TN-32B High Burnup (HBU) Demonstration Cask

NRC Docket 71-9377

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Agenda

- Introductions
- Meeting Objectives
- Plan for Collection of Thermal Data in Transportation Configuration
- TN-32B HBU Demonstration Cask Design - Transport
- Updated Planned Schedule for License Application
- Questions

Meeting Objectives

- Review of TN-32B HBU Demonstration Cask and Payload
- Discuss Collection of Additional Thermal Data
- Discuss TN-32B HBU Demonstration Cask Transport Configuration
- Discuss Leak Tightness of Thermocouple Lance Assemblies for Transport
- Discuss the Revised Schedule for Submittal of Application

TN-32B HBU Demonstration Cask Design

- Metallic, Welded Constructed Storage Cask
- Maximum Gross Weight: 272,002 lb_m
- Overall Dimensions: ∅144 inch × 262 inch length
  - 1.5-inch thick inner containment shell and bottom plate
  - 4.5-inch thick closure lid containment plate w/ 6-inch thick welded shield plate
  - 8-inch thick outer shield forging surround containment shell
  - 8.75-inch thick shield plate covering bottom containment plate
  - 4.5-inch thick neutron shield surrounding outer shield forging
- Impact limiters installed on each end
  - Same design as utilized on licensed TN-40 & TN-68 casks
  - Utilizes same redwood & balsa wood for impact absorption
- Modified Closure Lid
  - Thermocouple lance assemblies installed through lid

High Burnup (HBU) Payload

- Selected (32) PWR HBU fuel assemblies
  - Spent nuclear fuel assemblies with burnup greater than 45 GWd/MTU
  - Four different cladding types: (18) M5™, (12) ZIRLO™, (1) Zr-4, and (1) Low-Sn Zr-4
  - Stored on North Anna Power Station's ISFSI for 10-years
- Assembly temperatures monitored by seven (7) thermocouple lance assemblies installed through the closure lid
- Six (6) Poison Rod Assemblies (PRAs) installed for criticality control
- Payload loaded in cask and placed on ISFSI pad in November 2017

Collecting Additional Thermal Data

- Previously planned approach for transport:
  - Cease collecting thermal data at the end of the storage period at North Anna
  - Abandon thermocouples in preparation for transport
    - Sever thermocouple cables/OP tubing
    - Seal penetrations with a solid 1-inch thick welded alloy steel plate
    - Install 2-inch thick puncture resistant alloy steel plate
    - Thermocouple lance assemblies not part of containment boundary
- Following discussions with stakeholders (DOE, EPRI, National Labs), desire to obtain additional thermal data in the horizontal orientation after transport
- Results in the need to maintain thermocouples intact for transport

Maintaining Thermocouples in Transport

- Required changes to planned approach for transport to maintaining thermocouples intact:
  - Thermocouple cables/OP tubing are not severed
  - Provide thru-hole in 1-inch thick welded alloy steel plate for cable/connector pass-thru
  - Raise puncture resistant plate off the closure lid surface for cable/connector clearance
  - Revise the thickness of the puncture resistant plate to 1.75 inch to allow for machining
  - Insert spacer support steel bars around the thermocouple lance penetrations
  - Thermocouple lance assemblies become part of containment boundary
  - Provide defense in depth to provide containment of payload:
    - Primary
    - Secondary
    - Tertiary

TN-32B HBU Demonstration Cask, Containment Boundary

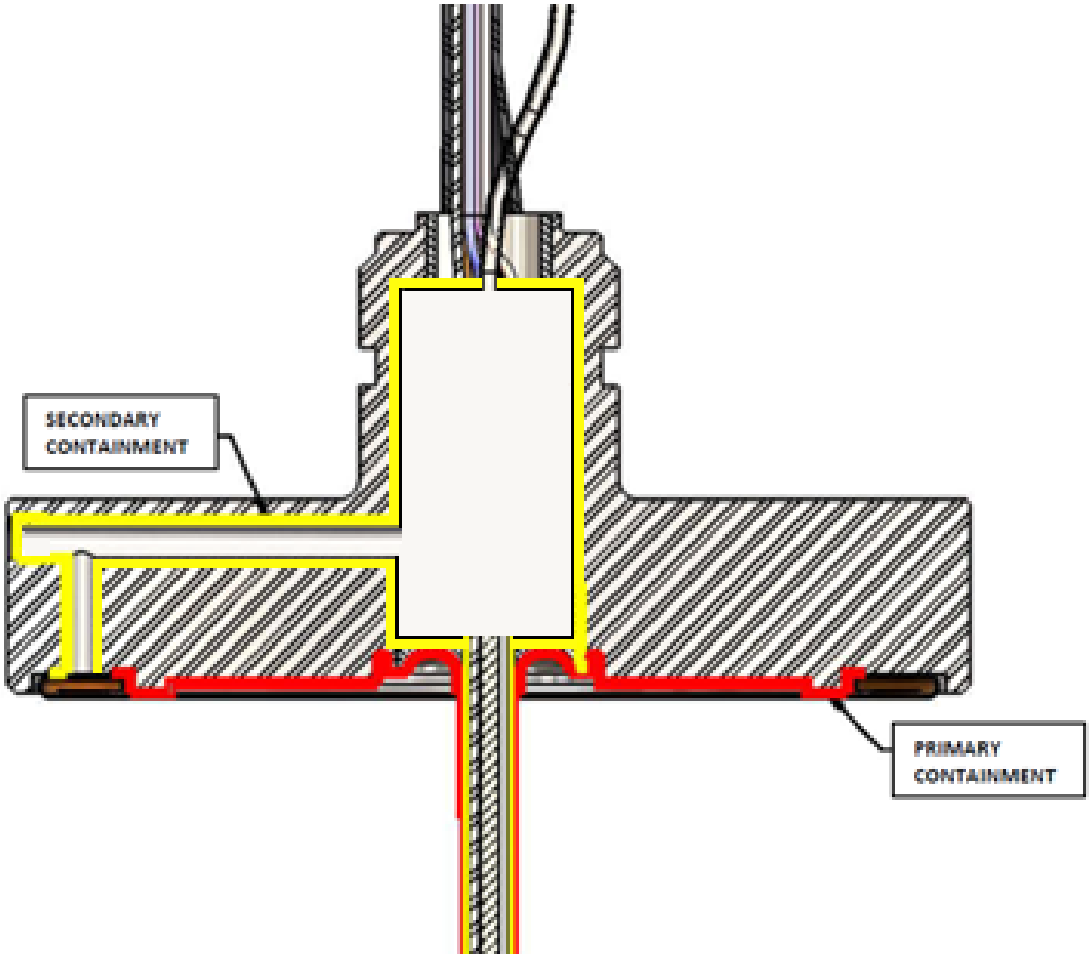
- Propose to Utilize Lance Assembly's:
  - Primary and Secondary Confinement Boundaries in Storage →
  - Primary and Secondary Containment Boundaries in Transport
- Primary Containment Boundary of Lance Assembly
  - Closure is constructed of Type 304L stainless steel
  - 160.2-inch long lance oversheath tube, reinforcing oversheath tube, lower closure plug and tip plug are constructed of annealed alloy Type UNS N06600
  - Penetration is sealed by a Helicoflex® silver jacketed metallic O-ring seal
  - All welds performed using Gas Tungsten Arc Welded (GTAW) process
- Secondary Containment Boundary of Lance Assembly
  - Closure, same as primary
  - Upper closure plug is constructed of Type 304L stainless steel
  - Overpressure tubing, which is constructed of annealed nickel-based alloy (Type UNS N06600), will be capped for transportation
  - Upper closure plug to closure weld performed using GTAW process
  - Upper closure plug–to–metal sheathed thermocouples and overpressure tubing are silver brazed

TN-32B HBU Demonstration Cask, Containment Boundary (con't)

- Tertiary Containment Boundary – Modified Puncture Resistant Alloy Steel Plate
  - A 1.38-inch gap is added between plate and modified closure lid for storing the thermocouple lance cables
  - Closure lid bolts are covered completely
  - Spacer support bars are welded to puncture resistant plate or closure lid:
    - Spans the lance penetration cover plate weld joint
    - Provides additional protection of lance assembly for postulated HAC puncture drop impact
    - Directs postulated HAC puncture bar impact load into closure lid plate
  - Double elastomer O-ring seals added to seal against cask body flange to provide an additional level of containment

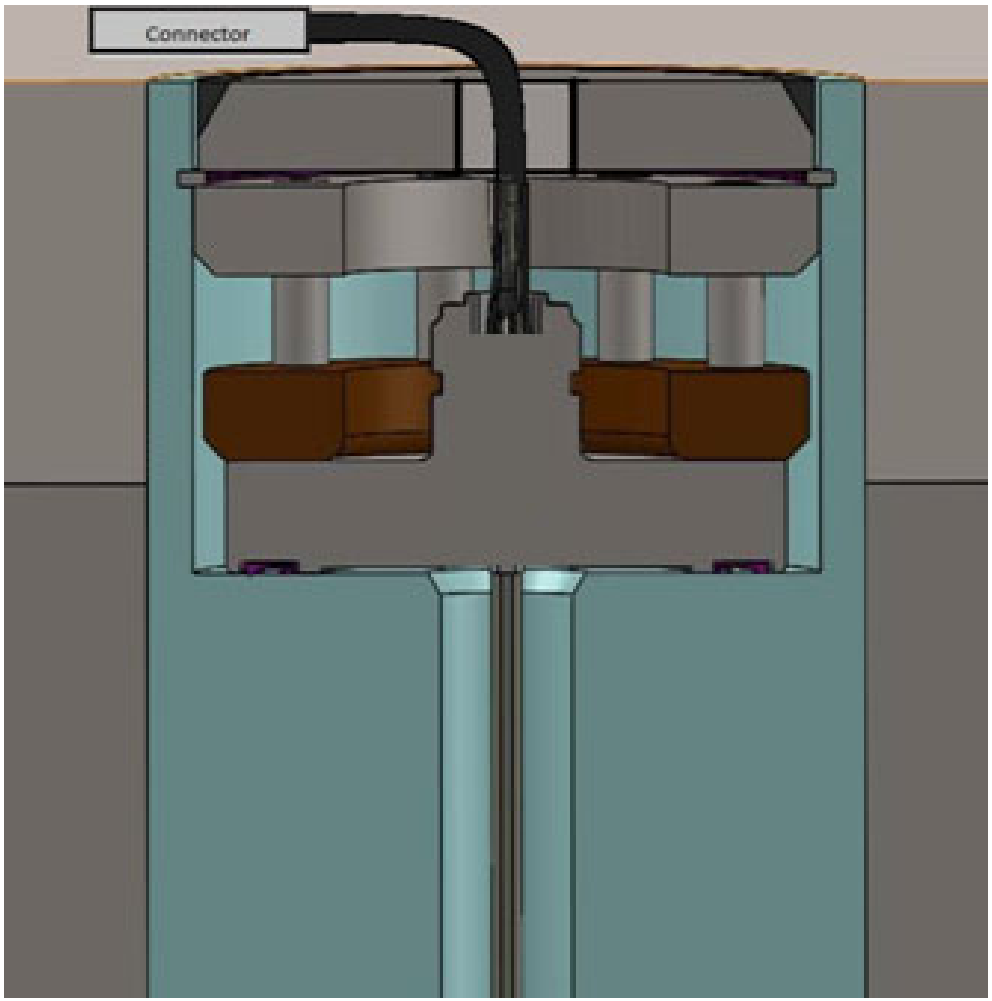
TN-32B HBU Demonstration Cask, Transport Configuration (cont'd)

Containment boundaries of thermocouple lance assemblies

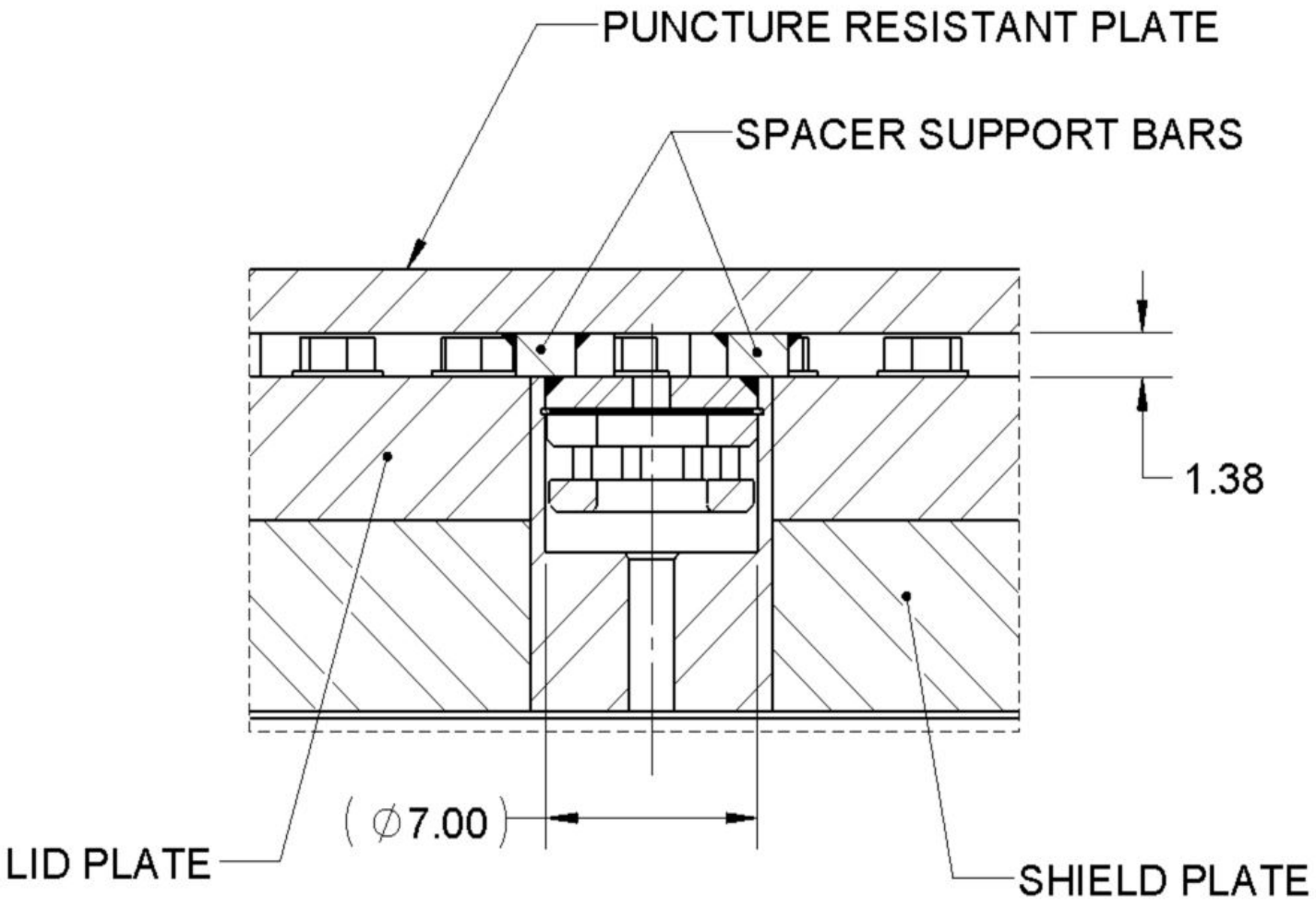


TN-32B HBU Demonstration Cask Design, Transport Configuration (cont'd)

Thermocouple Lance Penetration Cover Plate with thru-hole for Connector/Cable



TN-32B HBU Demonstration Cask Design, Transport Configuration (cont'd)



Leak Tightness of Lance Assemblies For Transport

- Lance Assemblies and O-ring Seals Leakage Rate Tested per ANSI N14.5:
  - Verification test included containment weld of penetration forging
  - Verified to be leaktight during fabrication and assembly for storage
  - Metallic O-ring seals continuously monitored during storage period
- §71.73(c)(1) 9-meter (30-foot) Free Side Drop Effect on Assembly
  - Postulated lateral movement of assembly due to impact
  - Metallic O-ring seal could possibly be affected
- Plan to Test of Prototypic Lance Assembly and Metallic O-ring Seal Interface
  - Configuration to replicate installed lance assemblies in cask lid
  - Perform leakage rate test pre-lateral movement of metallic O-ring seal
  - Exert lateral force on assembly to translate assembly/seal maximum displacement
  - Perform leakage rate test post-lateral movement of metallic O-ring seal
  - Effect of temperature to be considered in test
  - Record lateral force to translate lance assembly for comparison to side drop impact
  - Test results to demonstrate leak tightness of lance assembly/seal is maintained during transport

Leak Tightness of Lance Assemblies For Transport (con't)

- Primary Containment Provided by Lance Assemblies:
  - Protected by impact limiter for postulated free drop impacts and thermal event per §71.73(c)(1) and §71.73(c)(4), respectively
  - Protected by 1.75-inch thick puncture resistant plate and support bars for postulated puncture bar impact per §71.73(c)(3)
  - Plan to verify sealing maintained during any lateral translation of thermocouple lance assembly
  - Verified lance oversheath complies with ASME III NB Level D stress limits for 0.416 inch lateral displacement of funnel/fuel assembly
  - Additional assurance provided by sealing of puncture resistant plate to cask body flange
- Defense in depth provided by secondary and tertiary containment boundaries

Planned Schedule for License Application

- Calculations and SAR chapters to be completed within 6 months
- Submittal of SAR to NRC in early 4th quarter 2020
- Receipt of NRC Requests for Additional Information (RAIs) in 2nd quarter 2021
- Receipt of NRC Certificate of Compliance in 4th quarter 2021
- License application submittal to support planned transport in 2027
- Planned pre-transport activities:
  - Fabrication of impact limiters, transportation skid, and auxiliary equipment
  - Transportation planning from NAPS to a site to be identified later

Questions?

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Giving nuclear energy its full value