deformed by the test; and*

(2) *The height of the drop of the bar measured from its lower end to the intended point of impact on the upper surface of the specimen must be 1 m (3.3 feet) or greater.*

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

[See Section 4.2.4.](#)

A4.9 49 CFR §173.466 Additional Tests for Type A Packaging Designed for Liquids and Gases

A4.9.1 173.466(a) Additional Tests

(a) In addition to the tests prescribed in §173.465, Type A packagings designed for liquids and gases must be capable of withstanding the following tests:

(1) Free drop test. The packaging specimen must drop onto the target so as to suffer the maximum damage to its containment. The height of the drop measured from the lowest part of the packaging specimen to the upper surface of the target must be 9 m (30 feet) or greater. The target must be as specified in §173.465(c)(5).

(2) Penetration test. The specimen must be subjected to the test specified in §173.465(e) except that the height of the drop must be 1.7 m (5.5 feet).

This requirement applies only to DOT 7A Type A packagings used to transport liquids or gases. Based on the contents of the package, indicate below if the requirement applies or not. If the requirement applies, identify the type of documentation that shows this requirement is met and where the documentation can be found.

This requirement: Does not apply. Applies; indicate the following.
 Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not authorized for liquids or gases.

A4.10 49 CFR §178.2 Applicability and Responsibility

A4.10.1 49 CFR §178.2(c) Notification

(c) Notification. Except as specifically provided in §§178.337-18 and 178.345-10 of this part, the manufacturer or other person certifying compliance with the requirements of this part, and each subsequent distributor of that packaging shall--

(1) Notify in writing each person to whom that packaging is transferred--

(i) Of all requirements in this part not met at the time of transfer, and

(ii) With information specifying the type(s) and dimensions of the closures, including gaskets and any other components needed to ensure that the packaging is capable of successfully passing the applicable performance tests. This information must include any procedures to be followed, including closure instructions for inner packagings and receptacles, to effectively assemble and close the packaging for the purpose of preventing leakage in transportation. For packagings sold or represented as being in conformance with the requirements of this subchapter applicable to transportation by aircraft, this information must include relevant guidance to ensure that the packaging, as prepared for transportation, will withstand the pressure differential requirements in §173.27 of this subchapter.

(2) Retain copies of each written notification for at least one year from date of issuance; and

(3) Make copies of all written notifications available for inspection by a representative of the Department.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

This document in conjunction with the drawings, specification, and handling and operation manual, identify the requirements for a DOT 7A Type A packaging that are met and those requirements that remain to be completed (e.g., identified as "responsibility of shipper").

In paragraph 178.3(a)(2), the term "packaging manufacturer" means the person certifying that the package meets all requirements of this section. When loaded with the actual contents being shipped, the shipper assumes the responsibilities of the manufacturer to ensure that the requirements are met.

NOTE: Any organization that assembles the identified components should, before using or supplying the packagings to others, prepare a notification that updates the information. The notification should be supplied with the packagings.

A4.11 49 CFR §178.3 Marking of Packagings

A4.11.1 178.3(a) Marking Requirements

(a) *Each packaging represented as manufactured to a DOT specification or a UN standard must be marked on a non-removable component of the packaging with specification markings conforming to the applicable specification, and with the following:*

- (1) *In an unobstructed area, with letters, and numerals identifying the standards or specification (e.g. UN 1A1, DOT 4B240ET, etc.).*
- (2) *Unless otherwise specified in this part, with the name and address or symbol of the packaging manufacturer or, where specifically authorized, the symbol of the approval agency certifying compliance with a UN standard. Symbols, if used, must be registered with the Associate Administrator. Duplicative symbols are not authorized.*
- (3) *The markings must be stamped, embossed, burned, printed or otherwise marked on the packaging to provide adequate accessibility, permanency, contrast, and legibility so as to be readily apparent and understood.*
- (4) *Unless otherwise specified, letters and numerals must be at least 12.0 mm (0.47 inches) in height except that for packagings of less than or equal to 30 L (7.9 gallons) capacity for liquids or 30 kg (66 pounds) capacity for solids the height must be at least 6.0 mm (0.2 inches). For packagings having a capacity of 5 L (1 gallon) or 5 kg (11 pounds) or less, letters and numerals must be of an appropriate size.*
- (5) *For packages with a gross mass of more than 30 kg (66 pounds), the markings or a duplicate thereof must appear on the top or on a side of the packaging.*

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in:

<input checked="" type="checkbox"/> Drawing	<input type="checkbox"/> Analysis Report
<input checked="" type="checkbox"/> Specification	<input type="checkbox"/> Test Report
<input checked="" type="checkbox"/> Operating Instruction	<input type="checkbox"/> Other

Specify:

The shipper is responsible for ensuring that the requirements are met prior to the transport of the loaded packagings. Additional marking requirements are identified in §172.310 and §178.350(c), and shall be followed.

A4.11.2 178.3(b) UN Markings

(b) A UN standard packaging for which the UN standard is set forth in this part may be marked with the United Nations symbol and other specification markings only if it fully conforms to the requirements of this part. A UN standard packaging for which the UN standard is not set forth in this part may be marked with the United Nations symbol and other specification markings for that standard as provided in the ICAO Technical Instructions or the IMDG Code subject to the following conditions:

(1) The U.S. manufacturer must establish that the packaging conforms to the applicable provisions of the ICAO Technical Instructions (IBR, see §171.7 of this subchapter) or the IMDG Code (IBR, see §171.7 of this subchapter), respectively.

(2) If an indication of the name of the manufacturer or other identification of the packaging as specified by the competent authority is required, the name and address or symbol of the manufacturer or the approval agency certifying compliance with the UN standard must be entered. Symbols, if used, must be registered with the Associate Administrator.

(3) The letters "USA" must be used to indicate the State authorizing the allocation of the specification marks if the packaging is manufactured in the United States.

This requirement applies to DOT 7A Type A packagings. Indicate below the type of documentation that shows this requirement is met and where the documentation can be found.

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not UN standard packaging.

A4.11.3 178.3(c) Multiple Markings

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

This requirement applies to DOT 7A Type A packagings that also meet the requirements of a UN standard or another DOT specification. Based on the design of the package, indicate below if the requirement applies or not. If the requirement applies, identify the type of documentation that shows this requirement is met and where the documentation can be found.

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

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, not UN standard packaging.

A4.11.4 178.3(c) Marking Restrictions

(d) No person may mark or otherwise certify a packaging or container as meeting the requirements of a manufacturing special permit unless that person is the holder of or a party to that special permit, an agent of the holder or party for the purpose of marking or certification, or a third party tester.

This requirement applies to DOT 7A Type A packagings that have a manufacturing special permit. Based on the status of the package, indicate below if the requirement applies or not. If the requirement applies, identify the type of documentation that shows this requirement is met and where the documentation can be found.

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

Addressed in: Drawing Analysis Report
 Specification Test Report
 Operating Instruction Other

Specify:

N/A, no special permit.