Global Nuclear Fuel

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July 28, 2020

Damaris Marcano, Acting Chief
Fuel Facility Licensing Branch
Division of Fuel Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission

Attn: Document Control Desk

Subject: GNF-A Response to NRC Request for Supplemental Information

References:
1) NRC License SNM-1097, Docket 70-1113
2) GNF-A Letter Authorization Request, 6/23/20
3) Letter, K.M. Ramsey to S. P. Murray, "Request for Additional Information to Support Review of the Minimum Margin of Subcriticality for up to 8 wt. % Enrichment", 7/15/20

Dear Ms. Marcano:

Attached is Global Nuclear Fuel – Americas, LLC (GNF-A) response with the additional information requested on July 15, 2020 (Reference 3).

If you have any questions concerning this information, please call me at (910) 819-5950.

Sincerely,

Scott Murray, Manager
Facility Licensing

Attachment(s): 1) GNF-A Response to NRC Request for Additional Information

T.D, Naquin, USNRC NMSS
J. Munson, USNRC NMSS
SPM 20-028

Attachment 1

REQUEST FOR ADDITIONAL INFORMATION
GLOBAL NUCLEAR FUEL – AMERICAS, LLC (GNF-A): REQUEST FOR REVIEW OF MINIMUM MARGIN OF SUBCRITICALITY FOR USE UP TO 8 WEIGHT PERCENT

In a letter dated June 23, 2020 (ADAMS Accession No. ML20175A206), GNF-A requested a U.S. Nuclear Regulatory Commission (NRC) review of the minimum margin of subcriticality (MMS) for use up to 8 weight percent (wt.%) uranium (U)-235. The information detailed in the following request for additional information (RAI) is needed to facilitate the NRC staff's review performed in accordance with NUREG-1520, "Standard Review Plan for Fuel Cycle Facilities License Applications," and NUREG/CR-6698, "Guide for Validation of Nuclear Criticality Safety Calculational Methodology."

This information is needed to verify compliance with Title 10 of the *Code of Federal Regulations* (10 CFR) 70.61(d) which requires, in part, that the risk of nuclear criticality accidents be limited by assuring that under normal and credible abnormal conditions, all nuclear processes are subcritical, including use of an approved margin of subcriticality for safety.

Section 5.3.B.4 of NUREG-1520, "Standard Review Plan for Fuel Cycle Facilities License Applications," Revision 2, states that NRC staff reviews should include any relevant portions of the licensee's criticality code validation report(s), as appropriate. Section 5.3.B.4 also states that the reviewer should verify that calculations pertaining to changed operations are still within the licensee's validated area(s) of applicability (AOAs), or that AOA(s) have been appropriately extended, and that the licensee's approved margin of subcriticality for safety (i.e., minimum margin of subcriticality) remains valid.

In evaluating whether the licensee's MMS remains valid, Appendix B to NUREG-1520 states that the reviewer should consider several aspects of criticality code validation before making a qualitative determination of the adequacy of the MMS, including: (1) the similarity of benchmark experiments to actual applications; (2) sufficiency of the data (including the quantity and quality of benchmark experiments); (3) adequacy of the validation methodology; and (4) conservatism in the calculation of bias and bias uncertainty.

1. Section 5.4.5.3 of Special Nuclear Material License 1097 (SNM-1097) states that an AOA may be extended by extrapolation using established trends in the bias. The GNF-A SCALE 6.1 validation report, "SCALE6.1/KENO-VI Monte Carlo Code Validation Report," Revision 3, (hereafter referred to as "the validation report") states that the Tools for Sensitivity and Uncertainty Analysis Methodology Implementation (TSUNAMI) code may be used to determine an appropriate penalty for extensions to an AOA. However, Appendix B to NUREG-1520 states that conclusions involving the comparison of a system to benchmark experiments to assess similarity and penalty determination should not be based solely on the use of TSUNAMI.

   - Describe the method(s) used to determine appropriate penalties for extensions to an AOA.

GNF-A Response

Regarding selection of benchmarks similar to process application, Section 4.2 of the validation report "Selection and Modeling of Experiments" has detailed guidelines for selecting benchmarks that are similar to the application systems during normal and anticipated abnormal conditions. In addition, SNM-1097, Section 5.4.5.3, "Validation Techniques" provides detailed guidelines that consider a diverse set of parameters impacting system reactivity including fuel enrichment, composition of materials, geometry, neutron moderation, homogeneity and neutron energy spectra for similarity of benchmarks to application systems. The criteria for *selection* of critical experiments is also outlined in this section.

Regarding extension of AOA, Section 4.3.2.8 of the GNF-A validation report "Extrapolation" has detailed rules that must be followed in addition to use of TSUNAMI code for similarity and penalty determination. In summary, the GNF-A AOA penalty determination methodology is included in our validation report; our method incorporates both physics parameters comparison between process application and critical benchmarks and TSUNAMI code. Penalty determination for AOA extension is not based solely on the use of TSUNAMI code.

2. Section 4.4 of the validation report states that the upper subcritical limit (USL) from AOA-7, "[Low Enriched Uranium (LEU)] Heterogeneous Compound Systems with Gadolinium," may be used for heterogeneous systems without absorbers provided the USL is adjusted for the presence of gadolinium. Section 4.4 further states that TSUNAMI may be used to compare the two systems and calculate the penalty for the presence of gadolinium, which is then subtracted from the USL. However, Appendix B to NUREG-1520 states that penalty determinations should not be based solely on the use of TSUNAMI.

    - Provide a justification for applying the USL from AOA-7 to heterogeneous systems without absorbers considering that a validated AOA, AOA-3, "LEU Heterogeneous Compound Systems without Absorbers," has been established.

    - Describe the method(s) used to determine appropriate penalties/adjustments for the application of the AOA-7 USL to LEU heterogeneous systems without absorbers.

GNF-A Response

Because AOA-3 and AOA-7 are both for heterogenous systems and the established USL for AOA-7 is higher than the USL for AOA-3, users are required to provide justification for effects of Gadolinium on system reactivity in the unlikely event AOA-7 is selected for heterogenous systems without absorbers. As stated in the previous response, both the validation report and SNM-1097 provide detailed rules for selecting appropriate benchmarks and penalty determination. Comparison of process applications to benchmarks involves physics parameters and is not based solely on the use of TSUNAMI.

3. The validation report states that enrichment is a key parameter that is considered in the process of validation and describes seven different AOAs. Among the seven AOAs, AOA-4, "[Low Enriched Uranium (LEU)] Heterogeneous Compound Systems with Cadmium," AOA-5, "LEU Heterogeneous Compound Systems with Boron," and AOA-7, "LEU Heterogeneous Compound Systems with Gadolinium," are limited to enrichments less than or equal to 5 wt.% U-235.

- State whether GNF-A intends to extend AOAs 4, 5, and 7 to support calculations involving enrichments greater than 5 wt.% $^{U-235}$.

GNF-A Response

GNF-A intends to extend AOAs 4, 5 and 7 to support calculations involving enrichments greater than 5.0 wt. % ^{235}U. GNF-A validation report(s) are considered living documents and subject to ongoing periodic improvements in AOA determinations based on critical benchmark availability and updates to statistical methods, and process analysis needs.

For example: The current AOA5 utilized 5 benchmarks consisting of a total of 13 critical configurations resulting in a large bias and bias uncertainty. The updated validation report will include 10 benchmarks consisting of a total of 35 critical configurations. As a result, the 'updated' USL based on Energy of Average Lethargy causing Fission (EALF) trending is conservatively determined using the Single-Sided Lower Tolerance Limit (SSLTL) method, not linear regression resulting in a smaller bias and bias uncertainty.

4. Section 5.4.5.2 of SNM-1097 discusses the analytical methods used to perform nuclear criticality safety analyses, including several Monte Carlo criticality codes (e.g., SCALE 6.1/KENO-VI, GEMER, GEKENO, MCNP, etc.). NRC staff notes that GNF-A's request for NRC review of the proposed MMS for use up to 8 wt.% appears to be limited to the use of SCALE 6.1/KENO-VI with the ENDF-VII continuous energy (CE) cross-section library, and that the only validation report provided was for SCALE 6.1/KENO-VI, ENDF-VII CE. However, SNM-1097 does not state that only SCALE/KENO-VI will be used for analyses involving enrichments greater than 5 wt.%, nor does it provide any restrictions to prohibit the use of other Monte Carlo criticality codes for this purpose.

    - State whether SCALE 6.1/KENO-VI will be the only criticality code used to perform criticality safety analyses for enrichments greater than 5 wt.% or otherwise state which criticality codes, and their respective cross-section libraries, will be used. State whether the request for NRC review of the MMS includes any criticality codes other than SCALE 6.1/KENO-VI . If any criticality codes other than SCALE 6.1/KENO-VI will be used to perform such analyses, provide their respective validation reports.

GNF-A Response

GNF-A commits to only use SCALE 6.1/KENO-VI using the ENDF-VII continuous energy cross section library for calculations to support nuclear fuel fabrication process applications involving material enrichments greater than 5.0 wt. % ^{235}U. MCNP or GEMER Monte Carlo codes will not be used for this purpose. Currently GNF-A only intends to use SCALE 6.1/KENO-VI; if a newer version of SCALE/KENO-VI is adopted in the future, then that version will be validated using the methodology described in SNM-1097 and the validation report updated accordingly. GNF-A will notify NRC of future technical (non-administrative) changes to the GNF-A validation report and make updates of our validation report(s) available for NRC review.