orano

January 9, 2019
FS-19-0019

Mr. John McKirgan, Chief
Spent Fuel Licensing Branch
U. S. Nuclear Regulatory Commission
Office of Nuclear Material Safety and Safeguards
Two White Flint North – Mail Stop 4 B34
11555 Rockville Pike
Rockville, MD 20852-2738

Subject: One-Time Authorization to Ship RINSC Spent Fuel Having Excess Burnup in the BEA Research Reactor Package, Docket No. 71-9341

Dear Mr. McKirgan:

Orano Federal Services LLC, on behalf of the U. S. Department of Energy, Idaho National Laboratory (INL), hereby submits a request for a one-time authorization of a shipment of certain spent fuel elements from the Rhode Island Nuclear Science Center (RINSC) reactor having a burnup calculated to be slightly in excess of the amount approved in the transportation cask's Certificate of Compliance (CoC). This shipment is slated to occur using the BEA Research Reactor Package (BRR, NRC Docket No. 71-9341) in June, 2019. This one-time shipment request is being made to facilitate continuing operations of the reactor at RINSC.

Orano believes a one-time shipment approval is more appropriate than an amendment of the certificate. RINSC ships spent fuel very infrequently and it will not be known for several years what the burnup of subsequent elements may be.

The excess burnup is only 0.2% more than the approved burnup. The evaluation which follows (as Attachment A) demonstrates that the thermal and radiological characteristics of the subject elements still fall well within the bounds of the existing safety analysis. The structural and criticality aspects are also addressed.

Orano requests that the approval of this request be granted no later than May 31, 2019, to support the planned shipment. Please let me know at your earliest opportunity if your schedule can support this shipment date.

If you have any questions, please contact me at 253-552-1321 or phil.noss@orano.group.

NMSS01

Yours Truly,

Phil Noss

Philip Noss
Licensing Manager
Orano Federal Services LLC

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Attachments:

Attachment A, Safety Analysis of RINSC Spent Fuel Elements Having a Burnup Slightly in Excess of the Approved Value

Attachment A

Safety Analysis of RINSC Spent Fuel Elements Having a Burnup Slightly in Excess of the Approved Value

Introduction

Fuel from the Rhode Island Nuclear Science Center (RINSC) has been approved for transport in the BEA Research Reactor Package (BRR), NRC Docket No. 71-9341. The NRC Certificate of Compliance for the BRR, Revision 6, permits a maximum burnup of 52.5 MWd for each RINSC fuel element. The BRR is capable of transporting up to eight RINSC fuel elements. RINSC has identified five spent fuel elements having a burnup slightly in excess of the limit specified in the certificate as follows:

(1) 52.61 MWd
(2) 52.51 MWd
(3) 52.51 MWd
(4) 52.55 MWd
(5) 52.55 MWd

All of the other elements planned for shipment have a burnup less than or equal to the limit of 52.5 MWd. As shown, the maximum excess burnup is 0.11 MWd.

The following evaluation demonstrates that the safety of the BRR package when transporting the subject elements is equivalent to the safety of the BRR package when transporting currently licensed payloads. Of note, the evaluation conservatively assumes that all eight fuel elements in the payload have the maximum excess burnup. The affected thermal, shielding, and criticality characteristics of the payload fall well within the bounds for radioactive and fissile material established by the currently licensed payloads of the BRR package. The requested one-time shipment will meet all of the applicable requirements of 10 CFR 71[1].

Description of Contents

RINSC fuel currently licensed for shipment in the BRR package is 19.75% enriched U_3Si_2, with a maximum fuel loading of 275 g U-235, a minimum cooling time of 120 days, and a maximum burnup of 52.5 MWd. Additional fuel parameters are summarized in Table 5.2-10 of the SAR. The single payload which is the subject of this request differs from the currently licensed payload

only in burnup and cooling time. The subject RINSC fuel payload has a maximum burnup of 52.61 MWd and a minimum cooling time of 589 days.

Description of Packaging

The material will be shipped in the BRR Package, NRC Docket No. 71-9341 which is described in SAR Revision 14 (BRR SAR) [2]. The BRR is a lead-shielded cask developed initially for the transport of irradiated MTR-type and TRIGA fuel. It includes inner and outer shells connecting massive end structures and a bolted lid. The principal structural material is ASTM Type 304 stainless steel. The shells encase lead shielding of approximately 8 inches thickness. The bottom end and the upper shield plug are also made of stainless steel-encased lead. The interior cavity is nominally 16 inches in diameter and 54 inches long. The cask features polyurethane foam impact limiters at each end, encased in stainless steel shells. The lid is sealed with a butyl rubber containment O-ring. A vent port in the lid and a drain port in the lower end structure are sealed with butyl rubber sealing washers. The cask is leak tight in accordance with ANSI N14.5 [3]. The gross weight of the package is 32,000 lb. The cask is fully described in Revision 14 of the BRR Safety Analysis Report.

The licensed design includes five different baskets to accommodate the various fuel types which have been approved for transport. The currently licensed square fuel basket (Assembly A5 on drawing 1910-01-03-SAR) will be used in the transport of the subject RINSC fuel payload.

Structural Evaluation

Since the subject RINSC fuel payload is structurally identical to the currently licensed RINSC fuel payload, the current information in Chapter 2 of the BRR SAR is applicable to the subject payload.

Thermal Evaluation

Per Table 5.2-11 of the BRR SAR, the decay heat of the currently licensed RINSC fuel payload is 22.5 watts per element. Per section 3.1.2 of the BRR SAR, *Content's Decay Heat,* the maximum decay heat approved for a single cavity of the square fuel basket is 30 watts. Variation in decay heat due to an increase in burnup can be derived from Table 3 and Table 6 in Regulatory Guide 3.54 [4]. Figure 1 and Figure 2 below show the relative change in decay heat, P_f/P_i, due to a relative change in burnup, B_f/B_i, at specific cooling times for 28 kW/kgU PWR fuel and 30 kW/kgU BWR fuel, respectively. These two specific power levels are applicable to the RINSC fuel, which has a specific power of

24.629 kW/kgU per SAR Table 5.2-10 [2]. Figure 1 is for burnups of 25 to 50 MWd/kgU and enrichments of 2.4 to 4.2 wt% U-235, while Figure 2 is for burnups of 20 to 45 MWd/kgU and enrichments of 1.9 to 3.8 wt% U-235. The subject RINSC fuel payload has a maximum burnup of:

$$\frac{52.61\,MWd}{(0.275/0.1975)} = 37.8\,MWd/kgU$$

where the fuel element contains 275 g of U-235 at an enrichment of 19.75%. In both figures, solid reference lines are plotted corresponding to a slope of one. Cooling times of 1 year to 10 years are plotted. A 10 year cooling time results in the maximum slope, with slope decreasing for cooling times greater than 10 years (not shown, but available in Regulatory Guide 3.54 data).

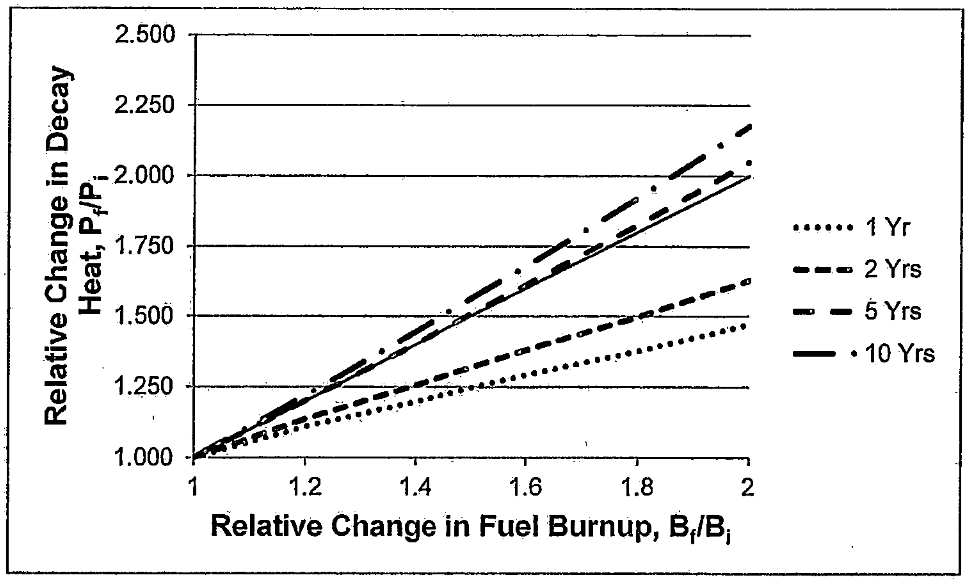

Figure 1 – Decay Heat Variation with Burnup (PWR, Specific Power = 28 kW/kgU)

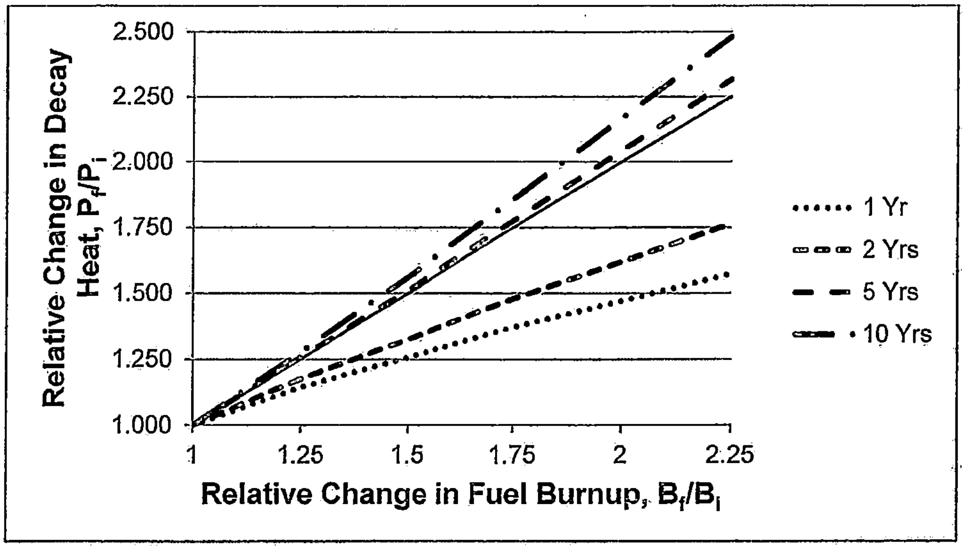

Figure 2 - Decay Heat Variation with Burnup (BWR, Specific Power = 30 kW/kgU)

As shown by the two figures, it is reasonable to conclude that RINSC fuel decay heat will vary linearly with increased decay heat, modeled by the following line equation:

$$\frac{P_f}{P_i} = m\left(\frac{B_f}{B_i}\right) + b \quad \rightarrow \quad P_f = P_i * \left(m\left(\frac{B_f}{B_i}\right) + b\right)$$

Worst-case behavior occurs at a 10 year cooling time. From the curves, it can be calculated that mmax = 1.25 and b = -0.25. Based on the currently licensed RINSC fuel payload burnup of 52.5 MWd and the subject RINSC fuel payload burnup of 52.61 MWd, the calculated RINSC fuel element decay heat for the subject payload is 22.6 watts (an increase of 0.1 watts). Thus, the subject RINSC fuel payload will be bounded by the currently licensed square fuel basket decay heat limit of 30 watts and the square fuel basket thermal evaluation in Chapter 3 of the BRR SAR is applicable to the subject payload.

Containment Evaluation

Since the BRR package is leak tight (a leak rate less than 1×10^{-7} reference cc/sec (air), in accordance with ANSI N14.5), then the current information in Chapter 4 of the BRR SAR is applicable to the proposed payload.

Shielding Evaluation

External radiation levels generated by the currently licensed RINSC fuel payload are discussed in Section 5.4.4, *External Radiation Levels*, of the BRR SAR. It is shown that, based on BRR package side dose rates as detailed in Table 5.4-2 of the BRR SAR, the external radiation levels generated by the currently licensed RINSC fuel payload are bounded by the loose plate box payload. The currently licensed RINSC fuel payload cask side dose rate is 3.8 mrem/hr (2.5 mrem/hr gamma and 1.3 mrem/hr neutron) while the loose plate box payload cask side dose rate is 39.2 mrem/hr (0.5 mrem/hr gamma and 38.7 mrem/hr neutron).

Variations in shielded cask dose rates due to increases in burnup are discussed in Section 3.4.1.1 of NUREG/CR-6716 [5]. It is concluded that neutron dose rates, D_n, will increase approximately as the burnup, B, to the power of four ($D_n \propto B^4$) while gamma dose rates, D_γ, will increase nearly linearly with burnup. When initial dose rates are known, final cask dose rates following an increase in burnup can be calculated using the following equations:

$$\frac{D_{n,f}}{D_{n,i}} = \frac{B_f^4}{B_i^4} \rightarrow D_{n,f} = \left(\frac{B_f^4}{B_i^4}\right) D_{n,i}$$

$$\frac{D_{\gamma,f}}{D_{\gamma,i}} = \frac{B_f}{B_i} \rightarrow D_{\gamma,f} = \left(\frac{B_f}{B_i}\right) D_{\gamma,i}$$

Based on the currently licensed RINSC fuel payload burnup of 52.5 MWd and the subject RINSC fuel payload burnup of 52.61 MWd, cask neutron dose rates will increase by a factor of 1.0084, while cask gamma dose rates will increase by a factor 1.0021 (no credit is taken for increased cooling time). Applying these factors to the dose rates calculated in the BRR SAR for the currently licensed RINSC fuel payload do not result in a significant increase for the subject RINSC fuel payload cask side dose rate (increase of less than 0.1 mrem/hr). Thus, the subject RINSC fuel payload will continue to be bounded by the loose plate box payload. The square fuel basket dose rates calculated in Chapter 5 of the BRR SAR are applicable to the subject payload.

Criticality Evaluation

In the currently licensed BRR criticality evaluation, all fuel elements are modeled as fresh fuel, with no credit taken for fuel element burnup or decay. Thus, the current information in Chapter 6 of the BRR SAR is applicable to the subject payload.

Package Operations

Operation of the BRR package will follow the existing requirements for RINSC fuel detailed in Chapter 7 of the BRR SAR.

Acceptance Tests and Maintenance Program

Since no changes are being made to the BRR package, the current information in Chapter 8 of the BRR SAR is applicable to the subject payload. Since this will be a one-time shipment, there is no effect on the existing BRR package maintenance procedures.

Summary

As shown above, the subject RINSC fuel payload has been fully described and evaluated for structural, thermal, containment, shielding, and criticality performance when transported in the BRR package. The subject, single-shipment payload exceeds the burnup limit currently licensed for RINSC fuel, but is still bounded by the existing evaluations within the BRR SAR. Thus, the subject payload meets all of the applicable requirements of 10 CFR 71.

References

1. Title 10, "Energy", Code of Federal Regulations, Part 71, *Packaging and Transportation of Radioactive Material.*
2. AREVA Federal Services, *BEA Research Reactor Package Safety Analysis Report*, Revision 14, November 2018
3. ANSI N14.5–2014, American National Standard for Radioactive Materials – Leakage Tests on Packages for Shipment, American National Standards Institute (ANSI), Inc.
4. Regulatory Guide 3.54, *Spent Fuel Heat Generation in an Independent Spent Fuel Storage Installation*, US Nuclear Regulatory Commission, Revision 1, January 1999
5. NUREG/CR-6716, *Recommendations on Fuel Parameters for Standard Technical Specifications for Spent Fuel Storage Casks*, US Nuclear Regulatory Commission, March 2001