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

March 31, 2016

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

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

Dear Mr. Noss:

By letter dated November 10, 2015, the U.S. Nuclear Regulatory Commissions (NRC) staff issued a request for additional information (RAI) related to the review of the application from AREVA Federal Services LLC (the applicant) [Agencywide Documents Access and Management System (ADAMS) Accession Number (No.) ML15316A160]. The applicant requested a revision to the certificate of compliance (CoC) for the Model No. BEA Research Reactor (BRR) packaging (ADAMS Accession No. ML15188A084). The applicant requests approval to modify the BRR package design to add the following irradiated fuel as authorized contents:

1) Irradiated fuel (square or nearly square rectangular in cross section and similar in size) from the research reactors at the following facilities:

   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 fuel rods from varoius TRIGA reactors.
3) Irradiated loose fuel plates from reactors at University of Massachusetts Lowell, University of Florida, and Purdue University.

The applicant developed a new basket design to accommodate some of the fuel types mentioned in item No. 1 of this list. The applicant also developed a loose plates box to hold the loose plate fuel.

The applicant provided its responses to the staff's RAIs by letter dated January 26, 2016 (ADAMS Accession No. ML16054A510).

In connection with our review, we need additional information identified in the enclosure to this letter. To assist us in scheduling the staff review of your response, we request that you provide this information by April 27, 2016. Inform us at your earliest convenience, but no later than April 12, 2016, if you are not able to provide the information by that date. If you are unable to provide a response by April 27, 2016, our review may be delayed.

Please reference Docket No. 71-9341 and TAC No. L25031 in future correspondence related to this request. The staff is available to meet with you 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

Enclosures:
1. Request for Additional Information
2. List of Some MCNP Publications

In connection with our review, we need additional information identified in the enclosure to this letter. To assist us in scheduling the staff review of your response, we request that you provide this information by April 27, 2016. Inform us at your earliest convenience, but no later than April 12, 2016, if you are not able to provide the information by that date. If you are unable to provide a response by April 27, 2016, our review may be delayed.

Please reference Docket No. 71-9341 and TAC No. L25031 in future correspondence related to this request. The staff is available to meet with you 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

Enclosures:
1. Request for Additional Information
2. List of Some MCNP Publications

Distribution: SFM r/f NMSS r/f

Ray Powell, RI	SWalker, RII	Mike Kunowski, RIII	Jack Whitten, RIV
NGarcia-Santos	DMarcano		

ADAMS Accession No: ML16092A192
G:\SFST\Garcia\Casework_NGS\Spent Fuel Packages\BRR-NGS\BRR_RAIs_2.docx

OFFICE	SFM	E	SFM	N	SFM	E
NAME	NGarcia-Santos		NGS for WWheatley		ZLi by e-mail	
DATE	3/22/2016		3/30/2016		3/28/2016	
OFC	SFM	E	SFM	E	SFM	C
NAME	EGoldfeiz by e-mail		ABarto for MRahimi		SRuffin	
DATE	3/29/2016		3/31/2016		3/31/2016	

C = COVER E = COVER & ENCLOSURE N = NO COPY
OFFICIAL RECORD COPY

Request for Additional Information
AREVA Federal Services, LLC
Docket No. 71-9341
Certificate of Compliance No. 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) transportation package. The application proposes to add seven types of research reactor fuel and 21 types of TRIGA fuel as authorized contents of the BRR package. The applicant is also seeking approval of a new basket design, including a loose plate box, to accommodate the seven types of research reactor fuel and loose plate fuel in a newly designed loose plate 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.

The staff reviewed the responses to the RAIs and the revised safety analysis report submitted by the applicant in the letter dated January 26, 2016 (ADAMS Accession No. ML16054A510). The staff found that it needs additional information to complete this review. This request for additional information (RAI) identifies additional information needed by the NRC staff in connection with its review of this application. The staff followed the guidance provided in NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material," and NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Fuel."

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.

SHIELDING EVALUATION

Sh-5-1$_2$ [1] Pertinent to the increased quantity of plutonium in the fuel:

a. Justify the increase in the maximum quantity of plutonium for the Model No. BRR package to 6,500 Ci (from previous amount of 5,890 Ci) and demonstrate that this value bounds all fuel types to be transported in the Model No. BRR in terms of radiation source terms for the proposed shielding design.
b. Provide calculations used for determining the quantity of plutonium, including the source term, modeling assumptions, and name and version of the software.
c. Provide the benchmarking analyses performed for the code used to perform source calculations for the contents requested.
d. Revise the shielding calculation, if necessary, with the increased source term resulting from the increase of plutonium content in the fuel.

[1] In general, the nomenclature used for identifying the RAIs is as follows: Topic-Application's Chapter-Counter. (Topics: Cr - Criticality and Sh – Shielding.) Subscript "2" refers to the second request for additional information.

In Section 1.2.3 of the application, Revision 9, “Special Requirements for Plutonium,” the applicant noted that the amount of plutonium was increased to 6,500 Ci without explaining and discussing the impact on the package external dose rates due to increasing the quantity of plutonium in the fuel.

This information is needed to determine compliance with 10 CFR 71.43, 71.47, and 71.51.

Sh-5-2$_2$ Under normal conditions of transport and hypothetical accident conditions, clarify how the redesigned basket for loose fuel plates can maintain:

a. its integrity under normal conditions of transport and hypothetical accident conditions.
b. the external dose from the package within the regulatory limits.
c. the loose plates in a safe geometry.

In response to the staff RAI dated November 10, 2015, the applicant changed some assumptions in its safety analysis, such as:

- *changing the loose plate box material* from aluminum to stainless steel in order to maintain the geometry of the loose plate box under hypothetical accident condition.
- *requiring the insertion of aluminum dunnage* into the loose plate box beside the fuel plates to limit the potential for motion of the loose plate during transport (see Section 7.1.2.1 and 7.1.2.2 of the application).

From drawing No. 1910-01-01-SAR, the loose plates box does not have a lid. Although the applicant states that the package will be transported in a vertical position and dunnage will be used to prevent fuel plates from moving, the applicant has not demonstrated what component is used to hold the fuel plates in the loose plate box so that the fuel plates would not slide out of the basket under normal conditions of transport and hypothetical accident conditions.

The applicant needs to perform shielding analyses for the package consistent with the conditions of the geometry of the content and corresponding source distribution and demonstrate that the package meets the requirements of 10 CFR 71.43, 71.47, and 71.51. Under the head drop test, it is conceivable that the loose plates in a loose plate box without lid could slide out of the basket because there is no device to hold the fuel plates in the basket and there is a space between the fuel plates in the loose plate box and the package closure lid. Therefore, the applicant also needs to demonstrate that the package meets the requirements of 10 CFR 71.55(d)(2) and 71.55(e)(1) under the tests specified in 10 CFR 71.71(c)(7) and 71.73(c)(1).

This information is needed to determine compliance with 10 CFR 71.43, 71.47, 71.51, 71.55(d)(2), and 71.55(e)(1).

CRITICALITY EVALUATION

Cr-6-1$_2$ With respect to the dunnage to be used, provide the following:

a. a detailed drawing and specifications (i.e. materials of construction, dimensions, etc.) for the dunnage used to restrict the fuel plate from sliding out the loose plate baskets, and
b. a demonstratration that the dunnage is effective for restricting the movement of the fuel plates in the box basket under normal and hypothetical accident conditions.

The applicant revised the design of the loose plate basket, in its response to the staff's RAI dated November 10, 2015, to use dunnage to restrict fuel movement out of the loose plate basket. However, the applicant did not provide any drawing and specifications for the dunnage to be used, nor a demonstration that the use of the dunnage is an effective mean for restricting the movement of the loose fuel plates. Regulations in 10 CFR Part 71 require that the geometric form of the content of a fissile package shall not substantially alter under normal conditions of transport [10 CFR 71.55(d)(2)] and that the package is subcritical with the fissile material in the most reactive credible configuration consistent with the damaged condition of the package and the chemical and physical form of the contents [10 CFR 71.55(e)(1)].

This information is needed in order for the staff to determine the package compliance with 10 CFR 71.55(d)(2), 71.71, and 71.73.

Cr-6-2$_2$ Demonstrate that the BRR package meets the regulatory requirements of 71.55(b) for all allowable contents requested in this amendment. This demonstration should include the number of plates at which the package reaches the maximum k_{eff}, for each fuel type with the appropriate criticality safety analyses.

In its response to RAIs Cr-6-1, Cr-6-2, and Cr-6-3, the applicant states that fewer than 31 plates may be loaded in a loose plate basket. One example is that the maximum number of plates per loose fuel basket is 17 for U-Florida fuel. However, the applicant did not provide:

- specific limitations on the number of plates that could be placed into a loose plate basket for each fuel type, or
- the criticality safety analysis for those various loading configurations with corresponding loading limits.

In addition, in its response to RAI Cr-6-3, the applicant states: "Note that the HAC single package analysis, which includes optimum moderation, bounds the requirements of 71.55(b)." The staff reviewed the assertion and found that the criticality safety analysis for a single package under HAC may not bound the requirements of 10 CFR 71.55(b) because: (1) the package is being loaded or unloaded in fresh water pool (wet loading) and therefore the number of plates increase or decreases during loading and unloading process, (2) the system is identified as under-moderated; therefore it will reach the optimal moderation as

fuel plates are added or removed from the basket, and (3) the criticality safety analysis for the single package under HAC was performed with a fully loaded package and therefore may not bound the configurations with fewer fuel plates.

This information is needed in order for the staff to determine the package compliance with 10 CFR 71.55(b).

Cr-6-3$_2$ Demonstrate that the criticality safety calculations using MCNP models have properly converged for all requested loose plate contents and loading configurations.

The applicant used MCNP to perform criticality safety analysis for the BRR packages with various loose fuel basket and fuel loading patterns. In the safety analyses report the applicant states:

> "All moderated cases are run with a minimum of 2500 neutrons per generation for 250 generations, skipping the first 50."

Given the new design of the loose fuel plate baskets, including the addition of various spacers and dunnage, the staff needs assurance that the MCNP model using 250 generations would result in proper convergence of the calculations.

Based on papers published by the MCNP development experts (see Enclosure 2 for examples of these publications), convergence of k_{eff} for a system with large water gap between fuel or non-uniform distribution of fuel in water does not assure the convergence of the calculation and the users should check the convergence of the calculations with Shannon Entropy to assure that the calculation has properly converged. The applicant needs to demonstrate that all criticality safety calculations using MCNP and the stated KCODE parameters have properly converged with both k_{eff} and Shannon Entropy indices.

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

OPERATING PROCEDURES

OP-7-1 Revise the Operating Procedures to clearly state when spacers and/or dunnage are needed and provide specific instructions for use of these components.

The applicant revised the design of the loose plate basket in its response to the staff's RAI dated November 10, 2015 to use dunnage and spacers in the loose plate box to restrict the movement of fuel plates under normal conditions of transport and hypothetical accident conditions. The applicant also revised its Operating Procedures (OP) to include use of spacers. However, Step 12(b) of OP 7.1.2.1 and 7.1.2.2 state:

> "***Using aluminum dunnage as necessary***, minimize the free space between the flat face of the loose plates and the box opening."

This instruction seems to leave the users to determine if dunnage is necessary. However, the criticality safety analyses credited the dunnage as shown in Figures 6.4.7 to 6.4.11 of the application. This instruction could lead to a potential criticality safety accident as it stands because the instructions seem to indicate that the dunnage is an optional component of the packaging but it is in fact a component important to safety because the criticality safety of the package is dependent on the dunnage. The applicant also needs to revise the Operating Procedures to provide clear instructions for the use of dunnage.

This information is needed in order for the staff to determine the package compliance with 10 CFR 71.55 and 71.89.

LIST OF SOME MCNP PUBLICATIONS

Some papers published by the MCNP development experts:

1. B.C. Kiedrowski & F.B. Brown, “Continuous-Estimator Representation for Monte Carlo Criticality Diagnostics,” Trans. AM. Nuc. Soc. 106, paper LA-UR-12-00386, presentation, LA-UR-12-22259 (2012).
2. F.B. Brown, “On the Use of Shannon Entropy of the Fission Distribution for Assessing Convergence of Monte Carlo Criticality Calculations,” PHYSOR-2006, Vancouver, LA-UR-06-3737 (2006).
3. F.B. Brown, B. Nease, & J. Cheatham, “Convergence Testing for MCNP5 Monte Carlo Eigenvalue Calculations,” M&C+SNA-2007, Monterey, LA-UR-07-1123 (2007).
4. T. Ueki & F.B. Brown, “Stationarity Diagnostics Using Shannon Entropy in Monte Carlo Criticality Calculations I: F Test,” Trans. Am. Nucl. Soc., LA-UR-02-3783 (November 2002).
5. J. Cheatham & F.B. Brown, “Investigation of Shannon Entropy for Characterizing Convergence of MCNP5 Eigenvalue Calculations,” LA-UR-06-5886 (2006).