(Holtec Non-Proprietary Version)

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HI-STAR 80
TYPE B(U)F TRANSPORTATION PACKAGE

New Application for Design Approval

a generation ahead by design

Pre-Application Presentation to NRC

(Holtec Non-Proprietary Version)

May 20, 2015

Holtec International

Presentation Agenda

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- Introduction
- Design Overview
- Principal Package Performance
- Package Contents to be Authorized
- Acceptance Criteria and Overview of Safety Analysis Approach
  - Structural Evaluation
  - Thermal Evaluation
  - Containment Evaluation
  - Shielding Evaluation
  - Criticality Evaluation
- Summary and Proposed Licensing Schedule

Introduction

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- Holtec is preparing to submit a license application for the new HI-STAR 80 Transportation Package.
- The HI-STAR 80 package design incorporates technologies and design features based on or derived from HI-STAR packages and HI-TRAC casks previously licensed by the USNRC.
- Holtec's safety analysis report on the HI-STAR 80 follows essentially the same basic framework of SAR format, licensing approach, and safety analysis as Holtec's latest SARs (e.g. HI-STAR 180, HI-STAR 180D).
- USNRC staff's feedback is highly encouraged during this presentation.

Design Overview
General Content and Performance

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- General Content – Fuel Packages
  - F-12P (bare basket): 12 PWR assemblies
  - F-32B (bare basket): 32 BWR assemblies
- Principal Package Performance – Fuel Packages
  - Maximum Fuel Package Payload Heat Load: Approx. 50 kW
  - ANSI N14.5 “Leaktight” Qualification
- General Content – Non-Fuel Waste Packages
  - Non-Fuel Waste (NFW) – power reactor-related waste in solid form. Up to 5 Mt (5.5 US Tons).
  - Non-Fuel Waste Basket (NFWB)
  - Core Component Cassettes (CCC) - Secondary Packaging Basket
- Principal Package Performance – Non-Fuel Waste Packages
  - Maximum NFW Payload Heat Load: Approx. 2 kW
  - Leakage rate acceptance criteria based on containment analysis

Design Overview (cont'd.)
Cask Body

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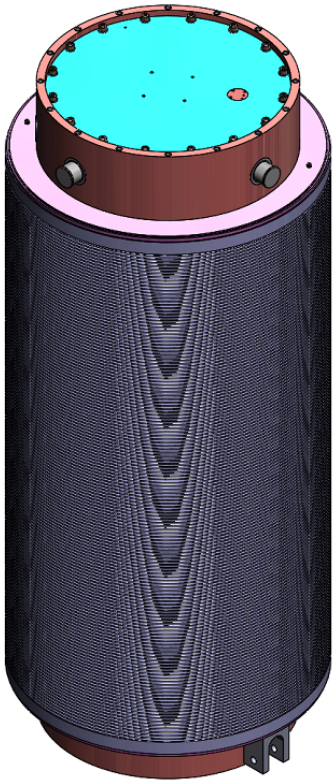


Double Lid System (SS or Cryogenic Steel)

Containment Closure Flange (SS)

Top Trunnions

Finned Enclosure Shell (Aluminum)

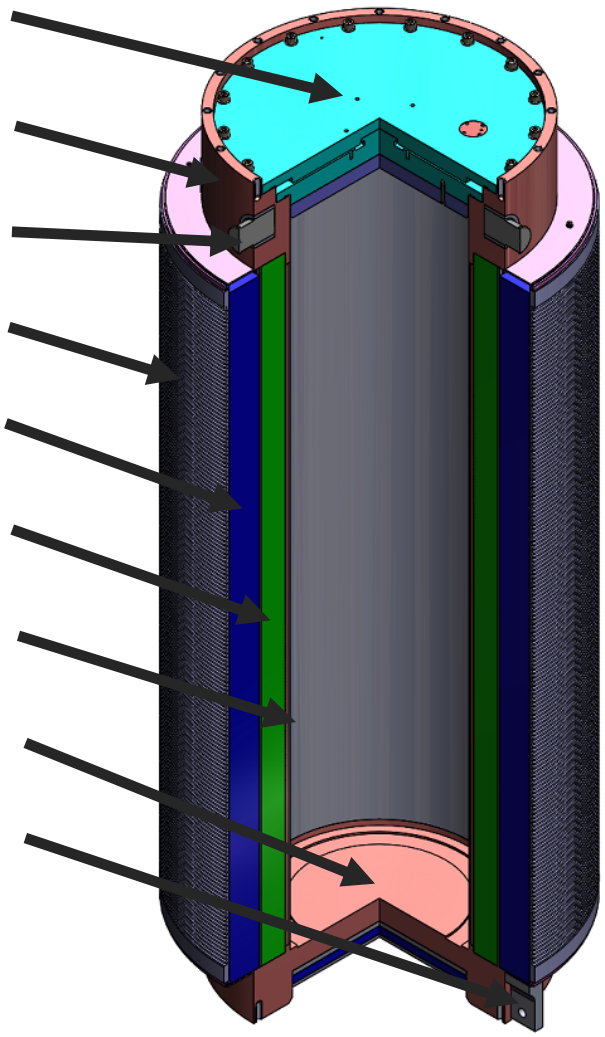
Neutron Shielding (Holtite)

Gamma Shielding (Lead)

Containment Shell (Cryogenic Steel)

Containment Baseplate (SS)

Bottom Pocket Trunnions



Design Overview (cont'd.)
Cask Body

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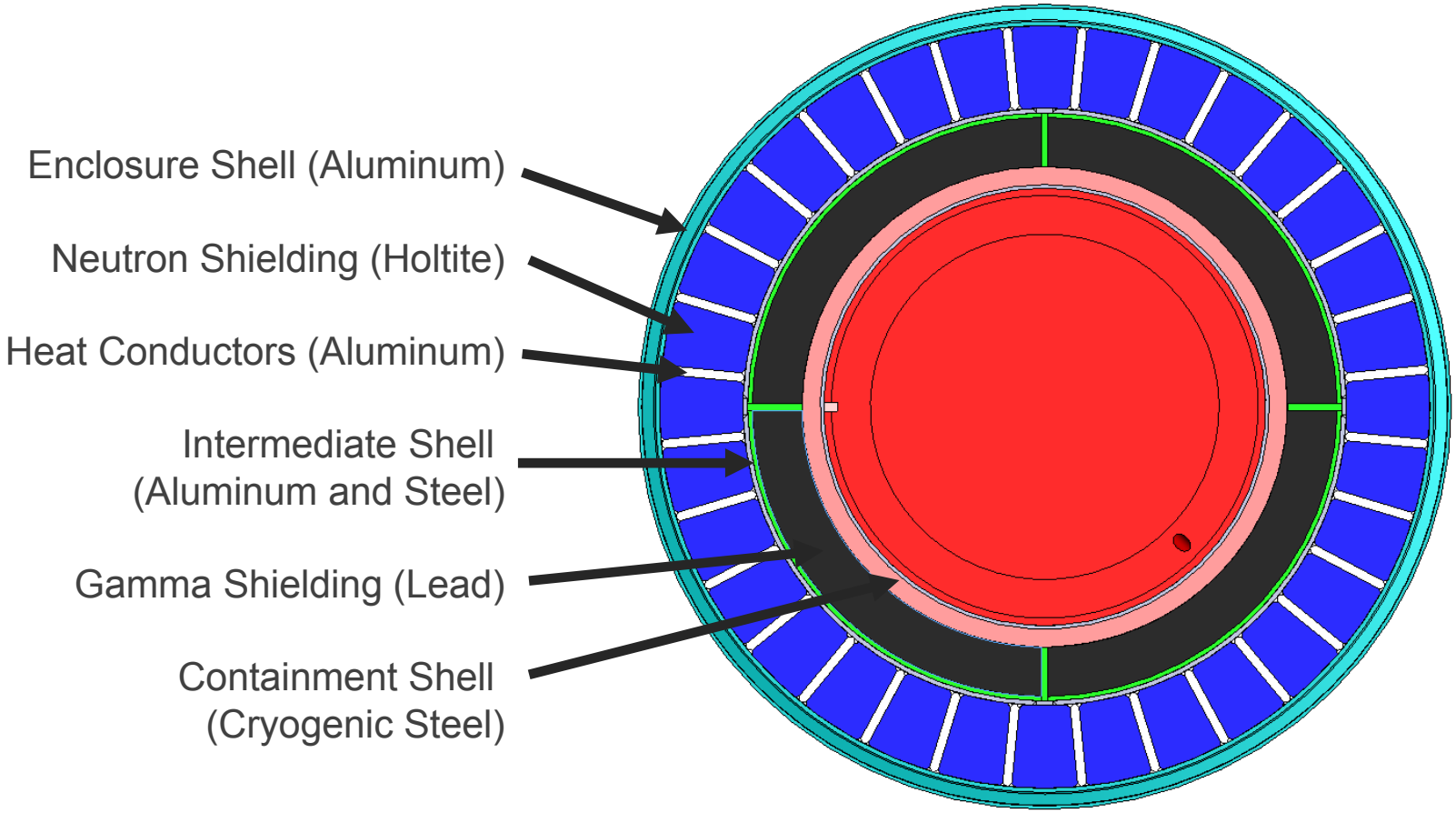

Design Overview (cont'd.)
Cask Body

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- Approximate Major Dimensions
  - Cavity Diameter: 1242 mm (slightly larger than HI-STAR 60)
  - Cavity Length: 4493 mm (slightly shorter than HI-STAR 100)
  - Cask External Diameter: 2285 mm (slightly larger than HI-STAR 60)
  - Cask Overall Length: 5171 mm (essentially same as HI-STAR 100)
- Vent and Drain Ports through Containment Forgings
- Closure System: Double Independently Bolted Closure Lids (same as HI-STAR 180/180D)
  - Metal to metal contact joints provide maximum protection against leakage under impulsive loading
  - Each closure lid is equipped with two independent elastomeric seals
  - Closure lid bolt material same as H180 and H180D

HI-STAR 80 - Design Overview (cont'd.)
Cask Body

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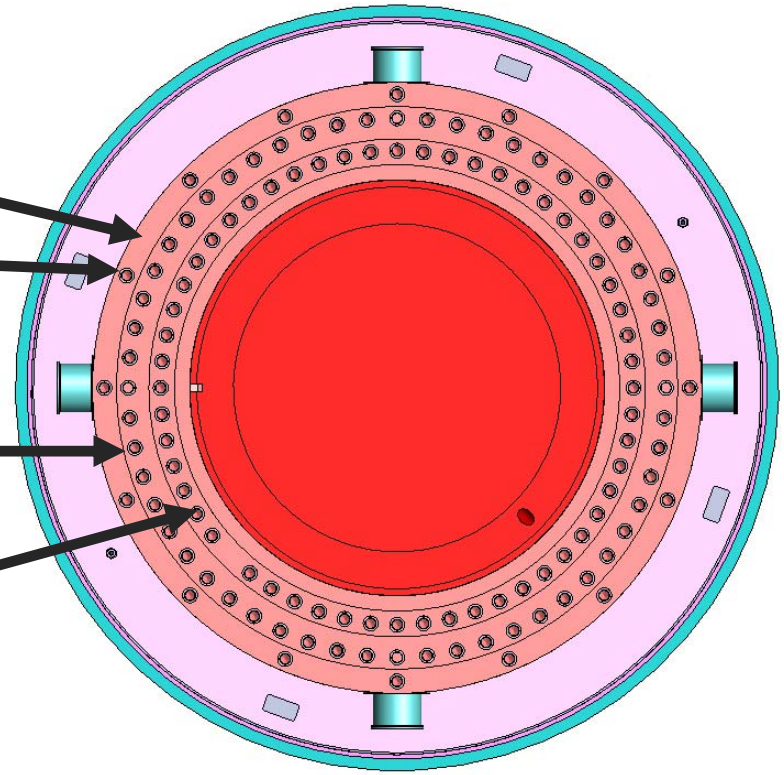
Containment Upper Forging

Impact Limiter Attachment Points (Qty16)

Outer Closure Lid Bolt Holes (Qty 56)

Inner Closure Lid Bolt Holes (Qty 55)



Design Overview (cont'd.)
F-12P Fuel Basket

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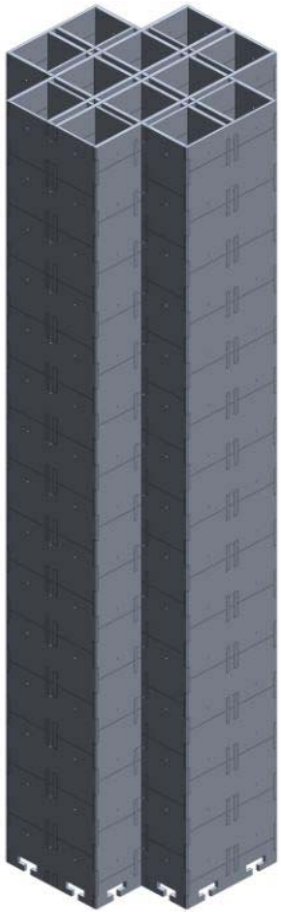

Fuel Basket
without Shims

80 - Design Overview (cont'd.)
F-32B Fuel Basket

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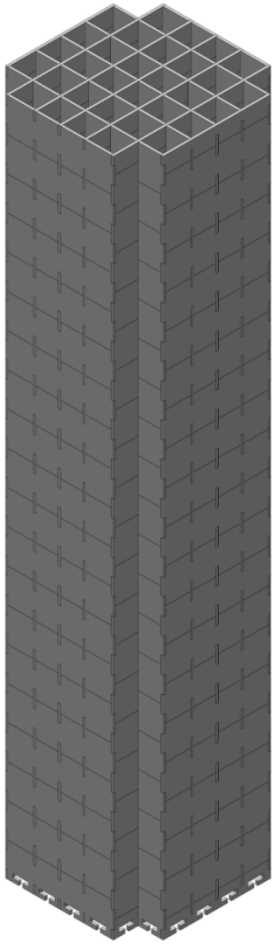

Fuel Basket
without Shims

Design Overview (cont'd.)
Non-Fuel Waste Basket

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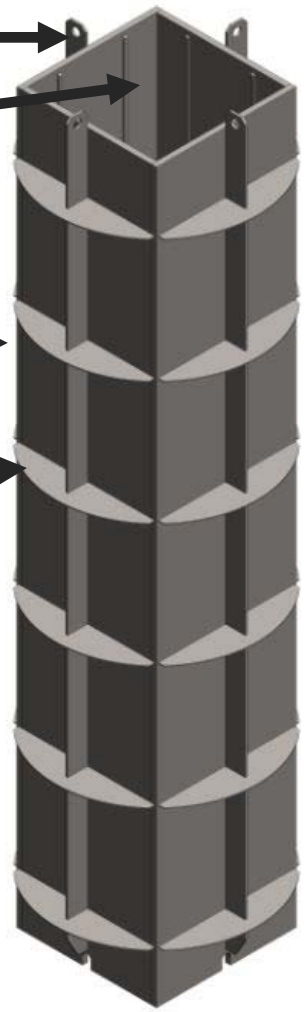
Lifting Points

Cavity Space for
Core Component Cassette
(Cassette Not Shown)

All Stainless Steel Weldment

Circular gussets enhances
Structural support and provides
Conformal contact with cask
Containment shell.



Max. Loaded Weight of NFW Basket:
10.2 Mt (22.5 US Tons)

Max. Loaded Weight of Core Component Cassette:
5.7 Mtons (12.6 US Tons)

Design Overview (cont'd.)
Package and Impact Limiters

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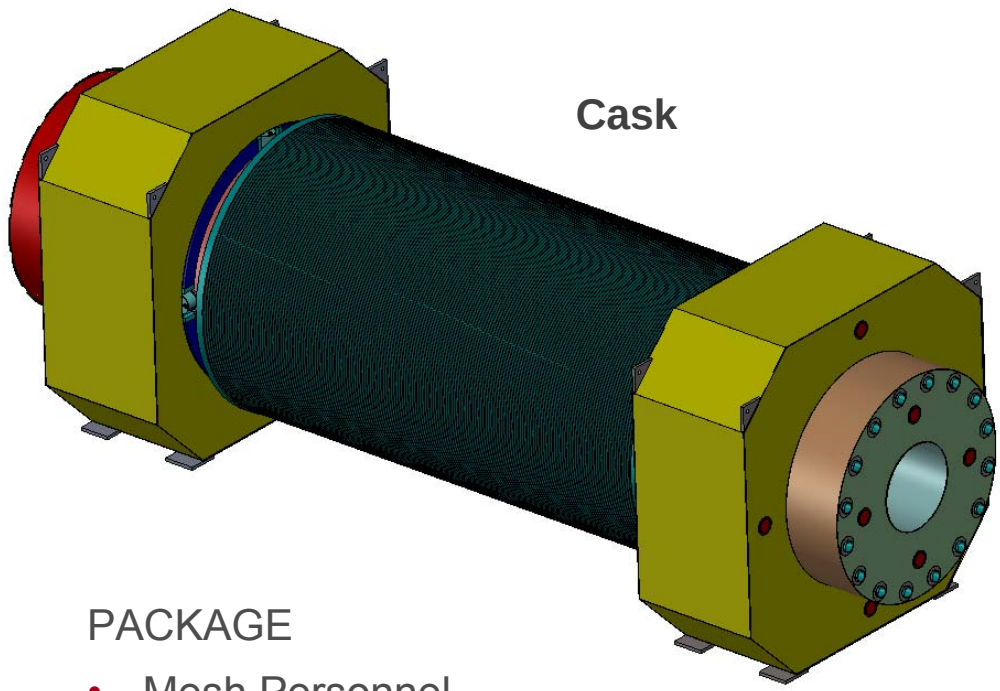
IMPACT LIMITER DESIGN

- Strong cylindrical backbone providing backing support to the crush material
- Crush material with two crush zones to optimize the performance under all drop orientations
- Snug fit of backbones over the cask flanges to prevent separation during drop events.
- Stainless Steel Skin

Top Impact Limiter



PACKAGE

- Mesh Personnel Barrier (not shown)

Bottom Impact Limiter

Package Contents to Be Authorized General Specifications

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- Fuel Package Content
  - F-12P Fuel Package: 12 PWR assemblies (with or without NFH)
    - 5% enrichment limit
    - MBF and HBF up to 70,000 MWd/mtHM
  - F-32B Fuel Package: 32 BWR assemblies
    - 5% enrichment limit
    - MBF and HBF up to 70,000 MWd/mtHM
- Non-Fuel Waste Content
  - Power reactor related waste in solid form and cutting chips
    - Fuel Channels, Core Grid, Control Rods, Neutron Monitors, Burnable Absorbers.
  - Additional Characterization
    - Activated non-dispersible solids with surface contamination
    - Surface contamination consists of fixed and non-fixed surface contamination
    - No fines made of the bulk material (no particles less than about 100 μm in size)

Package Contents to Be Authorized Fuel Specification in the CoC

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- Initial approach as for the HI-STAR 100, HI-STORM 100, HI-STORM FW
  - A range of PWR and BWR assemblies to be transported, including all current assemblies, will be included in the CoC by assembly class
  - Fuel dimensions will be specified as nominal min/max to provide some level of flexibility

Acceptance Criteria and Overview of Safety Analysis Approach

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- Fuel Package: Structural
  - Acceptance Criteria
    - **General Criteria:** Type B(U)F Provisions of 10CFR71
    - **Containment Integrity:** ASME B&PV Code Division 1 Subsection NB
    - **Closure Lid Seal Joint:** remains “leaktight” under NCT and HAC
    - **Fuel Basket:** Basket deflection based criterion - Global Avg. permanent deformation of panel below 0.5 mm.
    - **Shielding Components:** Remain functional after impactive events
    - **Defense in Depth Fuel Assembly Integrity:** Fuel pin evaluation
      - No secondary impact between fuel assemblies and cask.
    - **Impact Limiters:** Sufficient energy absorption to protect fuel pins, fuel basket and containment boundary and to maintain attachment to the cask.

Acceptance Criteria and Overview of Safety Analysis Approach

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- Fuel Package: Structural
  - Safety Analysis Approach (Same as HI-STAR 180/180D)
    - LS-DYNA
    - 10CFR71.71 and 10CFR71.73 Dynamic Analysis
      - 0.3 meter drop (horizontal cask)
      - 9 meter drop (side, ends, c.g. over corner, slapdown)
      - 1 meter puncture on cask outer closure lid - top end down and 1 meter puncture on enclosure shell – side drop
    - Static Analysis
      - Lifting, immersion, component stability, fire accident, etc. summarized in SAR with separate supporting report (methodology used previously for HI-STAR 180 and 180D)

Acceptance Criteria and Overview of Safety Analysis Approach

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- Non-Fuel Waste Package: Structural
  - Acceptance Criteria
    - NFW Basket:
      - No Gross Deformation Under NCT
      - No acceptance criteria under HAC (shielding evaluates dispersal of radioactive waste contents within cask cavity space)
    - Core Component Cassette:
      - No acceptance criteria under NCT or HAC (cassette is uniformly supported by the core component basket).
    - Cask Closure Lid Seal Joint:
      - Maintains leaktightness under NCT and HAC
  - Safety Analysis Approach
    - LS-DYNA
    - 10CFR71.71 Dynamic Analysis for 0.3 meter drop (horizontal cask)

Acceptance Criteria and Overview of Safety Analysis Approach

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- Fuel Package: Thermal
  - Acceptance Criteria (ISG-11 Rev. 3)
    - Package Component Temperature Limits as specified in the SAR
    - NCT: Maximum Peak Cladding Temperature (PCT) <= 400 °C
    - HAC: Maximum Peak Cladding Temperature (PCT) <= 570 °C
    - Short Term Operations – 400°C for HBF and 570 °C for MBF
    - Normal Design and Accident Design pressures specified in the SAR
  - Safety Analysis Approach (Same as HI-STAR 180 and 180D)
    - ANSYS-Fluent CFD Code
    - Each basket type explicitly modelled to determine the limiting fuel basket and fuel loading patterns.

Acceptance Criteria and Overview of Safety Analysis Approach

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- Fuel Package: Thermal
  - Safety Analysis Approach (continued)
    - Analyzed Conditions Inc.:
      - NCT – Cask in Horizontal Orientation (no effect from mesh personnel barrier)
      - Grid Sensitivity Studies
      - Moisture Removal Operations
      - Fire Condition Evaluation

Acceptance Criteria and Overview of Safety Analysis Approach

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- Non-Fuel Waste Package: Thermal
  - Acceptance Criteria
    - Type B(U)F Provisions of 10CFR71
    - Package Component Temperature Limits as specified in the SAR
    - Normal Design and Accident Design pressures specified in the SAR
  - Safety Analysis Approach
    - Qualitative safety evaluation based on very low heat load (approx. 2 kW). No numerical analysis is warranted.

Acceptance Criteria and Overview of Safety Analysis Approach

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- Fuel Package: Containment
  - Acceptance Criteria
    - Design and Testing to ANSI N14.5 reference leakage rate of “Leak Tight”
    - Package maintains leaktighness under normal and accident condition events.
  - Safety Analysis Approach
    - Same as HI-STAR 180 and HI-STAR 180D
    - Structural (and thermal) evaluation confirms containment boundary integrity under normal and accident conditions of transport

Acceptance Criteria and Overview of Safety Analysis Approach

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- Non-Fuel Waste Package: Containment
  - Acceptance Criteria
    - 10CFR71 NCT and HAC Allowable Release Rates
  - Safety Analysis Approach
    - Consulted References:
      - **ANSI N14.5**, "American National Standard for Radioactive Materials Leakage Tests on Packages for Shipment", 1997
      - **NUREG/CR-6487**, "Containment Analysis for Type B Packages Used to Transport Various Contents", 1996
      - **NUREG-1609**, "Standard Review Plan for Transportation Packages for Radioactive Material", 1999
      - **NUREG-1617**, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel", 2000

Acceptance Criteria and Overview of Safety Analysis Approach

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- Non-Fuel Waste Package: Containment (cont'd)
  - NCT: Analysis based on ^{60}Co source term from releasable surface contamination
    - Non-fuel waste is non-dispersible (i.e. structurally-robust); thus no fines released into cask cavity space.
    - 15% of the non-fixed contamination is considered releasable.
    - Fixed contamination is not considered releasable.
  - HAC: Non-fixed surface contamination is limited to an activity of less than or equal to $1A_2$ (based on 10.8 Ci, ^{60}Co) thus assuring 10CFR71.51(a)(2) accident release limits are not exceeded.
    - 100% of the non-fixed contamination is considered releasable.
    - Fixed contamination is not considered releasable.

Acceptance Criteria and Overview of Safety Analysis Approach

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- Fuel Package: Shielding
  - Acceptance Criteria
    - Normal Conditions of Transport: 10 CFR 71.51(a)(1) and 71.47(b)
      - The 2 meter dose rate is taken from the vertical planes projected by the outer edges of the flat-bed style vehicle (excluding top and underside) consistent with 71.47(b)(3). The Transport Frame overhangs the sides of the vehicle and is considered part of the vehicle.
    - Hypothetical Accident Conditions: 10CFR 71.51(a)(2)
  - Safety Analysis Approach
    - MCNP shielding calculations (dose rates)
    - SAS2H/ORIGENS (Scale 5) Source Term Calculations
    - Two different baskets are analyzed
    - Same as HI-STAR 180/180D SARs

Acceptance Criteria and Overview of Safety Analysis Approach

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- Non-Fuel Waste Package: Shielding
  - Acceptance Criteria
    - Normal Conditions of Transport: 10 CFR 71.51(a)(1) and 71.47(b)
      - The 2 meter dose rate is taken from the vertical planes projected by the outer edges of the flat-bed style vehicle (excluding top and underside) consistent with 71.47(b)(3). The Transport Frame overhangs the sides of the vehicle and is considered part of the vehicle.
    - Hypothetical Accident Conditions: 10CFR 71.51(a)(2)
  - Safety Analysis Approach
    - MCNP shielding calculations (dose rates)
    - Isotopic specific activities
    - Wide variety source region geometries

Acceptance Criteria and Overview of Safety Analysis Approach

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- Fuel Package: Criticality
  - Acceptance Criteria
    - 10CFR71.55 and 71.59
    - Max k-eff <= 0.95 (95/95)
    - No burnup or integral absorber credit
  - Safety Analysis Approach (Same as HI-STAR 180 and 180D)
    - Moderator Exclusion under Accident Conditions Based on Double Closure Lid System with Criticality Analysis of Hypothetical Fuel Reconfigurations.
      - Minor fuel reconfiguration: same as H180 and H180D

Acceptance Criteria and Overview of Safety Analysis Approach

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- Fuel Package: Criticality
  - Safety Analysis Approach (Same as HI-STAR 180 and 180D)
    - All fresh fuel (both baskets) – no burnup credit
    - MCNP5 Version 1.51 with ENDF/B-VII Library, CASMO-5 Version 2.00
    - No more than 90% of the minimum B_4C content in Metamic-HT is credited.

Acceptance Criteria and Overview of Safety Analysis Approach

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- Non-Fuel Waste Package: Criticality
  - Acceptance Criteria
    - Excepted from Fissile Material Classification per 10CFR71.15
  - Safety Analysis Approach
    - No criticality analysis since fissile exempt

Summary and Proposed Licensing Schedule

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- Many design details, materials and safety analyses approaches are essentially identical to those for HI-STAR family of casks, which supports an efficient licensing process.
- Submittal Target: End of 2015