August 31, 2016

Mr. Jerald G. Head
Senior Vice President, Regulatory Affairs
GE-Hitachi Nuclear Energy Americas, LLC
P.O. Box 780, M/C A-18
Wilmington, NC 28401-0780

SUBJECT: FINAL SAFETY EVALUATION FOR AMENDMENT 42 TO GLOBAL NUCLEAR FUEL – AMERICAS TOPICAL REPORT NEDE-24011-P-A-US GENERAL ELECTRIC STANDARD APPLICATION FOR REACTOR FUEL (GESTAR II) SUPPORTING THE TRANSITION FROM THE 3D-MONICORE CORE MONITORING SYSTEM TO ACUMEN (CAC NO. MF7438)

Dear Mr. Head:

By letter dated March 2, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16063A403), Global Nuclear Fuel – Americas (GNF) submitted Amendment 42 to Topical Report (TR) NEDE-24011-P-A/NEDO-24011-A, "General Electric Standard Application for Reactor Fuel (GESTAR II, U. S. Supplement) to the U. S. Nuclear Regulatory Commission (NRC) staff for review. A request for additional information (RAI) dated July 12, 2016 (ADAMS Accession No. ML16190A354), was sent to you to support the review. We received your response letter on August 9, 2016 (ADAMS Accession No. ML16222A476).

Upon receiving your response to our RAI letter, the NRC staff has found that Amendment 42 to GESTAR II is acceptable for referencing in licensing applications for General Electric-designed boiling water reactors to the extent specified in the enclosed final safety evaluation (SE). The final SE defines the basis for acceptance of the TR.

Our acceptance applies only to material provided in the subject TR. We do not intend to repeat our review of the applicable material described in the TR. When the TR appears as a reference in license applications, our review will ensure that the material presented applies to the specific plant involved. License amendment requests that deviate from this TR will be subject to a plant-specific review in accordance with applicable review standards.

The accepted versions shall incorporate this letter and the enclosed final SE after the title page. Also, they must contain historical review information, including NRC requests for additional information and your responses. The accepted versions shall include a "-A" (designating accepted) following the TR identification symbol.

If future changes to the NRC's regulatory requirements affect the acceptability of this TR, GNF will be expected to revise the TR appropriately or justify its continued applicability for subsequent referencing. Licensees referencing this TR would be expected to justify its continued applicability or evaluate their plant using the revised TR.

If you have any questions, please contact Joseph Golla at 301-415-1002.

Sincerely,

/RA/

Kevin Hsueh, Chief
Licensing Processes Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 712

Enclosure:
Final Safety Evaluation

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Enclosure:
Final Safety Evaluation

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NAME	JGolla	DHarrison	JDean	KHsueh
DATE	08/30/2016	8/30/2016	08/31/2016	08/31/2016

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FINAL SAFETY EVALUATION FOR AMENDMENT 42

TO GLOBAL NUCLEAR FUEL – AMERICAS LLC

TOPICAL REPORT NEDE-24011-P-A-20-US GENERAL ELECTRIC STANDARD APPLICATION (GESTAR II) SUPPORTING THE TRANSITION FROM THE 3D-MONICORE CORE MONITORING SYSTEM TO ACUMEN

(CAC NO. MF7438)

1.0 INTRODUCTION AND BACKGROUND

By letter dated March 2, 2016, Global Nuclear Fuel – Americas, LLC (GNF) submitted Amendment 42 (Ref. 1) to Topical Report (TR) NEDE-24011-P-A-22, "General Electric Standard Application for Reactor Fuel (GESTAR II, U. S. Supplement) (Ref. 4) to the U. S. Nuclear Regulatory Commission (NRC) staff for review and supplemented by additional information dated August 9, 2016 (Ref. 2).

In Amendment 42, GNF requests to amend GESTAR II to update GNF's core monitoring system (CMS) from virtual memory system (VMS) based 3D-MONICORE (3DM) to ACUMEN for compatibility with windows-based computer platforms and operating systems, and to streamline the cybersecurity aspects of core monitoring. In order to implement modern functionalities GNF is changing the name of the core monitoring system from 3D-MONICORE to ACUMEN. However, there is no methodology change in the core monitoring system.

2.0 REGULATORY EVALUATION

Not applicable in this case

3.0 TECHNICAL EVALUATION

3.1 Introduction

Global Nuclear Fuel – Americas (GNF- A) intends to update its core monitoring system for compatibility with windows-based computer platforms and operating systems. GNF proposes to change the core monitoring system from a VMS based platform to windows-based platform in order to streamline the cybersecurity aspects of core monitoring. The NRC staff requested GNF to provide justification for its claim that this change in platform will streamline the cybersecurity aspects of core monitoring. GNF responded that the change meets the cybersecurity requirements through the ACUMEN system design and through supplemental information supplied to the customers to fulfil their cybersecurity plan for core monitoring. The cybersecurity aspects of the ACUMEN system addresses many items from the NEI 08-09 guidelines (Ref. 3) that assist the customers/licensees in meeting the cybersecurity requirements. The ACUMEN supplemental information includes information such as: user account management including account types, groups, and policies, file and database

permission management, network communication/configuration and firewall configurations and administration, system logging and event management, privileged functions in ACUMEN and windows, process scheduling and prioritization, encryption, and malicious code, virus, and malware. The transition to ACUMEN does not change the functionality or the technical equivalence of the 3D-MONICORE nuclear kernel.

GNF explained in a response to an RAI question regarding the transition being an improvement that is consistent with modern functionalities and expectations. The customers (licensees) will be in line with industry information technology (IT) standards. The modern functionalities and expectations include: more efficient data transfer and engineering assistance support, facilitation of workspace optimization, customization and efficiency, use of structured query language (SQL) (provides flexibility for historical trending and analysis, including multiple fuel cycles, increased control, availability and flexibility of Windows OS, increased reporting capabilities, and increased human performance with respect to fuel conditioning analysis, and local power range monitor (LPRM) drift analysis.

The change in name of the CMS does not include any change in methodology since the widows-based system which analyzes the core performs the same functions as 3DM using the same core simulator PANACEA that is qualified for use in windows-based OS. In order to support the equivalency between 3DM and ACUMEN, GNF has performed a comparative testing of thermal margin outputs from the two systems using the same inputs.

3.2 ACUMEN and 3DM Thermal Margin Comparison Test

During the testing at the GNF's facility in North Carolina, the 3DM database for a plant was loaded in to an ACUMEN CMS that was installed at the GNF facility. This testing was to compare the output of ACUMEN and 3DM when the same input data is fed to both systems. The test data file was created from one set of plant process data taken at rated power and was the basis for all data entered into ACUMEN and 3DM. The 3DM CMS based on VMS uses PANACEA core simulator software to monitor fraction of limiting critical power ratio (CPRRAT) and fraction of limiting power density (FLPD). Both ACUMEN and 3DM received test input data from the same source. After the stabilizing period of three days for the test system xenon to reach near equilibrium levels, the test input data files were changed simulating a power maneuver. Both systems received the same test data. Minor differences between ACUMEN and 3DM was expected for reasons such as: (1) small platform differences in numerical methods in windows-based and VMS-based simulation and (2) small difference between the cycle energies since the ACUMEN starting calculation needed an increment in initial energy.

Attachment 1 to Reference 1 provides the results from the test. The statistical analysis results are given in Figures 1 and 2 of Reference 1. The minimum and maximum differences between CPRRAT and FLPD thermal margins between ACUMEN and 3DM core monitoring systems are listed in Attachment 1 and found to be insignificant based on the perspective of core monitoring operational experience. The small differences are due to the architectural differences in the two computer platforms and small differences in fuel parameters from initial setup

The NRC staff has reviewed the test configurations and the results from the thermal margin calculations from 3DM and ACUMEN CMSs and found that the two CMSs are essentially

equivalent for the fuel bundle and nodal power distributions. The NRC staff verified the statistical analysis on the results and determined that the associated uncertainties and confidence intervals are acceptable.

3.3 Impact on Operating Parameters

The NRC staff requested GNF to provide information on the impact of transition to ACUMEN CMS on other core operating parameters such as safety limit minimum critical power ratio (SLMCPR), linear heat generation rate (LHGR), and maximum planar LHGR (MAPLHGR). GNF responded that when simulations are run to eliminate the variability of the Monte Carlo SLMCPR methodology, the bias in SLMCPR due the platform related changes is extremely small with a standard deviation of correspondingly small value. The power distribution uncertainties are not affected by a platform change since they are an artifact of elements such as plant instrumentation and gamma scan data that are outside the influence of a computing platform change.

The bias in LHGR and maximum planar LHGR are reported to be extremely small and their respective standard deviations are acceptable.

The NRC staff reviewed the impact of CMS transition on SLMCPR, LHGR, and MAPLHGR and determined that the differences are insignificant and in accordance with industry core monitoring operational experience.

3.4 Impact on Other Operating Parameters – Case Study at a Plant

The NRC staff requested GNF to provide information on accuracy of core parameters (other than the ones described in the above sections), either automatic or on demand, monitored by the CMS. This requested information includes the parameters such as control rod positions, plant heat balance results, core average axial relative power, core average radial power distribution, and any other significant operational parameters that are monitored by the core monitoring system.

GNF responded to the RAI that the observable thermal margins CPRRAT and FLPD are representative of the fuel bundle and nodal power distribution, respectively. The CPRRAT and FLPD comparisons justify accuracy in the results of plant heat balance, core average axial power, and core average radial power distribution.

One US plant that is expected to adopt the ACUMEN core monitoring system has evaluated parallel operation of ACUMEN and 3DM core monitors during a recent control rod sequence exchange which covered wide changes in core operating parameters. Figures 3-1 through 3-5 of Reference 2 provide comparison of maximum fraction of limiting critical power ratio (MFLCPR), core flow, maximum planar average linear heat generation rate ratio (MAPRAT), ratio of nodal power to the fuel conditioned power (PCRAT), and maximum fraction of limiting power density (MFLPD), respectively. During the test, power maneuvering was done to vary the flow and core monitoring was performed at the same time for each of the monitoring

systems under the supervision of a reactor engineer. The results from the test indicates that there is reasonable agreement between ACUMEN and 3DM CMSs and also in agreement with an acceptable criteria.

The NRC staff has verified the results and the criteria for agreement between the results from the two CMSs and determined that there is reasonable and acceptable agreement between ACUMEN and 3DM monitored parameters during the study.

4.0 LIMITATIONS AND CONCLUSION

4.1 Limitations

(a) The change in computing platform to a windows-based from VMS-based for the CMS shall comply with Appendix B to Part 50 of the *Code of Federal Regulations*, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Processing Plants," specifically with respect to Section XVII, "Quality Assurance Records."

(b) For any licensee/plant that transitions to ACUMEN windows-based CMS, the licensee shall make appropriate changes to the input to the CMS during any potential license amendment requests, specifically, fuel transition, power uprate, and/or maximum extended load line limit analysis plus (MELLLA+) so that the accuracy, fidelity, and acceptable statistics is preserved for safety limits, control rod positions, axial and radial power distributions, thermal parameters, and other operating parameters.

5.0 CONCLUSION

The NRC staff has reviewed and evaluated GNF -A request for Amendment 42 to GESTAR II to transition the GNF's core monitoring system from VMS based 3D-MONICORE to ACUMEN for compatibility with windows-based computer platforms and operating systems. The staff reviewed the application with respect to the results obtained from the two core monitoring systems during test conducted at the GNF facility. The NRC staff also reviewed the results from the evaluation of core operating parameters from control rod sequence exchange at a plant. The NRC staff found that the core operating parameters obtained from these series of tests at GNF facility and at the plant have high degree of fidelity in the ACUMEN core monitoring system as compared to the 3D-M monitoring system. Therefore, the NRC staff has determined that the transition to windows-based ACUMEN core monitoring system is acceptable.

The NRC staff has reviewed Attachment 2 of Reference 1 and found that the marked up GESTAR II pages for Revision 22 (Reference 4), Section 3.2.2.2, "Power Distribution Accuracy," is acceptable.

6.0 REFERENCES

1. Letter, MFN 16-011 from Brian Moore (GNF- A) to US NRC, “Amendment 42 to GESTAR II Supporting the Transition from the 3D-MONICORE Core Monitoring System to ACUMEN,” Global Nuclear Fuel – Americas, LLC, March 2, 2016 (ADAMS Accession No. ML16063A403).
2. Letter, MFN 16-057 from Brian Moore (GNF – A) to US NRC, “Response to NRC Requests for Additional Information Regarding Amendment 42 to GESTAR II,” GNF – A, August 9, 2016 (ADAMS Accession No. ML16222A476).
3. NEI 08-09 Revision 3, “Cyber Security Plan for Nuclear Power Reactors,” Nuclear Energy Institute, September 2009 (ADAMS Accession No. ML092660548 non-public)
4. MFN 15-089, “NEDE-24011-P-A, Revision 22, “General Electric Standard Application for Reactor Fuel (GESTAR II, U.S. Supplement), GNF –A, November 2015 (ADAMS Accession No. ML15324A144).

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Date: August 31, 2016