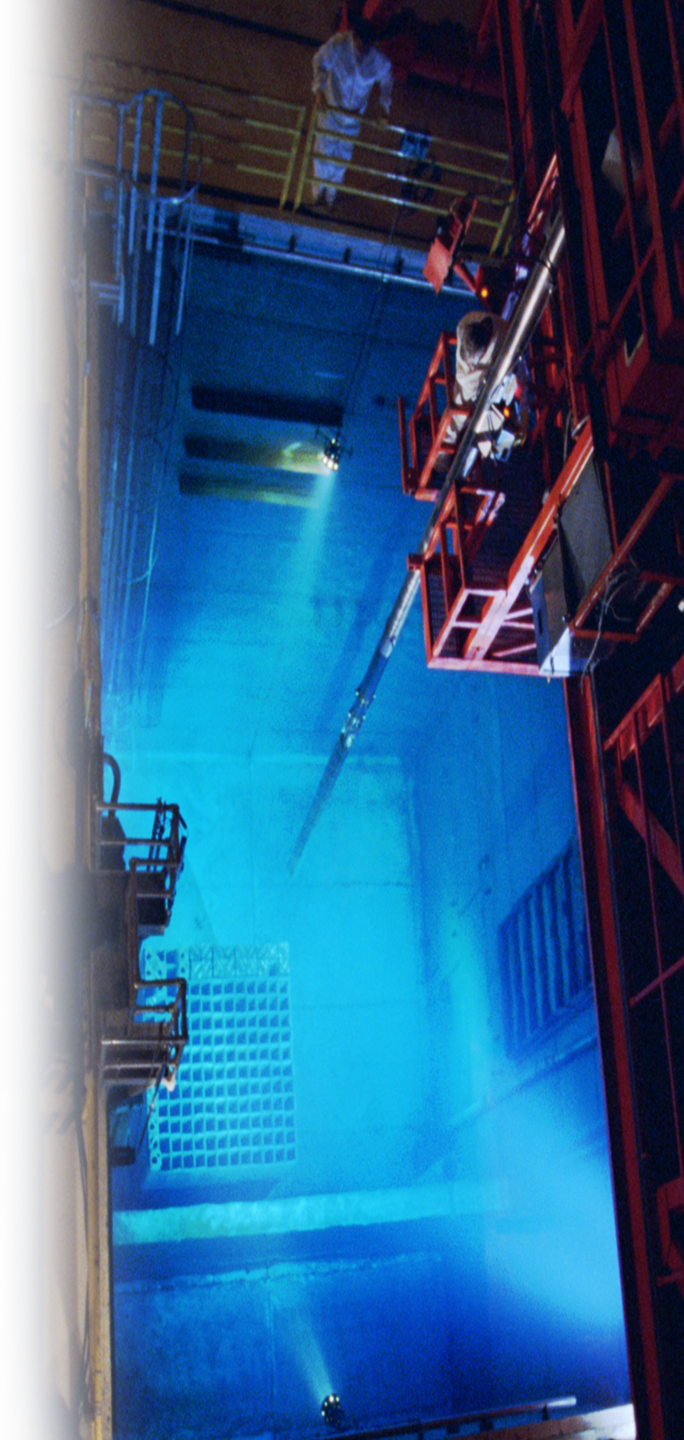
Global Nuclear Fuel

Shipments of GNF3 LUA in RAJ-II

Pre-application Meeting

Rockville, MD
July 9, 2014

GNF Global Nuclear Fuel
A Joint Venture of GE, Toshiba, & Hitachi



Agenda

- RAJ-II Basis Overview
- GNF3 Design Description
- Structural Evaluation
- Criticality Evaluation
- Letter Authorization Request

Purpose

Introduce the GNF3 design and provide NRC with information regarding the impending submittal for a letter authorization to ship limited quantities of GNF3 assemblies using RAJ-II container, CoC-9309.

RAJ-II BASIS OVERVIEW

Based on Docket No. 71-9309 (Rev. 7 of the SAR)

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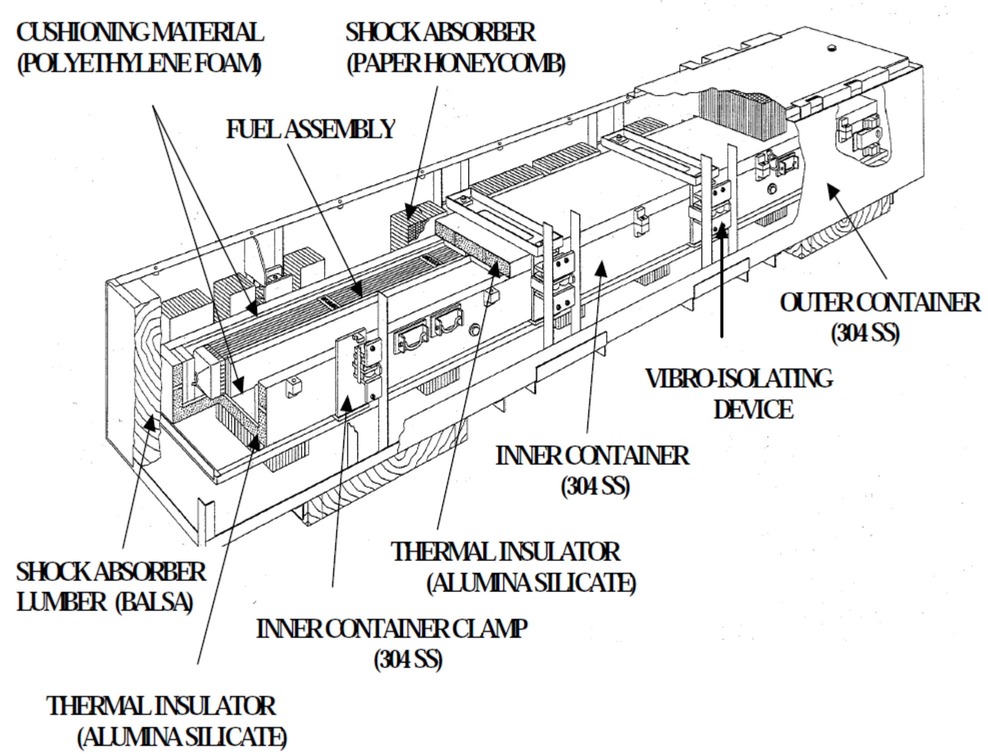
1 – General Information

- NRC approved for Type B fissile material package
- 2 compartments in the inner container (IC), SS sheets encasing thermal insulator
- SS outer container (OC)
- Vibro-isolating device and shock absorbers between IC and OC
- Approved for shipment for unirradiated BWR assemblies and loose rods (UC and generic BWR/PWR)



- Packaging materials: polyethylene foam, cluster separators
- Can ship channeled or unchanneled for 8x8, 9x9, 10x10 designs including GNF2

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2 - Structural

Full scale certification test units (CTU) passed free drop and puncture testing demonstrating adequate containment of the fuel, geometric configuration stability for criticality safety, and protection for the fuel.

- Deformation of the containers is limited by its redundant structure
  - Limited OC deformation due to shock absorbers
  - Deformation of the IC is limited and only in length
- CTU tests confirm the conservative nature of the geometry assumptions used in the criticality assessment

2 – Certification Tests

9m End Drop Test

- Payload mass was 685 kg
- Mass was added to the fuel cavity
- Mass was added to the exterior of the package
- Added mass in the contents represents the maximum payload weight (including the fuel) that could be required in the future

Test	CTU	Orientation with horizontal	Exterior damage	Interior damage	Fuel
9-meter (30-foot) lid down	1	15°	Minor deformation on both ends.	No bolts broken on the frame or the lids. Significant deformation to inner container and internal clamp frame. Reduction of spacing between outside of package and fuel to about 4 inches.	Minimal damage to the fuel assemblies. Some twist to the assembly. No real damage to the fuel rods. The fuel was demonstrated to have a leak rate of less than 1 $x10^{-7}$ atm-cc/s after the testing.
1-meter (40 in) lid down over cg	1	25°	Did not penetrate outer wall	Outer wall contacted inner container. Section 2.12 Figure 2-39 through 2-42 show some damage to the inner container, however, this damage is conservatively modeled in the HAC criticality analyses in Section 6.0 and is not sufficient to allow fuel to leak from the container.	The fuel appeared not to be affected by this test. Passed helium leak test.
9-meter (30-foot) lower end	2	90°	Localized damage on impact end.	Major crushing of the wood at the end of the inner package and breaking of the inner wall of the inner container on the impacted end. The outer wall was damaged but did not fail completely.	Fuel was bent and separated from end fittings. Fuel spacers were damaged. Fuel rods had no significant damage. Fuel bending was influenced by the movement of the weight added to the fuel cavity. Post drop leak test giving a He leak rate of 5.5×10^{-6} atm-cc/s demonstrated that containment had been maintained.

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3 - Thermal

- Fuel rods are pressurized to a maximum pressure of 1.145 MPa (absolute, 161.7 psia) with helium at ambient temperature prior to sealing
- Normal Condition of Transport (NCT)
  - Thermal loads solely from solar radiant heat
  - Ambient temperatures from -40ºC to 38ºC (-40ºF to 100ºF)
  - Max temperature 171ºF (77ºC); max pressure 1.33 MPa (192.9 psia)
- Hypothetical Accident Condition (HAC)
  - 800ºC (1,475°F) fire for half-hour
  - Ambient temperature of 38ºC (100 F), with solar heat loading (insulation) before and after the fire event
  - Max temperature of 1198ºF (648ºC), well below the fuel rod rupture temperature of 800+°C under all transportation conditions; max pressure of 3.50 MPa (508 psia)

4/5 Containment/Shielding

- The fuel rod cladding and ceramic nature of the fuel pellets provide primary containment of the radioactive material. The containment system includes the ceramic sintered pellet, clad in zirconium alloy tubes which are welded and leak tested prior to shipment.
- The contents of the RAJ-II require no shielding since unirradiated fuel gives off no significant radiation either gamma or neutron.

6 – Criticality Safety Evaluation

- Water exclusion is not required for this package. The package is analyzed in both undamaged and damaged arrays under optimal moderation, full water reflection, and demonstrated to be safe under NCT and HAC. HAC array case bounds all other cases.
- Sensitivity analyses performed varying fuel parameters (rod pitch, clad ID, clad OD, pellet OD, fuel orientation, polyethylene quantity, moderator density) to obtain the most reactive configuration
- No credit for structural components outside the active fuel length or spacers
- Honeycomb replaced by water, conservatively model the poly to be around fuel rods
- 75% credit for Gad
- The criticality analyses cover the range of 10% rod pitch contraction or **4.1% rod pitch expansion which is conservative based on drop tests**
- KENO V.a (SCALE 4.4a) with 44-group ENDF/B-V, USL=0.94254

GNF3 DESIGN DESCRIPTION