



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

October 31, 2014

Mr. Scott P. Murray  
Licensing & Liabilities  
Global Nuclear Fuel – Americas, LLC  
P.O. Box 780  
Wilmington, NC 28402

SUBJECT: AUTHORIZATION FOR SHIPMENT OF THE MODEL NO. RAJ-II PACKAGE  
WITH GNF3 LEAD USE ASSEMBLIES

Dear Mr. Murray:

As requested by your letter dated July 30, 2014, as supplemented August 7, and September 17, 2014, pursuant to Title 10 of the *Code of Federal Regulations* Part 71, the Certificate of Compliance (CoC) No. 9309 for the Model No. RAJ-II package is amended by letter to allow GNF3 lead use assemblies, which are not already authorized contents in the CoC, to be shipped. All other conditions of CoC No. 9309 shall remain the same. This authorization is valid for packages to be shipped between January 1, 2015, and December 31, 2016, and is limited by the following conditions:

1. The fuel assemblies will contain  $UO_2$  and  $Gd_2O_3$  only.
2. The fuel assemblies will contain commercial grade uranium and meet Type A material contents.
3. The fuel assemblies will be shipped un-channeled.
4. There will be a maximum of four RAJ-II packages on a single truck, each containing a maximum of two fuel assemblies.
5. The criticality safety index is 12.5.

If you have any questions regarding this authorization, please contact me or Huda Akhavannik at (301) 287-9241.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

/RA/

Michele Sampson, Chief  
Spent Fuel Licensing Branch  
Division of Spent Fuel Management  
Office of Nuclear Material Safety  
and Safeguards

Docket No. 71-9309  
TAC No. L24941

Enclosure: Safety Evaluation Report

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**OFFICIAL AGENCY RECORD**



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

SAFETY EVALUATION REPORT  
Docket No. 71-9309  
Model No. RAJ-II  
Certificate of Compliance No. 9309

## SUMMARY

By application dated July 30, 2014, as supplemented August 7, 2014, and September 17, 2014, Global Nuclear Fuel – Americas, LLC (GNF-A or the applicant) requested a one-time authorization to ship Model No. RAJ-II packages containing GNF3 lead use assemblies (LUA) which are not an authorized content in Certificate of Compliance (CoC) No. 9309.

A one-time letter authorization has been granted to authorize these shipments based on the statements and representations in the application. The staff agrees that the change does not affect the ability of the package to meet the requirements of 10 CFR Part 71.

## EVALUATION

The applicant requested a one-time authorization to ship Model No. RAJ-II packages containing GNF3 LUA which are not an authorized content in CoC No. 9309, Rev. 10. The GNF3 is a new fuel assembly design and is mostly within the approved range of Table 3, "Fuel Assembly Parameters," in the current CoC. As such, the analyses performed for this letter authorization mostly take their basis from the analyses performed as part of previous Model No. RAJ-II approvals for the assembly contents. The fuel parameters which exceed the limits of approved fuel assembly design have been evaluated and the staff has determined that the request does not affect the ability of the package to meet the requirements of 10 CFR Part 71.

### *Structural*

NRC staff reviewed the results as presented in Attachment 2 of the GNF-A letter dated July, 30, 2014, "GNF 3 RAJ-II Letter Authorization Request and Technical Basis," as supplemented, for shipping a new GNF3 LUA fuel assemblies in the Model No. RAJ-II container during normal condition of transport (NCT) of 10 CFR Part 71.71 and hypothetical accident condition (HAC) of 10 CFR Part 71.73. Staff also reviewed the impact of shipping fuel assemblies with the new weight in the Model No. RAJ-II. The maximum gross weight of a Model No. RAJ-II package is 1,614 kg (3,558 lbs). This includes a maximum payload weight of 684 kg (1,508 lbs), which remains unchanged. As a result, the previous analysis remains applicable and valid. The maximum vertical center of gravity (CG) and the maximum horizontal shift of the horizontal CG are also unchanged. The content, inner container and the outer container weights previously approved are bounding for the GNF3 contents.

During HAC testing for the Model No. RAJ-II, the end drop orientation caused the most severe deformation to the fuel assembly. For this letter authorization, the applicant performed a supplemental evaluation for the GNF3 fuel bundle Lower Tie Plate (LTP).

Previously, the CG over corner test produced higher acceleration of 203 g, and as such, it was conservatively applied to the LTP. The applicant performed an LS-DYNA finite element

analyses, and the resulting bundle displacement calculated was 0.036 inches (0.91m), equivalent to an approximate rotation of 1°. The GNF3 fuel bundle assembly mass is slightly greater than the previously tested bundle assembly, however, the new proposed contents are bounded by the maximum gross weight of the RAJ-II package of 1,614 kg (3,558 lbs). Therefore the GNF3 fuel design performs similar to the previously approved fuel assembly contents.

The applicant conservatively applied a 1.5° rotation of the end of the fuel rod to the lower tie plate grid, to calculate the subsequent fuel rod maximum deflection. The maximum localized deflection of 0.120 in was calculated for the second span between spacers 1 and 2. Staff reviewed this analysis and concludes that, as the applicant has taken a conservative approach, the results provide reasonable assurance of safety.

The applicant has demonstrated that the unchanneled GNF3 LUA fuel assemblies packaged in the Model No. RAJ-II (with maximum of two fuel assemblies in each shipping container), is bounded by the package testing performed by the current authorized contents and meets the required regulations of the 10 CFR Part 71.

### *Criticality*

Staff reviewed the criticality evaluation, as supplemented, presented in Attachment 2 of the GNF letter dated July 30, 2014, "GNF3 RAJ-II Letter Authorization Request and Technical Basis." The applicant evaluated the Model No. RAJ-II package containing two unchanneled GNF3 fresh, 5.0 weight percent enriched, UO<sub>2</sub> fuel assemblies. Gd<sub>2</sub>O<sub>3</sub> may be present in the fuel material, but is not credited in the criticality analysis. The GNF3 fuel assembly contents are within the bounds of the previously approved fuel assembly contents in the current CoC with respect to:

- Fuel pellet density and diameter,
- Cladding outer diameter and thickness,
- Active fuel lengths for full length, short partial length, and long partial length rods,
- Fuel rod pitch, and
- Maximum enrichment.

The GNF3 fuel assembly differs from previously approved contents as detailed in Figure 1-1 of Attachment 2 of the GNF3 RAJ-II Letter Authorization Request.

The applicant evaluated arrays of up to 25 packages under HAC. The applicant considered previously performed single package and NCT array evaluations for previously approved fuel assemblies to still be applicable, given the similarity to the GNF3 and the bounding nature of the HAC array model for the GNF3.

For the package array under HAC, the applicant used the most reactive condition determined from the criticality analysis for the previously approved assembly contents, due to the similarity of the GNF3 fuel assembly. The criticality model in the application for the previously approved contents included reduced package spacing due to the results of the drop tests, variation in inner container and outer container water density, and the moderating effects of melted polyethylene from cluster separators and wrapping material which may be present in the fuel assembly. Additionally, the applicant considered the potential for uniform pitch expansion due to a top or bottom end drop. The expanded pitch model included an evaluation over the entire length of the assembly for a 5x5 array of 25 packages, bounding the maximum localized pitch expansion resulting from the structural analysis. The applicant performed an additional analysis

for a 4x4 array of 16 packages, using a bounding pitch expansion over the length of the assembly. The maximum  $k_{\text{eff}} + 2\sigma$  under HAC was 0.9340 for the 5x5 array with the evaluated rod pitch expansion, and 0.8942 for the 4x4 array with the bounding rod pitch expansion. Both of these values are below the calculated Upper Safety Limit (USL) of 0.9369.

The applicant used the SCALE 6.1 code system, with the KENO VI three-dimensional Monte Carlo code and the continuous-energy ENDF/B-VII.0 cross section library, for all criticality analyses. The applicant performed a benchmarking analysis for this code and cross-section library, and determined a USL of 0.9369, which is applicable for the fuel assembly and package evaluated in this criticality safety analysis. This USL is based on a benchmarking analysis that included evaluation of  $k_{\text{eff}}$  for 70 applicable critical configurations, consisting of Low-Enriched Uranium heterogeneous compound systems without absorbers. The bounding criticality safety index (CSI), based on the hypothetical accident conditions array of 16 packages is 6.3. However, the applicant is conservatively limiting the number of packages per shipment to 4, resulting in an effective CSI of 12.5.

Staff finds that the criticality analyses provided in the application, as supplemented, demonstrate that a shipment of up to four Model No. RAJ-II packages, containing unchanneled GNF3 fuel assemblies, meets the criticality safety requirements of 10 CFR Part 71, with a CSI of 12.5.

## **CONDITIONS**

CoC No. 9309 has been amended by letter to authorize shipment of packages containing GNF3 lead use assemblies. The following conditions apply:

1. The fuel assemblies will contain  $\text{UO}_2$  and  $\text{Gd}_2\text{O}_3$  only.
2. The fuel assemblies will contain commercial grade uranium and meet Type A material contents.
3. The fuel assemblies will be shipped un-channeled.
4. There will be a maximum of four RAJ-II packages on a single truck, each containing a maximum of two fuel assemblies.
5. The criticality safety index is 12.5.

All other conditions of CoC No. 9309 shall remain the same. This authorization expires December 31, 2016.

## **CONCLUSION**

CoC No. 9309 has been amended by letter to authorize shipment of Model No. RAJ-II packages containing GNF3 lead use assemblies. This authorization expires December 31, 2016.

Based on the statements and representations in the application, and with the conditions listed above, the staff agrees that this change does not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Issued on October 31, 2014.