RH-TRU 72-B Packaging

Design, Testing, and Certification of Neutron Shielded Canisters

Presented to the US Nuclear Regulatory Commission
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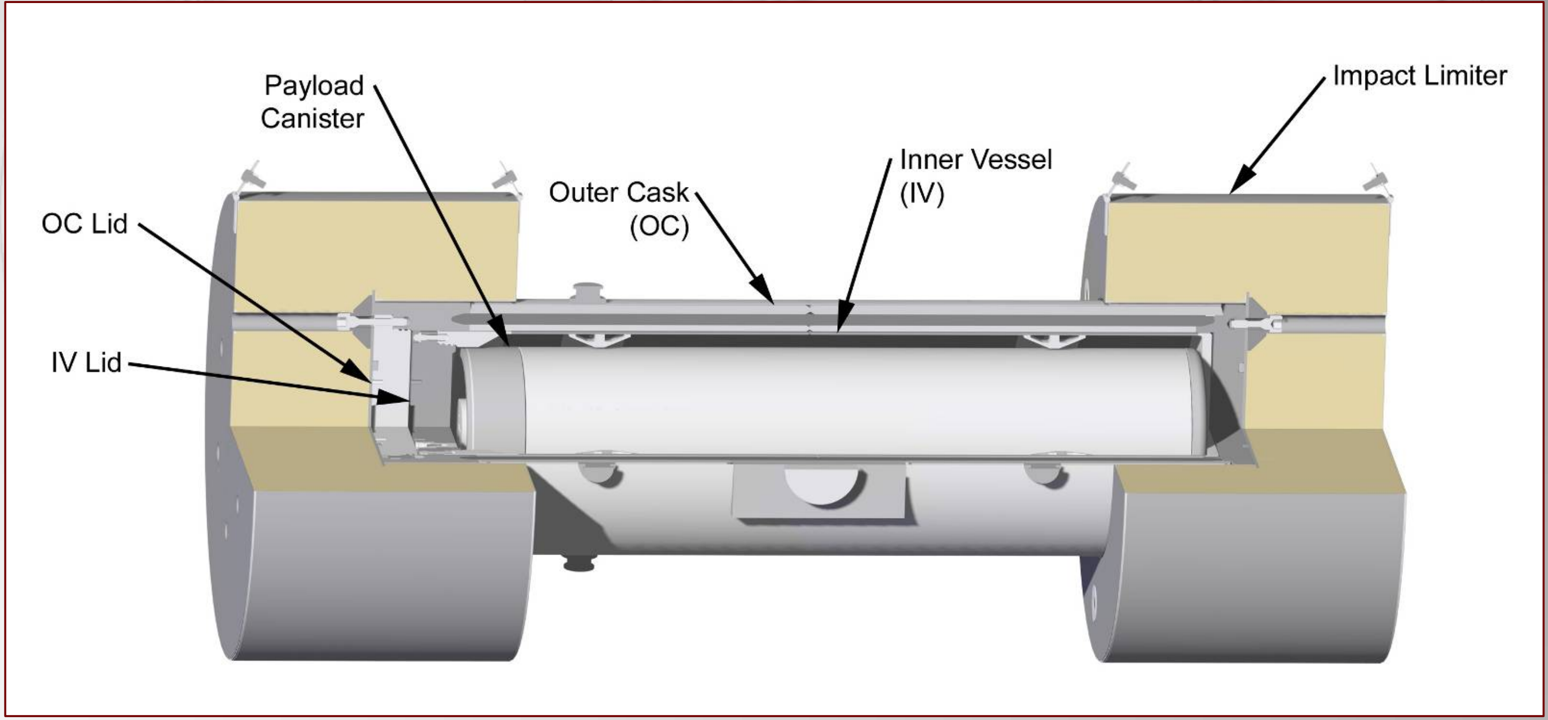
RH-TRU 72-B Summary

- Current Status
  - CoC issued under Docket No. 71-9212
    - RH-TRU 72-B SAR Rev. 4, RH-TRAMPAC Rev. 0, RH-TRU Payload Appendices Rev. 0
- Design Basis
  - Essentially a scaled version of 125B cask
  - Certified primarily by analysis (structural, thermal, shielding, and criticality) with supplemental static and dynamic verification testing performed on impact limiters at ½ scale

RH-TRU 72-B Summary (cont.)

Description

- Overall Length = 187-¾, Impact Limiter Diameter = 76”, Cask Length = 141-¾”, Outer Cask OD = 41-⅝”, Inner Vessel Length = 130”, Inner Vessel OD = 32”, Cask Lead Thickness = 1-⅞”, Max. Package Weight = 45,000 lb, Max. Contents Weight = 8,000 lb



Summary of Need/Objective

- Enhanced shipment of neutron source term
  - RH-TRU 72-B packaging provides a stainless steel (3 inch combined thk.) and lead (1-7/8 inch thk.) composite shield to primarily attenuate gamma dose
  - Neutron shielding is required to enhance ability to transport primarily Cm-240 and Cf-252 laden debris waste forms from ORNL
    - Both gamma and neutron sources currently authorized
  - Objective is to minimize impacts to WIPP site handling operations by shielding the payload canister rather than the transport cask
- Improvement of system efficiencies
  - e.g., reduced bolt torque for empty return shipments, etc.

Design Overview

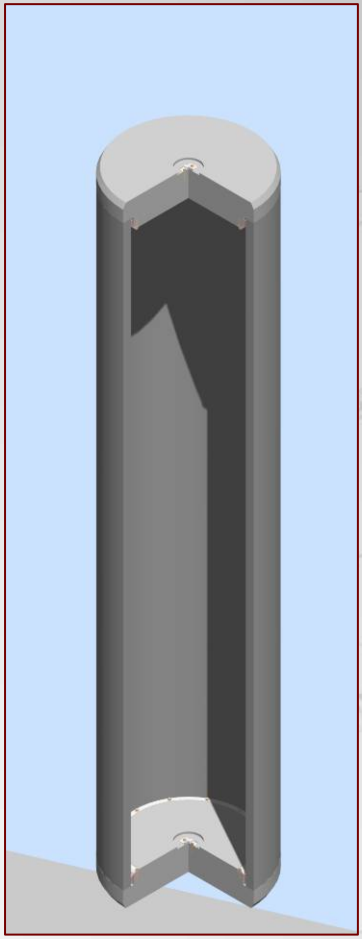
- Neutron Shielded Canisters
  - High-density polyethylene (HDPE) shield insert body and end caps added internally to existing DOT 7A Type A certified Removable Lid Canister (RLC)
    - RLC payload canister currently authorized
  - Two sizes
    - NS30 – accommodates three (3) ~30-gallon payload drums and provides a minimum neutron shielding thickness of ~1.4 inches
    - NS15 – accommodates three (3) ~15-gallon payload drums and provides a minimum neutron shielding thickness of ~3.3 inches

Design Overview (cont.)

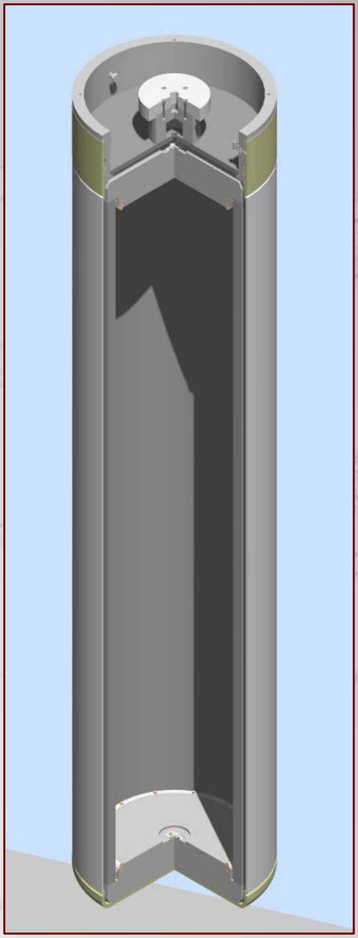
- Shield Inserts
  - Body constructed of commercially available 24-inch outside diameter (OD) HDPE pipe per ASTM F714
    - NS30 – DR 17.0 (DR = ratio of OD to wall thk.)
    - NS15 – DR 7.3
  - End caps constructed by molding pipe-grade HDPE resin per ASTM D3350
  - End caps fitted with “flap-seal” constructed of open-cell urethane foam (Poron™) to retain gross particulate and vent flammable gas

Design Overview (cont.)

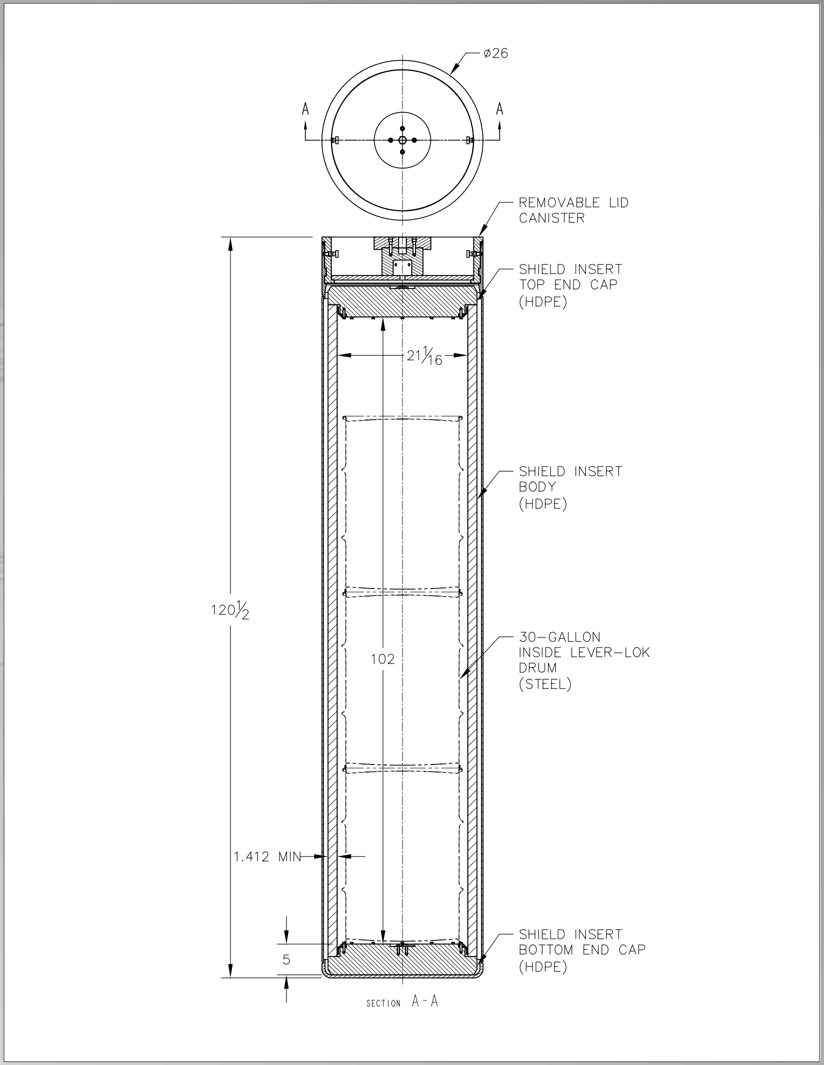
- NS30



Shield Insert Only

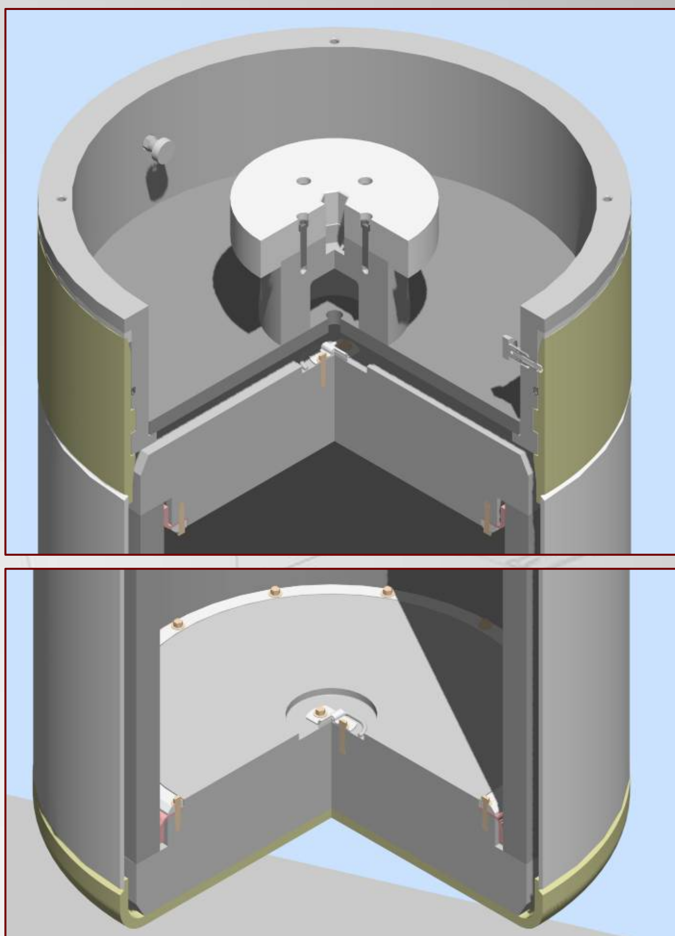


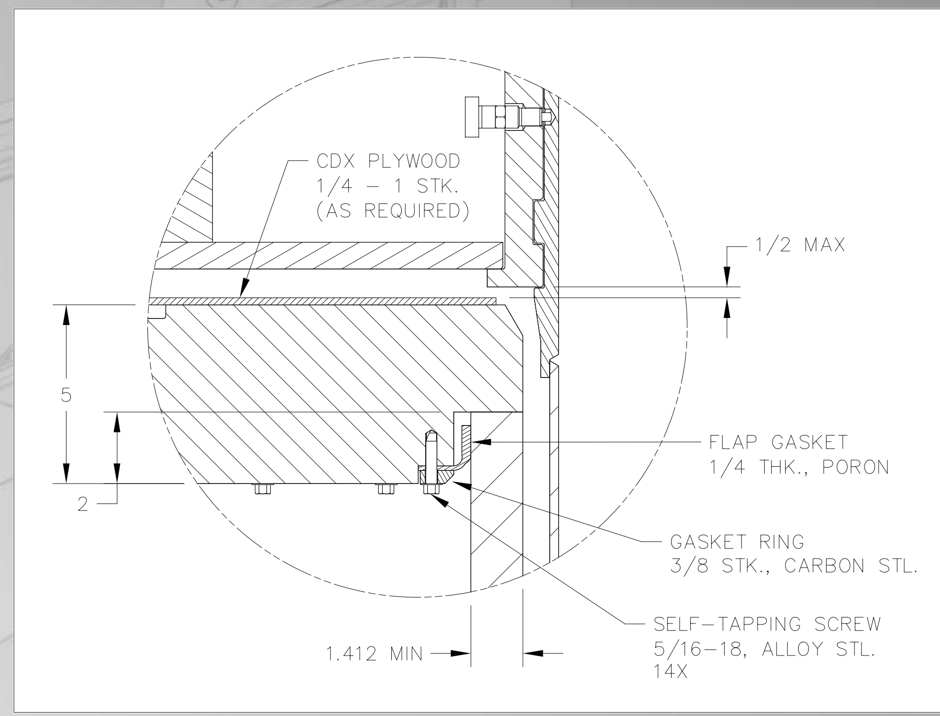
Inside RLC



Design Overview (cont.)

- NS30 (cont.)





Design Parameters

- Structural
  - Weight
    - Existing RLC is authorized for shipment in RH-TRU 72-B at a maximum gross weight limit of 8,000 lb with an approximate empty weight of 1,100 lb
    - NS15 and NS30 both designed with a maximum gross weight limit of 3,100 lb
      - NS15 approximate empty weight is 2,090 lb
        - Average internal payload drum weight is 337 lb
      - NS30 approximate empty weight is 1,660 lb
        - Average internal payload drum weight is 480 lb

Design Parameters (cont.)

- Structural (cont.)
  - Less payload weight and same payload interface with packaging ensures existing SAR analyses bound the response of the RH-TRU 72-B with the NS30 or NS15 neutron shielded canister as payload
  - Structural response of the NS30 and NS15 shield insert components to Hypothetical Accident Condition (HAC) 30 foot drops will be determined by physical tests
    - NCT response bounded by HAC tests

Design Parameters (cont.)

- Thermal
  - Wattage
    - Existing RLC is authorized for shipment in RH-TRU 72-B with a 50 watt decay heat limit for low-conductivity waste (i.e., paper) and 200 watt decay heat for high-conductivity waste (i.e., steel)
    - NS15 and NS30 both designed with a maximum decay heat limit of 50 watts (all waste types)
      - Average through-wall temperature at max point for HDPE shield insert under NCT (with insolation) conditions is ~137°F
      - Average through-wall temperature at max point for HDPE shield insert under HAC (w/o insolation) conditions is ~165°F (NS15) and ~187°F (NS30)

Design Parameters (cont.)

- Thermal (cont.)
  - Thermal response of the RH-TRU 72-B, NS30, and NS15 to NCT and HAC to be determined via analysis
    - Marked dependence upon temperature for HDPE material properties will prompt structural HAC drop testing at temperature extremes
    - Analysis assumptions and methodology consistent with existing thermal evaluations

Design Parameters (cont.)

- Shielding
  - Dose rate attenuation and associated HAC activity limits for the RH-TRU 72-B with the NS30 and NS15 payload to be determined via analysis (point-kernel for gamma and monte-carlo for neutron)
    - HAC drop testing results to provide geometry for analysis and verification that flap-seal limits gross particulate from escaping the neutron shield
    - Analysis assumption of single point source at minimum distance (inside of HDPE shield) to the detector location maintained
  - NCT dose rate compliance per preshipment surveys maintained

Design Parameters (cont.)

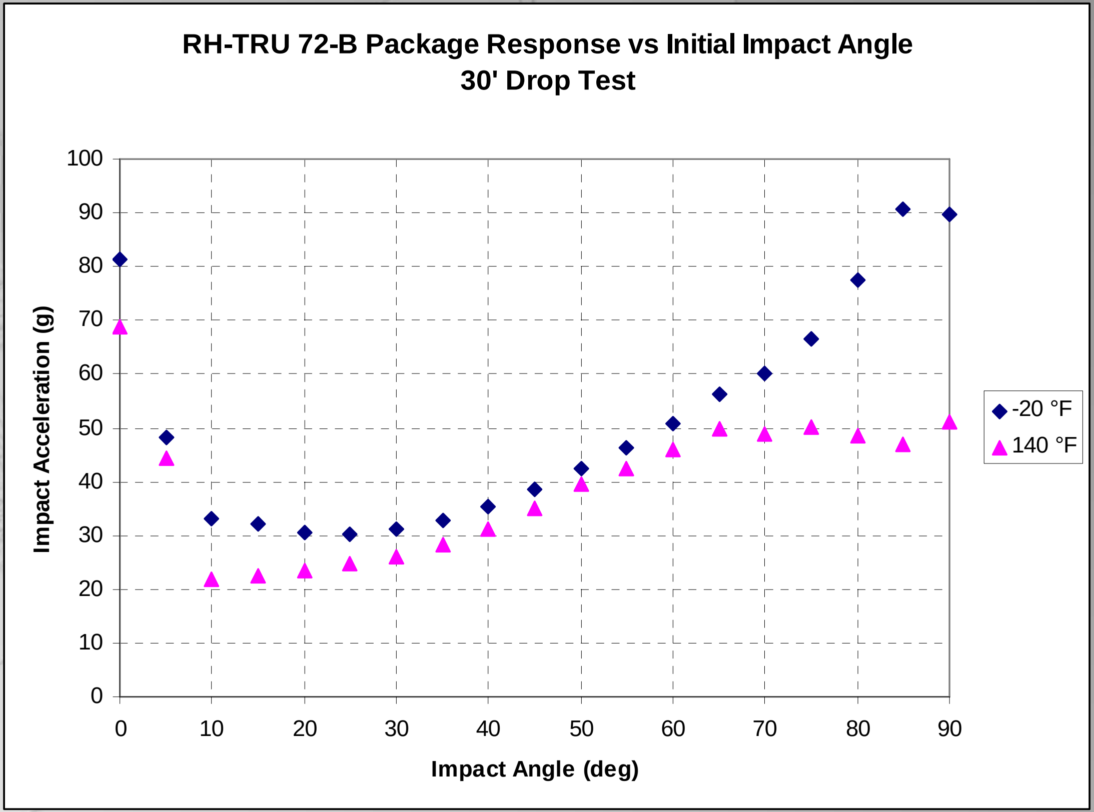
- Criticality
  - Subcriticality of the RH-TRU 72-B with the NS30 and NS15 payload to be determined via analysis (monte-carlo)
    - Additional HDPE reflector may minimally reduce FGE limits
    - Analysis assumptions and methodology consistent with existing criticality evaluations

HAC Test Plan

- HAC performance of RH-TRU 72-B demonstrated by existing analysis
- HAC tests planned to demonstrate structural response of NS15 and NS30 neutron shielded canisters only
  - Only NS30 planned for testing at cold and hot temperature conditions as the thinner wall design bounds the NS15 response
  - A test fixture that provides a conservative set of packaging interface boundary conditions and g-forces is planned for drop testing

HAC Test Plan (cont.)

- Drop Orientations
  - End and side drops are bounding



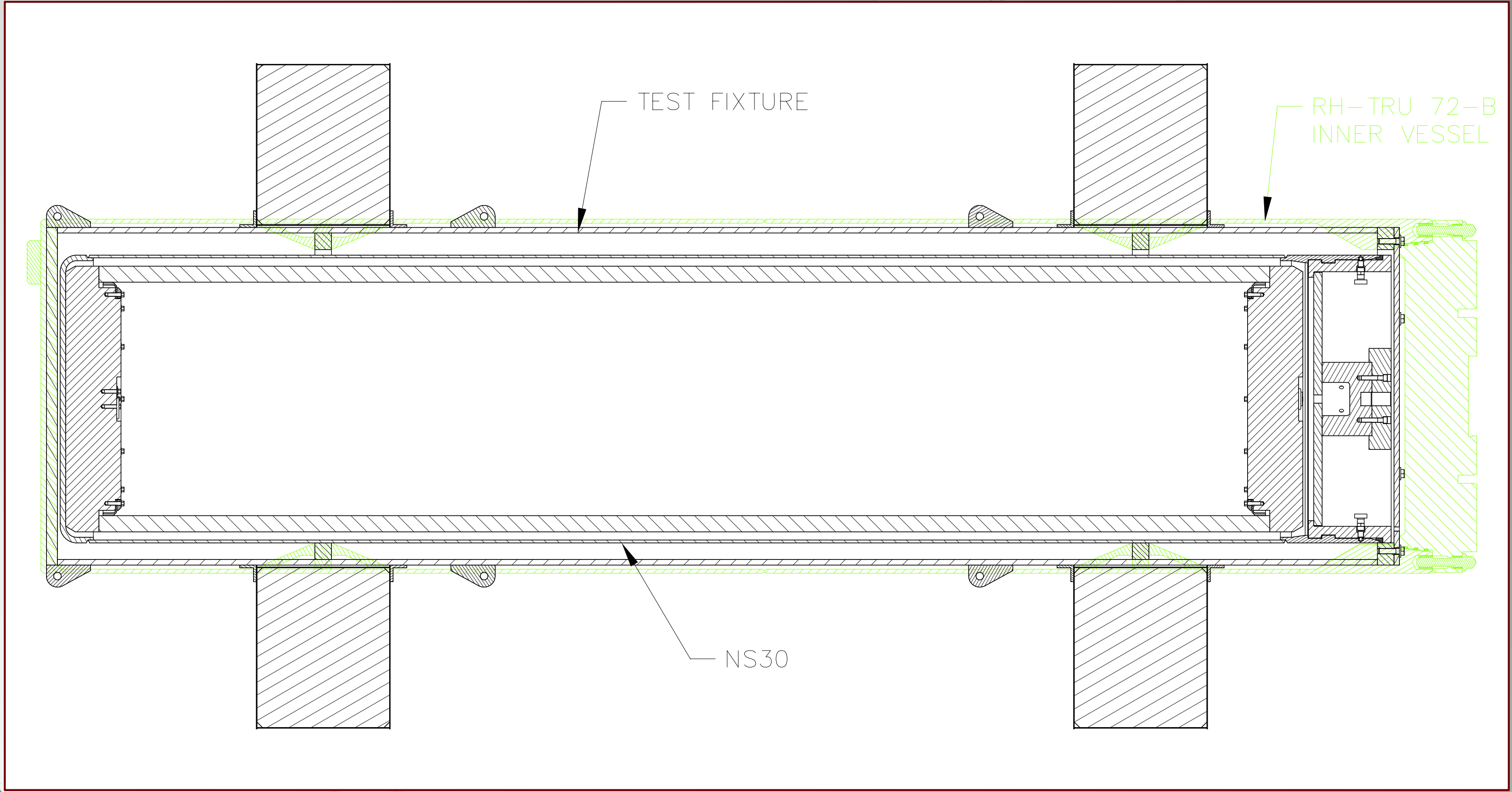
Ref: Table 2.10.3-11 and Table 2.10.3-12 of the RH-TRU 72-B SAR

HAC Test Plan (cont.)

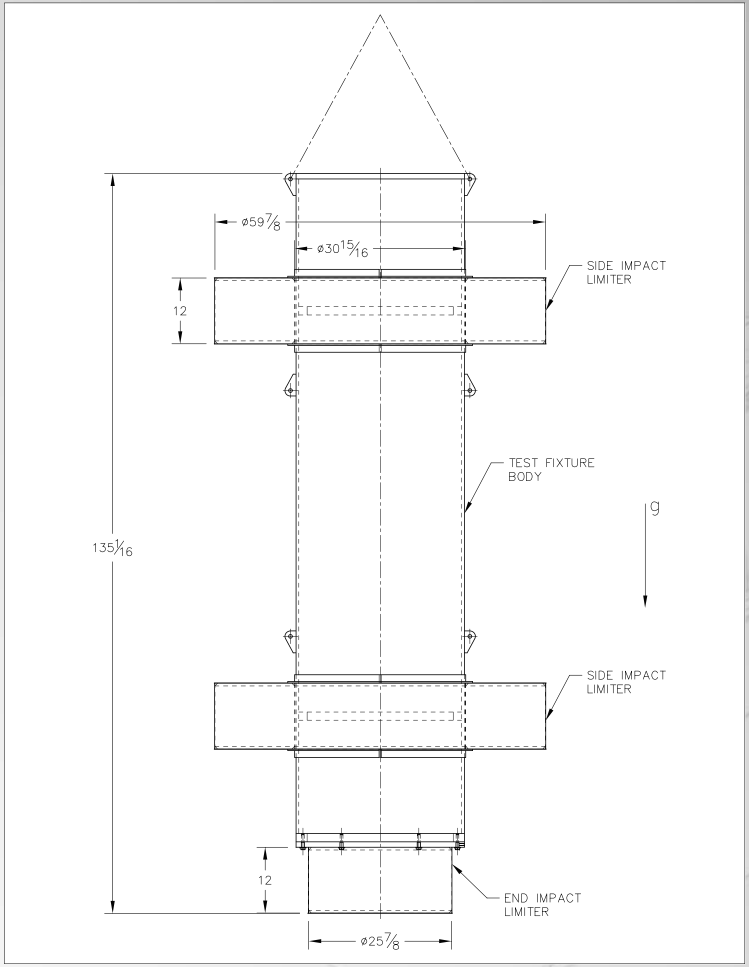
- Test Fixture
  - Interface Boundary Conditions
    - Conservatively simulates interface between canister and RH-TRU 72-B Inner Vessel (IV); i.e., IV flange, IV standoffs, IV bottom, IV lid
  - Impact Limiters
    - Produce g-loads that significantly exceed worst-cases already established for the RH-TRU 72-B impact limiters at hot and cold conditions
      - Foam properties conservatively account for crush strength at 20% below nominal (room temperature) with dynamic stiffening
      - End: General Plastics FR-3720; Side: FR-3716

HAC Test Plan (cont.)

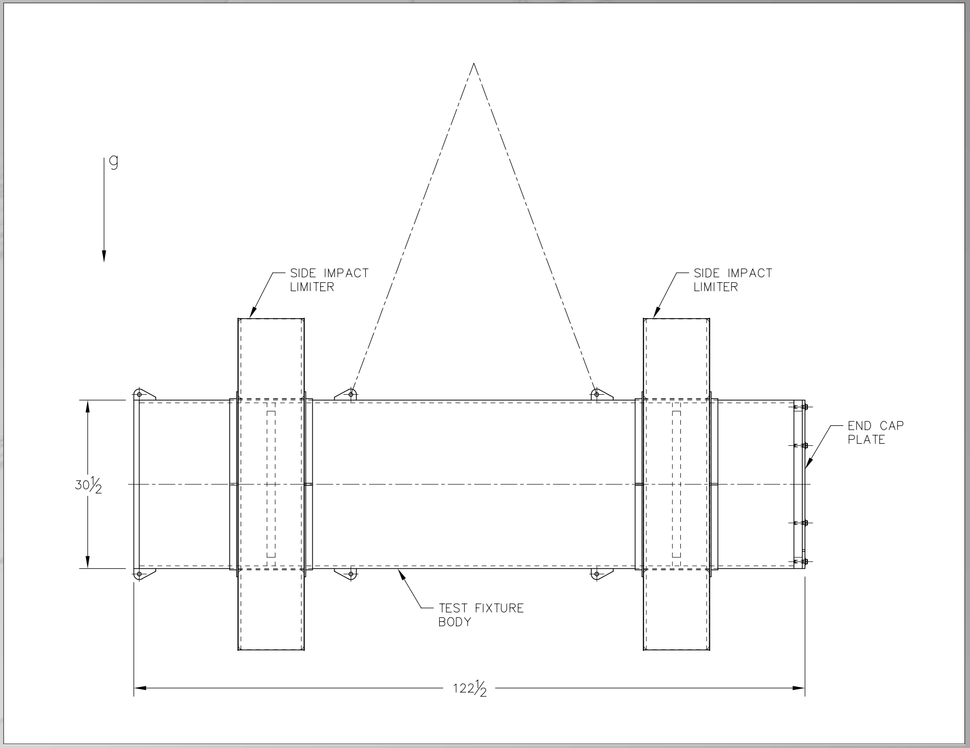
- Interface Boundary Comparison



HAC Test Plan (cont.)



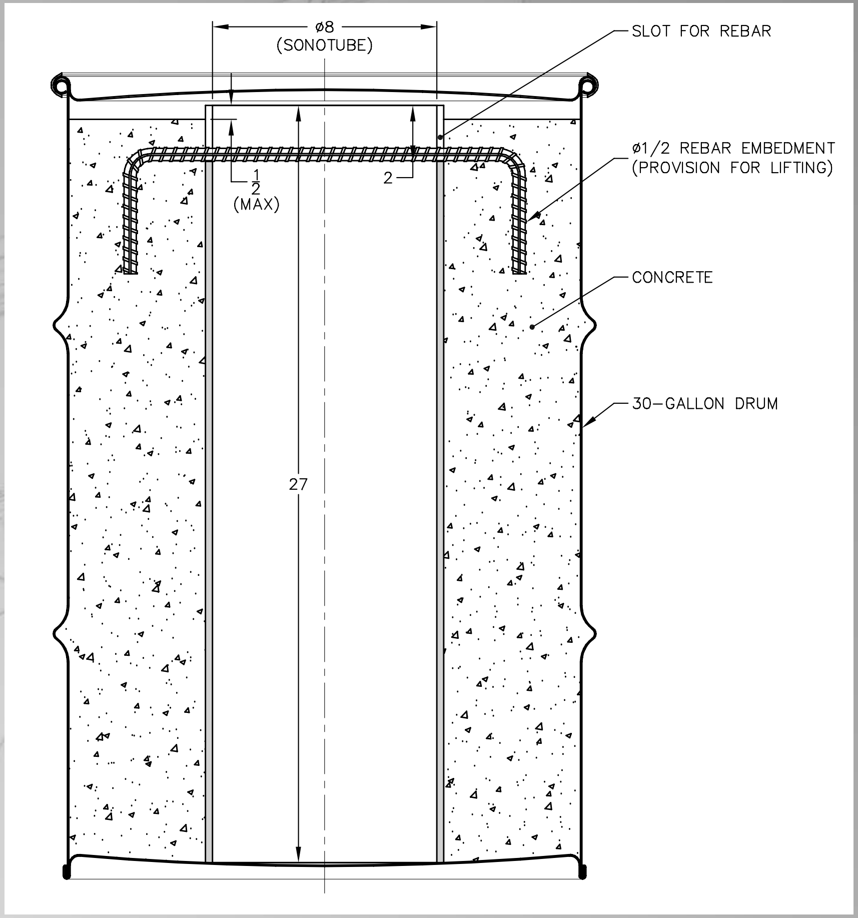
← Test Fixture in End Drop Configuration



↑ Test Fixture in Side Drop Configuration

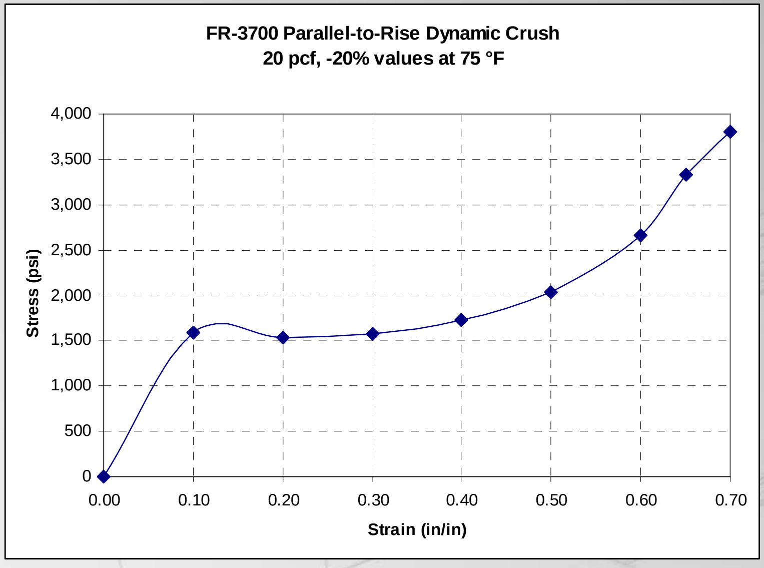
HAC Test Plan (cont.)

- Simulated Payload
  - 30-gallon drum, concrete filled, with supplemental sand in Sonotube to achieve 3,100 lb minimum total gross weight of NS30



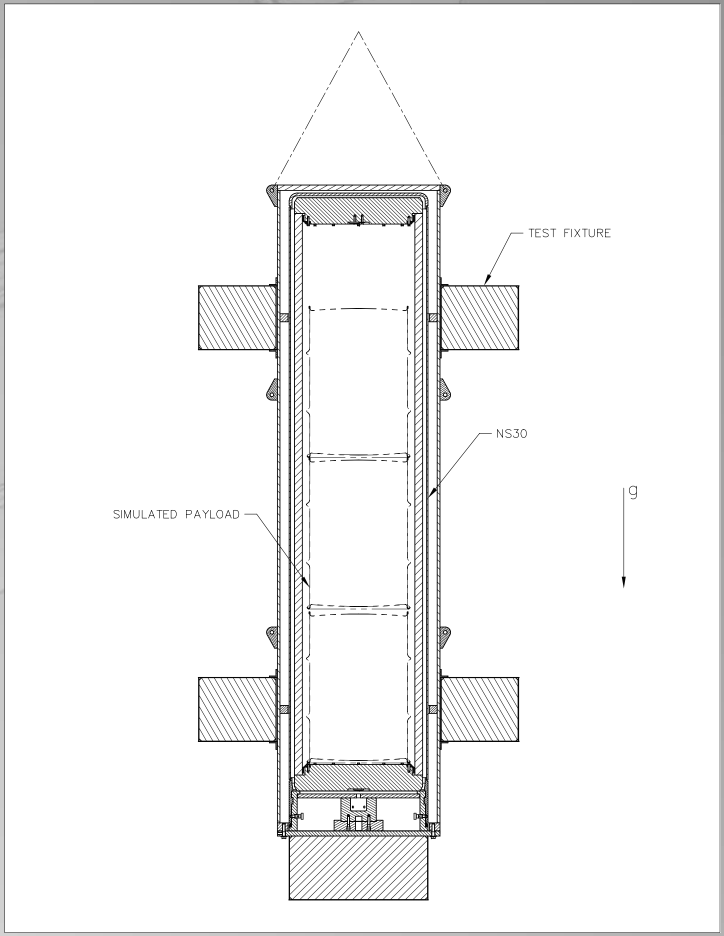
HAC Test Plan (cont.)

End Drop



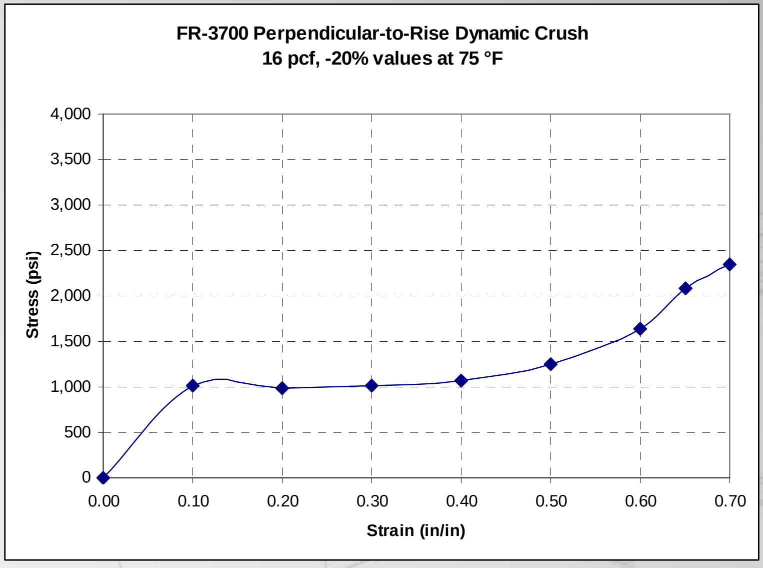
Configuration	Deflection (in.)	Strain (in./in.)	Impact Acceleration (g)
Test Fixture at 75 °F	3.35	0.28	133.35
RH-TRU 72-B at -20 °F	4.65	0.20	89.70
RH-TRU 72-B at 140 °F	8.67	0.38	51.10

Test Fixture g-load is a minimum whereas 72-B values are maximums.



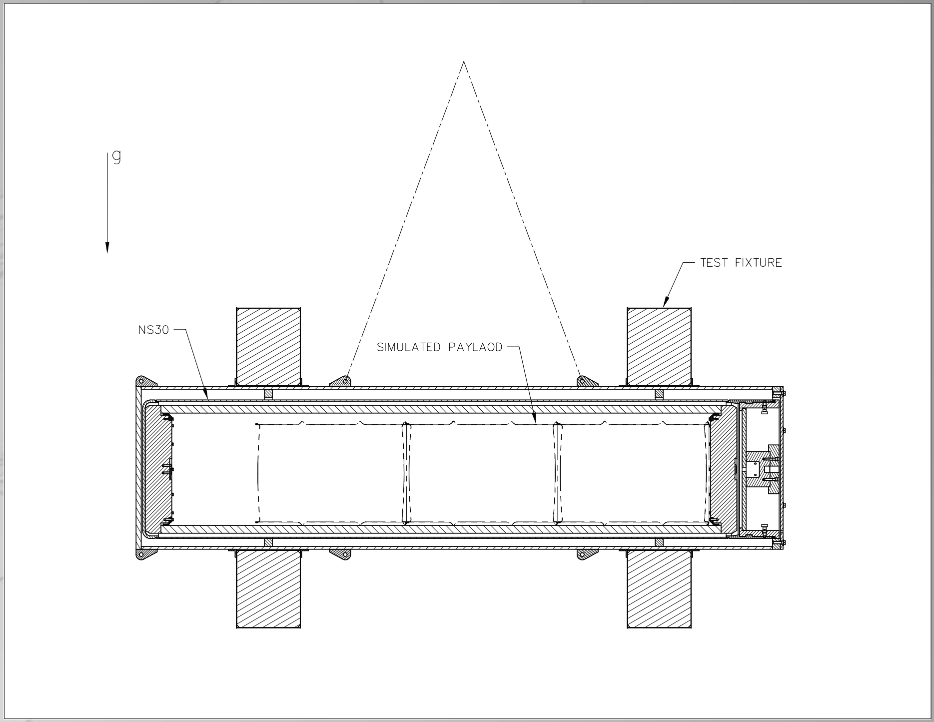
HAC Test Plan (cont.)

Side Drop



Configuration	Deflection (in.)	Strain (in./in.)	Impact Acceleration (g)
Test Fixture at 75 °F	5.12	0.35	121.08
RH-TRU 72-B at -20 °F	7.79	0.46	81.20
RH-TRU 72-B at 140 °F	11.52	0.68	68.90

Test Fixture g-load is a minimum whereas 72-B values are maximums.



HAC Test Plan (cont.)

- NS30 Test Temperatures
  - Hot conditioning at or above 150°F to bound thermal estimate of the through wall average temperature at the maximum point under NCT (with insolation) per 10 CFR 71.73(b)
    - HDPE shield materials subjected to bounding g-load at maximum temperature where yield strength is minimized
  - Cold conditioning at or below -20°F to bound trivial thermal case per 10 CFR 71.73(b)
    - HDPE shield materials subjected to bounding g-load at minimum temperature where notch sensitivity or nil-ductility response is maximized
      - ¼ in. deep v-groove defect to be routed around midline circumference of body and across outer surface of upper end cap at location of maximum tensile stress due to bending

HAC Test Plan (cont.)

- Test Sequence
  - NS30 Test Unit #1
    - Precondition to ≤-20°F, execute top-down end drop, recondition to ≤-20°F, execute side drop
  - NS30 Test Unit #2
    - Precondition to ≥150°F, execute top-down end drop, recondition to ≥150°F, execute side drop
  - Note: Test fixture dropped with impact limiters at ambient conditions and NS30 (including canister, shield, and contents) at prescribed hot or cold temperatures

Schedule

- Fabricate Test Articles – Jun. to Sep. 2009
- Perform HAC Tests – Sep. 2009
- Finalize SAR Analyses – Sep. to Dec. 2009
- Submit SAR Amendment – Jan. 2010