



Issues Related to High Burnup Spent Fuel Storage and Transportation Licensing

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Agenda

- ▶ **Purpose**
- ▶ **Regulatory Requirements for Part 72 and Part 71**
- ▶ **Guidance for Part 72 and Part 71**
- ▶ **High Burnup Fuel**
- ▶ **High Burnup Issues for Storage**
- ▶ **High Burnup Issues for Transportation**
- ▶ **Summary and Conclusion**



Purpose

- ▶ **To review the current regulatory requirements, guidance and issues related to Storage and Transportation of high burnup fuel**
- ▶ **To develop an understanding on some important issues associated with licensing the Dry Storage Systems / Transportation Packages with high burnup contents**
- ▶ **Present perspective on the need for regulatory guidance to resolve emerging issues**

Regulatory Requirements for Part 72

▶ 72.122: Overall Requirements

- (a) (1) The spent fuel cladding must be protected during storage against degradation that leads to gross ruptures
- (l) *Retrievability*. Storage systems must be designed to allow ready retrieval of spent fuel, high-level radioactive waste, and reactor-related GTCC waste for further processing or disposal.

▶ 72.236: Specific requirements for spent fuel storage cask approval and fabrication

- (m) To the extent practicable in the design of spent fuel storage casks, consideration should be given to compatibility with removal of the stored spent fuel from a reactor site, transportation, and ultimate disposition by the Department of Energy.

Regulatory Requirements for Part 71

- ▶ **71.55: General requirements for fissile material packages.**
 - (b) subcritical with water in-leakage
 - (d) subcritical under the tests specified in 71.71 (NCT)
 - (d) (2) The geometric form of the package contents would not be substantially altered
 - (e) subcritical under the tests specified in 71.73 (HAC)
- ▶ **71.47: External Radiation Standards for all packages**

Guidance for Part 72 and Part 71

▶ Regulatory Guidance Documents

- NUREG-1536, Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility (Part 72)
- NUREG-1567, Standard Review Plan for Spent Fuel Dry Storage Facilities (Part 72)
- NUREG-1617, Standard Review Plan for Transportation Packages for Spent Nuclear Fuel (Part 71)

▶ Generally provide good understanding of

- Staff expectations
- Clarifications on specific regulatory requirements

High Burnup Fuel

- ▶ **Prevalent definition of high burnup fuel is fuel that is irradiated to a burnup level greater than 45,000 MWD/MTU**
- ▶ **Issues associated with high burnup fuel include**
 - **Potential for degradation of fuel cladding**
 - **Uncertainty associated with high burnup fuel properties**
 - **Larger radiation source terms**

High Burnup Issues for Storage

- ▶ **Uncertainty associated with mechanical properties of high burnup fuel cladding is to be applied in the structural analyses**
- ▶ **Use of high burnup cladding properties under extended storage or during license renewal need additional justification**
- ▶ **Consolidated Storage after transportation**
- ▶ **Benchmarking of computer codes is required to perform calculations to determine decay heat, neutron and gamma source terms**

High Burnup Issues for Transportation

- ▶ **Uncertainty associated with mechanical properties resulting in potential issues with 71.55 (b), 71.55 (d) and 71.55 (e)**
- ▶ **Cladding properties require justification for use in safety analyses for transportation following extended storage**
- ▶ **Benchmarking of computer codes is required to perform calculations to determine decay heat, neutron and gamma source terms**

High Burnup Issues for Transportation

▶ Ductile – Brittle Transition Temperature (DBTT)

- Typically occurs during storage as the fuel cools down
- Preliminary discussions by Staff - [ML113120471](#)
- Dependent on clad material, irradiation and thermal history

▶ Leads to

- Minimum cladding temperature to be above DBTT for transport
- Consideration of uncertainty in the DBTT

High Burnup Issues for Transportation

▶ Retrievability (Implied) After Transportation

- Depends on unloading conditions
- May require the contents to be retrievable
- Need to determine condition of high burnup fuel prior to unloading

▶ Leads to

- Cladding integrity needs to be ensured

High Burnup Issues for Transportation

▶ Fuel Reconfiguration May be Required

- **Uncertainty in the Cladding Properties and in the Establishment of Mechanical limits**
- **ISG-19 Guidance on compliance to 71.55 (e) proposes fuel reconfiguration to demonstrate safety of the package under HAC for Criticality, Shielding and Thermal Evaluations**

▶ Leads to

- **Design challenge for high capacity systems**

High Burnup Issues for Transportation

▶ Still May Not be Enough

- Applying conservative methodology may be sufficient to demonstrate that the package meets the criteria
- The requirement of 71.55 (d) (2) (no substantial change in geometry) also needs to be demonstrated

▶ Leads to

- Need good quality cladding integrity data for high burnup fuel
- Need guidance on 71.55 (d) similar to ISG-19
- Alternatively consider high burnup contents as damaged

Summary and Conclusions

- ▶ **Transportation of high burnup fuel – in particular with fuel stored in Dry Storage Systems presents a licensing challenge because**
 - **Cladding integrity may not be assured under NCT**
 - **Retrievability may be implied for potential unloading**
 - **Regulatory Guidance may be needed**



Comments / Questions