February 7, 2017

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

FROM: Joseph A. Golla, Project Manager ***/RA/***
Licensing Processes Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

SUBJECT: GLOBAL NUCLEAR FUEL – THE PRIME MODEL FOR TRANSIENT ANALYSIS OF FUEL ROD THERMAL – MECHANICAL PERFORMANCE, NEDC-33840P/NEDO-33840 AUDIT PLAN (CAC NO. MF7687)

By letter dated April 22, 2016 (Agencywide Documents Access and Management System Accession No. ML16113A264), Global Nuclear Fuel (GNF) submitted Topical Report (LTR) NEDC-33840P/NEDO-33840, Rev. 0, "The PRIME Model for Transient Analysis of Fuel Rod Thermal – Mechanical Performance," for U.S. Nuclear Regulatory Commission (NRC) staff review. The LTR covers application of PRIME to the analysis of fast transient anticipated operational occurrences to determine compliance to specified acceptable fuel design limit for fuel temperature and cladding strain.

To assist in its review of NEDC-33840P, the staff conducted an audit at the GNF facilities in Wilmington, North Carolina on September 27-29, 2016. Enclosed are the goals and objectives of the audit as well as a detailed audit schedule.

Project No. 712

Enclosures:
As stated

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(301) 415-4043

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DATE	2/2/2017	1/12/2017	1/12/2017	2/7/2017	2/7/2017

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AUDIT PLAN

THE PRIME MODEL FOR TRANSIENT ANALYSIS OF FUEL ROD

THERMAL – MECHANICAL PERFORMANCE

NEDC-33840P, REVISION 0, APRIL 2016

1.0 BACKGROUND

By letter dated April 22, 2016, Global Nuclear Fuel (GNF) submitted a Licensing Topical Report (LTR), "The PRIME Model for Transient Analysis of Fuel Rod Thermal – Mechanical Performance," NEDC-33840P/NEDO-33840, Rev. 0. The LTR covers application of PRIME to the analysis of fast transient anticipated operational occurrences (AOOs) to determine compliance to specified acceptable fuel design limits for fuel temperature and cladding strain.

Global Nuclear Fuel LTRs NEDC-33256P-A, NEDC-33257P-A, and NEDC-33258P-A (Agencywide Documents Access and Management System (ADAMS) Accession No. ML102600248), document the technical basis, qualification and application methodology for steady-state application, including steady-state (long duration relative to the fuel rod thermal time constant) transients, of the PRIME fuel rod thermal-mechanical performance model. Subsequent to approval of the PRIME steady-state LTRs, the fast (short duration relative to the fuel rod thermal time constant) transient functionality of PRIME has been developed and qualified and a new application methodology specifically utilizing the transient functionality has been developed. The objectives of this LTR are to document the:

1) technical basis of the PRIME analysis capability utilizing the transient functionality;

2) experimental qualification of PRIME predictions of fuel cladding strains for transients utilizing the transient functionality, which includes Reactivity-Initiated Accident tests performed at the CABRI and Nuclear Safety Research Reactor test reactors, and Operational Transient tests conducted in the Power Burst Facility test reactor; and

3) application methodology of the PRIME transient analysis capability to commercial fuel rod behavior and licensing analyses.

2.0 REGULATORY AUDIT BASES

Regulatory Guidance for the review of fuel system designs and adherence to General Design Criteria (GDC)-10, GDC-27, and GDC-35 is provided in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (SRP), Section 4.2, "Fuel System Design." In accordance with SRP Section 4.2, the objectives of the fuel system safety review are to provide assurance that:

a. The fuel system is not damaged as a result of normal operation and AOOs,
b. Fuel system damage is never so severe as to prevent control rod insertion when it is required,
c. The number of fuel rod failures is not underestimated for postulated accidents, and
d. Coolability is always maintained.

In addition to licensed reload methodologies, an approved fuel rod thermal-mechanical model and application methodology is utilized to demonstrate compliance to SRP Section 4.2 fuel design and performance criteria. NEDC-33840P describes the technical basis, qualification, and application methodology for the PRIME Transients thermal-mechanical fuel rod performance model. The staff's review of this Topical Report is to ensure that the PRIME Transient models are capable of accurately (or conservatively) predicting the in-reactor performance of fuel rods under fast transient AOO conditions, to identify any limitations on the code's ability to perform this task, and ensure that the application methodology conservatively accounts for model uncertainties and is capable of ensuring compliance to SRP Section 4.2 criteria.

3.0 REGULATORY AUDIT SCOPE

The scope of this regulatory audit included supporting GNF engineering calculations and code Verification and Validation (V&V) documents for PRIME Transients. This audit focused on the following areas:

- Clad to coolant heat transfer correlations and code options
- Transient fission gas release
- Additive fuel pellets
- Defect recovery model and code options
- Plenum gas temperature
- Transient cladding temperature limits
- Transient temperature solution weighting factor
- FRAPTRAN benchmark calculations at high burnup
- Application of uncertainties in nodal power density history
- Application of uncertainties in steady-state versus transient
- Application method #3
- Limitations and conditions

4.0 INFORMATION NEEDS

The licensee was requested to have the following documentation available on site for the audit team either electronically or by paper copies.

1. NEDC-33840P and PRIME Transients V&V report

2. Supporting GNF engineering calculations

3. Output files from PRIME qualification runs

Additional information needs identified during the audit were communicated to the designated point of contact.

During the audit, the NRC staff performed FRAPCON/FRAPTRAN benchmark calculations. As such, the staff requested that GNF make personnel who are familiar with the LTR (including site staff and contractors, if appropriate) accessible upon request. Additional PRIME Transient calculations were requested during the audit to investigate code-to-code differences.

5.0 TEAM ASSIGNMENTS

Area of Review	Assigned Auditor
Audit Team Lead	Paul Clifford (NRC)
Technical Reviewer	Ian Porter (NRC)

6.0 LOGISTICS

The audit was conducted at GNF facilities in Wilmington, NC September 27 - 29, 2016. Entrance and exit briefings were held at the beginning and end of this audit, respectively. The licensee was requested to provide a room for the use by the audit team. A more detailed, proposed, audit schedule is attached.

7.0 DELIVERABLES

An audit report/summary will be issued to the licensee within approximately 90 days from the end of the audit. No requests for additional information were issued as a result of this audit.

PROPOSED GNF AUDIT SCHEDULE

SEPTEMBER 27 - 29, 2016

09/27/2016

8:30 a.m.	Check-in at Guard Shack
9:00 a.m.	Entrance Meeting
9:30 a.m.	PRIME – FRAPTRAN Benchmark Calculations at High Burnup
11:00 a.m.	Control Rod Drop Accident TR Presentation
3:00 p.m.	Clad-to-Coolant Heat Transfer Correlations
4:00 p.m.	Transient Fission Gas Release
4:30 p.m.	Additive Fuel Pellets
4:45 p.m.	Audit Team Daily Closeout – Action Items

09/28/2016

8:30 a.m.	Plenum Gas Temperature
9:00 a.m.	Cladding Temperature Limits
10:00 a.m.	Transient Temperature Solution Weighting Factor
11:00 a.m.	NSF Annual Report Review
1:00 p.m.	Application of Uncertainties in Nodal Power Density History
3:00 p.m.	Application of Uncertainties in Steady-State vs Transient
4:45 p.m.	Audit Team Daily Closeout – Action Items

09/29/2016

8:30 a.m.	Application Method #3
10:00 a.m.	Limitations and Conditions
1:00 p.m.	Identify Requests for Additional Information
2:00 p.m.	NRC Breakout – Findings and Conclusions
3:00 p.m.	Exit Meeting

Enclosure 2