

August 17, 2016

Mr. Scott Murray  
Facility Licensing Manager  
GE-Hitachi Nuclear Energy Americas, LLC  
3901 Castle Hayne Road  
Wilmington, NC 28401

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR REVIEW OF THE MODEL  
NO. 2000 PACKAGE

Dear Mr. Murray:

By letter dated April 28, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16119A329), as supplemented on May 4, 2016 (ADAMS Accession No. ML16119A329), GE Hitachi Nuclear Energy submitted an application for renewal of Certificate of Compliance No. 9228 for the Model No. 2000 package. GE Hitachi Nuclear Energy also requested an amendment to Certificate of Compliance No. 9228 to add a new High Performance Insert (HPI) as authorized contents, revise the descriptions of other authorized contents, and submitted a consolidated safety analysis report (SAR) in support of their amendment request. To assist with our review, the U.S. Nuclear Regulatory Commission staff needs the information identified in the enclosure to this letter. Discussion of this request for additional information (RAI) and a response date occurred on August 10, 2016.

We request that you provide this information by September 9, 2016. Inform us at your earliest convenience, but no later than September 2, 2016, if you are not able to provide the information by that date. If you are unable to provide a response by September 9, 2016, please propose a new submittal date with the reasons for the delay.

Please reference Docket No. 71-9228 and either CAC No. L25114 or CAC L25115 in future correspondence related to this amendment request. The staff is available to discuss these questions as well as your proposed responses. If you have any questions regarding this matter, feel free to contact me at (301) 415-6877.

Sincerely,

**/RA/**

Chris Allen, Project Manager  
Spent Fuel Licensing Branch  
Division of Spent Fuel Management  
Office of Nuclear Material Safety  
and Safeguards

Docket No. 71-9228  
CAC No. L25114  
CAC No. L25115

Enclosure: Request for Additional Information

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 Facility Licensing Manager  
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Chris Allen, Project Manager  
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Docket No. 71-9228  
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 CAC No. L25115

Enclosure: Request for Additional Information

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Request for Additional Information  
Docket No. 71-9228  
Model No. 2000 Package

By letter, dated April 28, 2016 (ADAMS Accession No. ML16119A329), as supplemented on May 4, 2016 (ADAMS Accession No. ML16119A329), GE Hitachi Nuclear Energy submitted an application for renewal of Certificate of Compliance No. 9228 for the Model No. 2000 package. In addition, GE Hitachi Nuclear Energy requested an amendment to modify the package design and revise authorized contents from Certificate of Compliance No. 9228, and submitted a consolidated SAR in support of their amendment request. This RAI letter identifies information needed by the staff in connection with its review of the application. NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material," was used by the staff in its review of the application.

Each individual RAI describes information needed by the NRC staff to complete its review of the application to determine whether the applicant has demonstrated compliance with the regulatory requirements.

### **General Information Review**

- 1.1 Clarify the maximum U-235 equivalent mass authorized for transport.

Although Section 1.2.2.3 states the maximum amount of special nuclear material for transport is 430 grams U-235 equivalent mass, 500 grams U-235 equivalent mass is specified both in the Section 7.2.2.2 title and text. The applicant needs to revise the SAR pages which incorrectly specify the allowable U-235 equivalent mass.

This information is necessary to satisfy the requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) 71.33(a)(5).

### **Structural Review**

- 2.1 Provide the following information with respect to the material basket stress analysis for the NCT end drop:

- a) the maximum induced bending and shear stresses in the basket,
- b) the minimum margin of safety in the basket, and
- c) the technical justification(s) to the assumption of no axial load.

This information is needed to verify compliance with 10 CFR 71.71(c)(7).

- 2.2 Provide the following information with respect to the material basket stress analysis for the HAC end drop:

- a) the maximum induced bending and shear stresses in the basket,
- b) the minimum margin of safety in the basket,
- c) technical assumptions (e.g., no axial load in the basket, etc.) made for the material basket stress analysis, and
- d) buckling analysis and its results for the elastic stability of the basket.

This information is needed to verify compliance with 10 CFR 71.73(c)(3).

## Thermal Review

- 3.1 Provide the data source for the Aluminum Honeycomb thermal conductivity and emissivity values used in the normal conditions of transport (NCT) and hypothetical accident conditions (HAC) thermal analyses.

The applicant listed the thermal properties of Aluminum Honeycomb in Table 3.2.1-1 of NEDE-33866P (Rev. 0), based on References 3-4 (Hexcel Corporation) and 3-7 (Siegel and Howell), for the NCT and HAC thermal analyses. Staff notes the Aluminum Honeycomb thermal conductivity listed in Table 3.2.1-1 is low compared with solid aluminum. In addition, both the thermal conductivity and emissivity values in Table 3.2.1-1 for Aluminum Honeycomb are not listed in References 3-4 and 3-7 of NEDE-33866P (Rev. 0). The applicant needs to provide the source from which the Aluminum Honeycomb thermal conductivity and emissivity values were obtained as well as justify that the value is acceptable.

This information is required by the staff to access compliance with 10 CFR 71.33(a)(5)(v), 10 CFR 71.71 and 10 CFR 71.73.

## Containment Review

- 4.1 Provide the allowable Configuration 1 containment O-ring seal temperature limits.

The applicant stated in Section 1.2.1.1 of NEDE-33866P (Rev. 0) that ethylene propylene diene monomer (EPDM) seals are used for the Configuration 1 cask lid, vent port plug, drain port plug and test port plug, and displayed the following allowable temperature limits in Table 3.5.1-3 (NCT) and Table 3.5.1-5 (HAC) for these locations: lid seal (400°F), drain port seal (612°F), vent port seal (612°F) and test port seal (612°F). The applicant needs to clarify why the allowable temperature limits are different at these locations even though the same EPDM material is used.

This information is needed to determine compliance with 10 CFR 71.51.

- 4.2 Provide the allowable Configuration 2 containment O-ring seal temperature limits.

The applicant stated in Section 3.2.2 of NEDE-33866P (Rev. 0) that **[[** **]]** seals are used at the cask lid, vent port plug, drain port plug and test port plug of Configuration 2, and displayed the following allowable temperature limits in Table 3.1.3-2 (NCT) and Table 3.1.3-3 (HAC) for these locations: lid seal (508°F), drain port seal (612°F), vent port seal (612°F) and test port (612°F). The applicant needs to clarify why the allowable temperature limits are different at these locations even though the same type of **[[** **]]** seal is used.

This information is needed to determine compliance with 10 CFR 71.51.

- 4.3 Provide test conditions and results on permeation of the new [[ ]] seal material.

Permeation can cause problems when demonstrating that a system is leaktight. The degree of permeation is affected by factors such as seal material, seal surface area, time and temperature. If the new [[ ]] seal material is permeable to helium, the staff needs to determine if the applicant can accurately differentiate helium detection caused by a leaking [[ ]] seal and helium permeating from an intact [[ ]] seal to the leaktight criterion on a repeatable basis. The applicant needs to provide the test conditions and results from the acceptance testing.

This information is needed to determine compliance with 10 CFR 71.51(a)(1), and 10 CFR 71.87(c).

### **Shielding Review**

- 5.1 Justify the gamma and neutron source term strength.

Typical spent fuel source terms for gammas increase linearly with burnup and to the fourth power for neutrons as discussed in NUREG/CR-6802. However, neither the gamma source strength in Table 5.2-2 of the SAR nor the neutron source strength in Table 5.2-6 of the SAR follow these relationships. The applicant needs to justify this atypical source term strength increase with increasing burnup.

This information is needed to verify compliance with 10 CFR 71.47(b) and 10 CFR 71.51(a)(2).

- 5.2 Discuss how fuel assemblies other than GE 10x10 meet both thermal and external dose rate regulations.

Chapter 1 of the SAR does not limit what kind of irradiated fuel will be shipped. All decay heat and external dose rate evaluations are based on source terms from GE 10x10 fuel. The applicant needs either to discuss how GE 10x10 fuel assemblies provide bounding radiological and decay heat source terms, or to provide additional information explaining how non-GE 10x10 fuel assemblies meet thermal and external dose rate regulations given the different source term they would produce.

This information is needed to verify compliance with 10 CFR 71.33(b)(1), 10 CFR 71.33(b)(7), 10 CFR 71.47(b), and 10 CFR 71.51(a)(2).

- 5.3 Provide neutron emitting nuclide limits for the irradiated hardware and byproduct contents to be shipped in the GE-2000.

Section 7.5.2 states that “any neutron emitting radionuclides are limited to trace amounts, strictly from surface contamination of the hardware or byproducts are permitted for shipment.” Since “trace amounts” is subjective, a quantitative limit should be specified. The staff also notes that many nuclides in Table 5.5-7 of the SAR can either emit neutrons directly or by alpha-n reactions. These include, but are not necessarily limited to Np-237, Cm-242, Cm-244, Am-241, Pu-238, Pu-239, and Pu-240. The applicant needs to provide both a limit for all neutron emitters in this table and a justification for this limit.

This information is needed to verify compliance with 10 CFR 71.47(b) and 10 CFR 71.51(a)(2).

- 5.4 Discuss the discrepancy between SAR Section 1.2.2.3 and SAR Section 5.5.3 regarding the allowable amount of Co-60 per rod [ ] [ ].

The content limit for the Co-60 isotope rods in SAR Section 1.2.2.3 differs from that stated in SAR Section 5.5.3. Section 1.2.2.3 limits the Co-60 rod [ ] [ ] to 17,000 Ci per rod [ ] [ ] within a single shipment. Section 5.5.3 (starting on page 5-48) has this same limit but the unit is per inch. Since the shielding analysis supports the per inch limit, staff intends to condition the CoC to reflect this unless the applicant provides information stating this is not the intended limit. If the per inch limit is not the intended limit, the applicant must provide justification for the 17,000 Ci per rod [ ] [ ] limit. Whichever limit is applicable, the applicant must reconcile the descriptions in SAR Sections 1.2.2.3 and SAR Section 5.5.3.

This information is needed to verify compliance with 10 CFR 71.33(b)(1), 10 CFR 71.47(b) and 10 CFR 71.51(a)(2).

- 5.5 Justify that Configuration 1 (up to 1500 Watts) sources not requiring the material basket still meet NCT dose rate limits considering the possibility of reconfiguration.

Table 1.2-1 of the SAR states that the contents limited to 1500 Watts decay heat do not require the material basket in Configuration 1. Without the material basket, or other shoring mechanisms, it is possible that the content could reconfigure during NCT. The applicant performed external dose rate evaluations for both irradiated fuel and Co-60 [ ] [ ] using line sources. Although the shielding evaluations are performed for Configuration 2, which allows up to 3000 Watts, the staff needs additional information demonstrating that, under plausible NCT reconfiguration, the concentrated 1500 Watt source doesn't exceed NCT dose rate limits. The applicant should either explain why the contents cannot reconfigure, provide analyses demonstrating that the contents cannot reconfigure, or provide analyses showing that the maximum reconfiguration would still not exceed regulatory external dose rate limits. The applicant could also justify if current conservative assumptions, e.g.; neglecting self-shielding, sufficiently compensate for this possibility. Alternatively, the applicant needs to discuss how these sources will be shored under NCT if they are not required to be shipped in the material basket.

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

- 5.6 Justify that the irradiated fuel content will meet the package external dose rate regulatory limits considering the burnup profile.

Section 5.3.1.1 of the SAR states that the irradiated fuel content is a single 10-inch line source with the photon and neutron sources uniformly distributed. The applicant needs to discuss how they account for the irradiated fuel burnup profile. For instance, if the fuel is qualified for shipment based on average assembly burnup, some segment burnups could be much higher than the average burnup. The variation in fuel segment burnup will produce variations in the source terms for both gamma and neutron. NUREG/CR-6802 points out that the gamma source of spent fuel is linearly proportional to the fuel burnup and the neutron source is proportional to the fourth power of fuel burnup. In addition, the potential exists for segments to be aligned such that higher burnup sections are loaded adjacent to one another maximizing burnup and placing the package in an unanalyzed condition. The applicant needs to discuss how fuel qualified for loading is classified, i.e., by the maximum local burnup or the assembly average burnup. If the assembly average burnup is used, the applicant needs to discuss how the package still meets regulator dose rate limits by either providing an analysis or demonstrating that conservative assumptions employed within the evaluation, are enough to bound the uncertainty of the burnup.

This information is needed to verify compliance with 10 CFR 71.47(b) and 10 CFR 71.51(a)(2).

### **Criticality Review**

- 6.1 Provide the chemical and physical form specifications of the special nuclear materials.

The requested contents of the GE-2000 package include solid form special nuclear materials. However, the SAR provides no specifications for the chemical (e.g., compound, pure metal, etc.) and the physical (e.g., solid metal, particulate, etc.) forms of these special nuclear materials. Although SAR page 5-4 states *"[t]here are no significant gamma or neutron sources in the SNM contents, thus this content type is not applicable for the shielding analysis, as it is not limited by dose rate or thermal calculations,"* this statement does not identify if these special nuclear materials have ever been irradiated or if they are products of reprocessed irradiated materials. The applicant needs to provide specific descriptions of the chemical and physical forms for these special nuclear materials.

This information is needed to verify compliance with 10 CFR 71.33(b)(1), 10 CFR 71.33(b)(3), and 10 CFR 71.55(e)(1).

- 6.2 Provide specifications for all rod types to be shipped by the GE-2000 package and demonstrate that the criticality safety analyses presented in the SAR bound all fuel types to be shipped.

The applicant performed criticality safety analyses for the GE-2000 package containing irradiated fuel rod segments. On page 5-4 of the SAR, the applicant states that it used the GE 10x10 as the design basis fuel assembly. However, the applicant indicates on SAR page 6-5 that the fuel rod outside radius can vary from 0.2 to 0.5 cm to encompass a variety of fuel designs. Therefore, staff is unable to determine if the GE 10x10 fuel rods are bounding. The applicant needs to provide specifications for all rod types to be shipped by the GE-2000 package and demonstrate that the criticality safety analyses, which use GE 10x10 BWR fuel rod design as the design basis fuel assembly, bound all fuel types to be shipped.

This information is needed to verify compliance with 10 CFR 71.33(b)(3) and 10 CFR 71.55.

## Operations Review

- 7.1 Clarify how segmented fuel rods with decay heat less than 1500 watts are shored, and revise the Operating Procedures in Chapter 7 if necessary.

On SAR page 1-4, when discussing the allowable contents and corresponding packaging requirements, the Safety Analysis Report for the GE-2000 package states: “*This may include irradiated fuel rods, irradiated hardware and byproducts, Co-60 isotope rods, or special nuclear material (SNM). The following are requirements for all shipments:*

- a) *The maximum quantity of material per package shall not exceed 5,450 lb, including all cask internals and contents.*
- b) *All contents shipped shall be in solid form.*
- c) *All configurations require the use of the HPI.*
- d) *All contents shall be shipped in Configuration 1 or Configuration 2 depending on decay heat. The decay heat limits for shipping Configuration 1 and Configuration 2 are outlined in Table 1.2-1. **See content specifics below as to whether a content configuration requires the use of the HPI material basket.***

In addition, on page 6-2 of the SAR, the applicant states: “*For all contents, shoring components such as rod holders or the HPI material basket **may be present.***” Also, on page 7-4 of the SAR, the applicant states: “*The use of the HPI material basket is not required for Configuration 1, but may be used as a shoring component.*” However, Figure 1.2-5 of the SAR seems to imply that both the rod **[[ ]]** holder and the material basket are required to hold the segmented fuel rods.

The applicant should clearly identify if the rod **[[ ]]** holder is required for transporting segmented fuel rods and the conditions for which the rod segment holder is required. The applicant should also revise the Chapter 7 Operating Procedures, if necessary, to provide clear instructions for loading segmented fuel rods.

This information is needed to verify compliance with 10 CFR 71.87(f).

7.2 Identify appropriate torque ranges for the Section 7 torque values.

The Section 7 torque values are exact numbers which implies the package cannot be safely transported if torque values above and below these values are employed. Package user personnel will also have difficulty applying such exact torque values. Therefore, the applicant should specify a range of torque values to clarify what is the acceptable package configuration and to facilitate package assembly.

This information is needed to ensure compliance with 10 CFR 71.33(a)(5) and 10 CFR 71.87(f).

7.3 Revise SAR Section 7.5.2 procedure to include all nuclides that contribute decay heat.

The second step of SAR Section 7.5.2 has several bullets clarifying what nuclides need to be listed in the loading table. The staff did not find an appropriate place for alpha and beta emitting nuclides. Although these nuclides are not significant to external dose rate, they could significantly contribute to decay heat. The applicant should revise this step to ensure users do not inadvertently exclude these nuclides.

This information is needed to verify compliance with 10 CFR 71.33(b)(7), 10 CFR 71.43(g) and 10 CFR 71.87(k).

7.4 Clarify SAR Section 7.5.3 language with respect to the Co-60 content.

SAR Section 7.5.3 contains the procedure for verifying package compliance when shipping Co-60 rods. As stated in RAI 5.4, staff interprets the Co-60 limit to be 17,000 Ci per inch based upon the shielding evaluations provided by the applicant. Since the last three bullets of step 1 do not seem to reflect this limit, staff is unclear what these bullets communicate. The applicant should revise the steps within this procedure as necessary to be consistent with the limit identified in response to RAI 5.4.

This information is needed to verify compliance with 10 CFR 71.47(b) and 10 CFR 71.51(a)(2).

7.5 Clarify how free form special nuclear material is loaded into the HPI, provide specific descriptions of the required shoring devices for the special nuclear material content, and revise the Chapter 7 Operating Procedures if necessary.

On page 6-2, the applicant states: *“For all contents, shoring components such as rod holders or the HPI material basket may be present.”* On page 7-4, the applicant further instructs the users: *“The use of the HPI material basket is not required for Configuration 1, but may be used as a shoring component.”* Since these statements indicate the material basket is optional, it is unclear how the free form special nuclear material is loaded and restrained in the HPI given the fact that the allowable quantity of special nuclear material (430 grams of U-235) will occupy only about 23 cm<sup>3</sup> of the HPI cavity. The applicant needs to clarify how the free form special nuclear material is loaded into the HPI, provide specific descriptions of the shoring devices required for the special nuclear materials content, and revise the Operating Procedures in Chapter 7 if necessary.

This information is needed to verify compliance with 10 CFR 71.55 and 10 CFR 71.87(f).

- 7.6 Provide specific instructions for what shoring devices are required, when shoring devices are required, and how shoring devices are installed.

SAR Section 7.1 states: “For Configuration 1: Load the contents directly into the HPI with additional shoring as required. For Configuration 2: Load the contents and any additional required shoring (e.g., rod holders) into the HPI material basket and load the material basket into the HPI.” These instructions neither specify when shoring is required, what shoring devices are required, nor how to install shoring. The applicant needs to provide more specific instructions for when and what shoring devices are required and how to install them to avoid misloading the package.

This information is needed to verify compliance with 10 CFR 71.87(f).

### Acceptance and Maintenance Review

- 8.1 Clarify the frequency at which periodic leak testing must be performed.

Although the Section 8.2.1.2 periodic inspections are performed either after 12 usages or once within a 12 month period and Section 8.2 identifies leak testing the package to  $1 \times 10^{-7}$  ref cm<sup>3</sup>/sec after 12 usages, Section 8.2.2.2 only indicates periodic leak testing must be performed once after the previous 12-month period.

This information is needed to ensure compliance with 10 CFR 71.87(f).

- 8.2 Revise the statement that the fabrication leakage rate testing is required for the “**entire**” containment boundary, not just for the “**primary**” containment boundary.

In Section 4.0, the applicant stated: “The entire primary containment boundary, including containment welds and base metals as shown in Figure 4.1.3-1, are leakage rate tested for fabrication, maintenance, and periodically as defined in Section 8.0.” The applicant needs to revise the statement to clarify that the fabrication leakage rate testing is required on the “entire” containment boundary in accordance with ANSI N14.5, 2014. Use of the phrase “entire primary containment boundary” lacks the requisite precision.

This information is needed to determine compliance with 10 CFR 71.51.

- 8.3 Provide the acceptance test results for the Configuration 2 lid seal.

The applicant tested the Configuration 2 cask lid **[[** seal, and presents the test results in Reference 8-10 (Report 003N5189 R0, 2016). The applicant should provide the test procedure and test results for staff review to ensure the test procedure is appropriate and the results demonstrate adequate seal performance.

This information is needed to determine compliance with 10 CFR 71.43(f), and 10 CFR 71.51.

In addition to the information requests above, staff identified the following editorial item:

1. The next to last bullet in Section 7.5.2 uses the term “criticality” instead of “activity”.