

HALEU, ATF, AND NON-LWR APPLICATIONS IN FUEL CYCLE, TRANSPORTATION, AND STORAGE LICENSING

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U.S. Nuclear Regulatory Commission

OVERVIEW

- Background
- Advanced Technology and High Burnup/Extended Enrichment LWR Fuel
- Non-LWR Fuel
- Licensing Actions
 - Fuel Cycle Facilities
 - Transportation
 - Storage
- Future Actions

BACKGROUND (1/2)

- Office of Nuclear Material Safety and Safeguards Division of Fuel Management (NMSS/DFM) within NRC is responsible for regulation of:
 - Fuel cycle facilities under 10 CFR Part 70
 - Radioactive material (including fissile material, e.g., HALEU) transportation package designs under 10 CFR Part 71
 - Dry storage systems and facilities under 10 CFR Part 72
- Regulations include requirements for criticality safety, radiation dose, and containment of radioactive material.

BACKGROUND (2/2)

- Fuel cycle facilities under 10 CFR Part 70:
 - Conversion
 - Enrichment
 - Fuel fabrication
- Radioactive material transportation under 10 CFR Part 71:
 - Type B packages
 - Fissile material
- Spent fuel storage under 10 CFR Part 72:
 - Independent spent fuel storage systems (ISFSIs) at or away from reactor (including Centralized Interim Storage)
 - Dry cask systems
 - Mostly dry cask storage, but can include away from reactor pool storage (GE Morris)

Advanced Technology Fuel (ATF) and High Burnup/Extended Enrichment (HBU/EE) LWR Fuel

- Near term ATF:
 - Coated cladding
 - Doped pellets
 - Iron-chromium-aluminum (FeCrAl) cladding
- Future ATF:
 - Silicon carbide (SiC) cladding
 - Alternative fuel material (U_3Si_2 , UN)
- Some ATF (e.g., FeCrAl) requires EE fuel (LEU+ between 5 and 10 wt%)
- LEU+ EE fuel can be used with or without ATF features to reach HBU (>60 GWd/MTU assembly average)



Non-LWR Fuel

- Much of the fuel cycle front end is similar
 - Mining, milling, conversion to UF_6
 - Feed material for enrichment (UF_6), and enrichment process
- But higher enrichment:
 - Most Non-LWRs operate in the HALEU range, up to 19.75 wt% ^{235}U
- And novel fuel forms:
 - TRISO (HTGRs, FHRs, and microreactors)
 - Metal fuel (SFRs)
 - Salt (MSRs)



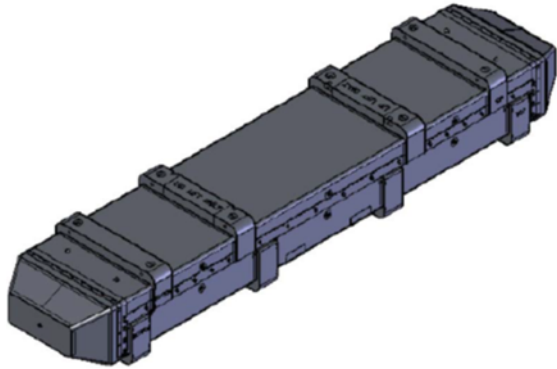
Licensing Actions – Fuel Cycle

- Issued 13 major licensing actions and 2 authorizations to support HALEU and ATF
- Currently reviewing 3 major licensing applications
- Licensing actions consist of:
 - Amendments to existing facilities to accommodate higher enrichments for ATF or HBU/EE fuel (e.g., GNFA up to 8 wt% LWR fuel)
 - New facilities for Non-LWR fuel (e.g., TRISO-X)

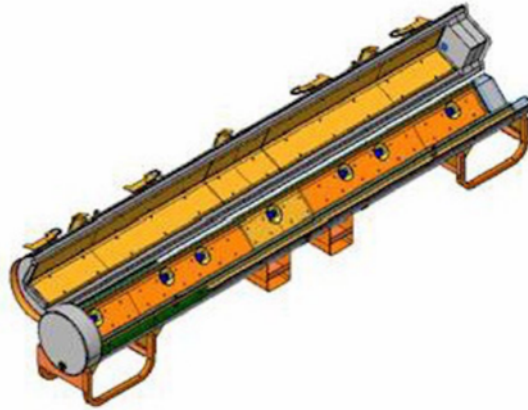


Licensing Actions – Transportation (1/3)

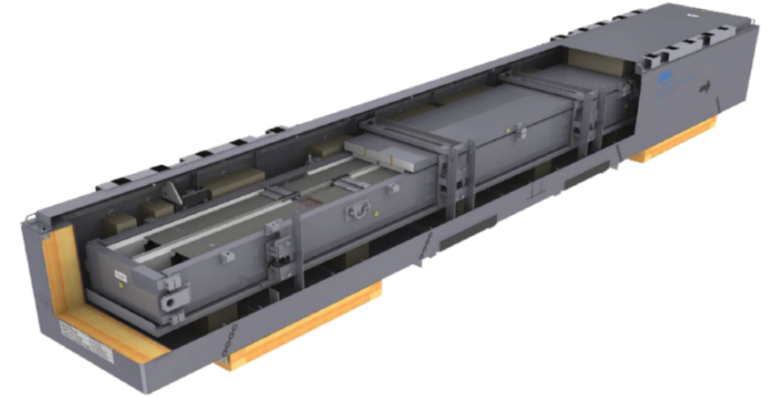
LWR Fresh Fuel:



MAP 12 and MAP 13 (71-9319)



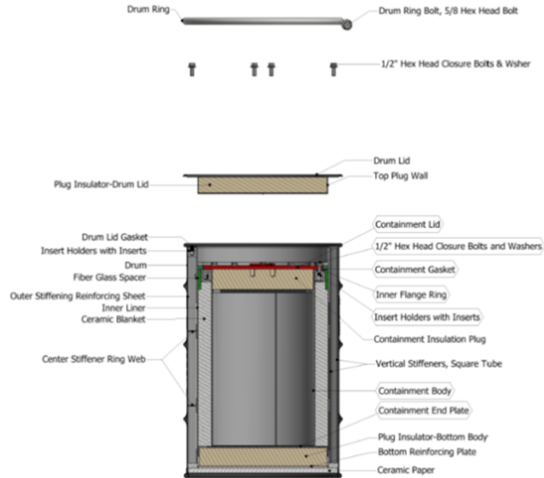
Traveller (71-9380)



GNF RAJ-II (71-9309)

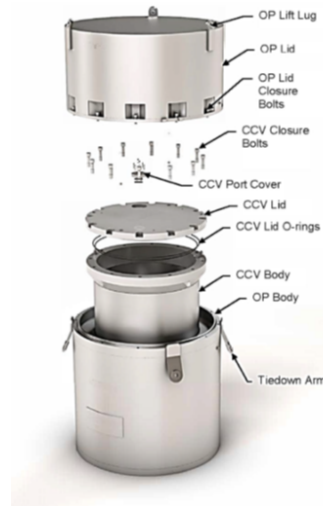
- Certified to LEU+ range – up to 8.0% enrichment
- Loose rods or full fuel assemblies
- Some amendments include ATF features – mostly coated cladding and doped pellets

Licensing Actions – Transportation (2/3)



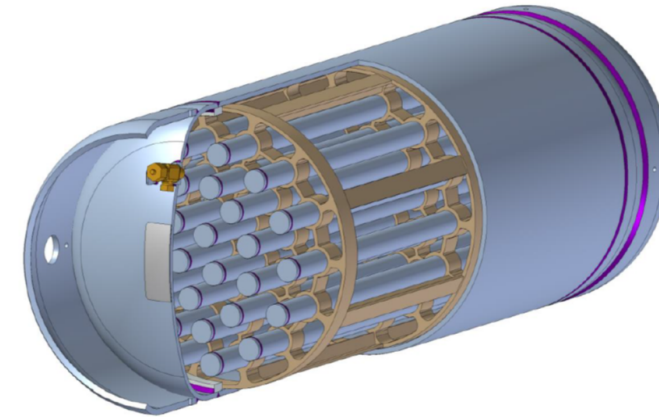
Versa Pac (71-9342)

- Varied uranium contents enriched up to 100%
- TRISO allowed
- UF_6 allowed (1S or 2S cylinders)
- Low mass of ^{235}U per package
- CSI 0.7 to 1.4



Optimus-L (71-9390)

- Up to 68 kg of 20% enriched TRISO compacts
- CSI = 0
- Gross weight ~9,200 lbs.



DN30-X (71-9388)

- UF_6 cylinder with internal criticality control system in overpack
- Up to 10% enriched UF_6 in 30B-10 cylinder; 20% enriched in 30B-20
- Up to 1,460 kg UF_6 in 30B-10, 1,271 kg in 30B-20 (standard 30B is 2,277 kg)
- CSI = 0.0

Licensing Actions – Transportation (3/3)

- GE-2000 Package amendment for FeCrAl clad spent fuel
- Type B waste package amendment for segmented lead test rods shipped for examination of cladding



Licensing Actions – Storage



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Future Actions – Fuel Cycle

- Anticipate an additional 10-12 medium to high-certainty major fuel cycle licensing action submittals through FY26
 - Enrichment facility amendments up to 20 wt% ^{235}U
 - Amendments to existing fabrication facilities, and new facilities for TRISO fuel, metal fuel, and salt

Future Actions – Transportation

- Amendments to existing LWR transportation packages for ATF features and LEU+ fuel
- New package designs for Non-LWR fuel forms (TRISO pebbles and compacts, metal SFR fuel, UF_4 MSR fuel feed or mixed salt)
- Amendments to LWR spent fuel packages to accommodate higher initial enrichments, higher burnup, and ATF features
- New package designs for Non-LWR spent fuel



Future Actions – Storage

- Amendments to existing dry cask storage designs to accommodate higher initial enrichments, higher burnup, and ATF features
 - Cladding performance during cask loading/drying
 - Fuel condition over storage period
- New storage cask and facility designs for Non-LWR fuels
 - Fuel condition over storage period, in different environments (dry or in water, residual sodium (SFR), salt processed or unprocessed (MSR))
 - New cask designs with different material challenges than currently licensed LWR spent fuel systems

Questions

