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Development of an Air Transport Type A Fissile Package

Paul S. Blanton
Savannah River National Laboratory
Savannah River Nuclear Solutions
Aiken, South Carolina 29808
paul.blanton@srnl.doe.gov

Kurt R. Eberl
Savannah River National Laboratory
Savannah River Nuclear Solutions
Aiken, South Carolina 29808
kurt.eberl@srnl.doe.gov

Linda J. Paschal
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831
paschallj@ornl.gov

ABSTRACT

This paper presents the summary of testing by the Savannah River National Laboratory (SRNL) to support development of a light weight (<140 lbs) air transport qualified Type A Fissile Packaging. The package design incorporates features and materials specifically designed to minimize packaging weight. The light weight package is being designed to provide confinement to the contents when subjected to the normal and hypothetical conditions required of an air transportable Type A Fissile radioactive material shipping package.

INTRODUCTION

The new air transport "LORX" packaging is being designed by SRNL for the Department of Homeland Security (DHS) to comply with the packaging safety requirements of Title 10, Part 71 of the Code of Federal Regulations for the shipment of Type A Fissile quantities of material.[1] In addition to required testing for Type AF packaging for ground transport, the LORX is subject to a 550 lb puncture bar dropped from 10 feet, an increased duration thermal event and drop representing an impact of 90 m/s. The design is required to be light weight and small to allow overnight transport by commercial carrier.

To support the design of the new package SRNL had five prototypes fabricated of different design configurations to evaluate their structural performance under Hypothetical accident Conditions required by 10 CFR71. Each prototype packaging consists of two primary parts: a drum assembly and an inner carrier for contents. The drum assembly provides impact protection and thermal insulation for the content secured in the carrier assembly. The drum assembly is made from of a modified carbon steel 10-gallon tight-head drum with an integral welded liner. A lid plug inserted and bolted to the drum secures the

content carrier. The carrier assembly is a machined aluminum right circular cylinder with a central threaded closure. The developmental packaging configuration assembly is depicted in Figure 1.

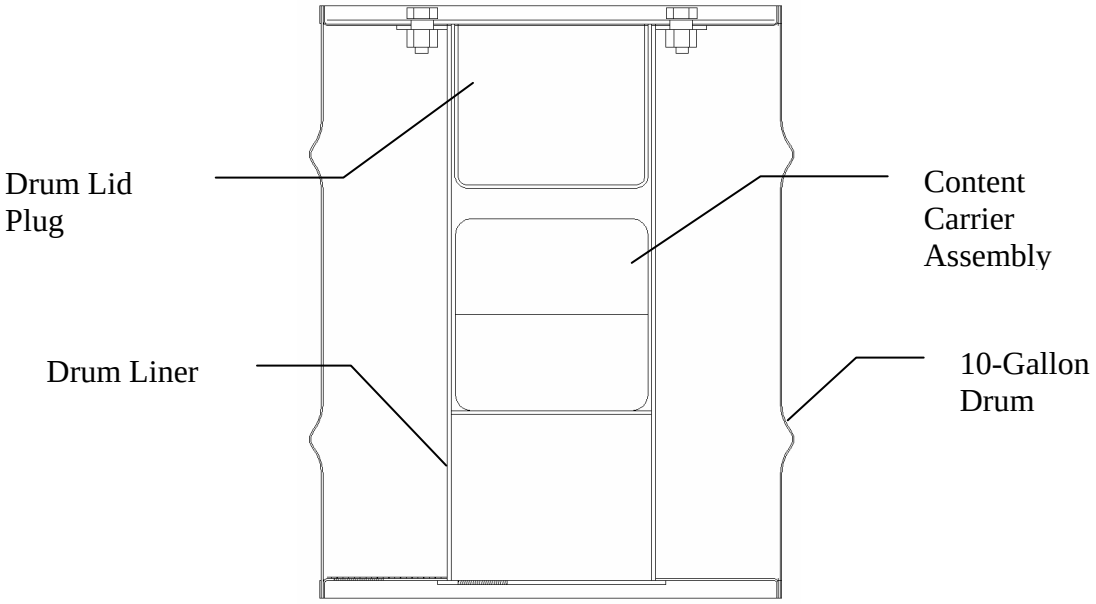


Figure 1 LORX Packaging Configuration

PACKAGING PERFORMANCE REQUIREMENTS

The LORX packaging is designed to facilitate overnight air transport of a 5-inch diameter metallic spherical content. The package is designed to confine the content within the packaging under the required regulatory normal and accident conditions of transport. The following are required design and performance requirements for the new LORX packaging:

- Include a removable closure lid/plug that secures the contents centered within the packaging cavity.
- Incorporate foam or other material as packing as necessary to secure the contents during normal conditions of transport.
- A packaging having an exterior drum configuration.
- Exterior drum features that allows stacking.
- Designed to minimize exterior damage during normal handling (e.g., durable).
- Incorporate energy absorbing and thermal insulation materials in the drum overpack to ensure that the package will confine its contents under regulatory NCT and HAC requirements.
- A maximum gross weight of 140-pounds.
- Have external dimensions that coincide with the approximate size of a standard 10-gallon drum (e.g., approximately 14-inch diameter and 17-inches tall).

- Standard tools for handling and assembly.

PROTOYPE DESCRIPTIONS

Five different prototype packages were designed and fabricated to comply with the packaging performance requirements, all consisted of a drum assembly and an inner carrier for simulated content. Each drum assembly consisted of a modified carbon steel 10-gallon drum with an integral liner. A lid plug inserted and bolted to the drum secured the content carrier. The carrier assembly design used for prototype testing consisted of two threaded cylindrical aluminum caps with and interior machined to receive a 5-inch sphere. A typical carrier assembly with a simulated spherical content is shown in Figure 2.

The following table compares the five tested prototype configurations.

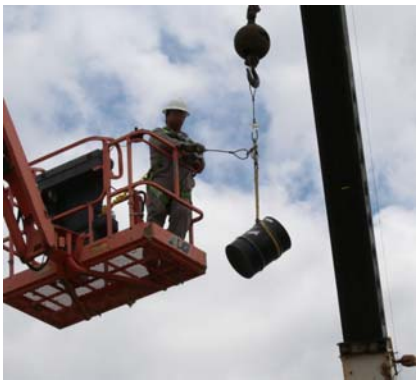
Prototype Number	**1**	**2**	**3**	**4**	**5**
Drum Shell Construction	Modification of carbon steel closed head drums. (14 inches in diameter by 17 inches high)				
Liner Construction	1/8" carbon steel (CS) rolled and welded	1/8" CS rolled and welded	multiple layers of aluminum foil	1/8" CS rolled and welded	1/8" CS rolled and welded
Liner Plug and Drum Impact and Thermal Material	General Plastics polyurethane 20 pcf	aluminum honeycomb Tubular Core	General Plastics polyurethane 20 pcf	DOW Automotive polyurethane Foam 24 pcf	General Plastics polyurethane 20 pcf
Additional Penetration Barrier	none	external carbon fiber wrap around aluminum honeycomb	none	none	external and internal carbon fiber wrap around polyurethane
Liner Attachment	welded	bolted	welded	welded	bolted
Plug Attachment to Lid	welded	unattached	welded	welded	welded
Content Carrier (6061-T6)	aluminum				
Contents (5-inch sphere)	stainless and aluminum	aluminum and stainless	aluminum	aluminum	aluminum

Figure 2 Content Carrier Assembly

TESTING AND RESULTS

Testing was performed by SRNL personnel in May of 2011 on the described prototypes at the Savannah River Sites N-Area Test Facility. The following tests were performed to evaluate the performance of the prototype packages.[2]

- 30-foot drop; Center of Gravity over Top and Bottom Corner and Horizontal
- Crush; Center of Gravity over Bottom Corner and Horizontal
- Puncture; Horizontal, Top and Bottom



Drop

Crush

Puncture

The following summarizes the testing of the prototypes and provides representative pictures from each of the tested prototypes.

Prototype 1	**30-ft Drop**	**CGOB**	**CGOT**
	1,100 lb Plate Crush	**CGOB**	
	550 lb puncture probe	**Horizontal**	

CGOT Drop img_6423	Crush img_6579	Puncture img_9097

Prototype 2	**30-ft Drop**	**CGOB**	**CGOT**
	1,100 lb Plate Crush	**Horizontal**	
	550 lb puncture probe	**Horizontal**	

CGOB Drop img_6438	Crush img_6483	Puncture img_9097

Prototype 3	**30-ft Drop**	**Horizontal**	
	1,100 lb Plate Crush	**Horizontal**	
	550 lb puncture probe	**Horizontal**	

Crush img_6556	Puncture img_6571

Prototype 4	**30-ft Drop**	**CGOB**	**CGOT**
	1,100 lb Plate Crush	**Horizontal**	
	550 lb puncture probe	**Horizontal**	

CGOB Drop img_8962	Crush img_8987	Puncture img_9060

Prototype 5	**30-ft Drop**	**CGOB**	
	1,100 lb Plate Crush	**Horizontal**	
	550 lb puncture probe	**Horizontal**	

CGOB Drop img_9017	Crush img_9039	Puncture img_9084

CONCLUSIONS

The objective of these tests was to provide design input to the final design for the LORX Type A Fissile Air Transport Packaging when subjected to the performance requirements of the drop, crush and puncture probe test of 10CFR71. The post test evaluation of the prototype packages indicates that all of the tested designs would satisfactorily confine the content within the packaging. The differences in the performance of the prototypes varied significantly depending on the core materials and their relative densities.
Information gathered from these tests is being used to develop the final design for the Department of Homeland Security.

REFERENCES

1. Packaging and Transportation of Radioactive Material, Code of Federal Regulations, Title 10, Part 71, Washington, DC (January 2009).
2. Test Report of Developmental Type AF Packaging for Air Transport, M-TRT-A-00022, (July 2011).