TENNESSEE VALLEY AUTHORITY

Post Office Box 2000, Soddy Daisy, Tennessee 37384-2000

April 20, 2023

10 CFR 50.4
10 CFR 50.46

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Sequoyah Nuclear Plant, Units 1 and 2
Renewed Facility Operating License Nos. DPR-77 and DPR-79
NRC Docket Nos. 50-327 and 50-328

Subject: **10 CFR 50.46 Annual Report for Sequoyah Nuclear Plant Units 1 and 2, and 30-Day for Sequoyah Nuclear Plant, Unit 2**

References:

1. Letter from NRC to TVA, "Sequoyah Nuclear Plant, Units 1 and 2 – Issuance of Amendment Nos. 356 and 349 Regarding the Transition to Westinghouse Robust Fuel Assembly-2 (RFA-2) Fuel (EPID L-2020-LLA-0216)," dated October 26, 2021

2. Letter from TVA to NRC, "10 CFR 50.46 Annual Report for Sequoyah Nuclear Plant Units 1 and 2, and 30-Day for Sequoyah Nuclear Plant, Unit 1," dated November 22, 2022

In accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 50.46, "Acceptance Criteria for ECCS for Light-Water Nuclear Power Reactors," paragraph (a)(3)(ii), this letter provides the annual report of changes and errors in the emergency core cooling system (ECCS) evaluation model for Sequoyah Nuclear Plant (SQN) Units 1 and 2. This letter also serves as the 30-day report in accordance with §50.46(a)(3)(ii) of the Loss of Coolant Accident (LOCA) peak cladding temperature (PCT) impacts for SQN Unit 2 associated with the transition to Westinghouse RFA-2 fuel as approved by Reference 1.

The annual §50.46 reports for SQN have normally been submitted in the Fall as indicated by Reference 2. It is TVA's intent that future §50.46 annual reporting will be based from this report unless otherwise stated.

The enclosed report provides a summary of the changes to the calculated PCTs for the limiting ECCS analyses applicable to SQN Unit 2. There have been no changes to the calculated PCT for SQN Unit 1 since the submittal of Reference 2.

The PCT for the Westinghouse RFA-2 fuel is calculated using the FULL SPECTRUM LOCA (FSLOCA) evaluation model per Reference 1. The accumulated PCT changes for RFA-2 fuel have not yet exceeded the 50°F threshold for a significant change or error as defined in §50.46(a)(3)(i).

The identified PCT changes for the Framatome HTP fuel exceed the 50°F Fahrenheit threshold for a significant change or error. Accordingly, any subsequently discovered change or error would be considered significant for the purposes of reporting until such time as a reanalysis of the ECCS evaluation model is completed. This significant change is the result of the loading of a transition core consisting of coresident Westinghouse RFA-2 and Framatome HTP fuel assemblies for SQN Unit 2 Cycle 26. When coresident with RFA-2 fuel, the calculated large-break Loss of Coolant Accident (LBLOCA) PCT for the HTP fuel is penalized by +23°F. Since the absolute magnitude of accumulated changes and errors in the LBLOCA PCT already exceeds 50°F, TVA is reporting this change as a 30-day report.

10 CFR 50.46(a)(3)(ii) also requires the licensee to provide a proposed schedule for providing a reanalysis or taking other action as may be needed to show compliance with the §50.46 requirements. The Enclosure demonstrates that the HTP fuel's updated net licensing basis PCT for the LBLOCA is below the §50.46(b)(1) PCT limit of 2200°F. HTP fuel's LOCA analysis will be retired from the SQN licensing basis upon completion of the transition to RFA-2 fuel. Therefore, TVA has concluded that no proposed schedule for reanalysis or other action is required to show compliance with §50.46 requirements.

There are no new regulatory commitments associated with this submittal. If you have any questions regarding this information, please contact Ricardo Medina, SQN Site Licensing Manager, at (423) 843-8129.

Respectfully,

Thomas B. Marshall
Site Vice President
Sequoyah Nuclear Plant

Enclosure: 10 CFR 50.46 Annual and 30-Day Report of Changes in PCT

cc:

NRC Regional Administrator - Region II
NRC Senior Resident Inspector - Sequoyah Nuclear Plant
NRC Project Manager - Sequoyah Nuclear Plant

ENCLOSURE

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 and 2

10 CFR 50.46 ANNUAL AND 30-DAY REPORT OF CHANGES IN PCT

In accordance with the reporting requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.46(a)(3)(ii), Tennessee Valley Authority (TVA) is providing the following summary of the limiting design basis loss of coolant (LOCA) analysis results established using the Emergency Core Cooling System (ECCS) evaluation models for Sequoyah Nuclear Plant (SQN) Units 1 and 2. This report describes the changes and errors affecting the calculated peak cladding temperatures (PCTs) since the last analysis of record was submitted to the Nuclear Regulatory Commission (NRC).

TVA submitted the last 10 CFR 50.46 annual report in Reference 1 of this Enclosure. The last PCT change for SQN Unit 1 was associated with the loading its first transition core, and is tabulated in the Summary of Changes in Reference 1. The last PCT change for SQN Unit 2 was tabulated in the Summary of Changes for the 2019 reporting year, or Reference 2 of this Enclosure.

The SQN units are transitioning from Framatome high thermal performance (HTP) fuel to Westinghouse Robust Fuel Assembly-2 (RFA-2) fuel assemblies. Each vendor calculates a PCT for its respective fuel type using its own LOCA analysis methodologies, resulting in two distinct PCTs until a full core of RFA-2 fuel is loaded. The LOCA Analysis of Record (AOR) for RFA-2 fuel at SQN uses the FULL SPECTRUM LOCA (FSLOCA) evaluation model. The application of FSLOCA to SQN was described as part of the SQN Technical Specification (TS) Change request, SQN-TS-20-09, to modify the TSs to allow the use of Westinghouse RFA-2 fuel. This TS Change request was approved by the NRC as documented in the Safety Evaluation dated October 26, 2021 (Reference 3 of this Enclosure).

The baseline PCTs for RFA-2 fuel in the SQN units result from the implementation of this FSLOCA analysis. Table 1 lists the subsequent changes in the large break LOCA (LBLOCA) PCT for the RFA-2 fuel since the baseline analysis, for both offsite power available (OPA) and Loss of Offsite Power (LOOP) scenarios. Table 2 lists the changes in the small break LOCA (SBLOCA) PCT for the RFA-2 fuel since the baseline analysis. PCT impacts incurred since the adoption of the baseline AOR are described in the notes to the tables.

The LOCA AORs for the HTP fuel at SQN are detailed in Topical Reports ANP-2970(P) and ANP-2970Q1(P), “Sequoyah Units 1 and 2 HTP Fuel Realistic Large Break LOCA Analysis,” and ANP-2971(P), “Sequoyah Units 1 and 2 HTP Fuel S-RELAP5 Small Break LOCA Analysis.” These reports were submitted to the Nuclear Regulatory Commission (NRC) as part of SQN Technical Specifications (TS) Change request, TS-SQN-2011-07, to modify the TS to authorize the use of AREVA HTP fuel assemblies. The TS Change request associated with the HTP fuel

design and supporting documentation were approved by the NRC as documented in the associated Safety Evaluation dated September 26, 2012 (Reference 4 of this Enclosure).

Table 3 details the changes in the LBLOCA and SBLOCA PCTs AOR PCTs for the HTP fuel since the baseline analysis. PCT impacts incurred against this analysis since the last submitted Summary of Changes for each unit (Reference 1 of this Enclosure for SQN Unit 1, and Reference 2 of this Enclosure for SQN Unit 2) are described in the notes to the tables.

There are no changes in PCTs for either the RFA-2 fuel or the HTP fuel for SQN Unit 1 since the previous report. For SQN Unit 2, a PCT is now reported for its RFA-2 fuel in addition to its HTP fuel. The changes in PCTs since the previous report for SQN Unit 2 are summarized as follows:

- The calculated PCT in the LBLOCA analysis for RFA-2 fuel remains unchanged, with a current licensing basis PCT of 1878°F.

- The calculated PCT in the SBLOCA analysis for RFA-2 fuel remains unchanged, with a current licensing basis PCT of 1213°F.

- The calculated PCT in the LBLOCA analysis for HTP fuel has increased 23°F, with a current licensing basis PCT of 2024°F.

- The calculated PCT in the SBLOCA analysis for HTP fuel remains unchanged, with a current licensing basis PCT of 1543°F.

TABLE 1

Summary of Changes in SQN Units 1 and 2 LBLOCA PCT for RFA-2 Fuel

Year	Description	OPA		LOOP		Note
		ΔPCT (°F)	**|ΔPCT| (°F)**	**ΔPCT (°F)**	**|ΔPCT| (°F)**	
2020	**FSLOCA AOR Baseline**	**1,878**	**---**	**1,878**	**---**	
2020	General Code Maintenance	0	0	0	0	1
2021	General Code Maintenance	0	0	0	0	1
2022	Hoop Stress Error	0	0	0	0	2
2022	GEDM Energy Non-Conservation	0	0	0	0	3
2022	General Code Maintenance	0	0	0	0	1
- - -	**Updated (net) licensing basis PCT** AOR PCT + ∑ ΔPCT	**1,878**	**---**	**1,878**	**---**	
- - -	**Cumulative sum of PCT changes** ∑ |ΔPCT|	**---**	**0**	**---**	**0**	

TABLE 2

Summary of Changes in SQN Units 1 and 2 SBLOCA PCT for RFA-2 Fuel

Year	Description	ΔPCT (°F)	|ΔPCT| (°F)	Note
2020	**FSLOCA AOR Baseline**	**1,213**	**---**	
2020	General Code Maintenance	0	0	1
2021	General Code Maintenance	0	0	1
2022	Hoop Stress Error	0	0	2
2022	GEDM Energy Non-Conservation	0	0	3
2022	General Code Maintenance	0	0	1
- - -	**Updated (net) licensing basis PCT** AOR PCT + ∑ ΔPCT	**1,213**	**---**	
- - -	**Cumulative sum of PCT changes** ∑ |ΔPCT|	**---**	**0**	

TABLE 3

Summary of Changes in SQN Units 1 and 2 LBLOCA and SBLOCA PCT for HTP Fuel

Year	Description	LBLOCA ΔPCT (°F)	LBLOCA |ΔPCT| (°F)	SBLOCA ΔPCT (°F)	SBLOCA |ΔPCT| (°F)	Note
2013	**AOR PCT associated with AREVA HTP fuel**	1,950	- - -	1,470	- - -	
2012	Sleicher–Rouse heat transfer correlation equation error	Included in AOR PCT	0	-89	89	
2013	Cathcart-Pawel Uncertainty Correlation in RLBLOCA	0	0	- - -	- - -	
2013	RODEX3a error in treatment of “trapped stack” condition	-10	10	- - -	- - -	
2014	S-RELAP5 vapor absorptivity correlation	0	0	+11	11	
2014	Axial power shape mapping by modal decomposition	0	0	- - -	- - -	
2015	Operator action time allowance for restarting the high head ECCS pumps when transferring the pump suctions from the RWST to the containment sump	- - -	- - -	+151	151	
2017	M5® LOCA Swelling and Rupture Model (SRM) Update	0	0	0	0	
2017	Higher metal water reaction rate	61	61	0	0	
2019	Cathcart-Pawel correlation implementation	0	0	- - -	- - -	
2022 (Unit 1) 2023 (Unit 2)	RFA-2 Fuel Transition Core Effects	+23	23	0	0	4
- - -	**Updated (net) licensing basis PCT** AOR PCT + ∑ ΔPCT	**2,024**	- - -	**1,543**	- - -	
- - -	**Cumulative sum of PCT changes:** ∑ ΔPCT and ∑ |ΔPCT|	**+74**	**94**	**+73**	**251**	

Notes for Tables 1, 2, and 3:

1) Various changes have been made to enhance the usability of codes and to streamline future analyses. Examples of these changes include improving the input diagnostic checks; enhancing the code output; optimizing active coding; and eliminating inactive coding. The nature of these changes leads to an estimated peak cladding temperature impact of 0°F.

2) For two instances within the cladding rupture logic, the elastic deformation model hoop stress variable was used instead of the hoop stress variable intended for cladding creep deformation and rupture models. The error was evaluated to have a negligible impact on the calculated results, leading to an estimated PCT impact of 0°F.

3) The Generalized Energy Deposition Model (GEDM), described in Section 9.6.2 of WCAP-16996 Revision 1, was discovered to exhibit a non-conservation of deposited energy whereas a small faction of redistributed energy was not being included in the core balance rods. The energy deposited to the hot rod and hot assembly was confirmed to be conserved and correct. The error was estimated to have a PCT impact of 0°F.

4) Westinghouse evaluated HTP/RFA-2 mixed cores with respect to the LOCA analyses assuming homogenous cores of each fuel type. Because the loss coefficient of Westinghouse RFA-2 fuel is slightly lower than the Framatome HTP fuel, the RFA-2 fuel would receive a flow benefit in the presence of the HTP fuel, which would experience a flow reduction. For SBLOCA, the core-wide collapsed liquid levels correspond closely to a 1-dimensional flow pattern and the effects of differing grid loss coefficients are relatively insignificant in regard to PCT. For LBLOCA, the hydraulic mismatch effects are more substantial. A PCT increase was calculated based on these effects on a transient with the reflood time and cladding heatup rate consistent with the Framatome RLBLOCA case that yielded the PCT for homogenous HTP cores.

   The effect of this change for SBLOCA is 0°F since the existing AOR supports HTP/RFA-2 transition cores. For LBLOCA, the PCT increase was estimated to be 23°F.

REFERENCES

1. Letter from TVA to NRC, “10 CFR 50.46 Annual Report for Sequoyah Nuclear Plant Units 1 and 2, and 30-Day for Sequoyah Nuclear Plant, Unit 1,” dated November 22, 2022

2. Letter from TVA to NRC, “10 CFR 50.46 Annual and 30 Day Report for Sequoyah Nuclear Plant, Units 1 and 2,” dated October 22, 2019

3. Letter from NRC to TVA, “Sequoyah Nuclear Plant, Units 1 and 2 - Issuance of Amendment Nos. 356 and 349 Regarding the Transition to Westinghouse Robust Fuel Assembly-2 (RFA-2) Fuel (EPID L-2020-LLA-0216),” dated October 26, 2021

4. Letter from NRC to TVA, “Sequoyah Nuclear Plant, Units 1 and 2 - Issuance of Amendments to Revise the Technical Specification to Allow Use of AREVA Advanced W17 High Thermal Performance Fuel (TS-SQN-2011-07) (TAC Nos. ME6538 and ME6539),” dated September 26, 2012