Attachment 4

GNRO-2011/00064

GNF-A Analysis Summary (Non-Proprietary)

This is a non-proprietary version of Attachment 1 from which the proprietary information has been removed. The proprietary portions that have been removed are indicated by double square brackets as shown here: [[ ]].

Global Nuclear Fuel

A Joint Venture of GE,Toshiba, & Hitachi

Global Nuclear Fuel

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Non-Proprietary Information – Class I (Public)

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

Grand Gulf Cycle 19
Extended Power Uprate

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Information Notice

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1.0 Methodology

Global Nuclear Fuel (GNF) performs Safety Limit Minimum Critical Power Ratio (SLMCPR) calculations in accordance with NEDE-24011-P-A, "General Electric Standard Application for Reactor Fuel," Revision 18 (Reference 1), using the following NRC-approved methodologies and uncertainties:

- NEDC-32601P-A, "Methodology and Uncertainties for Safety Limit MCPR Evaluations," August 1999. (Reference 2)
- NEDC-32694P-A, "Power Distribution Uncertainties for Safety Limit MCPR Evaluations," August 1999. (Reference 3)
- NEDC-32505P-A, "R-Factor Calculation Method for GE11, GE12 and GE13 Fuel," Revision 1, July 1999. (Reference 4)

  NEDC-32505P-A is the generic R-Factor methodology report that describes the changed methodology that was adopted after part length rods were introduced. The NRC staff's Safety Evaluation (SE) for NEDC-32505P-A has a requirement that the applicability of the R-Factor methodology is confirmed when a new fuel type is introduced. The confirmation for GE14 is contained in "GEXL14 Correlation for GE14 Fuel, NEDC-32851P Revision 2, and GEXL10 Correlation for GE12 Fuel with Inconel Spacer, NEDC-32464P Revision 2," FLN-2001-018, September 25, 2001 (Reference 5) and in Reference 6. The confirmation for GNF2 is contained in "GNF2 Advantage Generic Compliance with NEDE-24011-P-A (GESTAR II), NEDC-33270P, March 2007, and GEXL17 Correlation for GNF2 Fuel, NEDC-33292P, March 2007," FLN-2007-011, March 14, 2007 (Reference 7).

Table 2 identifies the actual methodologies used for the Grand Gulf Cycle 18 and the Cycle 19 SLMCPR calculations.

2.0 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.

This information regarding requested changes to the Technical Specification SLMCPR is based on and is for the Grand Gulf Extended Power Uprate (EPU) license condition of 4,408 MWt in Cycle 19. The EPU condition represents a 13% increase in power relative to the 3,898 MWt licensed power of Cycle 18.

Also addressed is the application of the limitations from the SE for the Interim Methods Licensing Topical Report (IMLTR) (Reference 8) related to EPUs. Specifically, the following limitation is being addressed:

- For EPU operation, a 0.02 value shall be added to the cycle-specific SLMCPR value. This adder is applicable to SLO, which is derived from the dual loop SLMCPR value.

2.1. Major Contributors to SLMCPR Change

In general, the calculated safety limit is dominated by two key parameters: (1) flatness of the core bundle-by-bundle Minimum Critical Power Ratio (MCPR) distribution; and (2) flatness of the bundle pin-by-pin power / R-Factor distribution. Greater flatness in either parameter yields more rods susceptible to boiling transition and thus a higher calculated SLMCPR. MIP (MCPR Importance Parameter) measures the core bundle-by-bundle MCPR distribution and RIP (R-Factor Importance Parameter) measures the bundle pin-by-pin power / R-Factor distribution. The effect of the fuel loading pattern on the calculated TLO SLMCPR using rated core power and rated core flow conditions has been correlated to the parameter MIPRIP, which combines the MIP and RIP values.

Table 3 presents the MIP and RIP parameters for the previous cycle and the current cycle along with the TLO SLMCPR estimate using the MIPRIP correlation. If the minimum core flow case is applicable, the TLO SLMCPR estimate is also provided for that case although the MIPRIP correlation is only applicable to the rated core flow case. This is done only to provide some reasonable assessment basis of the minimum core flow case trend. In addition, Table 3 presents estimated effects on the TLO SLMCPR due to methodology deviations, penalties, and/or uncertainty deviations from approved values. Based on the MIPRIP correlation and any effects due to deviations from approved values, a final estimated TLO SLMCPR is determined. Table 3 also provides the actual calculated Monte Carlo SLMCPRs. Given the bias and uncertainty in the MIPRIP correlation [[ ]] and the inherent variation in the Monte Carlo results [[ ]], the change in the Grand Gulf Cycle 19 calculated Monte Carlo TLO SLMCPR using rated core power and rated core flow conditions is consistent with the corresponding estimated TLO SLMCPR value.

The intent of the final estimated TLO SLMCPR is to provide an estimate to check the reasonableness of the Monte Carlo result. It is not used for any other purpose. The methodology and final SLMCPR is based on the rigorous Monte Carlo analysis.

The items in Table 3 that result in the increase of the estimated SLMCPR are discussed in Section 2.2.

2.2. Deviations in NRC-Approved Uncertainties

Tables 4 and 5 provide a list of Nuclear Regulatory Commission (NRC)-approved uncertainties along with values actually used. A discussion of deviations from these NRC-approved values follows; all of which are conservative relative to the NRC-approved values. Also, the estimated effect on the SLMCPR is provided in Table 3 for each deviation.

2.2.1. R-Factor

At this time, GNF has generically increased the GEXL R-Factor uncertainty from [[ ]] to account for an increase in channel bow due to the emerging unforeseen 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. The step "σ RPEAK" in Figure 4.1 from NEDC-32601P-A (Reference 2), which has been provided for convenience in Figure 3 of this attachment, is affected by this deviation. Reference 9 technically justifies that a GEXL R-Factor uncertainty of [[ ]] accounts for a channel bow uncertainty of up to [[ ]].

Grand Gulf has experienced control blade shadow corrosion-induced channel bow to the extent that an increase in the NRC-approved R-Factor uncertainty of [[ ]] is deemed prudent to address its effect. Accounting for the control blade shadow corrosion-induced channel bow, the Grand Gulf Cycle 19 analysis shows an expected channel bow uncertainty of [[ ]], which is bounded by a GEXL R-Factor uncertainty of [[ ]]. Thus the use of a GEXL R-Factor uncertainty of [[ ]] adequately accounts for the expected control blade shadow corrosion-induced channel bow for Grand Gulf Cycle 19.

2.2.2. Core Flow Rate and Random Effective TIP Reading

In Reference 10 GNF committed to the expansion of the state points used in the determination of the SLMCPR. Consistent with the Reference 10 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.

For the TLO calculations performed at 92.8% core flow, the approved uncertainty values for the core flow rate (2.5%) and the random effective Traversing In-Core Probe (TIP) reading (1.2%) are conservatively adjusted by dividing them by 92.8/100. The steps "σ CORE FLOW" and "σ TIP (INSTRUMENT)" in Figure 4.1 from NEDC-32601P-A (Reference 2), which has been provided for convenience in Figure 3 of this attachment, are affected by this deviation.

Historically, these values have been construed to be somewhat dependent on the core flow conditions, as demonstrated by the fact that higher values have always been used when performing SLO calculations. It is for this reason that GNF determined that it is appropriate to consider an increase in these two uncertainties when the core flow is reduced. The amount of increase is determined in a conservative way. For both parameters it is assumed that the absolute uncertainty remains the same as the flow is decreased so that the percentage uncertainty increases inversely proportional to the change in core flow. This is conservative relative to the core flow uncertainty because the variability in the absolute flow is expected to decrease somewhat as the flow decreases. For the random effective TIP uncertainty, there is no reason to believe that the percentage uncertainty should increase as the core flow decreases for TLO. Nevertheless, this uncertainty is also increased as is done in the more extreme case for SLO primarily to preserve the historical precedent established by the SLO evaluation. Note that the TLO condition is different than the SLO condition because for TLO there is no expected tilting of the core radial power shape.

The treatment of the core flow and random effective TIP reading uncertainties is based on the assumption that the signal to noise ratio deteriorates as core flow is reduced. GNF believes this is conservative and may in the future provide justification that the original uncertainties (non-flow dependent) are adequately bounding.

The core flow and random TIP reading uncertainties used in the SLO minimum core flow SLMCPR analysis remain the same as in the rated core flow SLO SLMCPR analysis because these uncertainties (which are substantially larger than used in the TLO analysis) already account for the effects of operating at reduced core flow.

2.3. Departure from NRC-Approved Methodology

No departures from NRC-approved methodologies were used in the Grand Gulf Cycle 19 SLMCPR calculations.

2.4. Fuel Axial Power Shape Penalty

At this time, GNF has determined that higher uncertainties and non-conservative biases in the GEXL correlations for the various types of axial power shapes (i.e., inlet, cosine, outlet and double hump) could potentially exist relative to the NRC-approved methodology values (References 11, 12, 13 and 14). The following table identifies, by marking with an "X", this potential for each GNF product line currently being offered:

[[				
				]]

Axial bundle power shapes corresponding to the limiting SLMCPR control blade patterns are determined using the PANACEA 3D core simulator. These axial power shapes are classified in accordance to the following table:

[[	

]]

If the limiting bundles in the SLMCPR calculation exhibit an axial power shape identified by this table, GNF penalizes the GEXL critical power uncertainties to conservatively account for the effect of the axial power shape. Table 6 provides a list of the GEXL critical power uncertainties determined in accordance to the NRC-approved methodology contained in NEDE-24011-P-A (Reference 1) along with the actual values used.

For the limiting bundles, the fuel axial power shapes in the SLMCPR analysis were examined to determine the presence of axial power shapes identified in the above table. These power shapes were not found; therefore, no power shape penalties were applied to the calculated Grand Gulf Cycle 19 SLMCPR values.

2.5. Methodology Restrictions

The four restrictions identified on page 3 of NRC's SE relating to the General Electric Licensing Topical Reports NEDC-32601P (Reference 2), NEDC-32694P (Reference 3), and Amendment 25 to NEDE-24011-P-A (Reference 15) are addressed in References 6, 11, 16, and 17.

The four restrictions for GNF2 were determined to be acceptable by the NRC review of "GNF2 Advantage Generic Compliance with NEDE-24011-P-A (GESTAR II)," NEDC-33270P, Revision 0 (Reference 7). Specifically, in the NRC audit report (Reference 18) for the said 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."

GNF's position is that GNF2 is an evolutionary fuel product based on GE14. It is not considered a new fuel design as it maintains the previously established 10x10 array and 2 water rod makeup, as stated by the NRC audit report (Reference 18), Section 3.4.2.2.1, page 59:

> "The NRC staff finds that the calculational methods, evaluations and applicability of the OLMCPR and SLMCPR are in accordance with existing NRC-approved methods and thus valid for use with GNF2 fuel."

As such, no new GNF fuel designs are being introduced in Grand Gulf Cycle 19; therefore, the NEDC-32505P-A (Reference 4) statement "...if new fuel is introduced, GENE must confirm that the revised R-Factor method is still valid based on new test data" is not applicable.

2.6. Minimum Core Flow Condition

For Grand Gulf Cycle 19, the minimum core flow SLMCPR calculation performed at 92.8% core flow and rated core power condition was limiting as compared to the rated core flow and rated core power condition. At low core flows, the search spaces for the limiting rod pattern and the

nominal rod pattern are essentially the same. Additionally, the condition that MIP [[ ]] establishes a reasonably bounding limiting rod pattern. Hence, the rod pattern used to calculate the SLMCPR at 100% rated power / 92.8% rated flow reasonably assures that at least 99.9% of the fuel rods in the core would not be expected to experience boiling transition during normal operation or anticipated operational occurrences during the operation of Grand Gulf Cycle 19. Consequently, the SLMCPR value calculated from the 92.8% core flow and rated core power condition limiting MCPR distribution reasonably bounds this mode of operation for Grand Gulf Cycle 19.

2.7. Limiting Control Rod Patterns

The limiting control rod patterns used to calculate the SLMCPR reasonably assures that at least 99.9% of the fuel rods in the core would not be expected to experience boiling transition during normal operation or anticipated operational occurrences during the operation of Grand Gulf Cycle 19.

2.8. Core Monitoring System

For Grand Gulf Cycle 19, the 3D Monicore system will be used as the core monitoring system.

2.9. Power/Flow Map

The utility has provided the current and previous cycle power/flow map in a separate attachment.

2.10. Core Loading Diagram

Figures 1 and 2 provide the core-loading diagram for the current and previous cycle, respectively, which are the Reference Loading Pattern as defined by NEDE-24011-P-A (Reference 1). Table 1 provides a description of the core.

2.11. Figure References

Figure 3 is Figure 4.1 from NEDC-32601P-A (Reference 2). Figure 4 is Figure III.5-1 from NEDC-32601P-A (Reference 2). Figure 5 is based on Figure III.5-2 from NEDC-32601P-A (Reference 2), and has been updated with GE14 and GNF2 data.

2.12. Additional SLMCPR Licensing Conditions

Grand Gulf's safety analysis report for constant pressure power uprate (PUSAR) (Reference 19) includes Limitation and Condition 9.4 of the IMLTR (Reference 8) to include a 0.02 adder to the calculated cycle-specific SLMCPR value for both the SLO and TLO SLMCPR.

For Grand Gulf Cycle 19, the additional SLMCPR licensing condition that the SLMCPR shall be established by adding 0.02 to the cycle-specific SLMCPR value calculated using the NRC-approved methodologies documented in NEDE-24011-P-A (Reference 1) has been applied (see Table 3).

2.13. GNF2 Spacer Bent Flow Wing Effect

A manufacturing defect was discovered in the spacer flow wings of the fresh GNF2 fuel loaded in Grand Gulf Cycle 18. The condition is characterized as the spacer flow wing associated with a corner location being bent downward. This condition is described further in Attachment 2 of GNF Enclosure 3 of Reference 20, Attachment 1. The manufacturing process leading to this condition has been corrected such that the Grand Gulf Cycle 19 GNF2 bundles are not affected by this defect. However, as the Cycle 18 GNF2 fuel continues to reside in Cycle 19, the effect of this defect on the SLMCPR has been assessed.

The method used for evaluation of the effect on the defect is the same as that reviewed in an audit by the NRC on August 20, 2010 associated with the FitzPatrick Cycle 20 SLMCPR Technical Specification change submittal. The NRC acknowledged this audit and consideration of the GNF2 bent spacer wing in their FitzPatrick SLMCPR Technical Specification change SE (Reference 21). In approving the FitzPatrick SLMCPR change, the NRC accepted this evaluation method for assessing the effect of the GNF2 bent spacer wing.

The statistically based MCPR evaluation, including the GNF2 spacer bent flow wings, for Grand Gulf Cycle 19, shows that the effect is less than a [[ ]] relative to the calculated Monte Carlo SLMCPR that is shown in Table 3. Thus the effect would result in an adjusted Table 3 limiting Cycle 19 TLO SLMCPR of [[ ]]. Similarly, the adjusted Table 3 limiting Cycle 19 SLO SLMCPR would be [[ ]] for this effect.

2.14. Summary

The requested changes to the Technical Specification SLMCPR values are 1.11 for TLO and 1.14 for SLO for Grand Gulf Cycle 19.

3.0 References

1. Global Nuclear Fuel, "General Electric Standard Application for Reactor Fuel," NEDE-24011-P-A, Revision 18, April 2011.
2. GE Nuclear Energy, "Methodology and Uncertainties for Safety Limit MCPR Evaluations," NEDC-32601P-A, August 1999.
3. GE Nuclear Energy, "Power Distribution Uncertainties for Safety Limit MCPR Evaluations," NEDC-32694P-A, August 1999.
4. GE Nuclear Energy, "R-Factor Calculation Method for GE11, GE12 and GE13 Fuel," NEDC-32505P-A, Revision 1, July 1999.
5. Letter, Glen A. Watford (GNF-A) to U.S. Nuclear Regulatory Commission Document Control Desk with attention to J. Donoghue (NRC), "GEXL14 Correlation for GE14 Fuel, NEDC-32851P Revision 2, and GEXL10 Correlation for GE12 Fuel with Inconel Spacer, NEDC-32464P Revision 2," FLN-2001-018, September 25, 2001.
6. Letter, Glen A. Watford (GNF-A) to U.S. Nuclear Regulatory Commission Document Control Desk with attention to J. Donoghue (NRC), "Confirmation of the Applicability of the GEXL14 Correlation and Associated R-Factor Methodology for Calculating SLMCPR Values in Cores Containing GE14 Fuel," FLN-2001-017, October 1, 2001.
7. Letter, Andrew A. Lingenfelter (GNF) to U.S. Nuclear Regulatory Commission Document Control Desk, "GNF2 Advantage Generic Compliance with NEDE-24011-P-A (GESTAR II), NEDC-33270P, March 2007, and GEXL17 Correlation for GNF2 Fuel, NEDC-33292P, March 2007," FLN-2007-011, March 14, 2007.
8. GE Hitachi Nuclear Energy, "Applicability of GE Methods to Expanded Operating Domains," NEDC-33173P-A, Revision 1, September 2010.
9. Letter, John F. Schardt (GNF-A) to U.S. Nuclear Regulatory Commission Document Control Desk with attention to Mel B. Fields (NRC), "Shadow Corrosion Effects on SLMCPR Channel Bow Uncertainty," FLN-2004-030, November 10, 2004.
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12. Letter, Glen A. Watford (GNF-A) to U.S. Nuclear Regulatory Commission 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.

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

14. Letter, Andrew A. Lingenfelter (GNF-A) to U.S. Nuclear Regulatory Commission Document Control Desk with cc to MC Honcharik (NRC), "Removal of Penalty Being Applied to GE14 Critical Power Correlation for Outlet Peaked Axial Power Shapes," FLN-2007-031, September 18, 2007.

15. Letter from Frank Akstulewicz (NRC) to Glen A. Watford (GE), "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–003–99, March 11, 1999.

16. Letter, Glen A. Watford (GNF-A) to U.S. Nuclear Regulatory Commission Document Control Desk with attention to R. Pulsifer (NRC), "Confirmation of 10x10 Fuel Design Applicability to Improved SLMCPR, Power Distribution and R-Factor Methodologies," FLN-2001-016, September 24, 2001.

17. Letter, Andrew A. Lingenfelter (GNF-A) to U.S. Nuclear Regulatory Commission Document Control Desk with cc to SS Philpott (NRC), "Amendment 33 to NEDE-24011-P, General Electric Standard Application for Reactor Fuel (GESTAR II) and GNF2 Advantage Generic Compliance with NEDE-24011-P-A (GESTAR II), NEDC-33270P, Revision 3, March 2010," MFN 10-045, March 5, 2010.

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

19. GE Hitachi Nuclear Energy, "Safety Analysis Report for Grand Gulf Nuclear Station Constant Pressure Power Uprate," NEDC-33477P, Revision 0, August 2010.

20. Letter, Pete Deitrich (JAF) to U.S. Nuclear Regulatory Commission Document Control Desk, "Response to Follow-up Request for Additional Information Re: James A. FitzPatrick Nuclear Power Plant Proposed Change to the James A. FitzPatrick Nuclear Power Plant's Technical Specification Concerning the Safety Limit Minimum Critical Power Ratio (TAC No. ME3786)," JAFP-10-0122, September 2, 2010.

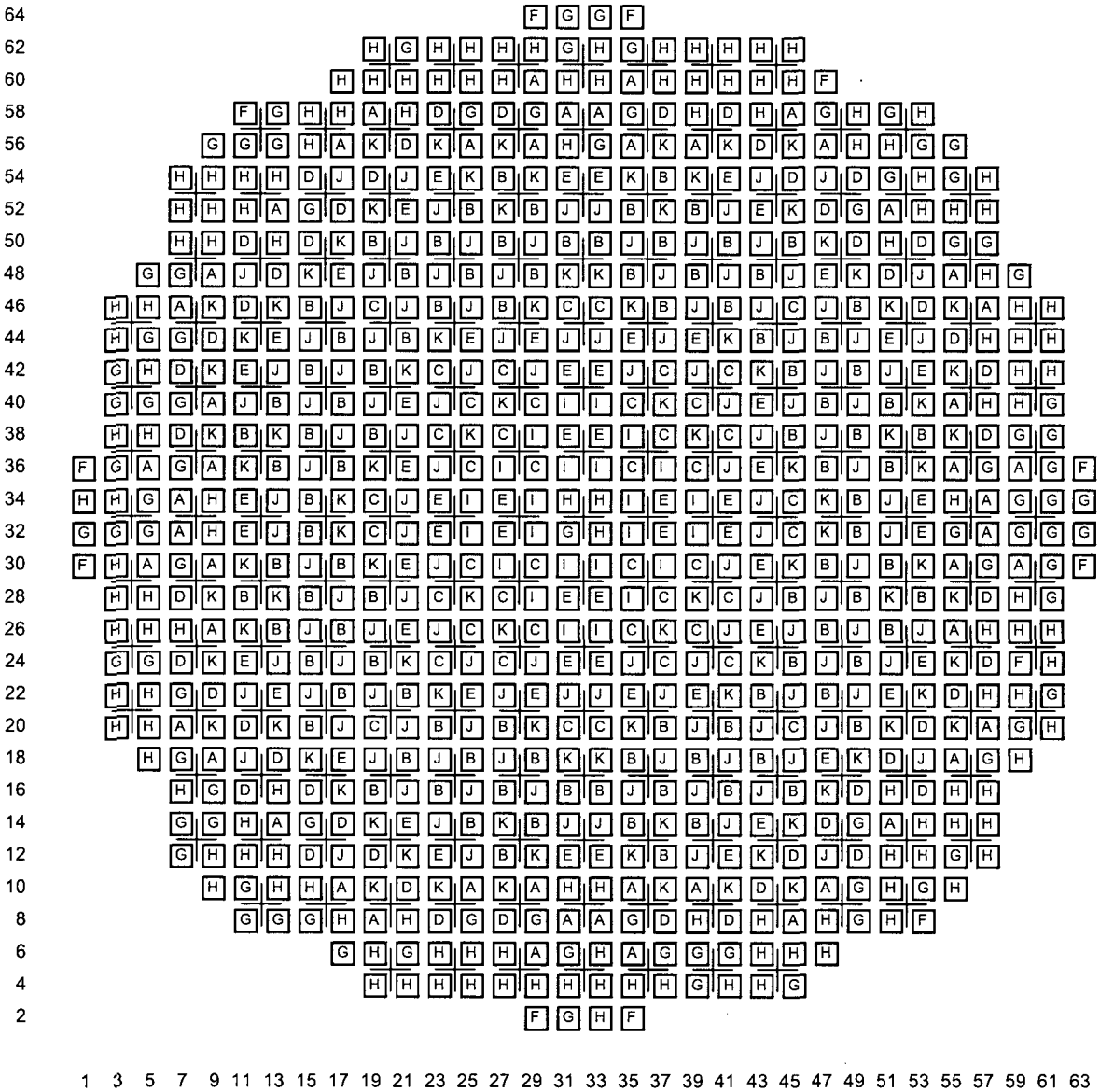
21. Letter, Bhalchandra K. Vaidya (NRC) to James A. FitzPatrick Nuclear Power Plant, "James A. FitzPatrick Nuclear Power Plant – Issuance of Amendment RE: Changes to the Safety Limit Minimum Critical Power Ratio (TAC NO. ME3786)," September 27, 2010.

Figure 1. Current Cycle Core Loading Diagram

64																16	16	16	16																
62											17	17	16	17	17	17	4	4	17	17	16	17	17	15											
60										16	17	4	1	1	7	7	19	19	7	7	1	1	4	17	16										
58							16	17	17	16	4	7	19	7	7	7	2	2	7	7	7	19	7	4	17	17	17	17							
56						16	17	4	1	7	7	7	19	1	9	1	19	19	1	9	1	19	7	7	7	1	4	16	16						
54					17	17	17	1	18	19	4	9	5	20	9	9	5	5	9	9	20	5	9	4	19	18	1	17	17	15					
52					16	4	1	19	19	4	9	5	20	4	20	2	6	6	2	20	4	20	5	9	4	19	19	1	4	17					
50					17	1	18	19	1	19	2	20	2	20	2	20	2	2	20	2	20	2	20	2	19	1	19	18	1	17					
48			16	17	7	19	4	19	2	18	2	20	2	6	2	6	6	6	2	6	2	20	2	18	2	19	4	19	7	17	16				
46		15	17	4	7	4	9	2	18	5	6	2	6	2	6	3	3	6	2	6	2	6	5	18	2	9	4	7	4	17	17				
44		17	4	7	7	9	5	20	2	6	3	6	5	6	5	6	6	5	6	5	6	3	6	2	20	5	9	7	7	4	17				
42		17	1	19	19	5	20	2	20	2	6	5	6	3	6	3	3	6	3	6	5	6	2	20	2	20	5	19	19	1	17				
40		17	1	7	1	20	2	20	2	6	5	6	5	6	3	8	8	3	6	5	6	5	6	2	20	2	20	1	7	1	16				
38		17	7	7	9	9	20	2	6	2	6	3	6	5	8	3	3	8	5	6	3	6	2	6	2	20	9	9	7	7	17				
36	16	17	7	7	1	9	2	20	2	6	5	6	3	8	3	8	8	3	8	3	6	5	6	2	20	2	9	1	7	7	17	16			
34	15	4	19	2	19	5	6	2	6	3	6	3	8	5	8	2	2	8	5	8	3	6	3	6	2	6	5	19	2	19	4	16			
32	16	4	19	2	19	5	6	2	6	3	6	3	8	5	8	2	2	8	5	8	3	6	3	6	2	6	5	19	2	19	4	16			
30	16	17	7	7	1	9	2	20	2	6	5	6	3	8	3	8	8	3	8	3	6	5	6	2	20	2	9	1	7	7	17	16			
28		17	7	7	9	9	20	2	6	2	6	3	6	5	8	3	3	8	5	6	3	6	2	6	2	20	9	9	7	7	16				
26		16	1	7	1	20	2	20	2	6	5	6	5	6	3	8	8	3	6	5	6	5	6	2	20	2	20	1	7	1	16				
24		17	1	19	19	5	20	2	20	2	6	5	6	3	6	3	3	6	3	6	5	6	2	20	2	20	5	19	19	1	17				
22		17	4	7	7	9	5	20	2	6	3	6	5	6	5	6	6	5	6	5	6	3	6	2	20	5	9	7	7	4	17				
20		17	17	4	7	4	9	2	18	5	6	2	6	2	6	3	3	6	2	6	2	6	5	18	2	9	4	7	4	15	17				
18			16	17	7	19	4	19	2	18	2	20	2	6	2	6	6	2	6	2	20	2	18	2	19	4	19	7	17	16					
16				17	1	18	19	1	19	2	20	2	20	2	20	2	2	20	2	20	2	20	2	19	1	19	18	1	17						
14				17	4	1	19	19	4	9	5	20	4	20	2	6	6	2	20	4	20	5	9	4	19	19	1	4	17						
12				17	17	17	1	18	19	4	9	5	20	9	9	5	5	9	9	20	5	9	4	19	18	1	17	17	17						
10					16	17	4	1	7	7	7	19	1	9	1	19	19	1	9	1	19	7	7	7	1	4	17	16							
8						16	17	17	17	4	7	19	7	7	7	2	2	7	7	7	19	7	4	17	17	17	15								
6									15	15	4	1	1	7	7	19	19	7	7	1	1	4	17	16											
4										16	17	17	16	17	17	4	4	17	17	17	17	17	16												
2															16	16	16	16																	
	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63			

Fuel Type			
1=GNF2-P10SG2B421-10G8.0-120T2-150-T6-3265	(Cycle 18)	9=GNF2-P10SG2B416-16GZ-120T2-150-T6-4026	(Cycle 19)
2=GNF2-P10SG2B401-15GZ-120T2-150-T6-3266	(Cycle 18)	15=GE14-P10SNAB396-18GZ-120T-150-T6-3091	(Cycle 17)
3=GNF2-P10SG2B400-19GZ-120T2-150-T6-3267	(Cycle 18)	16=GE14-P10SNAB391-18GZ-120T-150-T6-3092	(Cycle 17)
4=GNF2-P10SG2B435-14GZ-120T2-150-T6-3269	(Cycle 18)	17=GE14-P10SNAB395-18GZ-120T-150-T6-3093	(Cycle 17)
5=GNF2-P10SG2B400-19GZ-120T2-150-T6-3270	(Cycle 18)	18=GNF2-P10SG2B397-14GZ-120T2-150-T6-4027	(Cycle 19)
6=GNF2-P10SG2B387-14GZ-120T2-150-T6-4023	(Cycle 19)	19=GNF2-P10SG2B409-14GZ-120T2-150-T6-4028	(Cycle 19)
7=GNF2-P10SG2B424-14GZ-120T2-150-T6-4024	(Cycle 19)	20=GNF2-P10SG2B397-15GZ-120T2-150-T6-4029	(Cycle 19)
8=GNF2-P10SG2B385-14GZ-120T2-150-T6-4025	(Cycle 19)		

Figure 2. Previous Cycle Core Loading Diagram



Fuel Type			
A=GNF2-P10SG2B421-10G8.0-120T2-150-T6-3265	(Cycle 18)	G=ATRM10-P10SAEB404-15GZ-114T-9WR-149-T6-3050	(Cycle 16)
B=GNF2-P10SG2B401-15GZ-120T2-150-T6-3266	(Cycle 18)	H=ATRM10-P10SAEB405-15GZ-114T-9WR-149-T6-3051	(Cycle 16)
C=GNF2-P10SG2B400-19GZ-120T2-150-T6-3267	(Cycle 18)	I=GE14-P10SNAB396-18GZ-120T-150-T6-3091	(Cycle 17)
D=GNF2-P10SG2B435-14GZ-120T2-150-T6-3269	(Cycle 18)	J=GE14-P10SNAB391-18GZ-120T-150-T6-3092	(Cycle 17)
E=GNF2-P10SG2B400-19GZ-120T2-150-T6-3270	(Cycle 18)	K=GE14-P10SNAB395-18GZ-120T-150-T6-3093	(Cycle 17)
F=ATRM10-P10SAEB404-15GZ-114T-9WR-149-T6-3048	(Cycle 15)		

Figure 3. Figure 4.1 from NEDC-32601P-A

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Figure 4. Figure III.5-1 from NEDC-32601P-A

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Figure 5. Relationship Between MIP and CPR Margin

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Table 1. Description of Core

Description	Previous Cycle Minimum Core Flow Limiting Case	Previous Cycle Rated Core Flow Limiting Case	Current Cycle Minimum Core Flow Limiting Case	Current Cycle Rated Core Flow Limiting Case
Number of Bundles in the Core	800		800	
Limiting Cycle Exposure Point (i.e., BOC/MOC/EOC)	EOC	EOC	EOC	EOC
Cycle Exposure at Limiting Point (MWd/STU)	13840	13840	15700	15700
% Rated Core Flow	77.1	100.0	92.8	100.0
Reload Fuel Type	GNF2		GNF2	
Latest Reload Batch Fraction, %	38.5		45.5	
Latest Reload Average Batch Weight % Enrichment	4.10		4.03	
Core Fuel Fraction: GNF2 GE14 ATRIUM-10	 0.385 0.310 0.305		 0.840 0.160 0.0	
Core Average Weight % Enrichment	4.03		4.04	

Table 2. SLMCPR Calculation Methodologies

Description	Previous Cycle Minimum Core Flow Limiting Case	Previous Cycle Rated Core Flow Limiting Case	Current Cycle Minimum Core Flow Limiting Case	Current Cycle Rated Core Flow Limiting Case
Non-power Distribution Uncertainty	NEDC-32601-P-A		NEDC-32601-P-A	
Power Distribution Methodology	NEDC-32694P-A		NEDC-32694P-A	
Power Distribution Uncertainty	NEDC-32694P-A		NEDC-32694P-A	
Core Monitoring System	3D MONICORE		3D MONICORE	
R-Factor Calculation Methodology	NEDC-32505P-A		NEDC-32505P-A	

Table 3. Monte Carlo Calculated SLMCPR vs. Estimate

Description	Previous Cycle Minimum Core Flow Limiting Case	Previous Cycle Rated Core Flow Limiting Case	Current Cycle Minimum Core Flow Limiting Case	Current Cycle Rated Core Flow Limiting Case
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Table 3. Monte Carlo Calculated SLMCPR vs. Estimate

Description	Previous Cycle Minimum Core Flow Limiting Case	Previous Cycle Rated Core Flow Limiting Case	Current Cycle Minimum Core Flow Limiting Case	Current Cycle Rated Core Flow Limiting Case
				]]

Table 4. Non-Power Distribution Uncertainties

	Nominal (NRC-Approved) Value ± σ (%)	Previous Cycle Minimum Core Flow Limiting Case	Previous Cycle Rated Core Flow Limiting Case	Current Cycle Minimum Core Flow Limiting Case	Current Cycle Rated Core Flow Limiting Case
GETAB					
Feedwater Flow Measurement	1.76	N/A	N/A	N/A	N/A
Feedwater Temperature Measurement	0.76	N/A	N/A	N/A	N/A
Reactor Pressure Measurement	0.50	N/A	N/A	N/A	N/A
Core Inlet Temperature Measurement	0.20	N/A	N/A	N/A	N/A
Total Core Flow Measurement	6.0 SLO/2.5 TLO	N/A	N/A	N/A	N/A
Channel Flow Area Variation	3.0	N/A	N/A	N/A	N/A
Friction Factor Multiplier	10.0	N/A	N/A	N/A	N/A
Channel Friction Factor Multiplier	5.0	N/A	N/A	N/A	N/A

Table 4. Non-Power Distribution Uncertainties

	Nominal (NRC-Approved) Value ± σ (%)	Previous Cycle Minimum Core Flow Limiting Case	Previous Cycle Rated Core Flow Limiting Case	Current Cycle Minimum Core Flow Limiting Case	Current Cycle Rated Core Flow Limiting Case
NEDC-32601P-A					
Feedwater Flow Measurement	[[ ]]	[[ ]]	[[ ]]	[[ ]]	[[ ]]
Feedwater Temperature Measurement	[[ ]]	[[ ]]	[[ ]]	[[ ]]	[[ ]]
Reactor Pressure Measurement	[[ ]]	[[ ]]	[[ ]]	[[ ]]	[[ ]]
Core Inlet Temperature Measurement	0.2	0.2	0.2	0.2	0.2
Total Core Flow Measurement	6.0 SLO/2.5 TLO	6.0 SLO/3.24 TLO	6.0 SLO/2.5 TLO	6.0 SLO/2.69 TLO	6.0 SLO/2.5 TLO
Channel Flow Area Variation	[[ ]]	[[ ]]	[[ ]]	[[ ]]	[[ ]]
Friction Factor Multiplier	[[ ]]	[[ ]]	[[ ]]	[[ ]]	[[ ]]
Channel Friction Factor Multiplier	5.0	5.0	5.0	5.0	5.0

Table 5. Power Distribution Uncertainties

Description	Nominal (NRC-Approved) Value ± σ (%)	Previous Cycle Minimum Core Flow Limiting Case	Previous Cycle Rated Core Flow Limiting Case	Current Cycle Minimum Core Flow Limiting Case	Current Cycle Rated Core Flow Limiting Case
GETAB/NEDC-32601P-A					
GEXL R-Factor	[[ ]]	N/A	N/A	N/A	N/A
Random Effective TIP Reading	2.85 SLO/1.2 TLO	N/A	N/A	N/A	N/A
Systematic Effective TIP Reading	8.6	N/A	N/A	N/A	N/A
NEDC-32694P-A, 3DMONICORE					
GEXL R-Factor	[[ ]]	[[ ]]	[[ ]]	[[ ]]	[[ ]]
Random Effective TIP Reading	2.85 SLO/1.2 TLO	2.85 SLO/1.56 TLO	2.85 SLO/1.2 TLO	2.85 SLO/1.29 TLO	2.85 SLO/1.2 TLO
TIP Integral	[[ ]]	[[ ]]	[[ ]]	[[ ]]	[[ ]]
Four Bundle Power Distribution Surrounding TIP Location	[[ ]]	[[ ]]	[[ ]]	[[ ]]	[[ ]]
Contribution to Bundle Power Uncertainty Due to LPRM Update	[[ ]]	[[ ]]	[[ ]]	[[ ]]	[[ ]]

Table 5. Power Distribution Uncertainties

Description	Nominal (NRC-Approved) Value ± σ (%)	Previous Cycle Minimum Core Flow Limiting Case	Previous Cycle Rated Core Flow Limiting Case	Current Cycle Minimum Core Flow Limiting Case	Current Cycle Rated Core Flow Limiting Case
Contribution to Bundle Power Due to Failed TIP	[[ ]]	[[ ]]	[[ ]]	[[ ]]	[[ ]]
Contribution to Bundle Power Due to Failed LPRM	[[ ]]	[[ ]]	[[ ]]	[[ ]]	[[ ]]
Total Uncertainty in Calculated Bundle Power	[[ ]]	[[ ]]	[[ ]]	[[ ]]	[[ ]]
Uncertainty of TIP Signal Nodal Uncertainty	[[ ]]	[[ ]]	[[ ]]	[[ ]]	[[ ]]

Table 6. Critical Power Uncertainties

Description	Nominal Value ± σ (%)	Previous Cycle Minimum Core Flow Limiting Case	Previous Cycle Rated Core Flow Limiting Case	Current Cycle Minimum Core Flow Limiting Case	Current Cycle Rated Core Flow Limiting Case
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