Design, Testing, and Certification of Four New Shielded Containers

April, 16 2019

Presented by:

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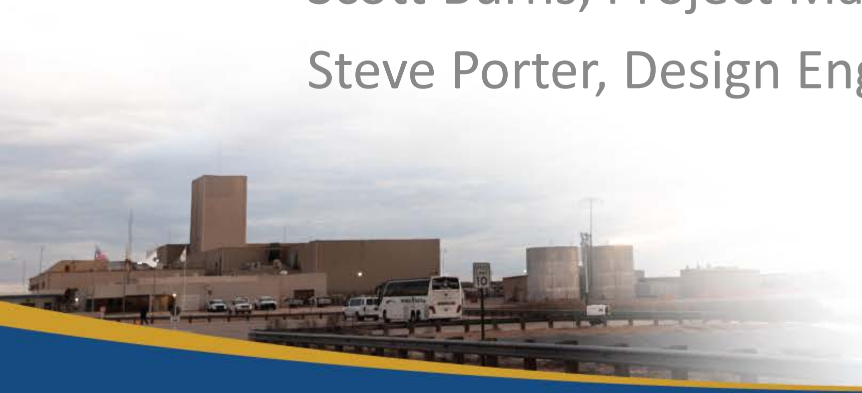
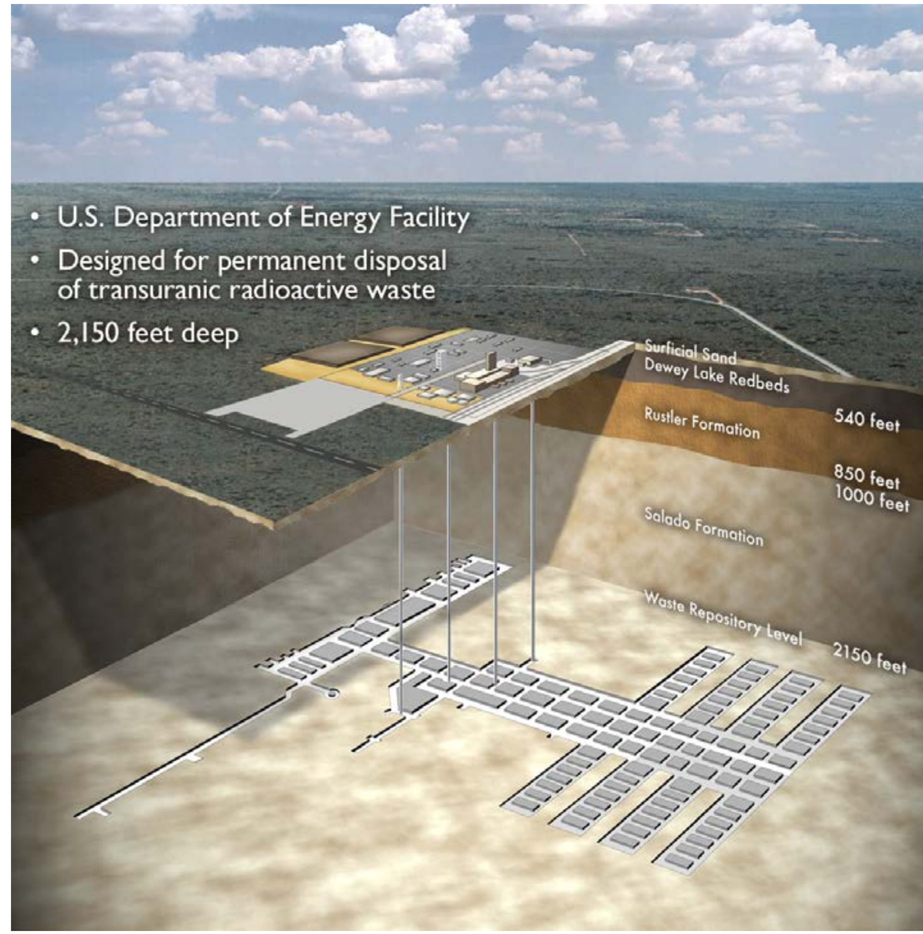


Summary Overview

- WIPP Background
- Present the Need for Additional Methods for Transporting RH-TRU Waste
- Design Requirements/Objectives
- Approach similar to original Shielded Container Assembly (SCA) (currently approved) Testing and Certification Process
- Four (4) New Shielded Container Designs for 30- and 55-Gallon Drums
- Payload Assembly includes ancillary dunnage
- Planned Certification Tests and Bounding Conditions
  - DOT Specification 7A, Type A, 4-Foot Drop Tests
  - HAC 30-Foot Free-Drop Tests
- 10 CFR 71 safety evaluations (Thermal, Shielding, & Criticality)
- Interim Design Parameters
- Schedule

WIPP Background



WIPP Background (*Continued*)

- Contact Handled (CH) waste emplaced in stackable containers placed on the floor
- Remote Handled (RH) waste emplaced in drilled boreholes in the “Rib” (or shielded containers) on the floor

Need for Additional Shielded Options

- Following the events of February 14, 2014, the WIPP Site has been operating with greatly reduced ventilation in the underground facilities (from 425K CFM to 120K CFM).
- Due to the condition of the underground after the event, concerns relative to airborne contamination during borehole drilling required for WIPP emplacement of RH waste in RLCs have halted the shipment of RH waste in RH-TRU 72B casks.

Need for Additional Shielded Options *(Continued)*

- Until the new permanent ventilation system and new utility shaft is completed (projected in FY2025), there are no plans for RH borehole drilling.
- RH-TRU 72-B shipments of RH-TRU waste in RLCs cannot be received at WIPP because RLC emplacement has been halted.
- This has greatly impacted the storage capacity of the DOE TRU waste facilities across the complex, relative to RH waste.

Need for Additional Shielded Options *(Continued)*

- The currently approved SCA (SC-30G1) authorized for use with issuance of CoC 9279, Revision 5, in May of 2009 has proven beneficial to the DOE, however:
  - The majority of the currently packaged RH waste is in 55-gallon drums, or the activity is greater than can be accommodated with the currently authorized SCA (SC-30G1).
  - Due to the delay of future 72B shipments, the need for additional shielded options for the shipment of RH waste is vital to the continued waste emplacement without the need for mining boreholes.

Benefits of Additional Shielded Containers

- Similar to the currently approved SCA (SC-30G1), these additional shielded containers allow for the following advantages;
  - More efficient method for emplacing RH waste at WIPP
  - Overall reduction in the number of RH waste shipments required in a RH-TRU 72B by as much as 2:1
  - Reduced number of shipments to WIPP equates to a reduced potential for shipping accidents
  - Will allow for an accelerated clean-up of generator sites
  - Accelerated clean-up provides for risk reduction at generator sites

Benefits of Additional Shielded Containers *(Continued)*

- Additional authorized shielded containers will allow generator sites to store and manage RH waste as CH waste without a need to repackage prior to shipment.
- These additional shielded containers offer a significant benefit to the complex; the potential for increased efficiencies, gains in worker and public health and safety makes these additional shielded containers an important initiative to pursue for approval.

Design Requirements/Objectives

- Shielded containers shall be DOT Specification 7A, Type A certified, and equipped with filter vents
  - Consistent with currently authorized HalfPACT TRU waste payload containers
  - DOT 7A, Type A, 4-foot free drop of bare container onto an unyielding surface in worst-case orientation is primary testing constraint
  - Drop-test acceptance is primarily based on demonstrating confinement of payload and no significant decrease in shielding effectiveness

Design Requirements/Objectives
(Continued)

- Current package (HalfPACT) design and licensing bases and limits shall be maintained
  - Maximum package payload weight
    - 7,600 lbs (HalfPACT)
  - Maximum package decay heat:
    - 30 watts (HalfPACT)
  - Maximum Pu-239 fissile gram equivalent (FGE):
    - 325 FGE (HalfPACT)

Similarities to Previous Testing Activities

The designs of the new shielded containers and polyurethane foam-filled dunnage are similar to the SCA (SC-30G1) design approved for transport in the HalfPACT package

Four (4) New Designs

The new designs predominately address gamma shielding

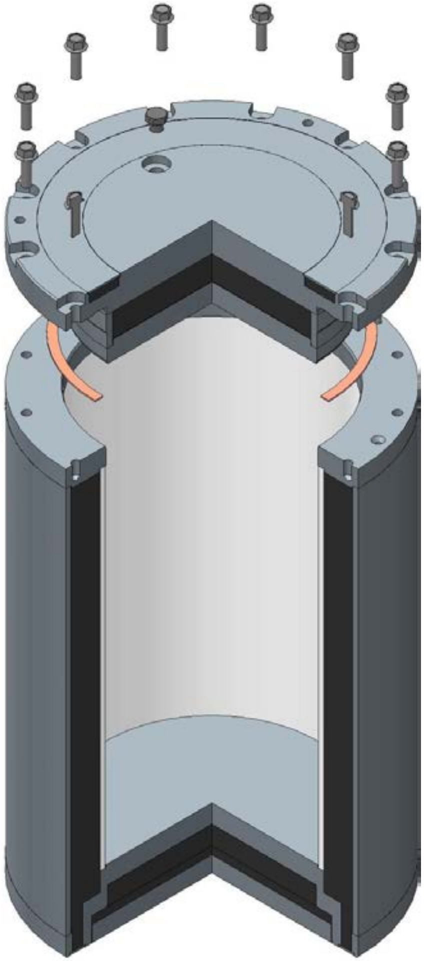
- Two (2) for 30-gallon drum payloads
  - SC-30G2 (two per HalfPACT package)
  - SC-30G3 (one per HalfPACT package)
- Two (2) for 55-gallon drum payloads
  - SC-55G1 (two per HalfPACT package)
  - SC-55G2 (one per HalfPACT package)

SC-30G2

- Carbon steel per ASTM A516, Grade 70 (plate), or ASTM A266, Grade 2 (forging), normalized to fine grain practice for the lid base, flange, and shells
- Nominally, 2-inch thick lead and 5/8-inch thick steel in the sidewall, 3⅞-inch thick laminated lead/steel lid, and 3-inch thick laminated lead/steel base
- 12, 5/8-inch Grade 8 closure bolts
- Silicone rubber gasket
- Filtered vent port
- Sidewall lead gamma scanned; lid and base lead plates ultrasonically inspected; container welds visually examined
- Nominal empty weight: 2,610 pounds
- Shipped via HalfPACT (2 per package)

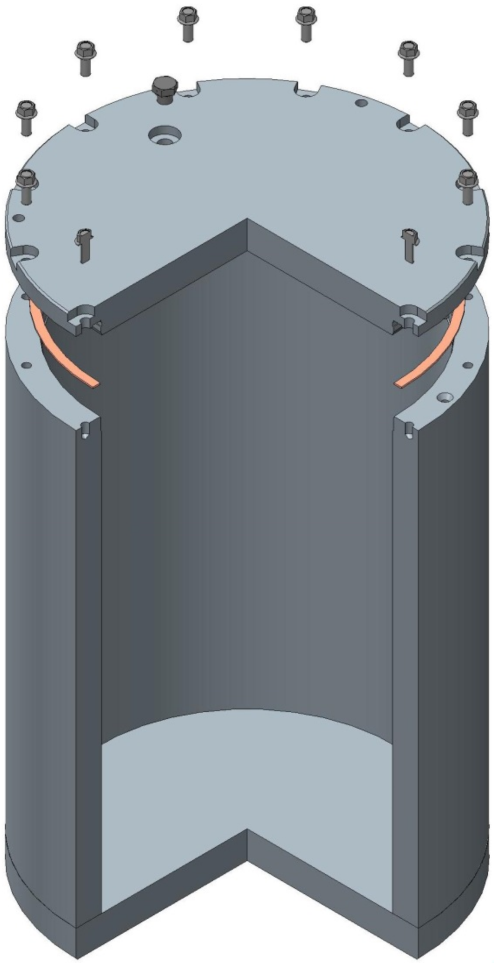
SC-30G3

- Carbon steel per ASTM A516, Grade 70 (plate), or ASTM A266, Grade 2 (forging), normalized to fine grain practice for the lid, base, flange, and shells
- Nominally, 3-inch thick lead and 1-inch thick steel in the sidewall, 6¾-inch thick laminated lead/steel lid, and 5¾-inch thick laminated lead/steel base
- 12, 3/4-inch Grade 8 closure bolts
- Silicone rubber gasket
- Filtered vent port
- Sidewall lead gamma scanned, lid and base lead plates ultrasonically inspected; container welds visually examined
- Nominal empty weight: 5,750 pounds
- Shipped via HalfPACT (1 per package)



SC-55G1

- Carbon steel per ASTM A516, Grade 70 (plate), or ASTM A266, Grade 2 (forging), normalized to fine grain practice for the lid, base, and shell
- Nominally, 2.2-inch thick solid steel sidewall, 2.4-inch thick solid steel lid, and 2.35-inch thick solid steel base
- 12, 5/8-inch Grade 8 closure bolts
- Silicone rubber gasket
- Filtered vent port with lead shield plug
- Welds visually examined
- Nominal empty weight: 2,810 pounds
- Shipped via HalfPACT (2 per package)



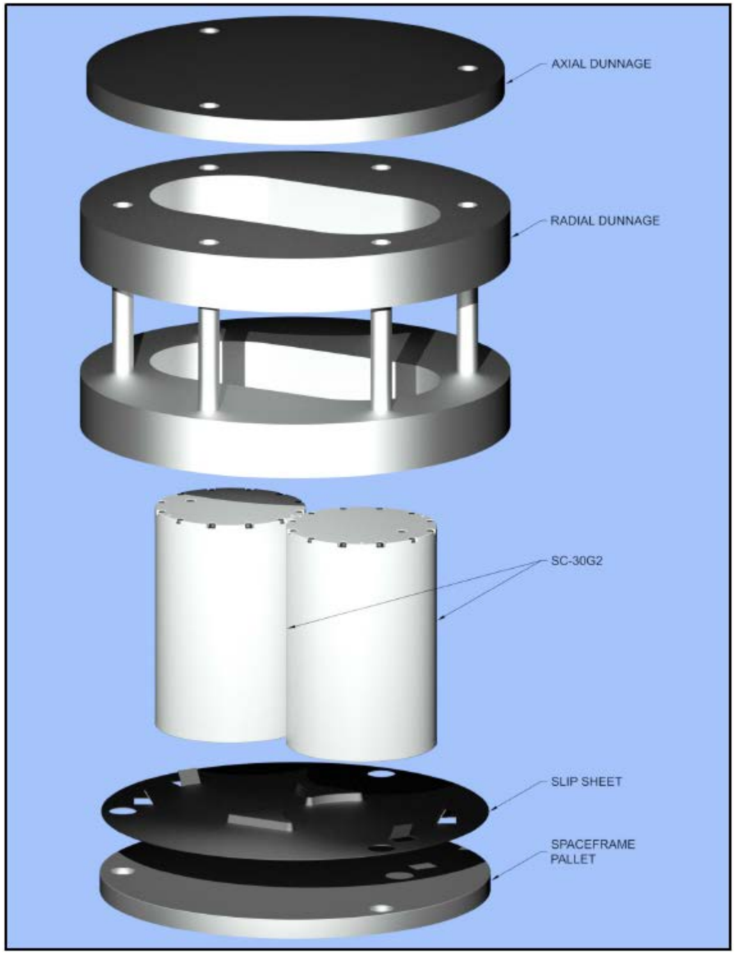
SC-55G2

- Carbon steel per ASTM A516, Grade 70 (plate), or ASTM A266, Grade 2 (forging), normalized to fine grain practice for the lid, base, flange, and shells
- Nominally, 2-inch thick lead and 1-inch thick steel in the sidewall, 5¾-inch thick laminated lead/steel lid, and 4¼" -inch thick laminated lead/steel base
- 12, 3/4-inch Grade 8 closure bolts
- Silicone rubber gasket
- Filtered vent port
- Sidewall lead gamma scanned, lid and base lead plates ultrasonically inspected; container welds visually inspected
- Nominal empty weight: 5,900 pounds
- Shipped via HalfPACT (1 per package)

Ancillary Dunnage and Payload Configurations

SC-30G2

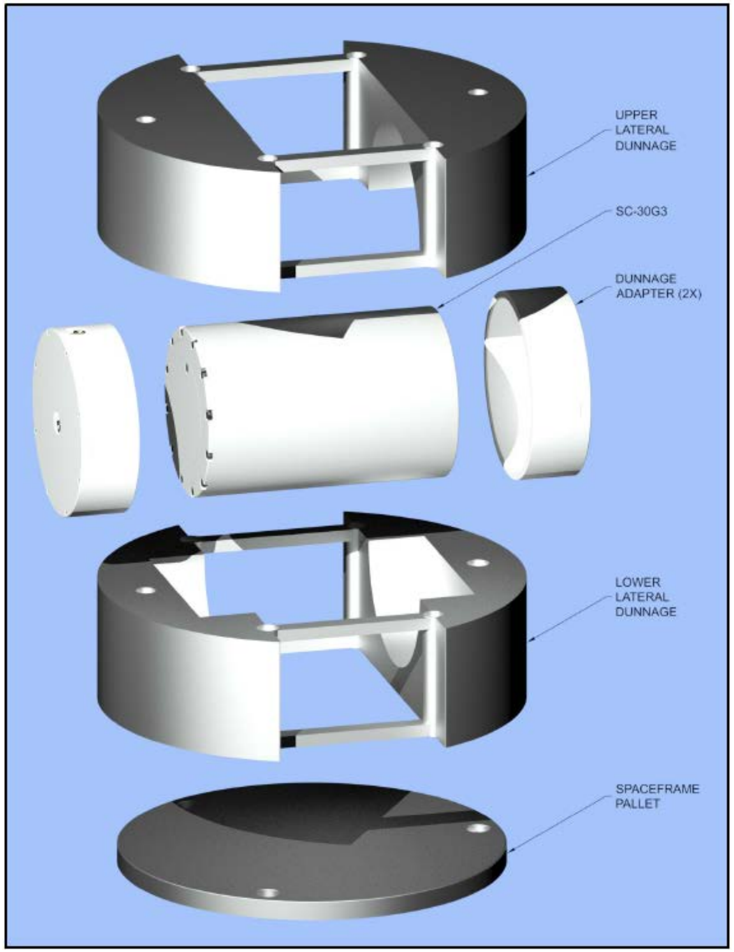
- Axial and radial dunnage
- Slip sheet and spaceframe pallet
- Payload assembly consists of two units
- Shipped in HalfPACT



Ancillary Dunnage and Payload Configurations *(Continued)*

SC-30G3

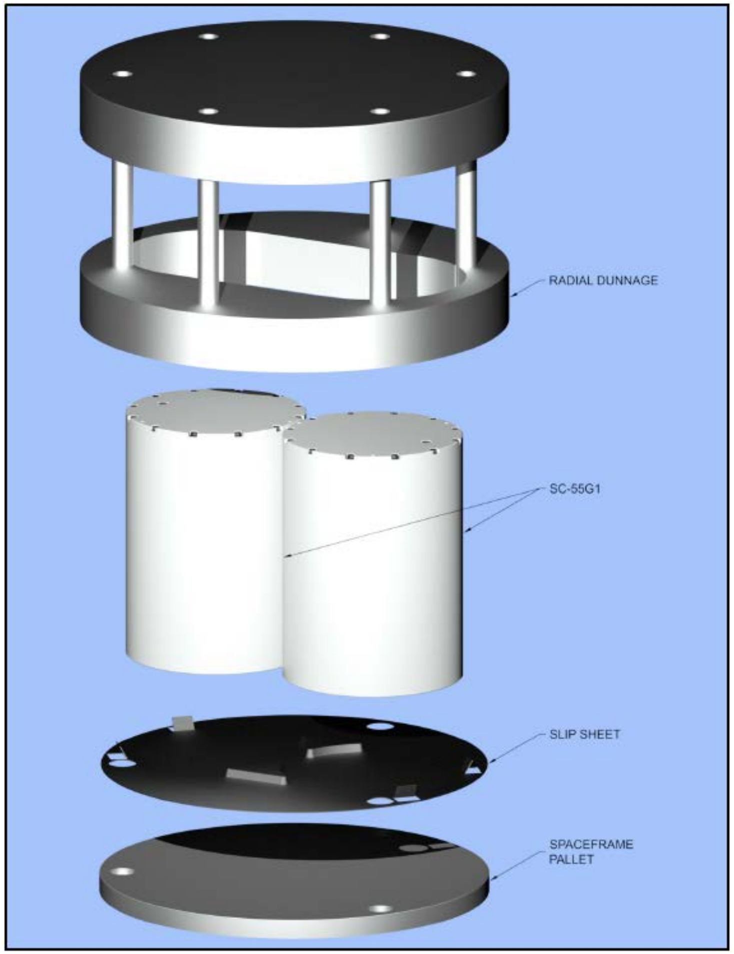
- Upper and lower lateral dunnage
- Dunnage adapter endcaps
- Spaceframe pallet
- Payload assembly consists of one unit
- Shipped in HalfPACT



Ancillary Dunnage and Payload Configurations *(Continued)*

SC-55G1

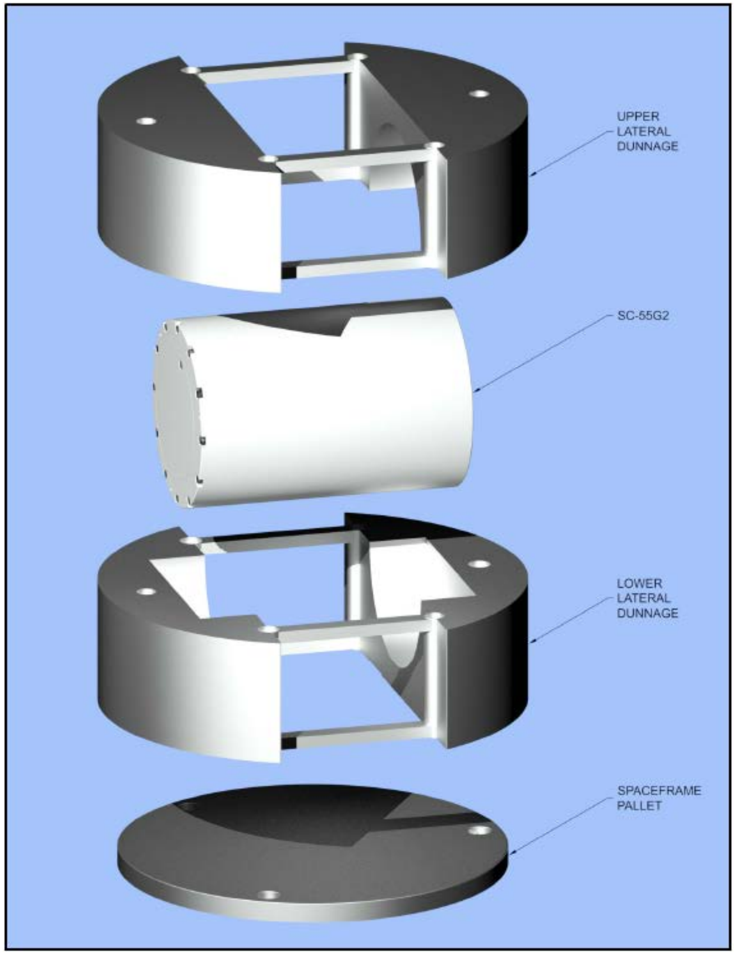
- Radial dunnage
- Slip sheet and spaceframe pallet
- Payload assembly consists of two units
- Shipped in HalfPACT



Ancillary Dunnage and Payload Configurations *(Continued)*

SC-55G2

- Upper and lower lateral dunnage
- Spaceframe pallet
- Payload assembly consists of one unit
- Shipped in HalfPACT



Certification Tests and Bounding Conditions

- DOT Specification 7A, Type A
  - Each shielded container will meet DOT Specification 7A, Type A
  - Bounding 4-foot drops will be conducted on the payload containers and orientations, as described
- HAC Free-Drop Tests
  - Each shielded container payload assembly will be drop tested with the appropriate dunnage inside a test surrogate HalfPACT inner containment vessel (ICV), as described
  - 30-foot drops will be conducted on the payload assemblies and orientations, as described

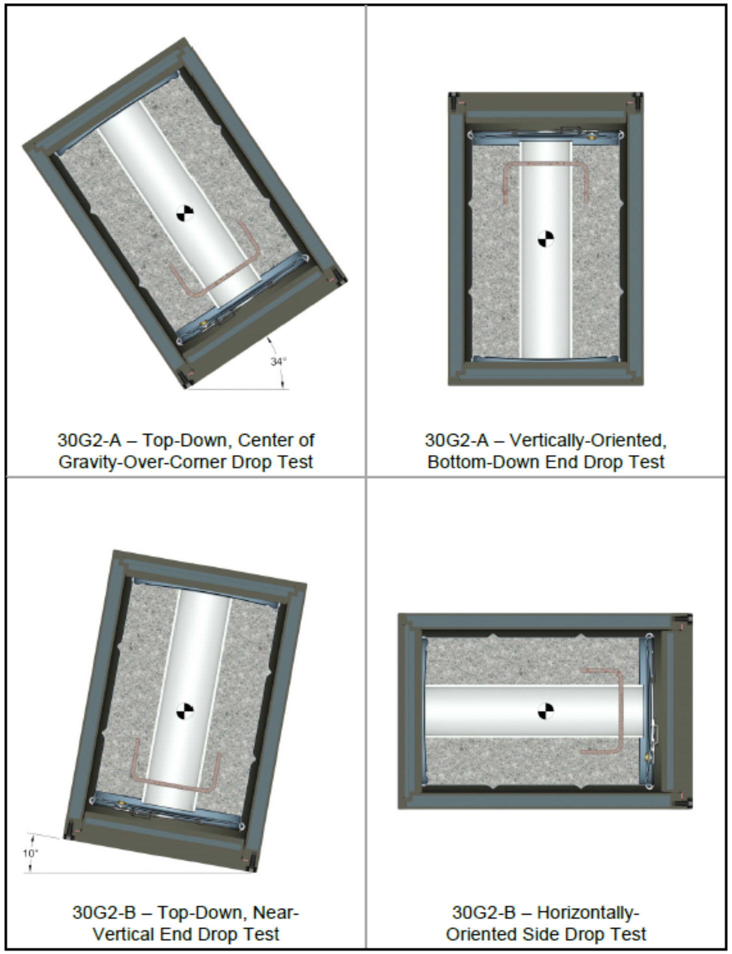
Certification Tests and Acceptance Criteria

- Drop-test acceptance is primarily based on demonstrating confinement of payload and no significant decrease in shielding effectiveness
  - No release of contents verified by scanning for fluorescein/flour release
  - For lead lined containers (SC-30G2, SC-30G3, and SC-55G2), pre- and post-drop test gamma scans to ensure no significant decrease in shielding
  - For non-lead lined containers (SC-55G1), permanent deformations will be added to shielding models and compared to the original (vs 20%)

DOT Specification 7A, Type A Testing

SC-30G2

- Two prototype units will be used for Type A testing
- Four drop test scenarios will be conducted



30G2-A – Top-Down, Center of Gravity-Over-Corner Drop Test

30G2-A – Vertically-Oriented, Bottom-Down End Drop Test

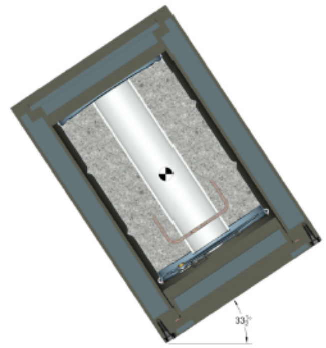
30G2-B – Top-Down, Near-Vertical End Drop Test

30G2-B – Horizontally-Oriented Side Drop Test

DOT Specification 7A, Type A Testing
(Continued)

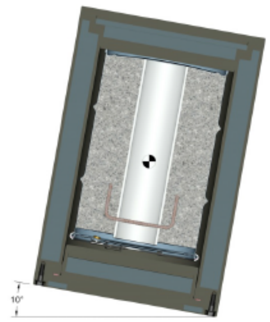
SC-30G3

- Two prototype units will be used for Type A testing
- Four drop test scenarios will be conducted

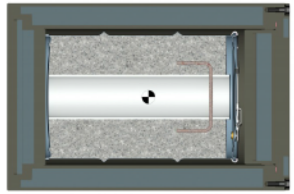


30G3-A – Top-Down, Center of Gravity-Over-Corner Drop Test

30G3-A – Vertically-Oriented, Bottom-Down End Drop Test



30G3-B – Top-Down, Near-Vertical Corner Drop Test

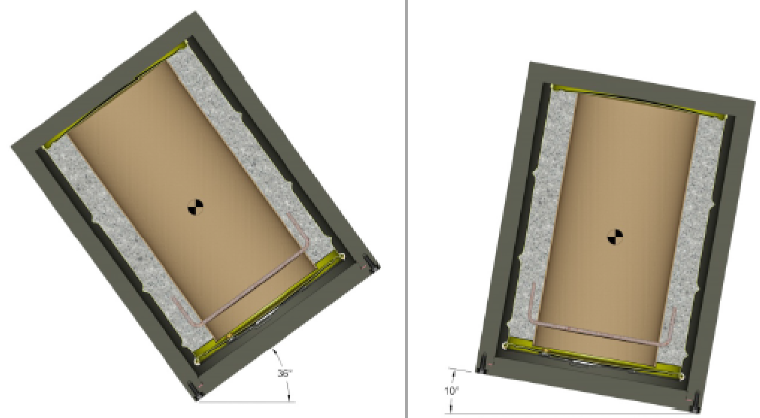


30G3-B – Horizontally-Oriented Side Drop Test

DOT Specification 7A, Type A Testing
(Continued)

SC-55G1

- One prototype unit will be used for Type A testing
- Two drop test scenarios will be conducted



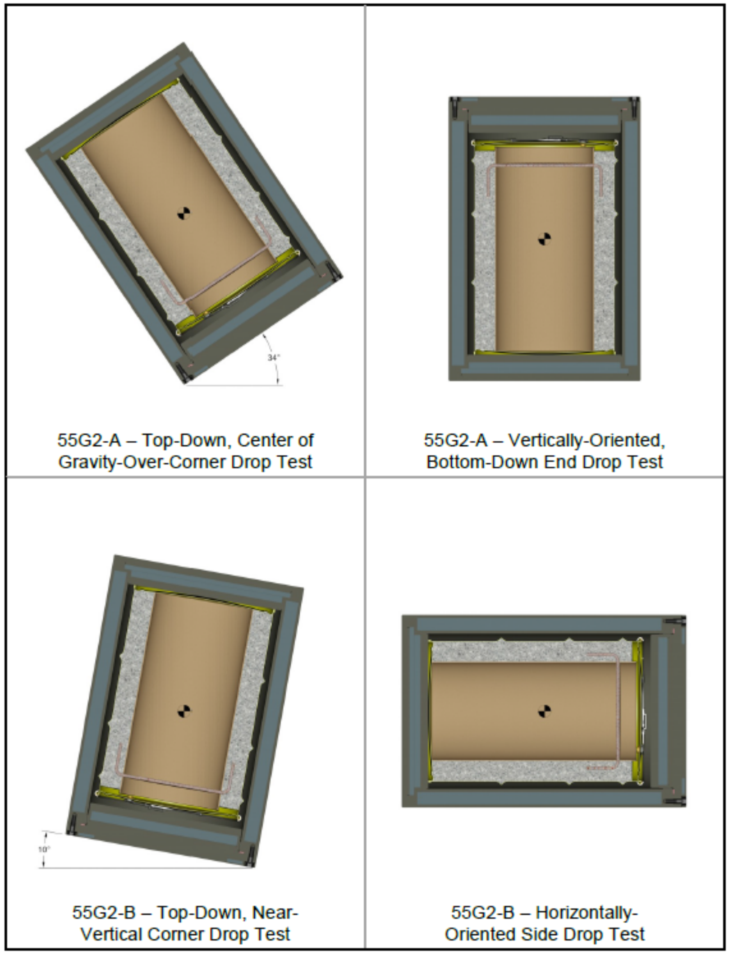
55G1-A – Top-Down, Center of Gravity-Over-Corner Drop Test

55G1-A – Top-Down, Near-Vertical Corner Drop Test

DOT Specification 7A, Type A Testing *(Continued)*

SC-55G2

- Two prototype units will be used for Type A testing
- Four drop test scenarios will be conducted



55G2-A – Top-Down, Center of Gravity-Over-Corner Drop Test

55G2-A – Vertically-Oriented, Bottom-Down End Drop Test

55G2-B – Top-Down, Near-Vertical Corner Drop Test

55G2-B – Horizontally-Oriented Side Drop Test

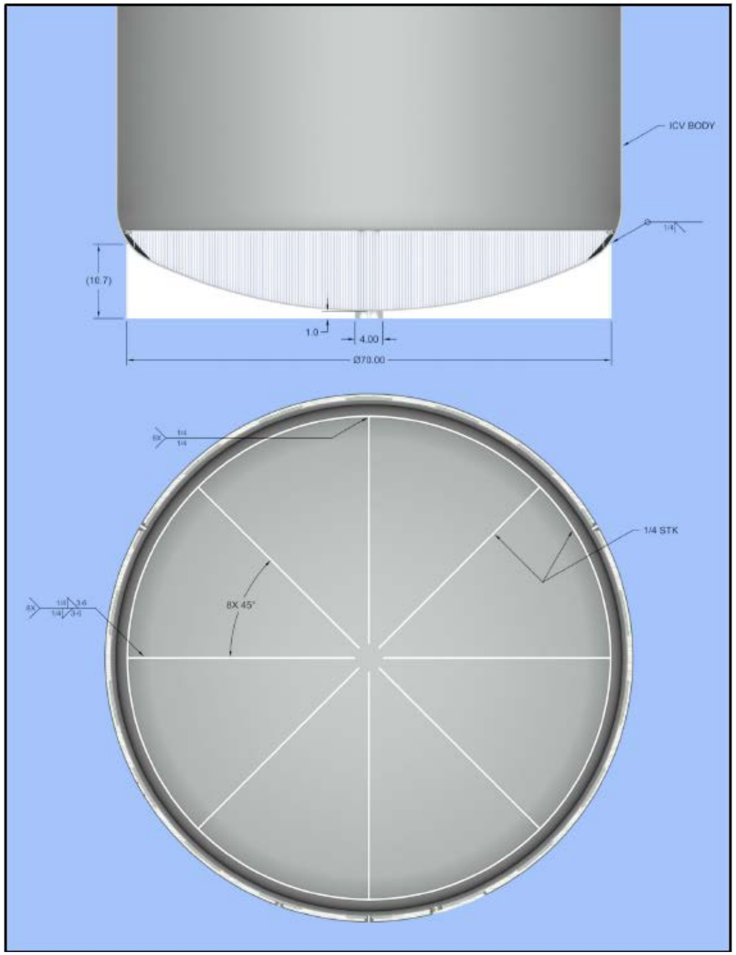
HAC Free-Drop Tests

Two test articles will be drop tested to support HAC testing

- Two HalfPACT test surrogate ICVs will be tested.
- The bottom of each test article will be reinforced with stiffeners to ensure the end drops will result in higher acceleration loads to the shielded containers than if inside an impact-attenuating outer containment assembly (OCA).
- Each test scenario will bound two of the shielded container payload assemblies, so testing will be performed only on those payload assemblies, as described.

HAC Free-Drop Tests *(Continued)*

ICV Bottom Reinforcement



HAC Free-Drop Tests *(Continued)*

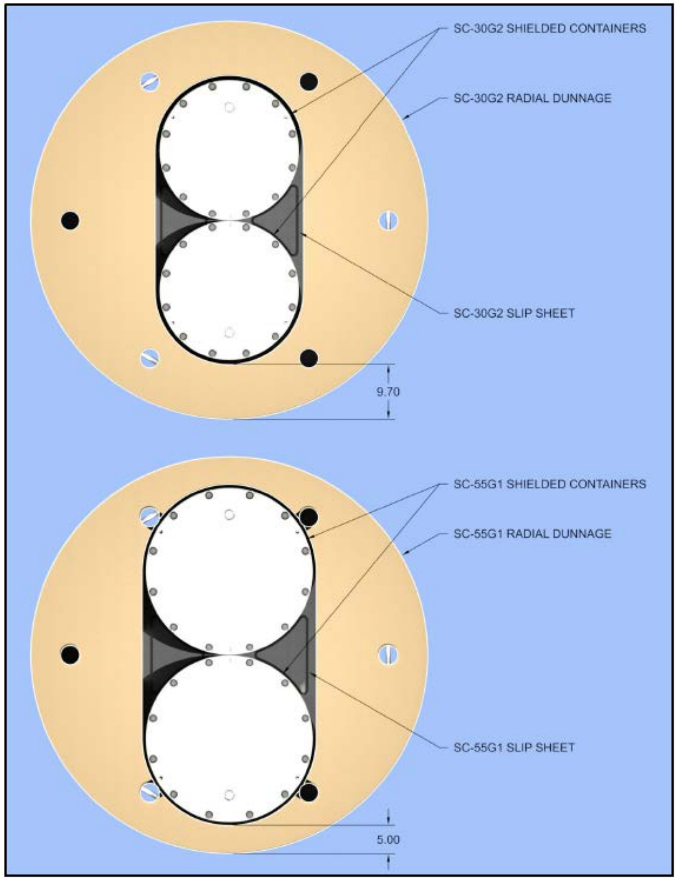
Justification for the Tested Configurations

- The two test configurations are chosen to demonstrate that damage inflicted by the shielded containers to the HalfPACT package is insufficient to preclude them from meeting all the regulatory performance requirements of 10 CFR 71
- The two test configurations are described in the following slides

HAC Free-Drop Tests *(Continued)*

SC-30G2 vs SC-55G1 Side Drop

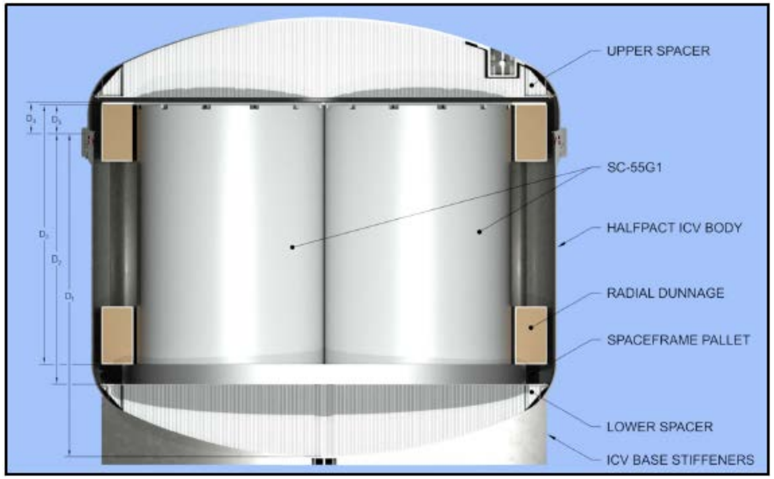
- The larger diameter and height of the SC-55G1 compared to the SC-30G2 results in less available protective thickness by the radial dunnage for attenuating the kinetic energy associated with the side drop impact
- To maximize damage, the SC-55G1 shielded containers will be oriented as shown, aligning the most highly concentrated load with the least amount of radial dunnage thickness
- The **SC-55G1** bounds the SC-30G2 and will be used for testing



HAC Free-Drop Tests *(Continued)*

SC-30G2 vs SC-55G1 End Drop

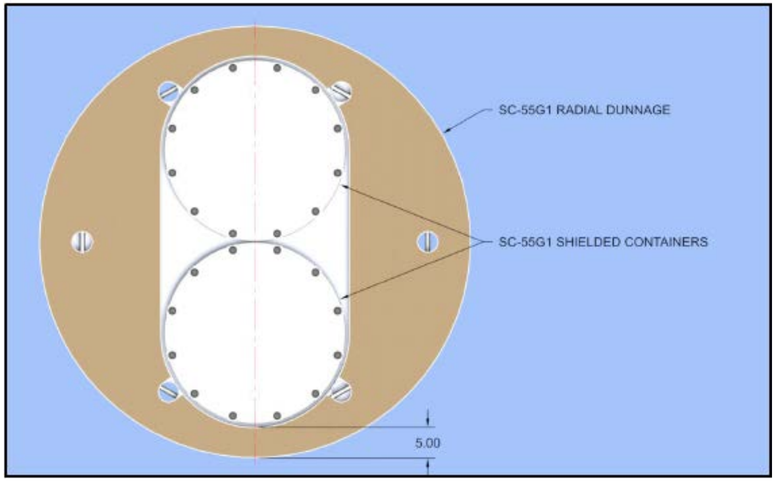
- The end drop is performed on an unprotected and stiffened ICV, resulting in higher acceleration loads than if inside an impact attenuating OCA
- Not using axial dunnage, the **SC-55G1** bounds the SC-30G2 for testing



HAC Free-Drop Tests *(Continued)*

SC-30G2 vs SC-55G1 Side Drop

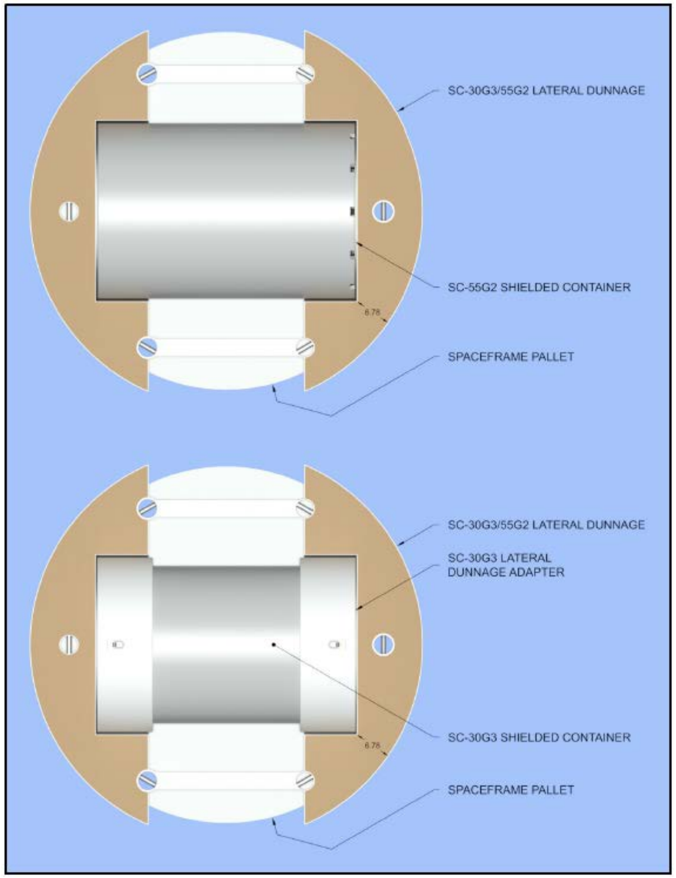
- The side drop is performed on an unprotected ICV resulting in higher acceleration loads than when inside an impact attenuating OCA
- To maximize damage, the shielded containers will be oriented as shown, aligning the most highly concentrated load with the least amount of radial dunnage thickness



HAC Free-Drop Tests *(Continued)*

SC-30G3 vs SC-55G2 *Side Drop*

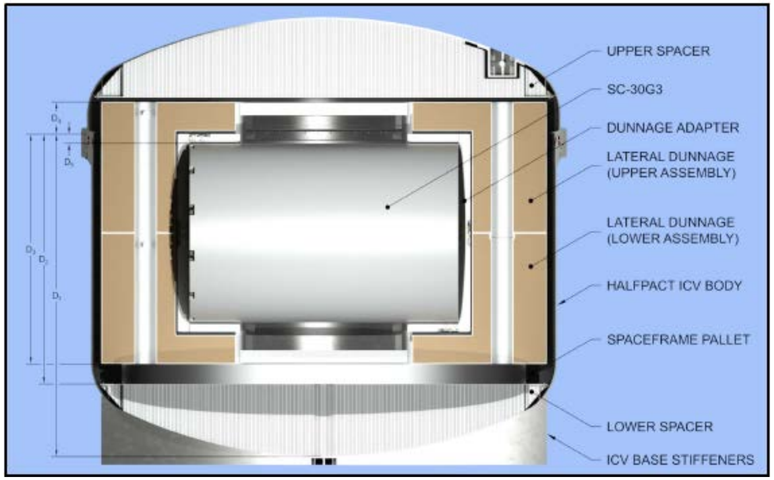
- The SC-30G3 is smaller than the SC-55G2; however, with its HDPE dunnage adapter "end caps," it is essentially the same size and weight
- The dunnage adapters provide additional radial and axial clearances between the SC-30G3 and the lateral dunnage
- The **SC-30G3** bounds the SC-55G2 for testing.



HAC Free-Drop Tests *(Continued)*

SC-30G3 vs SC-55G2 End Drop

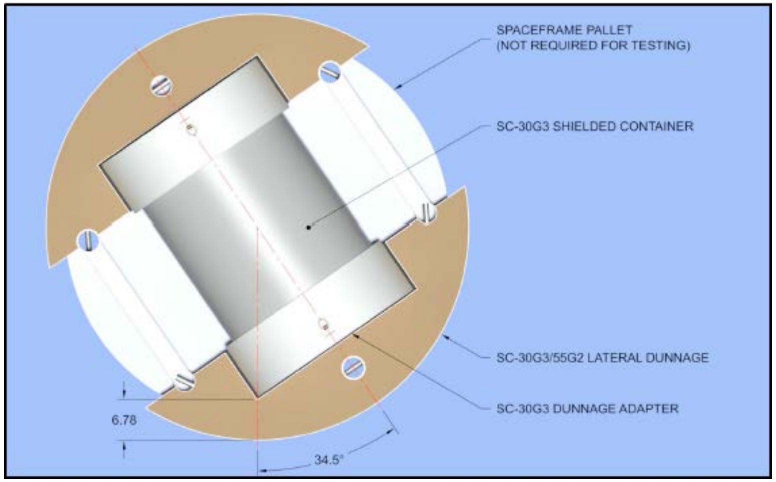
- The end drop is performed on an unprotected and stiffened ICV, resulting in higher acceleration loads than if inside an impact attenuating OCA



HAC Free-Drop Tests *(Continued)*

SC-30G3 vs SC-55G2 Side Drop

- The side drop is performed on an unprotected ICV, resulting in higher acceleration loads than when inside an impact attenuating OCA
- To maximize damage, the shielded containers will be oriented as shown, aligning the most highly concentrated load with the least amount of radial dunnage thickness.



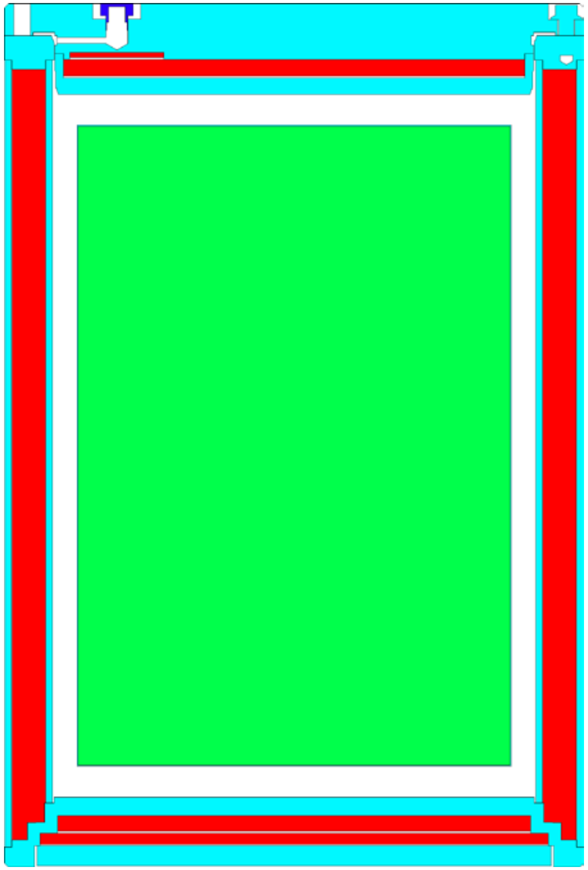
Thermal, Shielding, and Criticality Evaluations

- SAR analyses will use analytical methods similar to those used for the currently approved thermal, shielding, and criticality analyses

MCNP Shielding Models

SC-30G2

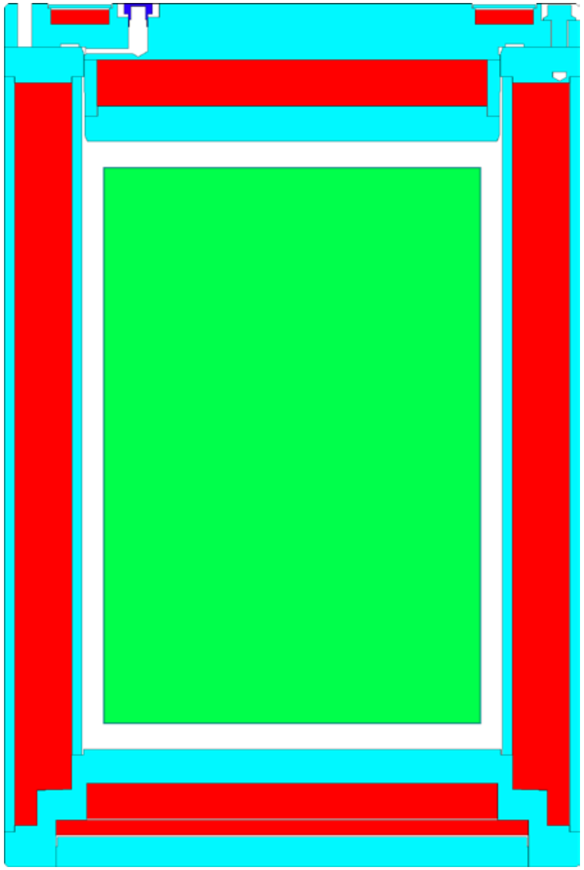
- Cyan is carbon steel
- Blue is stainless steel
- Red is lead
- Green is the 30-gallon drum payload representation



MCNP Shielding Models *(Continued)*

SC-30G3

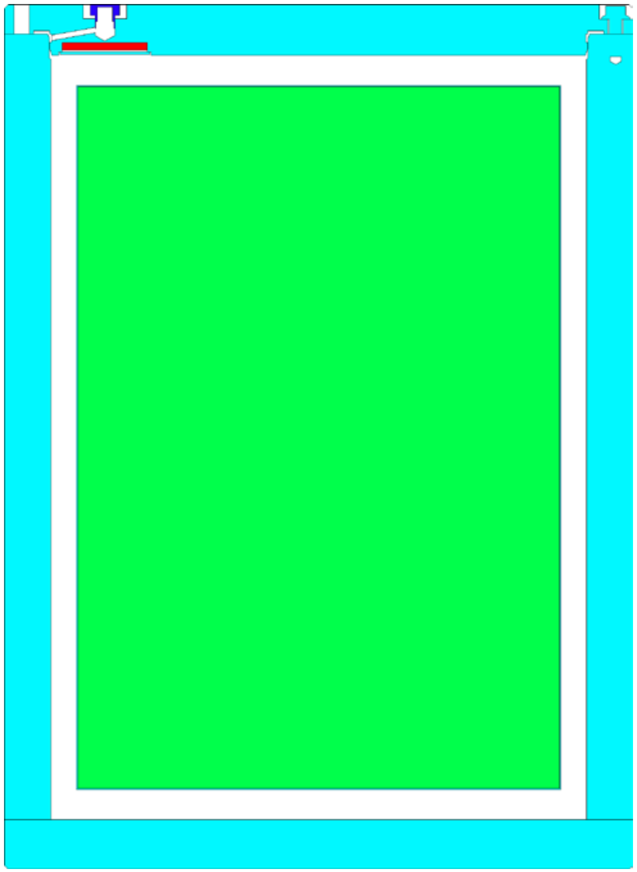
- Cyan is carbon steel
- Blue is stainless steel
- Red is lead
- Green is the 30-gallon drum payload representation



MCNP Shielding Models *(Continued)*

SC-55G1

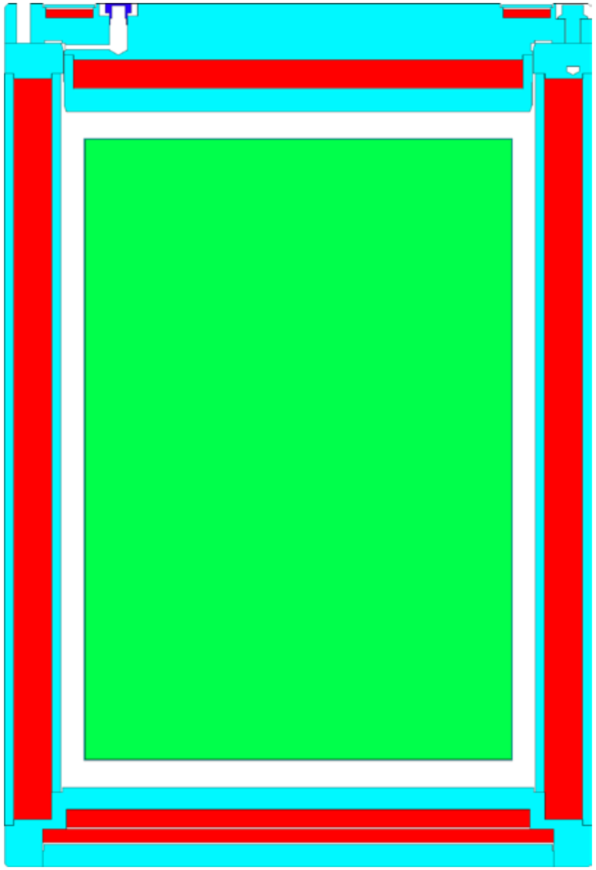
- Cyan is carbon steel
- Blue is stainless steel
- Red is lead
- Green is the 55-gallon drum payload representation



MCNP Shielding Models *(Continued)*

SC-55G2

- Cyan is carbon steel
- Blue is stainless steel
- Red is lead
- Green is the 55-gallon drum payload representation

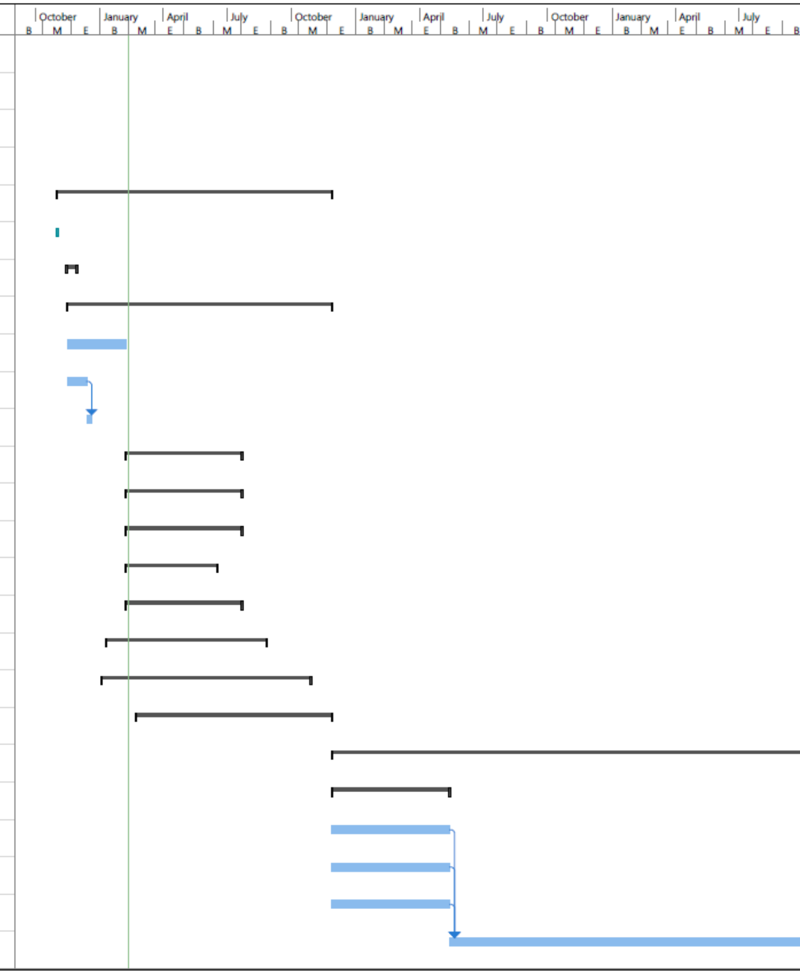


Interim Shielded Container Design Parameters

Parameter	SC-30G1	SC-30G2	SC-30G3	SC-55G1	SC-55G2
— Overall Shielded Container Configuration —					
• Approximate Lead Equivalency (in)	1	1¾	3¼	3/4	2¼
• Approximate HDPE Thickness (in)	—	—	—	—	—
• Quantity per HalfPACT/TRUPACT-II Package	3	2	1	2	1
• Payload Drum Size	30-Gallon	30-Gallon	30-Gallon	55-Gallon	55-Gallon
— Shielded Container Component Weights —					
• Container Body (lb)	1,423	2,175	4,870	2,405	4,822
• Container Lid (lb)	303	435	880	405	999
• Container Tare (lb)	1,726	2,610	5,750	2,810	5,821
• Payload Drum & Contents (lb)	534	550	550	600	534
• Container Gross (lb)	2,260	3,160	6,300	3,410	6,354
• Pallet and Dunnage (lb)	820	940	1,280	1,191	1,087
• HalfPACT Package Total (7,600-lb Limit)	7,600	7,260	7,580	7,406	7,441
— Shielded Container Component Dimensions and Sizes —					
• Outside Diameter (in)	23	24½	28	29⅜	31
• Outside Height (in)	30¾	36⅝	42¼	40½	45¾
• Payload Cavity Diameter (in)	20⅜	20⅜	20⅜	25	25
• Payload Cavity Height (in)	29¾	29¾	29¾	35¾	35¾
• Base Thickness (in)	3	3	5¾	2⅜	4¼
• Lid Thickness (in)	3	3⅞	6¾	2⅜	5¾
• Sidewall Thickness (in)	15/16	2 1/16	3 13/16	2 3/16	3
• Closure Screw Size	1/2	5/8	3/4	5/8	3/4
• Number of Closure Screws	15	12	12	12	12
— Estimated Allowable Payload Drum Side Surface Dose Rate with a Low-Density, Uniformly Distributed Source (R/hr) —					
• Gamma-Emitting Radionuclide: ^{137}Cs	10.1	71.6	8,980	4.5	754
• Gamma-Emitting Radionuclide: ^{60}Co	2.2	6.3	95.8	2.3	24.6

Schedule

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		SCA Prototype Designs Complete				
2		SCA Test Plans Complete				
3		Secure Funding				
4		NRC Meeting				
5		**Prototype Fabrication & Testing Subcontract**	**281 days**	**Wed 10/31/1**	**Wed 11/27/19**	
6		Contract Award / PO	1 day	Wed 10/31/1	Wed 10/31/18	
7		**Pre-planning Activities**	**11 days**	**Wed 11/14/1**	**Wed 11/28/18**	
10		**Prototype Test articles Fabrication & Testing**	**270 days**	**Thu 11/15/18**	**Wed 11/27/19**	
11		Material Procurements	60 days	Thu 11/15/18	Wed 2/6/19	8
12		Develop travelers (or equivalent)	20 days	Thu 11/15/18	Wed 12/12/18	8
13		NWP approval of travelers	5 days	Thu 12/13/18	Wed 12/19/18	12
14		**Fabrication**	**118 days**	**Thu 2/7/19**	**Mon 7/22/19**	
15		**SC-30G2 (2 units)**	**118 days**	**Thu 2/7/19**	**Mon 7/22/19**	
24		**SC-30G3 (3 units)**	**118 days**	**Thu 2/7/19**	**Mon 7/22/19**	
33		**SC-55G1 (3 units)**	**93 days**	**Thu 2/7/19**	**Mon 6/17/19**	
42		**SC-55G2 (2 units)**	**118 days**	**Thu 2/7/19**	**Mon 7/22/19**	
51		**Type A Testing**	**163 days**	**Thu 1/10/19**	**Mon 8/26/19**	
62		**Ancillary Dunnage and Test Surrogate Fabrication**	**213 days**	**Thu 1/3/19**	**Mon 10/28/19**	
76		**Type B (HAC) Testing**	**200 days**	**Thu 2/21/19**	**Wed 11/27/19**	
86		**SAR Application and NRC Review**	**480 days**	**Thu 11/28/19**	**Wed 9/29/21**	
87		**SAR Application**	**120 days**	**Thu 11/28/19**	**Wed 5/13/20**	
88		Revise SAR	120 days	Thu 11/28/19	Wed 5/13/20	85
89		Revise TRAMPAC	120 days	Thu 11/28/19	Wed 5/13/20	85
90		Revise Payload Appendices	120 days	Thu 11/28/19	Wed 5/13/20	85
91		NRC Review & Approval	360 days	Thu 5/14/20	Wed 9/29/21	88,89,90



Page 1

Summary Overview

- Present the Need for Additional Methods for Transporting RH-TRU Waste
- Design Requirements/Objectives
- Approach similar to original Shielded Container Assembly (SCA) (currently approved) Testing and Certification Process
- Four (4) New Shielded Container Designs for 30- and 55-Gallon Drums
- Planned Certification Tests and Bounding Conditions
  - DOT Specification 7A, Type A, 4-Foot Drop Tests
  - HAC 30-Foot Free-Drop Tests
- 10 CFR 71 safety evaluations (Thermal, Shielding, & Criticality)