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April 19, 2018
FS–18–0056

ATTN: Bernie White
Mail Stop T4B34
U. S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2746

Subject: One-Time Authorization to Ship Irradiated PWR Rod Sections in the BEA Research Reactor Package, Docket No. 71-9341

Dear Mr. White:

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 irradiated nuclear fuel rod segments in the BEA Research Reactor Package (BRR). This material is not included as an approved payload in the current NRC-issued Certificate of Compliance, Revision 5 (CoC). However, the structural, thermal, shielding, and criticality characteristics of the payload fall well within the bounds for radioactive and fissile material established by the currently approved payloads, and the requested one-time shipment will meet all of the applicable requirements of 10 CFR 71. The evaluation which follows (as Attachment A) demonstrates the safety of the BRR package when transporting the payload described below.

This one-time shipment authorization request is being made in support of a research project related to fuel fragmentation under high burnup conditions. The INL would prefer that this request be reviewed in parallel with the current review of Revision 11 of the BRR SAR. Approval of this shipment is requested in time to support a shipping date during October, 2018. (Of note, this shipment is planned to occur under the current NRC CoC for the BRR package, and is not associated with the new SAR revision now undergoing NRC review.)

Once you have familiarized yourself with this one-time authorization request, I suggest a phone conference between NRC, Orano, and the interested parties at INL to formulate an acceptable review timetable. Please notify me when you are ready for this conference call.

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

Yours Truly,

Philip Noss
Licensing Manager
Orano Federal Services LLC

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Attachments:

Attachment A, Safety Analysis of the Fuel Rod Payload

Attachment B, BRR Fuel Rod Segment Shielding Analysis, CALC-3020462-000

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Attachment A

Safety Analysis of the Fuel Rod Segment Payload

Introduction

It has been proposed to use the BEA Research Reactor package (BRR) to transport a small payload consisting of several short segments of irradiated, pressurized water reactor (PWR) fuel rods. The segments are located at Oak Ridge National Laboratory and are to be transported to Idaho National Laboratory. They are being studied to generate sufficient test data to inform industry and regulatory agencies to enable the disposition of the fuel fragmentation issue in standard light water reactor (LWR) fuel designs irradiated to high burnup. The structural, thermal, shielding, and criticality characteristics of the payload fall well within the bounds for radioactive and fissile material established by the currently approved payloads of the BRR package. The evaluation which follows demonstrates that the safety of the BRR package when transporting the proposed payload is equivalent to the safety of the BRR package when transporting currently approved payloads. The requested one-time shipment will meet all of the applicable requirements of 10 CFR 71 [1].

Description of Contents

The segments originated from three different commercial reactors in the U.S. The initial enrichments vary between 2.9% and 4.2% U-235, the burnups vary from 48 MWd/kgU to 70 MWd/kgU, and the discharge years range from 1995 to 2004.

The rods are approximately 0.4 inches in diameter (including cladding), and are cut to various lengths between approximately 1 inch long and approximately 13 inches long. Some segments have end caps and some are open-ended. The total length of the segments will be less than approximately 120 inches.

As stated in Section 4.2.3 of Attachment B, the total payload contains 3.14 grams U-235, 6.30 grams Pu-239, and 0.97 grams Pu-241, for a total fissile mass of 10.41 grams. The decay heat generation is less than 3 watts. All of the material will be transported in a single shipment of the BRR package.

Description of Packaging

The material will be shipped in the BRR Package, NRC Docket No. 71-9341. The current NRC CoC is Revision 5, which is supported by SAR Revision 10

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(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 10 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 fuel rod segments payload.

Description of Payload Container

The fuel rod segments will be secured in up to two identical containers and will be transported in up to two of the eight cavities in the square fuel basket (one container per cavity). The container is shown in Figure 1 and Figure 2.

The rod container is an ASTM Type 304 stainless steel weldment. The body is made from a section of tubing with a plate at the closed end and a bolted lid and dust seal. The lid is attached with four captured screws and features a pintle for handling in a hot cell. The lower closure plate and the top lid have a nominally 3.25-inch square cross section. Inside the cavity, three U-shaped sections of sheet material, tack welded to the inner wall, form three smaller axial cavities, which accommodate the rod segments which have closed ends. The remaining cavity holds rod segments contained in stainless steel tubes closed at each end with end caps.

The bottom of the lower closure plate supports an extension tube which is separable from the main body of the container using a quick-release pin. The total length of the container assembly, including the extension tube, is 39 inches.

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Structural Evaluation

As will be discussed below, the shielding analysis takes no credit for the payload container. Thus, there are no structural criteria of the container relative to shielding. Further, as will be discussed below, the payload material is exempt from classification as a fissile material. Thus, there are no structural criteria of the container relative to criticality. Containment is offered by the leak tight BRR cask. Consequently, the payload container is not important to safety, and no structural criteria or material properties are applied.

The payload container is not designed as a leak tight vessel. However, the welded construction and dust seal of the container will prevent loss of any material into the cask interior during transport. As a further level of confinement, the rod segments will be prepared either with closed ends or will be placed in closed-end tubes prior to placement in the payload container. Thus, contamination of the interior of the BRR cask is not of concern.

Each payload container, including the extension tube and contents (up to approximately 60 inches of segmented fuel rod each) has a weight of approximately 20 lb. This is less than the bounding weight of a fuel element in the square fuel basket of 48 lb per Table 2.1-3 of the BRR SAR. Thus, the container weight may be safely carried by the square fuel basket.

The lateral dimension of the container is nominally 3.25 inches square. The square fuel basket opening is nominally 3.4 inches square. The combined length of the payload container and the extension tube is 39 inches. The length of the square fuel basket cavities is a minimum of 39.88 inches. Thus, the payload container will be adequately supported by the basket without any risk of interference under any conditions.

The container and the cask will be loaded dry, thus there will be no possibility of radiolysis or other significant gas generation within the container.

Because the proposed payload has a lighter weight than the bounding currently approved payloads, and occupies up to two cavities in the square fuel basket, any effect of the payload on the BRR package from any free drop, puncture, or immersion events is bounded by the existing SAR evaluations. Thus, there are no structural concerns.

Thermal Evaluation

The decay heat of the total payload is less than 3 watts. The maximum decay heat approved for a single cavity of the square fuel basket is 30 watts, and for the whole BRR package is 1,264 watts (MURR fuel payload). This means that the

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temperature of the BRR package and the payload will be bounded by the NCT and HAC maximum temperatures recorded in the BRR SAR for the currently approved payloads (see BRR SAR Table 3.1-1). Since there was an adequate thermal margin of safety on all of the temperatures recorded in the BRR SAR, and since there are no materials in the proposed payload that are temperature sensitive such as aluminum, then the thermal margins of safety for the proposed payload will be at least as large (and in fact much larger) as for the currently approved payloads. Therefore temperature is not of concern.

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

A shielding evaluation has been performed and is documented in Attachment B. The shielding evaluation utilizes the MCNP computer program to compute the dose rates from the BRR package. The computer model is based on the current SAR shielding model. The SAR model cask dimensions are maintained, while new source terms and tallies are developed to accurately model and evaluate the new payload. The spent fuel and fuel basket geometry are conservatively ignored, bounding real-world shielding performance.

The source term for the fuel rods has been provided by the Department of Energy (USDOE) client and is included in Attachment B. The SCALE computer program was used to decay the isotopes to January 1, 2018.

Because the payload container is not relied upon for safety, the fuel rod segments were conservatively assumed to take the form of a point source located in several different locations on the cask inner surface to determine the worst case dose. No source material is assumed to enter the vent or drain locations, since the robust nature of the payload container and its protected location made such a scenario non-credible. Thus, the payload container and the basket were not explicitly modeled, and the payload material was modeled as a point.

The bounding NCT dose rate on the surface of the BRR package is calculated to be 29.7 mrem/hr against a 10 CFR 71.47(b) limit of 200 mrem/hr. The bounding dose rate at two meters from the vehicle side is 0.3 mrem/hr, against a limit of 10 mrem/hr. The bounding HAC dose rate at one meter from the package surface is 5.2 mrem/hr, against a 10 CFR 71.51(a)(2) limit of 1,000 mrem/hr. These results

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are very conservative given the assumptions described above. Thus, the dose rate for the BRR package for the proposed payload is not of concern.

Criticality Evaluation

Per 10 CFR 71.4, fissile material is defined as the radionuclides U-233, U-235, Pu-239, and Pu-241, or any combination of these radionuclides. The spent fuel payload contains 3.14 grams U-235, 6.30 grams Pu-239, and 0.97 grams Pu-241. The spent fuel payload does not contain a significant amount of U-233. The package is exempt from a criticality analysis by satisfying the following exemption requirements per 10 CFR 71.15(b):

- The total fissile material mass is 10.41 grams, which is less than the threshold of 15 grams
- The total nonfissile material mass (which includes cask body steel but not lead) is greater than 200 grams per gram of fissile material

Thus, a criticality evaluation does not need to be performed.

Package Operations

The following steps shall be performed to load the payload container(s):

1. All operations shall observe ALARA principles and make use of a hot cell as required.
2. All operations shall be performed dry.
3. Remove the lid of the payload container assembly by removing four, ¼-20 UNC captured screws. Visually inspect the interior to verify that it is empty and clean.
4. Place the fuel rod segments into the container. Individual payload components (either the bare, closed-end segments or the segments in end-capped tubes) may be stacked as necessary within the container.
5. When loading is complete, verify that no part of the payload will interfere with the lid when assembled.
6. Steel wool may be used to cushion and stabilize the contents. Carbon steel wool or stainless steel wool may be used. It is not necessary to pack or immobilize the segments with steel wool.
7. Verify the presence of the dust seal and install the lid using the four lid screws.

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8. Install the extension tube into the socket beneath the lower plate, and install the quick release pin.
9. The payload container is now ready for placement into the BRR cask.

The cask shall be operated according to the procedure specified in Chapter 7 of Revision 10 of the BRR SAR. Prepare the BRR cask for loading according to Section 7.1.1 and steps 1 through 9 of Section 7.1.2.2 of the BRR SAR. The basket shall be the square fuel basket (Assembly A5 on SAR drawing 1910-01-03-SAR). No pedestal spacers shall be used.

The following steps replace steps 10 through 12 of Section 7.1.2.2. Other than these three steps, the procedural steps specified in Section 7.1.2.2 shall be followed as found in the BRR SAR.

10. Verify that the payload container(s) has been loaded and closed according to this procedure.
11. Place up to two payload containers into any two of the eight cavities in the square fuel basket.
12. Verify that the top of the pintle of each container is below the top surface of the basket.

Return to SAR Section 7.1.2.2, continuing with Step 13. Prepare the cask for transport according to Section 7.1.3 of the SAR. Unload the package according to Section 7.2 of the SAR.

Acceptance Tests and Maintenance Program

Since the payload container is not important to safety, there are no specific acceptance tests required other than an over check against drawing requirements. And since this will be a one-time shipment, there is no effect on the existing BRR package maintenance procedures.

Summary

As shown above, the proposed fuel rod segment payload has been fully described and evaluated for structural, thermal, containment, shielding, and criticality performance when transported in the BRR package. The proposed payload is of the same type as currently approved payloads (irradiated nuclear fuel) but in much smaller quantities (decay heat less than 3 watts, and less than 15g of fissile isotopes). A detailed operating procedure for the shipment has also been provided. Thus, the one-time shipment meets all of the applicable requirements of 10 CFR 71.

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References

1. Title 10, "Energy", Code of Federal Regulations, Part 71, *Packaging and Transportation of Radioactive Material.*
2. AREVA Federal Services SAR, *BEA Research Reactor Package Safety Analysis Report*, Revision 10, May 2016
3. ANSI N14.5–2014, American National Standard for Radioactive Materials – Leakage Tests on Packages for Shipment, American National Standards Institute (ANSI), Inc.

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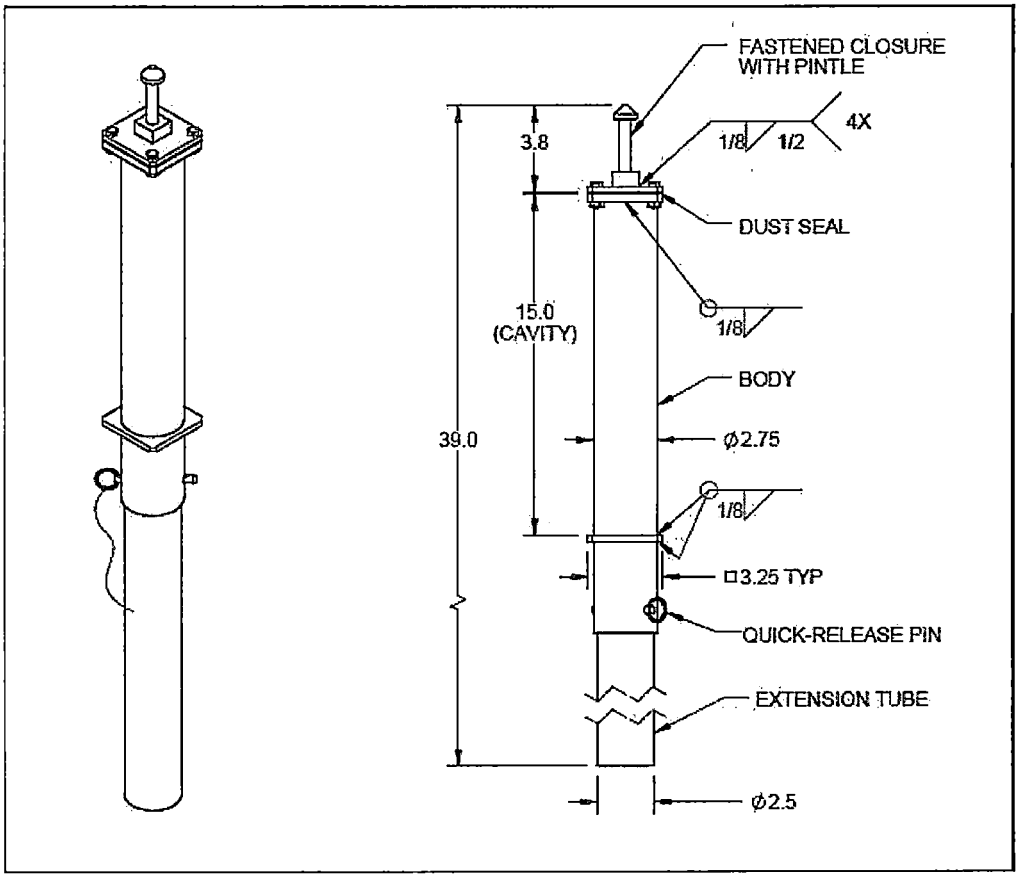

Figure 1 – Payload Container, General Views

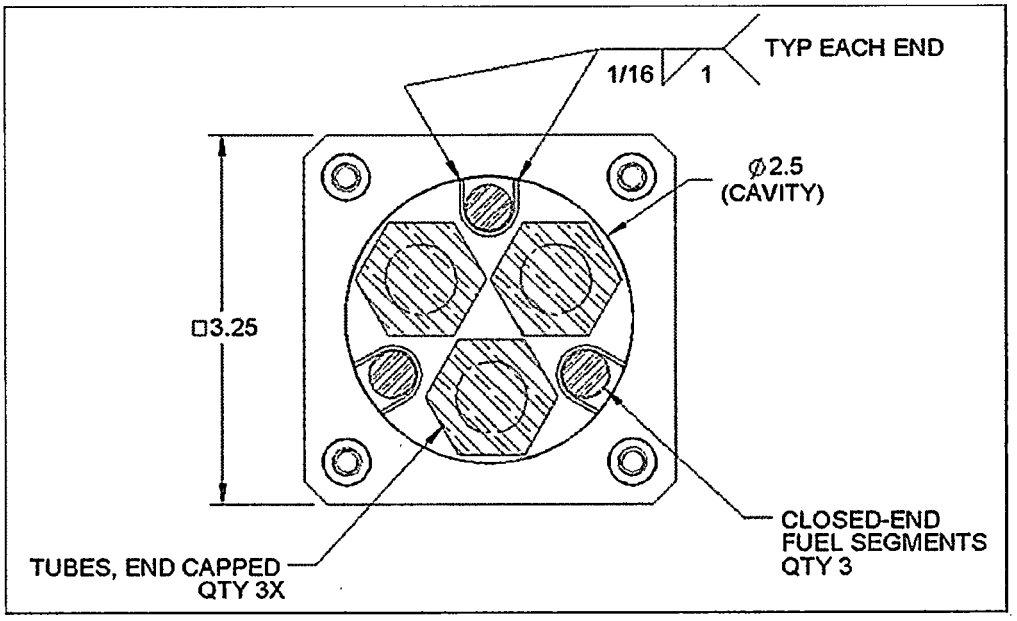

Figure 2 – Payload Container, Top View, Lid Removed

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Attachment B

BRR Fuel Rod Segment Shielding Analysis