ATTACHMENT 5 TO NG-16-0102

NEXTERA ENERGY DUANE ARNOLD, LLC
DUANE ARNOLD ENERGY CENTER

LICENSE AMENDMENT REQUEST (TSCR-161)
For Revision of Technical Specifications 2.1.1.2 Safety Limit Minimum Critical Power Ratio, and to Remove an Outdated Historical Footnote from Table 3.3.5.1-1

GNF Additional Information Regarding the Requested Changes to the Technical Specification SLMCPR Duane Arnold Energy Center Cycle 26

NON-PROPRIETARY VERSION

12 pages follow

April 2016

GNF-003N5133-R1-NP

Non-Proprietary Information – Class I (Public)

GNF Additional Information Regarding the Requested Changes to the Technical Specification SLMCPR

Duane Arnold Energy Center Cycle 26

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Please Read Carefully

The design, engineering, and other information contained in this document is furnished for the purpose of providing information regarding the requested changes to the Technical Specification SLMCPR for NextEra Energy Duane Arnold Energy Center. The only undertakings of GNF-A with respect to information in this document are contained in the contract between GNF-A and NextEra Energy, and nothing contained in this document shall be construed as changing that contract. The use of this information by anyone other than NextEra Energy, or for purposes other than those for which it is intended is not authorized; and with respect to any unauthorized use, GNF-A makes no representation or warranty, and assumes no liability as to the completeness, accuracy, or usefulness of the information contained in this document.

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1.0 Summary

The requested changes to the Technical Specification (TS) Safety Limit Minimum Critical Power Ratio (SLMCPR) values are 1.08 for Two-Loop Operation (TLO) and 1.11 for Single Loop Operation (SLO) for Duane Arnold Energy Center (DAEC) Cycle 26. Additional details are provided in Table 1.

The primary reason for the change is that DAEC is currently using the revised methodology with reduced uncertainties (References 1 and 2) which results in a lower calculated SLMCPR than the previous methodology (Reference 3) that was used to establish the existing TS values.

2.0 Regulatory Basis

10 Code of Federal Regulations (CFR) 50.36(c)(1), "Technical Specifications," requires that power reactor facility TS include safety limits for process variables that protect the integrity of certain physical barriers that guard against the uncontrolled release of radioactivity. The fuel cladding is one of the physical barriers that separate the radioactive materials from the environment. The purpose of the SLMCPR is to ensure that Specified Acceptable Fuel Design Limits (SAFDLs) are not exceeded during steady state operation and analyzed transients.

General Design Criterion (GDC) 10, "Reactor Design," of Appendix A to 10 CFR 50 states that the reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that SAFDLs are not exceeded.

Guidance on the acceptability of the reactivity control systems, the reactor core, and fuel system design is provided in NUREG-0800, "Standard Review Plan [SRP] for the Review of Safety Analysis Reports for Nuclear Power Plants." Specifically, SRP Section 4.2, "Fuel System Design," specifies all fuel damage criteria for evaluation of whether fuel designs meet the SAFDLs. SRP Section 4.4, "Thermal Hydraulic Design," provides guidance on the review of thermal-hydraulic design in meeting the requirement of GDC 10 and the fuel design criteria established in SRP Section 4.2.

3.0 Methodology

GNF performs SLMCPR calculations in accordance with NEDE-24011-P-A, "General Electric Standard Application for Reactor Fuel (GESTAR II)" (Reference 4) for plants such as DAEC that are equipped with the GNF 3DMonicore core monitoring system, by using the following Nuclear Regulatory Commission (NRC) approved methodologies and uncertainties:

- NEDC-32601P-A, "Methodology and Uncertainties for Safety Limit MCPR Evaluations," August 1999. (Reference 1)

- NEDC-32694P-A, "Power Distribution Uncertainties for Safety Limit MCPR Evaluations," August 1999. (Reference 2)
- NEDC-32505P-A, "R-Factor Calculation Method for GE11, GE12 and GE13 Fuel," Revision 1, July 1999. (Reference 5)

These methodologies were used for the DAEC Cycle 25 and the Cycle 26 SLMCPR calculations.

3.1. Methodology Restrictions

Four restrictions were identified on page 3 of NRC's Safety Evaluation (SE) relating to the General Electric (GE) Licensing Topical Reports (LTRs) NEDC-32601P, NEDC-32694P, and in Amendment 25 to NEDE-24011-P-A (Reference 6).

The following statement was extracted from the generic compliance report for the GNF2 fuel assembly design (Reference 7) that GNF sent to the NRC in March of 2007:

> "The NRC Safety Evaluation (SE) for NEDC-32694P-A provides four actions to follow whenever a new fuel design is introduced. These four conditions are listed in Section 3 of the SE. In the last paragraph of Section 3.2.2 of the Technical Evaluation Report included in the SE are the statements "GE has evaluated this effect for the 8x8, 9x9, and 10x10 lattices and has indicated that the R-Factor uncertainty will be increased ... to account for the correlation of rod power uncertainties" and "it is noted that the effect of the rod-to-rod correlation has a significant dependence on the fuel lattice (e.g., 9x9 versus 10x10). Therefore, in order to insure the adequacy of the R-Factor uncertainty, the effect of the correlation of rod power calculation uncertainties should be reevaluated when the NEDC-32601P methodology is applied to a new fuel lattice." Therefore, the definition of a new fuel design is based on the lattice array dimensions (e.g., NxN). Because GNF2 is a 10x10, and the evaluations in NEDC-32694P-A include 10x10, then these four actions are not applicable to GNF2."

In an NRC audit report (Reference 8) for this document, Section 3.4.1 page 59 states:

> "The NRC staff's SE of NEDC-32694P-A (Reference 19 of NEDC-33270P) provides four actions to follow whenever a new fuel design is introduced. These four conditions are listed in Section 3.0 of the SE. The analysis and evaluation of the GNF2 fuel design was evaluated in accordance with the limitations and conditions stated in the NRC staff's SE, and is acceptable."

Another methodology restriction is identified on page 4 of the NRC's SE relating to the GE LTR NEDC-32505P (Reference 9). Specifically, it states that "if new fuel is introduced, GENE must confirm that the revised R-factor method is still valid based on new test data." NEDC-32505P addressed the GE12 10x10 lattice design (i.e., how the R-Factor for a rod is calculated based upon its immediate surroundings (fuel rods, water rods or channel wall)). Validation is provided by the fact that the methodology generates accurate predictions of Critical Power Ratio (CPR) with reasonable bias and uncertainty. The applicability of the R-Factor method is coupled and documented (along with fuel specific additive constants) with the GEXL correlation development (Reference 10), which is submitted as a part of GESTAR II compliance for each new fuel product line.

4.0 Discussion

In this discussion, the TLO nomenclature is used for two recirculation loops in operation, and the SLO nomenclature is used for one recirculation loop in operation.

Table 2 provides the description of the current cycle and previous cycle for the reference loading pattern as defined by NEDE-24011-P-A (Reference 4).

4.1. Major Contributors to SLMCPR Change

The existing DAEC SLMCPR TS values were established in Cycle 17. Those SLMCPR TS values have been conservatively maintained through the current operating cycle (Cycle 25). Cycle 26 is the first cycle for which NextEra Energy has decided to request a change to the TS SLMCPR values in order to reflect the calculated results.

The revised methodology with reduced uncertainties (References 1 and 2) was used to determine the SLMCPR beginning with Cycle 24. Prior cycles used the original methodology with GETAB uncertainties (Reference 3). The revised methodology with reduced uncertainties consistently provides lower SLMCPR results for a given core design than the original methodology with GETAB uncertainties.

4.2. Deviations from Standard Uncertainties

Table 3 provides a list of deviations from NRC-approved uncertainties (References 1 and 2). A discussion of deviations from these NRC-approved values follows; all of which are conservative relative to NRC-approved values.

4.2.1. R-Factor

GNF has generically increased the GEXL R-Factor uncertainty from [[{3}]] to account for an increase in channel bow due to the phenomena called control blade shadow corrosion-induced channel bow, which is not accounted for in the channel bow uncertainty component of the approved R-factor uncertainty. Reference 11 technically justifies that a GEXL R-Factor uncertainty of [[{3}]] accounts for a channel bow uncertainty of up to [[{3}]]. The DAEC Cycle 26 analysis shows an expected channel bow uncertainty of

[[{3}]], which is bounded by a GEXL R-Factor uncertainty of [[{3}]]. Thus, the use of a GEXL R-Factor uncertainty of [[{3}]] adequately accounts for the expected control blade shadow corrosion-induced channel bow. The effect of this change is considered not significant (i.e., < 0.005 increase on SLMCPR).

4.2.2. Core Flow Rate and Random Effective TIP Reading

In Reference 12 GNF committed to the expansion of the state points used in the determination of the SLMCPR. Consistent with the Reference 12 commitments, GNF performs analyses at the rated core power and minimum licensed core flow point in addition to analyses at the rated core power and rated core flow point. The approved SLMCPR methodology is applied at each state point that is analyzed.

The available flow range at rated power, 99% to 100% rated core flow, does not warrant analysis at the minimum core flow point.

4.2.3. Flow Area Uncertainty

GNF has calculated the flow area uncertainty for GNF2 using the process described in Section 2.7 of Reference 1. It was determined that the flow area uncertainty for GNF2 is conservatively bounded by a value of [[{3}]]. Because this is larger than the Reference 1 value of [[{3}]], the bounding value was used in the SLMCPR calculations. The effect of this change is considered not significant (i.e., < 0.005 increase on SLMCPR).

4.2.4. Fuel Axial Power Shape Penalty

The GEXL correlation critical power uncertainty and bias are established for each fuel product line according to a process described in NEDE-24011-P-A (Reference 4).

GNF determined that higher uncertainties and non-conservative biases in the GEXL correlations for certain types of axial power shapes could exist relative to the NRC-approved methodology values (References 13, 14, and 15). The GNF2 product line is potentially affected in this manner only by Double-Hump (D-H) axial power shapes.

The D-H axial shape did not occur on any of the limiting bundles (i.e., those contributing to the 0.1% rods susceptible to transition boiling) in the current and/or prior cycle limiting cases. Therefore, D-H power shape penalties were not applied to the GEXL critical power uncertainty or bias.

5.0 References

1. GE Nuclear Energy, "Methodology and Uncertainties for Safety Limit MCPR Evaluations," NEDC-32601P-A, August 1999.

2. GE Nuclear Energy, "Power Distribution Uncertainties for Safety Limit MCPR Evaluations," NEDC-32694P-A, August 1999.

3. General Electric, "General Electric BWR Thermal Analysis Basis (GETAB): Data, Correlation and Design Application," NEDO-10958-A, January 1977.

4. Global Nuclear Fuel, "General Electric Standard Application for Reactor Fuel," NEDE-24011-P-A, Revision 22, November 2015.

5. GE Nuclear Energy, "R-Factor Calculation Method for GE11, GE12 and GE13 Fuel," NEDC-32505P-A, Revision 1, July 1999.

6. Letter, Frank Akstulewicz (NRC) to Glen A. Watford (GNF-A) "Acceptance for Referencing of Licensing Topical Reports NEDC-32601P, Methodology and Uncertainties for Safety Limit MCPR Evaluations; NEDC-32694P, Power Distribution Uncertainties for Safety Limit MCPR Evaluation; and Amendment 25 to NEDE-24011-P-A on Cycle-Specific Safety Limit MCPR (TAC Nos. M97490, M99069 and M97491)," MFN-003-099, March 11, 1999.

7. Letter, Andrew A. Lingenfelter (GNF-A) to NRC Document Control Desk with cc to MC Honcharik (NRC), "GNF2 Advantage Generic Compliance with NEDE-24011P-A (GESTAR II), NEDC-33270P, March 2007, and GEXL17 Correlation for GNF2 Fuel, NEDC-33292P, March 2007," FLN-2007-011, March 14, 2007.

8. Memorandum, Michelle C. Honcharik (NRC) to Stacy L. Rosenberg (NRC), "Audit Report for Global Nuclear Fuels GNF2 Advantage Fuel Assembly Design GESTAR II Compliance Audit," September 25, 2008, (ADAMS Accession Number ML081630579).

9. Letter, Thomas H. Essig (NRC) to Glen A. Watford (GNF-A), "Acceptance for Referencing of Licensing Topical Report NEDC-32505P, Revision 1, 'R-factor Calculation Method for GE11, GE12 and GE13 Fuel,'" (TAC Nos. M99070 and M95081)," MFN-046-98, January 11, 1999.

10. Global Nuclear Fuel, "GEXL17 Correlation for GNF2 Fuel," NEDC-33292P, Revision 3, April 2009.

11. Letter, John F. Schardt (GNF-A) to NRC Document Control Desk with attention to Mel B. Fields (NRC), "Shadow Corrosion Effects on SLMCPR Channel Bow Uncertainty," FLN-2004-030, November 10, 2004.

12. Letter, Jason S. Post (GENE) to U.S. NRC Document Control Desk with attention to Chief, Information Management Branch, et al. (NRC), "Part 21 Final Report: Non-Conservative SLMCPR," MFN 04-108, September 29, 2004.

13. Letter, Glen A. Watford (GNF-A) to NRC Document Control Desk with attention to Joseph E. Donoghue (NRC), "Final Presentation Material for GEXL Presentation – February 11, 2002," FLN-2002-004, February 12, 2002.

14. Letter, Glen A. Watford (GNF-A) to NRC Document Control Desk with attention to Alan Wang (NRC), "NRC Technology Update – Proprietary Slides – July 31 – August 1, 2002," FLN-2002-015, October 31, 2002.

15. Letter, Jens G. Munthe Andersen (GNF-A) to NRC Document Control Desk with attention to Alan Wang (NRC), "GEXL Correlation for 10X10 Fuel," FLN-2003-005, May 31, 2003.

Table 1. Monte Carlo SLMCPR

	Previous Cycle Limiting Case	**Current Cycle Limiting Case**
Description	**Rated Power Rated Core Flow**	**Rated Power Rated Core Flow**
Limiting Cycle Exposure Point Beginning of Cycle (BOC) / Middle of Cycle (MOC) / End of Cycle (EOC)	EOC	EOC
Cycle Exposure at Limiting Point (MWd/STU)	14,220	14,100
[[{3}	{3}	{3}
{3}	{3}	{3}
{3}	{3}	{3}]]
Requested Change to the TS SLMCPR	N/A	1.08 TLO / 1.11 SLO

Table 2. Description of Core

Description	Previous Cycle	Current Cycle
Core Rated Power (MWt)	1912.0	1912.0
Minimum Flow at Rated Power (% rated core flow)	99.0	99.0
Number of Bundles in the Core	368	368
Batch Sizes and Types: (Number of Bundles in the Core) Fresh Once-Burnt Twice-Burnt Thrice-Burnt or more	 152 GNF2 152 GNF2 64 GE14 None	 152 GNF2 152 GNF2 64 GNF2 None
Fresh Fuel Batch Average Enrichment (Weight %)	4.11	4.09
Core Monitoring System	3DMonicore	3DMonicore

Table 3. Deviations from Standard Uncertainties

Description	NRC Approved Value ± σ (%)	Previous Cycle	Current Cycle
Power Distribution Uncertainties			
GEXL R-Factor	[[{3}]]	[[{3}]]	[[{3}]]
Non-Power Distribution Uncertainties			
Channel Flow Area Variation	[[{3}]]	[[{3}]]	[[{3}]]