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10 CFR 50.46(a)(3)(ii)

June 7, 2021
Serial: RA-21-0164

Attn: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Shearon Harris Nuclear Power Plant, Unit 1
Docket No. 50-400 / Renewed License No. NPF-63

SUBJECT: 30-Day Report Pursuant to 10 CFR 50.46, Changes to or Errors in an Acceptable Loss of Coolant Evaluation Model

References:

1. Letter from Duke Energy Progress, LLC to NRC, "License Amendment Request to Reduce the Minimum Required Reactor Coolant System Flow Rate and Update the List of Analytical Methods Used in the Determination of Core Operating Limits," dated March 6, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML20066L112)
2. Letter from NRC to Duke Energy Progress, LLC, "Shearon Harris Nuclear Power Plant, Unit 1 – Issuance of Amendment No. 185 Regarding Reduction of Reactor Coolant System Minimum Flow Rate and Update to the Core Operating Limits Report References (EPID L-2020-LLA-0040)," dated April 8, 2021 (ADAMS Accession No. ML21047A470)

Ladies and Gentlemen:

10 CFR 50.46(a)(3)(ii) requires the reporting of changes to or errors in Emergency Core Cooling System (ECCS) evaluation models (EMs), or in the application of such models that affect the temperature calculation. Therefore, Duke Energy Progress, LLC (Duke Energy), hereby submits information regarding the results of a full reanalysis of the Shearon Harris Nuclear Power Plant, Unit 1 (HNP) Loss of Coolant Accident (LOCA), considering a transition to Framatome Inc. (Framatome) W17x17 GAIA fuel assembly design (GAIA). HNP Cycle 24 first entered Mode 1 (Power Operation) on May 14, 2021, with fresh fuel of the GAIA design.

This submittal satisfies the notification of a significant change, as required by 10 CFR 50.46(a)(3)(ii), due to a greater than 50 °F change in calculated peak cladding temperature (PCT) for the Realistic Large Break LOCA (RLBLOCA) and Small Break LOCA (SBLOCA) analyses. The details of the RLBLOCA and SBLOCA reanalysis for the GAIA fuel design were submitted to the NRC in Reference 1 as proprietary and non-proprietary LOCA summary reports. Review of these HNP GAIA fuel LOCA reanalysis summary reports by the NRC Staff is described in Reference 2.

The HNP licensing basis RLBLOCA PCT is changed from 2095 °F to 1820 °F as a result of the GAIA reanalysis described in Reference 1 using the NRC-approved RLBLOCA methodology described in Framatome Topical Report EMF-2103(P)(A), Revision 3, "Realistic Large Break

LOCA Methodology for Pressurized Water Reactors." The resident Advanced 17x17 HTP fuel design (HTP) at HNP was evaluated using EMF-2103(P)(A), Revision 3, methodology, with a resulting PCT of 1870 °F for once-burned HTP fuel in the mixed-core configuration for Cycle 24. The HNP licensing basis limiting SBLOCA PCT is changed from 1727 °F to 1832 °F as a result of the GAIA reanalysis described in Reference 1. The details of the RLBLOCA and SBLOCA reanalysis for the GAIA fuel design are contained in the enclosure to this letter.

Since the changes in PCT were identified as part of a reanalysis, the schedule for providing a reanalysis or other actions to show compliance with 10 CFR 50.46 as discussed in 10 CFR 50.46(a)(3)(ii) are considered complete and no additional actions beyond reporting are required.

No regulatory commitments are contained in this submittal.

Please refer any questions regarding this submittal to Art Zaremba, Manager – Nuclear Fleet Licensing, at (980) 373-2062.

Sincerely,

Kim E. Maza

Enclosure: Discussion of Changes to LOCA Analyses

cc:

J. Zeiler, NRC Sr. Resident Inspector, HNP
W. L. Cox, III, Section Chief, N.C. DHSR
M. Mahoney, NRC Project Manager, HNP
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U.S. Nuclear Regulatory Commission
Serial: RA-21-0164

ENCLOSURE

DISCUSSION OF CHANGES TO LOCA ANALYSES

SHEARON HARRIS NUCLEAR POWER PLANT, UNIT 1

DOCKET NO. 50-400

RENEWED LICENSE NUMBER NPF-63

7 PAGES PLUS THE COVER

The new Loss of Coolant Accident (LOCA) analyses were submitted as part of a Shearon Harris Nuclear Power Plant, Unit 1 (HNP), license amendment request (Reference 1) in support of the transition to the Framatome Inc. (Framatome) GAIA fuel design for HNP Cycle 24. The new HNP LOCA analyses support the use of the GAIA fuel design operating 18-month fuel cycles with gadolinia as a burnable absorber. In the NRC Safety Evaluation (Reference 2) for license amendment No. 185 to the HNP Renewed Facility Operating License, the NRC Staff approved the use of the Realistic Large Break LOCA (RLBLOCA) Evaluation Model described in Framatome Topical Report EMF-2103(P)(A), Revision 3 (Reference 3), as an acceptable replacement for the HNP-specific RLBLOCA analysis methodology. The new HNP RLBLOCA analyses for GAIA fuel implemented in Cycle 24 were performed in accordance with EMF-2103(P)(A), Revision 3. The new HNP Small Break LOCA (SBLOCA) analyses for GAIA fuel were performed in accordance with the NRC-approved SBLOCA Evaluation Model described in Framatome Topical Reports EMF-2328(P)(A), Revision 0 (Reference 4), and EMF-2328(P)(A), Revision 0, Supplement 1(P)(A), Revision 0 (Reference 5).

As described in the NRC Safety Evaluation in Reference 2, HNP Technical Specification (TS) 6.9.1.6.2 lists the analytical methods used to determine the core operating limits, and identifies EMF-2103 and EMF-2328 as the applicable RLBLOCA and SBLOCA evaluation methodologies, respectively. HNP TS 6.9.1.6.2 states that the approved revision of the analytical methods used to determine the core operating limits shall be identified in the Core Operating Limits Report (COLR). The COLR for HNP Cycle 24 (ADAMS Accession No. ML21126A342) specifies the appropriate revision number and supplement number for these NRC-approved LOCA methodologies.

The methodology of EMF-2103(P)(A), Revision 3, is used to establish core operating limits for the parameters listed below.

TS 3.2.1 – Axial Flux Difference
TS 3.2.2 – Heat Flux Hot Channel Factor
TS 3.2.3 – Nuclear Enthalpy Rise Hot Channel Factor

The HNP Cycle 24 RLBLOCA analysis for GAIA fuel is described in Framatome Licensing Report ANP-3767P (Reference 6). Table 3-4 of ANP-3767P provides a list of all the NRC limitations cited in Section 4.0 of the final Safety Evaluation for EMF-2103(P)(A), Revision 3. All NRC limitations have been satisfactorily addressed.

The HNP Cycle 24 RLBLOCA analysis for GAIA fuel assumes full-power operation at a core power level of 2958 MWt (including measurement uncertainty), a total peaking factor (F_Q) up to a value of 2.62 (includes uncertainty), and a radial peaking factor ($F_{\Delta H}$) of 1.73 (includes uncertainty). A K(z) correction factor is applied to the total peaking factor F_Q to yield an elevation dependent peaking limit. The analysis also addresses typical operational ranges or TS limits for pressurizer pressure and level; accumulator pressure, temperature, and level; Reactor Coolant System (RCS) temperature; RCS flow; containment pressure and temperature; and refueling water storage tank temperature.

The HNP Cycle 24 RLBLOCA analysis explicitly analyzes fresh GAIA and once-burned GAIA fuel assemblies, and meets the Emergency Core Cooling System (ECCS) performance acceptance criteria in 10 CFR 50.46(b) paragraphs (1) through (3), with 95/95 results summarized below.

10 CFR 50.46(b) Criteria	HNP GAIA Results for RLBLOCA
Peak Cladding Temperature	1820 °F
Maximum Local Oxidation	6.79% (includes pre-transient oxidation)
Total Core-Wide Oxidation	0.07%

Framatome performed an RLBLOCA evaluation of the resident once-burned 17x17 HTP fuel design, using the methodology described in EMF-2103(P)(A), Revision 3.

Differences between the GAIA and HTP fuel designs include (but are not limited to) the HTP fuel having lower pellet density, a slightly smaller pellet diameter, and a slightly larger cladding thickness. To assess the peak cladding temperature (PCT) difference for once-burned HTP fuel under the methodology described in EMF-2103(P)(A), Revision 3, a set of S-RELAP5 runs were performed to determine the impact of a change in the once-burned fuel. The cases were re-analyzed with the same seeds from the GAIA RLBLOCA analysis, but with modified fuel rod models to represent the resident HTP fuel product. The once-burned HTP fuel product was analyzed with the same once-burned fuel peaking limits as the GAIA RLBLOCA analysis.

In the EMF-2103(P)(A), Revision 3, methodology, the analysis-specific order statistic is used to establish the 95/95 PCT result. Comparing the analogous cases from the once-burned GAIA and once-burned HTP case sets showed a PCT increase of 46 °F for once-burned HTP fuel. Based on this comparison, a reasonable PCT penalty of +50 °F was established for once-burned HTP fuel relative to the limiting PCT of 1820 °F for GAIA fuel. To support the removal of the methodology described in Framatome Report ANP-3011(P) (Reference 8) from the HNP licensing basis for Cycle 24, a PCT penalty of +50 °F will be applied to the resident once-burned HTP fuel, relative to the limiting PCT of 1820 °F for the GAIA fuel design.

Subsequent to the issuance of Framatome Licensing Report ANP-3767P, Framatome notified Duke Energy Progress, LLC, of an error in the application of the EMF-2103(P)(A), Revision 3, RLBLOCA methodology. The error is an inconsistency in S-RELAP5 inputs related to fuel rod radiation enclosures. The error occurs only in applications of the Framatome EMF-2103(P)(A), Revision 3, RLBLOCA methodology. Fuel stored energy uncertainty, established for simulation of limiting fuel rods, were inadvertently applied to the hot fresh and once-burned UO_2 rod radiation enclosures. The intent of the methodology is that the uncertainty for enclosure stored energy matches that of the hot fuel assembly, which has no applied uncertainty. Enclosures account for the effect of rod-to-rod thermal radiation. Rod-to-rod radiation comprises a fraction of the total heat transfer characteristic of fuel rods in a steam environment. This effect of the input error is small since the total heat transfer from an uncovered fuel rod is relatively small. The imposition of stored energy uncertainty can cause radiation heat transfer from a limiting rod to surrounding rods to either increase or decrease as a result of the error. Corrections have been made to the input so that uncertainty adjustments are not made to the hot fresh and once-burned UO_2 rod radiation enclosures. Before and after runs of Westinghouse 3-loop sample case sets were subsequently compared. Differences in the results are negligible. Thus, there is no effect on the EMF-2103(P)(A), Revision 3, RLBLOCA analyses of record PCT calculations.

The impact of the error on the HNP Cycle 24 RLBLOCA analysis of record PCT for GAIA fuel is 0°F. The error also has no impact on the once-burned HTP evaluation, as it was performed with

EMF-2103(P)(A), Revision 3, methods. The effects of the error on maximum local oxidation and whole core oxidation results are negligible as well.

Small Break LOCA analyses were also performed by Framatome to support the transition to GAIA fuel for HNP Cycle 24. These SBLOCA analyses were performed in accordance with the NRC-approved methodology described in EMF-2328(P)(A), Revision 0 (Reference 4), including EMF-2328(P)(A), Revision 0, Supplement 1(P)(A) (Reference 5). The HNP Cycle 24 SBLOCA analysis for GAIA fuel is described in Framatome Licensing Report ANP-3766P (Reference 7).

A complete spectrum of cold leg break sizes was considered, ranging from 1.0 inch diameter to 8.7 inch diameter. In addition, other supporting analyses prescribed by the methodology were performed which consider a delayed reactor coolant pump trip, attached piping breaks, and sensitivity to reduced ECCS fluid temperature.

The HNP Cycle 24 GAIA fuel SBLOCA analysis meets the ECCS performance acceptance criteria in 10 CFR 50.46(b) paragraphs (1) through (4), with results summarized below.

10 CFR 50.46(b) Criteria	**HNP GAIA Results for SBLOCA**
Peak Cladding Temperature	1832 °F
Maximum Local Oxidation	4.89% (includes pre-transient oxidation)
Total Core-Wide Oxidation	0.017%
Core Coolable Geometry	Maintained

The new SBLOCA analysis for the GAIA fuel design in Reference 7 will replace the existing SBLOCA analysis for the HTP fuel design in ANP-3238(P) (Reference 9). The SBLOCA analysis methodology described in References 4 and 5 cover the entire burnup range of the fuel, from Beginning of Cycle (BOC) to End of Cycle (EOC). The PCT is expected to occur at EOC burnup conditions. This is due to the dominant effect of a top-skewed EOC axial power distribution and a larger actinide decay heat at EOC, per Reference 4, page 3-3. The SBLOCA analysis assumes the hot rod is at the maximum allowed core peaking factors. It is generally expected that the once-burned fuel will have assembly powers that are lower than the fresh fuel, per Reference 3, page A-161. For these reasons, the new SBLOCA analysis described in Reference 7 is considered applicable to the resident HTP fuel in mixed core configurations of GAIA and HTP fuel.

Information contained in the GAIA LOCA analysis Licensing Reports (References 6 and 7) will be included in HNP Final Safety Analysis Report (FSAR) Section 15.6.5 to support the implementation of Framatome GAIA fuel for HNP Cycle 24. Since these GAIA LOCA analysis Licensing Reports were previously submitted as part of the license amendment request in Reference 1, they are not included in this submittal.

References

1. Letter from Duke Energy Progress, LLC, to NRC, Subject: “License Amendment Request to Reduce the Minimum Required Reactor Coolant System Flow Rate and Update the List of Analytical Methods Used in the Determination of Core Operating Limits,” dated March 6, 2020 (ADAMS Accession No. ML20066L112).

2. Letter from NRC to Duke Energy Progress, LLC, Subject: “Shearon Harris Nuclear Power Plant, Unit 1 – Issuance of Amendment No. 185 Regarding Reduction of Reactor Coolant System Minimum Flow Rate and Update to the Core Operating Limits Report References (EPID L-2020-LLA-0040),” dated April 8, 2021 (ADAMS Accession No. ML21047A470).

3. EMF-2103(P)(A), Revision 3, “Realistic Large Break LOCA Methodology for Pressurized Water Reactors,” Framatome Inc., June 2016.

4. EMF-2328(P)(A), Revision 0, “PWR Small Break LOCA Evaluation Model, S-RELAP5 Based,” Framatome Inc., March 2001.

5. EMF-2328(P)(A), Revision 0; Supplement 1(P)(A), Revision 0, “PWR Small Break LOCA Evaluation Model, S-RELAP5 Based,” Framatome Inc., December 2016.

6. Framatome Inc. Licensing Report ANP-3767P, Revision 0, “Harris Nuclear Plant Unit 1 Realistic Large Break LOCA Analysis with GAIA Fuel Design,” July 2019.

7. Framatome Inc. Licensing Report ANP-3766P, Revision 0, “Harris Nuclear Plant Unit 1 Small Break LOCA Analysis with GAIA Fuel Design,” July 2019.

8. Framatome Inc. Licensing Report ANP-3011P, Revision 1, “Harris Nuclear Plant Unit 1 Realistic Large Break LOCA Analysis,” August 2011.

9. Framatome Inc. Licensing Report ANP-3238P, Revision 0, “Harris Nuclear Plant Unit 1 Small Break LOCA Analysis,” August 2013.

10 CFR 50.46 Report for Shearon Harris Unit 1 – Large Break LOCA – GAIA Fuel

Plant:	Shearon Harris, Unit 1	
Reporting Period:	January 1, 2021 - May 14, 2021	
LOCA Analysis Type (if applicable):	Large Break	
Evaluation Model:	EMF-2103(P)(A), Revision 3 Realistic Large Break LOCA for PWRs	
Fuel:	17x17 GAIA	
A. Analysis of Record PCT	1820 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections – Previously Reported	Net PCT Effect N/A	Absolute PCT Effect N/A
C. Baseline PCT for assessing new changes for significance (A + B)	1820 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period 1. Estimated effect of error in rod-to-rod thermal radiation modeling.	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
F. Licensing Basis PCT (C + E)	1820 °F	

10 CFR 50.46 Report for Shearon Harris Unit 1 – Large Break LOCA – HTP Fuel

Plant:	Shearon Harris, Unit 1	
Reporting Period:	January 1, 2021 – May 14, 2021	
LOCA Analysis Type (if applicable):	Large Break	
Evaluation Model:	EMF-2103(P)(A), Revision 3 Realistic Large Break LOCA for PWRs	
Fuel:	17x17 HTP	
A. Analysis of Record PCT	1820 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections – Previously Reported	Net PCT Effect N/A	Absolute PCT Effect N/A
C. Baseline PCT for assessing new changes for significance (A + B)	1820 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period 1. Estimated effect of error in rod-to-rod thermal radiation modeling. 2. Evaluation of resident once-burned HTP fuel, in mixed cores of GAIA and HTP fuel, using EMF-2103, Rev. 3.	0 °F +50 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect +50 °F	Absolute PCT Effect 50 °F
F. Licensing Basis PCT (C + E)	1870 °F	

10 CFR 50.46 Report for Shearon Harris Unit 1 – Small Break LOCA

Plant:	Shearon Harris, Unit 1	
Reporting Period:	January 1, 2021 – May 14, 2021	
LOCA Analysis Type (if applicable):	Small Break	
Evaluation Model:	EMF-2328(P)(A), Revision 0, and EMF-2328(P)(A), Rev. 0, Supplement 1, Rev. 0 PWR Small Break LOCA Evaluation Model	
Fuel:	17x17 GAIA, 17x17 HTP	
A. Analysis of Record PCT	1832 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections – Previously Reported	Net PCT Effect N/A	Absolute PCT Effect N/A
C. Baseline PCT for assessing new changes for significance (A + B)	1832 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period 1. None.	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
F. Licensing Basis PCT (C + E)	1832 °F	