UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 10, 2015

Mr. Philip W. Noss
Licensing Manager
AREVA Federal Services LLC
505 S. 336th St., Suite 400
Federal Way, WA 98003

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR REVIEW OF THE CERTIFICATE OF COMPLIANCE NO. 9341, FOR THE MODEL NO. BEA RESEARCH REACTOR (BRR) PACKAGE (CAC NO. L25031)

Dear Mr. Noss:

By application dated June 26, 2015, AREVA Federal Services, LLC (AFS or the applicant), requested to revise Certificate of Compliance (CoC) No. 9341 for the Model No. BEA Research Reactor (BRR) transport package. The application proposes to modify the BRR package to authorize or add the following contents or components, respectively:

1) Research reactor fuel (square or nearly square rectangular in cross section and similar in size):

   a) Rhode Island Nuclear Science Center,
   b) University of Massachusetts Lowell,
   c) Ohio State University,
   d) Missouri University of Science and Technology,
   e) University of Florida,
   f) Purdue University, and
   g) North Carolina State's PULSTAR.

2) 21 types of TRIGA research reactor fuel.

3) A new basket design to accommodate some of the fuel types mentioned in item No. 1 of this list.

4) Loose plates box, which fits into the new basket.

In connection with our review, we need the information identified in the enclosure to this letter. To assist us in scheduling staff review of your response, we request that you provide this information by January 4, 2015. Inform us at your earliest convenience, but no later than December 3, 2015, if you are not able to provide the information by that date. If you are unable to provide a response by January 4, 2015, our review may be delayed.

Please reference Docket No. 71-9341 and CAC No. L25031 in future correspondence related to this request. The staff is available to meet to discuss your proposed responses. If you have any questions regarding this matter, I may be contacted at (301) 415-6999.

Sincerely,

/RA/

Norma Garcia Santos, Project Manager
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9341
CAC No. L25031

Enclosure: Request for Additional Information

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Request for Additional Information
AREVA Federal Services, LLC
Docket No. 71-9341
Certificate of Compliance No. 71-9341
Model No. BEA Research Reactor (BRR) Package

By application dated June 26, 2015, AREVA Federal Services, LLC (AFS or the applicant), requested to revise the Certificate of Compliance (CoC) for the Model No. BEA Research Reactor (BRR) transport package. The application proposes to add seven types of research reactor fuel and 21 types of TRIGA fuel as authorized contents of the BRR. The applicant is also seeking approval of a new basket design to accommodate the seven types of research reactor fuel, as well as a loose plates box. The applicant plans to use the basket design already approved by the U.S. Nuclear Regulatory Commission (NRC) for transporting the additional types of TRIGA fuel.

This request for additional information (RAI) identifies information needed by the NRC staff in connection with its review of the application. NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material," and NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Fuel," were used by the staff in its review of the application.

Each RAI describes information needed by the staff to complete its review of the application and to determine whether the applicant has demonstrated compliance with the regulatory requirements of 10 CFR Part 71.

GENERAL

G-1. [1] Demonstrate that the loose plate fuel basket will not deform and the fuel will not move in the box under hypothetical accident conditions or provide safety analyses with appropriate justification for the assumptions about the degree of deformation. The demonstration should include the following information as this relates to the containment evaluation, shielding evaluation, and criticality safety evaluation:

a. releases of radioactive material with bounding fuel plate damage resulting from loose plate fuel basket deformation;

b. impact on dose rate at 1 meter from the surface of the package under hypothetical accident conditions with justified change of source geometry; and

c. the impact on the k_{eff} of the package under hypothetical accident conditions with justified fuel geometry.

[1] In general, the nomenclature used for identifying the RAIs is as follows: Topic-Application's Chapter-Counter. (Topics: G - General; Cr – Criticality; M – Materials; and Sh – Shielding.)

The applicant proposes nearly square or slightly curved loose fuel plates as authorized contents for the Model No. BRR. The request includes approval of a new basket design for shipping these fuel plates in the Model No. BRR packaging system. However, the applicant did not provide structural stability analyses demonstrating that the loose fuel basket will not deform or the fuel will not be damaged to cause fuel deformation or cladding breach.

This information is needed to determine compliance with 10 CFR 71.31(b), 71.73(c), and 71.55(d).

CRITICALITY SAFETY

Cr-6-1. Provide detailed drawing(s) for the loose plate basket demonstrating that the loose plates will remain evenly distributed during normal conditions of transport (as modeled).

The applicant states the following in the application:

> "A loose plate box is used to transport up to 31 loose plates per basket. Loose plates are limited to U-Mass (aluminide), U-Florida, and Purdue fuel plates."

However, the Licensing Drawing No. 1910-01-01-SAR does not show the location, spacing, and distribution of loose plates in the basket. In addition, this licensing drawing shows that the internal cavity of the loose plate basket is 7.62 centimeters (cm) long and 6.35 cm wide.

Based on the information provided in Table 6.2-11 of the application, the "specifications" for the U-Florida fuel plates are as follows:

i. 6.2738 cm wide,
ii. 0.0762 cm thick, and
iii. the channel spacing is 0.29718 cm.

The total thickness of the 31 plates would be as follows:

i. 2.3622 cm without channels, and
ii. 11.57478 cm with channels.

As such, 31 loose plates <u>with channels</u> would not fit into a loose plate basket.

For 31 or fewer plates <u>without channels</u>:

i. the fuel plates would take less than one third of the space of the loose plate basket cavity, and
ii. there will be a 5.62 cm space to allow the plates to move in a random manner.

This information is needed to determine compliance with 10 CFR 71.55.

Cr-6-2. Demonstrate that a Model No. BRR package loaded with 31 loose fuel plates (maximum number of plates per basket) meets the regulatory requirements of 10 CFR 71.55(d)(2).

On page 1.2-9 of the application, the applicant states the following:

> "A loose plate box is used to transport up to 31 loose plates per box. Loose plates are limited to U-Mass (aluminide), U-Florida, and Purdue fuel plates."

Therefore, the package may be loaded with fewer than the maximum allowable content.

Also, from the Licensing Drawing No. 1910-01-01-SAR and the fuel plates geometry data, there will be a large space in the loose plate fuel basket, even if the basket is loaded with the maximum payload of 31 loose fuel plates without channels. The gap between plates will be even larger if the basket is loaded with fewer loose plates. It is not clear how the package meets the requirements of 10 CFR 71.55(d)(2) because the content may move around during loading and transportation.

This information is needed to determine compliance with 10 CFR 71.55(d)(2).

Cr-6-3. Revise the application to ensure that the package meets the criticality safety requirements of 10 CFR 71.55 and 71.59 for less than full loads of loose fuel plates, and for plates unevenly spaced within the basket. Revise the criticality safety index for loose fuel plates in the Model No. BRR package accordingly.

The applicant states that the loose plate box is intended to be used to transport *up to 31* plates per box. Therefore, the package may be loaded with fewer than the maximum number of plates. Additionally, the criticality analysis for loose fuel plates assumes equal spacing between the plates, even though the plates are loose with no structural material to ensure this spacing.

Given that the system is under-moderated when the package is fully loaded, as discussed on page 6.3-3 of the application, the package with fewer loose fuel plates, or with uneven spacing between plates, could be more reactive. The application should be revised to demonstrate that packages loaded with fewer than 31 loose fuel plates per box, and boxes with uneven spacing between loose fuel plates, remain subcritical. This demonstration should include single packages with water inleakage per 10 CFR 71.55(b), single packages under normal conditions of transport per 10 CFR 71.55(d), single packages under hypothetical accident conditions per 10 CFR 71.55(e), and arrays of packages under normal conditions of transport and hypothetical accident conditions per 10 CFR 71.59.

This information is needed to ensure compliance with 10 CFR 71.55 and 10 CFR 71.59.

MATERIALS EVALUATION

M-1-1. Describe in detail how the applicant or user determines the extent of damage for PULSTAR, TRIGA, and Square plate fuels during hypothetical accident conditions.

Except for visual inspection of the fuel, the applicant does not describe an operation or process to determine the magnitude of the damaged for each type of fuel during hypothetical accident conditions (see Sections 2.2, 2.7.8, and 3.2.1 of the application). The applicant (or user) monitors:

i. excessive corrosion/erosion,
ii. mechanical wear and damage, and
iii. plate swelling (and/or blistering).

The applicant assumes the following in its analysis for damage fuel under hypothetical accident conditions:

i. square plate fuels keep their structural integrity with conservative removal of end structure (see Section 6.3.1 of the application),
ii. PULSTAR fuel is similar to the commercial pressurized water reactor (PWR) fuel (see Section 6.3.4 of the application), and
iii. PULSTAR fuel expands until constrained by the Zircaloy fuel box (see Section 6.3.1 of the application).

The conservatisms and the basis for their use in the evaluation of fuel damage for the proposed contents are unclear [i.e., reference damage (e.g., damages shown on page 3.5-3 of the application, Reference No. 30)]. The damage information referenced was for a different fuel (i.e., aluminum spent fuel).

This information is needed to determine compliance with 10 CFR 71.43(d) and 71.73(c).

M-1-2. Provide the basis for the assumption that the release of fission-generated gases for aluminum-based uranium dioxide (UO_2) fuel is applicable to the types of fuel proposed as authorized contents in this revision to the Model No. BRR.

In Section 3.1.4 of the application, the applicant mentions that the release of fission-generated gases from uranium-aluminide and uranium-zirconium hydride based fuels is diffusion-limited to the PULSTAR fuel and insignificant:

i. 6 pounds per square inch gauge [lb_f/in^2 gauge or psig (NORMAL CONDITIONS OF TRANSPORT limit, 10 psig)], and
ii. hypothetical accident conditions 12 psig with 2.9 psig fission gas release (maximum pressure of 25 psig).

The applicant assessed a diffusion-limited slow gas release with aluminum-based UO_2 fuel (see page 3.5-3 of the application, Reference 30). The applicant did not provide the basis for assuming that this assessment is applicable to the other types of fuel under consideration.

This information is needed to determine compliance with 10 CFR 71.43(d).

M-1-3. Describe the the vacuum drying process after loading PULSTAR, TRIGA, and Square Plate undamaged and damaged fuels. Also, explain how the applicant ensures that residual water is not present in the package (after the drying process) in order to avoid adverse chemical reactions.

In Section 3.3.3, the applicant mentions that under inadequate drying conditions, the fuel can generate gases by radiolysis. The staff notes that in humid conditions and a long period of time, galvanic corrosion (e.g., aluminum and stanless steel) may also occur.

This information is needed to determine compliance with 10 CFR 71.43(d).

SHIELDING EVALUATION

Sh-5-1. Explain the assumption for the mass of stainless steel in the stainless steel rods with a length greater than 30 inches.

On page 5.2-6 of the application, the applicant states the following:

> "From [4], the mass of stainless steel in the stainless steel clad standard rod (Type 103) is 800 g. This rod is 29.15-in long. It is assumed that all TRIGA rods with a length < 30-in will have 800 g stainless steel. The longest rods have an overall length of 45.5-in. Due to the increased cladding length, it is assumed that all rods with a length > 30-in have 1000 g stainless steel."

The mass of a 30-inch long stainless steel rod is approximately 800 grams. The longest rod has a length of 45.5 inches. Therefore, assuming that these rods each have a mass of 1,000 grams is not realistic. A 45 inch rod should have a mass greater than 1,000 grams, based on the stainless steel mass per unit length of the 30-inch rod.

This information is needed to determine compliance with 10 CFR 71.33(b)(1).

Sh-5-2. Explain the rationale for the assumptions used to model pitch for all TRIGA fuels including selecting IPR-RI TRIGA fuel as the bounding case and not other types of fuel. Also, provide a description of the type(s) of IPR-RI TRIGA fuel used for modeling pitch for all TRIGA fuels.

On page 5.2-6 of the application, the applicant states the following:

> "The fuel element pitch used in the models is estimated based on data for the IPR-R1 TRIGA reactor. IPR-R1 has an effective triangular pitch of 4.404 cm and a TRIGA element with an outer diameter of 3.76 cm. Assuming the ratio of pitch (P) to rod diameter (D) is approximately

constant for any host reactor, P/D = 4.404 cm/3.76 cm = 1.171, or P = 1.171D. This pitch is used on the LATTICECELL card for each rod diameter D. When building the NEWT geometry model, the outer boundary is modeled as a square because a hexagonal outer boundary is not allowed, and the dimension of the square is selected to preserve the area of the unit cell. The area of the unit cell is $\sqrt{3}/2\ P^2$."

Describe the characteristics of IPR-RI and why the applicant selected this specific fuel as the bounding case. In several places, the applicant mentions that TRIGA Type 109 fuel or Type 219 fuel was used as the bounding condition for this licensing action.

This information is needed to determine compliance with 10 CFR 71.47(b).

Sh-5-3. Provide the following information about the bounding conditions used for evaluating the proposed contents:

a. Explain why the TRIGA Type 219 is not modeled explicitly as Type 109;

b. Clarify which TRIGA fuel type (109 or 219) is used as bounding condition; and

c. Provide supporting information to demonstrate that TRIGA Type 109 or 219 is bounding for all enrichments, burnups, and cooling times requested in this licensing action.

On page 5-2-6 of the application, the applicant states the following:

> "This MCNP model is described in detail in Section 5.3, *Shielding Model*. In the MCNP model, element Type 109 is modeled explicitly and the source is distributed evenly throughout the fuel matrix. Element Type 109 is modeled in MCNP because it has the highest U-235 enrichment (70%) of all TRIGA elements and the criticality analysis demonstrated it is the most reactive."

On page 5-2-7 of the application, the applicant states the following:

> "The dose rates computed at the side of the cask for each TRIGA source are provided in Table 5.2-8. The maximum package surface dose rate of 32.2 mrem/hr occurs for Type 219 with a burnup of 119 MWD and a cooling time of 530 days burnup. TRIGA Type 219 has the largest uranium loading of all TRIGA elements considered (825 g U) and the largest burnup (in MWD)."

It is not clear from the cited text which assembly type is considered bounding in the shielding analysis, and why.

This information is needed to determine compliance with 10 CFR 71.47(b).

Sh-5-4. Clarify why the loose plates remain in the loose plate box under hypothetical accident conditions.

The applicant states the following in its application:

> "The loose plate box is not relied upon to maintain its configuration in the hypothetical accident, although the plates would remain within the basket compartments. It is assumed in the shielding models that the loose plates remain within the loose plate box in an accident because the bulk shielding provided by the box would remain largely unchanged if the box is damaged."

The applicant should demonstrate that loose plates stay in the loose plate box under hypothetical accident conditions, and that this demonstration is valid even if the box is damaged.

This information is necessary to determine compliance with 10 CFR 71.47(a) and (b)