HITACHI

GE Hitachi Nuclear Energy

Proprietary Notice

This letter transmits proprietary information in accordance with 10 CFR 2.390. Upon the removal of Enclosures 1 and 4, the balance of the letter may be considered non-proprietary.

Lisa K. Schichlein

GE-Hitachi Nuclear Energy Americas LLC
Senior Project Manager, Regulatory Affairs
P.O. Box 780, M/C A-70
Wilmington, NC 28401 USA

T 910.819.4815
lisa.schichlein@ge.com

M190017

PROJ0710
99902024

February 13, 2019

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

Subject: Response to Request for Additional Information for NEDC-33173P, Supplement 6, Revision 0, "Applicability of GE Methods to Expanded Operating Domains - Removal of the Safety Limit Minimum Critical Power Ratio (SLMCPR) Penalty" (EPID No. L-2017-TOP-0040)

This letter transmits the GE Hitachi Nuclear Energy (GEH) responses to the Nuclear Regulatory Commission (NRC) Requests for Additional Information (RAIs) for NEDC-33173P Supplement 6. In addition, a copy of the tabulated Root Mean Square (RMS) data that is cited in the response to RAI-5 has been included.

Please note that Enclosure 1 contains proprietary information of the type that GEH maintains in confidence and withholds from public disclosure. The affidavit contained within Enclosure 3 identifies that the information contained in Enclosure 1 has been handled and classified as proprietary to GEH. GEH hereby requests that the information in Enclosure 1 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390 and 9.17. Enclosure 2 is the non-proprietary version of Enclosure 1.

Enclosure 4 contains a copy of tabulated Root Mean Square (RMS) data, which is deemed proprietary in its entirety. Thus, a non-proprietary version of Enclosure 4 has not been provided in accordance with NRC Information Notice 2009-07, Requirements for Submittals, (2), which states: "In instances in which a nonproprietary version would be of no value to the public because of the extent of the proprietary information, the agency does not expect a nonproprietary version to be submitted."

D065
NRR

If you have questions regarding the enclosed documents, please contact me.

Sincerely,

Lisa K. Schichlein

Lisa K. Schichlein
Senior Project Manager
Regulatory Affairs
GE-Hitachi Nuclear Energy Americas LLC

Docket No. 99902024
Project No. 710

No commitments are made in this letter beyond those specifically made in the RAI responses.

Enclosures:

1. Response to Requests for Additional Information – GEH Proprietary Information – Non-Public
2. Response to Requests for Additional Information – Non-Proprietary Information
3. Affidavit for Enclosure 1 dated February 2019
4. Tabulated RMS Data – CD-ROM - GEH Proprietary Information – Non-Public
5. Affidavit for Enclosure 4 dated February 2019

cc: J Golla, US NRC
M Catts, GEH/Wilmington
BR Moore, GNF/Wilmington
PLM Specification 004N4568 R1

ENCLOSURE 3

M190017

Affidavit for Enclosure 1

GE-Hitachi Nuclear Energy Americas, LLC

AFFIDAVIT

I, **Lisa K. Schichlein,** state as follows:

(1) I am a Senior Project Manager, NPP/Services Licensing, Regulatory Affairs, GE-Hitachi Nuclear Energy Americas LLC (GEH), and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Enclosure 1 of GEH letter, M190017, L. K. Schichlein (GEH) to Document Control Desk (USNRC), Subject: Response to Request for Additional Information for NEDC-33173P, Supplement 6, Revision 0, "Applicability of GE Methods to Expanded Operating Domains - Removal of the Safety Limit Minimum Critical Power Ratio (SLMCPR) Penalty" (EPID No. L-2017-TOP-0040), dated February 13, 2019. The proprietary information in Enclosure 1, entitled "Response to Requests for Additional Information", is identified by a dotted underline within double square brackets. [[This sentence is an example.{3}]] Figures and large objects containing GEH proprietary information are identified with double square brackets before and after the object. In all cases, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GEH relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for "trade secrets" (Exemption 4). The material for which exemption from disclosure is here sought also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975 F2.d 871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F2.d 1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH's competitors without license from GEH constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals aspects of past, present, or future GEH customer-funded development plans and programs, resulting in potential products to GEH;

d. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a and (4)b above.

(5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GEH, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or subject to the terms under which it was licensed to GEH.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist, or other equivalent authority for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2) is classified as proprietary because it contains detailed results and conclusions regarding GEH methods supporting evaluations of the safety-significant changes necessary to demonstrate the regulatory acceptability for the expanded power/flow operating domains including Extended Power Uprates, Constant Pressure Power Uprates, and the MELLLA+ domain for a GE BWR, utilizing analytical models and methods, including computer codes, which GEH has developed, obtained NRC approval of, and applied to perform evaluations of transient and accident events in the GEH Boiling Water Reactor ("BWR"). The development and approval of these system, component, and thermal hydraulic models and computer codes was achieved at a significant cost to GEH.

The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GEH asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this 11th day of February 2019.

Lisa K. Schichlein

Lisa K. Schichlein
Senior Project Manager
NPP/Services Licensing
Regulatory Affairs
GE-Hitachi Nuclear Energy Americas, LLC
3901 Castle Hayne Road
Wilmington, NC 28401
Lisa.Schichlein@ge.com

ENCLOSURE 2

M190017

Response to Requests for Additional Information

Non-Proprietary Information

IMPORTANT NOTICE

This is a non-proprietary version of Enclosure 1, from which the proprietary information has been removed. Portions of the enclosure that have been removed are indicated by an open and closed bracket as shown here [[ ]].

RAI-1

(High) In Limitation 5 of the SE for the interim methods licensing topical report (IMLTR) NEDC-33173P-A (Reference 1), the NRC staff imposed a penalty to the SLMCPR for MELLLA+ operation of 0.03. This adder was comprised of a 0.02 value to account for increased uncertainties in pin peaking and bundle powers at EPU operation and a 0.01 value to account for: (1) the fact that operation at lower core flow conditions at rated or EPU power levels are generally more limiting, and (2) potential changes in the uncertainties on both pin peaking and bundle power due to the higher power-to-flow ratios present in the MELLLA+ operating domain. In the SE for Supplement 2 of the IMLTR (Reference 2), the NRC staff removed the 0.02 value from Limitation 5 but retained the 0.01 value that is meant to capture potential changes in uncertainties for both pin peaking and bundle power. However, the discussion presented in Supplement 6 of the IMLTR (Reference 3) for removal of the remaining SLMCPR penalty focuses on bundle power uncertainty and does not address pin peaking uncertainty. Therefore, the justification for removal of the remaining penalty is incomplete. Provide justification that the uncertainty in pin peaking does not change with the higher power-to-flow ratios present in the MELLLA+ operating domain.

References

1. NEDC-33173P-A, Revision 4, "Applicability of GE Methods to Expanded Operating Domains," November 2012, (Agency-wide Documents Access and Management System (ADAMS) Accession No. ML12313A107 / ML12313A106 (Publically Available / Non-Publically Available)).
2. NEDC-33173P-A, Supplement 2, Parts 1-3P-A, "Applicability of GE Methods to Expanded Operating Domains – Power Distribution Validation for Confrentes," April 2012, (ADAMS Package Accession No. ML121150469 (Publically Available)).
3. NEDC-33173P, Supplement 6, Revision 0, "Applicability of GE Methods to Expanded Operating Domains – Removal of the Safety Limit Minimum Critical Power Ratio (SLMCPR) Penalty," September 2017 (ADAMS Package Accession No. ML17261A067 (Publically Available)).

GNF Response

The Nuclear Regulatory Commission (NRC) staff is correct in noting that the data presented in Supplement 6 focuses on bundle power uncertainty derived from cycle-tracking data and does not directly address pin peaking uncertainty. This is due to expectations established with the NRC regarding what type of information would be necessary to revisit the removal of the penalty. In particular, Global Nuclear Fuel (GNF) agrees with the NRC's Safety Evaluation of Supplement 2 which states that "...[postulated] anomalies associated with MELLLA+ operation ... would affect the overall transport solution methodology and would be observable in detailed TIP comparisons.

Therefore, the NRC staff will revisit Limitation 5 during its review of the MELLLA+ cycle-tracking evaluation that will be provided by GEH."

Further confidence in the use of current pin power peaking uncertainties in the Maximum Extended Load Line Limit Analysis Plus (MELLLA+) domain can be obtained by investigating the performance of GNF methods in MCNP to TGBLA infinite lattice peaking comparisons. One good historical example to consider can be found in Figure 2-1 and Figure 2-2 of Supplement 3 of the IMLTR, which are shown below. In these figures, data is provided on pin power uncertainty at both Beginning of Cycle (BOC) and 65 GWD/STU lattice average exposures. The data is plotted as a function of relative water density, and discrete lattice designs for GNF2 are called out explicitly in the figures.

Of particular interest from a MELLLA+ performance perspective are [[ ]] data points at high void conditions ([[ ]]). These data points correspond to the lattice design at the very top of the assembly. This portion of the assembly will experience the highest void fraction and would be most affected by any trend in void with high core-wide Power-to-Flow (P/F) ratios.

The TGBLA to MCNP benchmarking results provided indicate that pin power peaking uncertainty is actually at or near its lowest reported value for these conditions. While some upward trending as a function of relative water density is observed in Figure 2-2, the absolute value of the comparisons at these late exposures is considerably lower than the corresponding BOC points for all void fractions.

In summary, the fact that (1) any potential anomalies in the overall transport solution method (including pin power peaking) would be observable in the detailed Traversing In-Core Probe (TIP) comparisons provided, and (2) TGBLA to MCNP pin power benchmarking results, showing excellent performance near the top of the assembly that would actually experience the highest voids, provides justification that the uncertainty in pin peaking does not change with the higher P/F ratios present in the MELLLA+ operating domain.

[[

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Figure 2-1 TGBLA06 Fission Density Benchmark for GNF2, at BOC

[[

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Figure 2-2 TGBLA06 Fission Density Benchmark for GNF2, at 65 GWD/MT

RAI-2

(Low) During examination of supporting documentation for Supplement 6 of the IMLTR, the NRC staff observed discrepancies in terminology and uncertainty values, and the staff is seeking clarification. Five different requests for clarification are presented within this RAI. For purposes of fully understanding the source of the NRC staff's requests for clarification on pin power uncertainty terminology and the values associated with the uncertainties, it is beneficial to begin with the IMLTR, Revision 1 (Reference 0) and proceed "backward" into the historical supportive documentation. This discussion is presented below with the request for clarification identified throughout. Additionally, the requests for clarification are compiled in a summary at the end of this RAI for ease of reference.

NEDC-33173P-A, Revision 1:

Page 2-4 of Revision 1 of the IMLTR (Reference 0) describes uncertainty associated with what is referred to as "*local pin peaking factor*" and states it is primarily associated with the lattice code TGBLA. Page 2-5 of the IMLTR goes on to state that the 1σ uncertainty was evaluated to be [[ ]] in NEDE-32601P-A based on comparisons with MCNP Monte Carlo evaluations. At this point, no symbol has been defined for the parameter, but one may see that "local pin peaking factor uncertainty = [[ ]]".

Page 2-5 of the IMLTR, Revision 1, also discusses an "*overall pin peaking uncertainty*", indicating it is comprised of [[ ]], and that it was confirmed via comparison to [[ ]] measurements. However, the discussion on page 2-5 subsequently discusses how the standard deviation between TGBLA and MCNP pin powers for GE11, GE14, and several Non-GE fuel designs are all similar (Table 2-4 of the IMLTR). As a result, the NRC staff's understanding is that, because reference is being made to TGBLA and MCNP comparisons and the results are consistent with [[ ]], the discussion within the IMLTR at this point has shifted back to "*local pin peaking factor uncertainty.*"

At the top of Page 2-6 of the IMLTR, Revision 1, the discussion of additional pin power uncertainty on the determination of SLMCPR begins. It indicates that a review of [[ ]]. The NRC staff infers from this that the discussion is now in reference to "*overall pin peaking uncertainty*" as this is the uncertainty associated with comparisons to [[ ]]. However, the IMLTR, Revision 1, does not explicitly state whether it is the "*local pin peaking factor uncertainty*" or the "*overall pin peaking uncertainty*" that is [[ ]]. The IMLTR simply states that the resultant effects on the SLMCPR due to [[ ]].

Safety Evaluation for NEDC-33173P-A, Revision 1:

The IMLTR, Revision 1, did not explicitly state which of the uncertainties [[ ]]. The NRC staff therefore examined the SE (Reference 0) associated with the IMLTR, Revision 1.

Section 3.2.2.2, page 27, 4th full paragraph of the SE for the IMLTR, Revision 1, discusses a "*peak pin uncertainty*" and associates with it the symbol "σ_{Ppeak}". Since the discussion in the SE mentions how this was [[ ]], the NRC staff infers "σ_{Ppeak}" to be the "*overall pin peaking uncertainty*" discussed in the IMLTR, Revision 1.

In the following paragraph (5th full paragraph on page 27) of the SE, the discussion of [[ ]] begins. Again, making reference to [[ ]] suggests, just as in the IMLTR, that the uncertainty [[ ]] is the "*overall pin peaking uncertainty,*" or "σ_{Ppeak}". The SE goes on to state that the uncertainty [[ ]].

This is the first of the NRC staff's requests for clarification regarding terminology. Based on the IMLTR and associated SE, it is σ_{Ppeak}, otherwise known as the "*overall pin peaking uncertainty,*" that is [[ ]]. However, it would seem that [[ ]], is that of the "*local pin peaking factor uncertainty*" as identified on Page 2-5 of the IMLTR. This appears to be a discrepancy in the documentation.

The NRC staff considered that σ_{Ppeak} and the "*local pin peaking factor*" may possess the same values, but based on examination of NEDC-32694P-A (discussed below), σ_{Ppeak} has a nominal value of [[ ]].

<u>NEDC-32601P–A, Revision 0:</u>

Page 2-5 of the IMLTR, Revision 1, indicates the "*local pin peaking factor uncertainty*" is assessed in NEDC-32601P-A (Reference 0). This document was examined to further inform the NRC staff's understanding.

Page 3-1 of NEDC-32601P-A discusses the uncertainty in pin power peaking factor. Section 3.1 identifies that "*total uncertainty in fuel pin power peaking factor*" is defined as:

[[

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If correct, this would mean σ_{peak} is consistent with the definition of "*overall pin peaking uncertainty*" as identified on Page 2-5 of the IMLTR. This would then suggest σ_{peak} as defined above and σ_{Ppeak} from the SE for the IMLTR are the same parameter and possess a value of [[ ]]. The above equation also suggests that "*local pin power peaking uncertainty*" as discussed on page 2-5 of the IMLTR is [[ ]].

This is the second of the NRC staff's requests for clarification concerning terminology. Are σ_{peak} and σ_{Ppeak} the same parameter, and is [[ ]] the "*local pin power peaking uncertainty*" whose value is [[ ]]?

NEDC-32694P-A, Revision 0:

NEDC-32694P-A (Reference 0) is also referenced by the IMLTR, Revision 1, and was examined to further the NRC staff's understanding of uncertainties associated with pin peaking.

Page A-9 of NEDC-32694P-A provides a discussion on "*pin power peaking uncertainty*". This discussion indicates the uncertainty can be determined from the factors summarized in Section 3 of NEDC-32601P (discussed above). Specifically, [[

]]

This is consistent with the discussion presented in NEDC-32601P-A for "*total uncertainty in fuel pin power peaking factor*". This suggests that the "*pin power peaking uncertainty*" discussed in NEDC-32694P-A and the "*total uncertainty in fuel pin power peaking factor*" discussed in NEDC-32601P-A are the same parameter and are given the symbol σ_{peak}. Additionally, this suggests [[ ]]. However, the values of σ_{peak} and [[ ]] vary from one document to the other.

This is the third of the NRC staff's requests for clarification. [[

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The Fourth of the NRC Staff's Requests for Clarification:

Based the discussion presented above, it appears to the NRC staff that the IMLTR, Revision 1, is [[ ]]. However, based on the IMLTR, Revision 1, not specifically identifying [[ ]] and the SE associated with the IMLTR, Revision 1, it is the NRC staff's understanding that [[ ]]. Examination of both NEDC-32601P-A and NEDC-32694P-A suggests that the value of [[

]].

If the NRC staff's understanding is correct that the IMLTR, Revision 1, is [[ ]], then the NRC staff acknowledges that [[

]]. However, the NRC staff is not aware of a discussion justifying this position and is seeking such a discussion.

The Fifth of the NRC Staff's Requests for Clarification:

Section 3 of NEDC-32601P-A discusses the uncertainty associated with R-Factor. NEDC-32601P-A indicates it is [[

]] Given the clarification requested above regarding [[
]], clarify whether the R-factor uncertainty discussed in Section 3 of NEDC-32601P-A is [[
]].

Summary:

Below is a table summarizing the various terminology within the examined documents, its source, and the NRC staff's understanding of what the terms are. Short descriptions of the NRC staff's requests for clarification are also provided after the table.

Table 2-1: NRC Staff's Understanding of Various Uncertainty Terminology

Terminology	Source	Symbol	NRC Staff's Understanding
Local pin peaking factor uncertainty	NEDC-33173P-A, Revision 1, Page 2-4	None Provided	[[
Overall pin peaking uncertainty	NEDC-33173P-A, Revision 1, Page 2-5	None Provided	
Peak pin uncertainty	SE for NEDC-33173P-A, Revision 1, Page 27	σ_{Ppeak}	

Terminology	Source	Symbol	NRC Staff's Understanding
Total uncertainty in fuel pin power peaking factor	NEDC-32601P-A, Revision 0, Page 3-1	σ_{peak}	
Infinite Lattice Peaking Uncertainty	NEDC-32601P-A, Revision 0, Page 3-2	[[ ]]	
Pin power peaking uncertainty	NEDC-32694P-A, Revision 0, Page A-9	σ_{peak}	
Pin peaking uncertainty determined from Monte Carlo comparisons	NEDC-32694P-A, Revision 0, Page A-9	[[ ]]	]]

NRC Staff's requests for clarification:

1) Is the NRC staff's understanding of the various terminology presented in Table 2-1 correct?
2) Are σ_{peak} and σ_{Ppeak} the same parameter?
3) [[
]]
4) If the discussion provided in the IMLTR, Revision 1, [[
]] If it is only necessary [[
]], what is the justification for [[
]]
5) Is the R-factor uncertainty that is discussed in Section 3 of NEDC-32601P-A [[
]]

References

4. NEDC-32601P-A, "Methodology and Uncertainties for Safety Limit MCPR Evaluations," August 1999 (ADAMS Accession No. ML003740145 (Non-Publically Available)).
5. NEDC-33173P-A, Revision 1, "Applicability of GE Methods to Expanded Operating Domains," November 2012, (ADAMS Accession No. ML102920140 (Non-Publically Available)).
6. NEDC-32694, Revision 0, "Power Distribution Uncertainties for Safety Limit MCPR Evaluations," August 1999, (ADAMS Accession No. ML003740151 (Non-Publically Available)).

GNF Response

GNF response to requests for clarification (1) and (2):

The Nuclear Regulatory Commission (NRC) staff's interpretation of the terminology presented in Table 2-1 appears to be correct. In those cases where the NRC was the author of the terminology used (in the referenced Safety Evaluation (SE)), Global Nuclear Fuel (GNF) infers the same meaning inferred by the NRC staff. In particular, GNF agrees that the NRC staff's use of the symbol σ_{Ppeak} (in the SE of NEDC-33173P-A Revision 1) agrees with GNF's use of the symbol σ_{peak} (in NEDC-32601P-A Revision 0). The most precise terminology with respect to power uncertainty components can be found in Table 2-14 of NEDC-33173P-A Revision 1, or the most recent revision NEDC-33173P-A Revision 4, while the meaning of less precise terminology, when used, must be inferred based on full context.

GNF response to request for clarification (3):

The correct value of the [[ ]], as reported in Revision 0 of NEDC-33173P, and in the most recent revision, NEDC-33173P-A Revision 4. The value of [[ ]] is the correct original value reported in NEDC-32601P-A and is associated with the original [[ ]] overall peak pin uncertainty value. The value of [[ ]] for this uncertainty component was incorrect and appears to have been originally reported in NEDC-32694P-A Revision 0 RAI II.5 (Reference 2-1). Subsequent references to this [[ ]] value and the [[ ]] were incorrect. The correct value for the overall peak pin power uncertainty, σ_{peak}, for current plant-specific Safety Limit Minimum Critical Power Ratio (SLMCPR) calculations is the value of [[ ]].

GNF response to request for clarification (4):

The application of the postulated increased uncertainty in NEDC-33173P-A Revision 1, from [[ ]] was the subject of a former SE which approved the application and is not the subject of the current submittal. The increase to the component uncertainty was removed with the addition of data in the subsequently approved Supplement 2 of NEDC-33173P-A (See Table 3-14 of NEDC-33173P-A Revision 4), and the

discussion of the referenced interim approach was therefore removed from the most recently approved NEDC-33173P-A Revision 4.

The following discussion is provided to assist the NRC in consolidating historical context. The NRC's SE for NEDC-33173P Revision 0 (February 10, 2006) identifies the interim measure used by General Electric (GE), in the approved NEDC-33173P-A Revision 1 of that document, to account for a possible increase in pin power uncertainty. The reason for this interim approach was to account for potential additional uncertainties in pin power uncertainty as modern fuel types were not represented in the original gamma scan data. This approach led to additional safety limit margin by means of treating the existing data with a more conservative statistical treatment than approved in the SLMCPR methodology.

Table 2-14 of NEDC-33173P-A Revision 4 shows that the [[ ]] value was decreased to its original value of [[ ]] in what is referred to as NEDC-33173P Revision 2, which is described in the text as reflecting changes motivated by additional confirmatory data of Supplement 2 of the IMLTR. Supplement 2 provided the basis for removing the artificially introduced increased pin power uncertainty [[ ]], which is captured in the referenced table.

The following is a discussion of [[

]]

The above information was provided for clarification of historical context, by reference to historical documents.

GNF response to request for clarification (5):

The [[ ]] uncertainty that is discussed in Section 3 of NEDC-32601P-A is solely dependent upon the uncertainty [[ ]].

References

2-1 GE Nuclear Energy, "Power Distribution Uncertainties for Safety Limit MCPR Evaluations," NEDC-32694P-A, August 1999.

2-2 Letter, J. S. Charnley (GE Nuclear Energy) to NRC Document Control Desk, "Fuel Channel Bow Assessment," MFN086-89, November 15, 1989.

2-3 Letter, Ashok C. Thadani (NRC) to J. S. Charnley (GE Nuclear Energy), "Acceptance for Referencing of Topical Report Titled "GE-Nuclear Energy Report MFN086-89"," MFN 014-91, January 11, 1991.

2-4 Letter, J. S. Charnley (GE Nuclear Energy) to NRC Document Control Desk, "Responses to Channel Bow Questions," MFN-041-90, May 3, 1990.

2-5 Letter, Robert J. Wanczyk (Entergy) to NRC Document Control Desk, "Vermont Yankee Nuclear Power Station Technical Specification Proposed Change No. 263 - Supplement No. 30 Extended Power Uprate - Response to Request for Additional Information," BVY 05-072, August 1, 2005.

RAI-3

(Moderate) Section 2.0 of Supplement 6 of the IMLTR states, [[ ]] with respect to exposure is expected". However, no explanation is provided to qualify this statement. The [[ ]] with respect to exposure is also exhibited in [[ ]]. An [[ ]] with respect to exposure could be indicative of difficulty in accurately predicting plutonium accrual and removal. This will be exacerbated by operation at MELLLA+ conditions due to the greater amount of plutonium generated by the harder neutron spectrum that is present. Given that higher power-to-flow ratios exhibit increasingly harder neutron spectrums, a possible [[ ]] with power-to-flow ratio could manifest. This would be in opposition to the approach presented in Supplement 6 for justifying removal of the SLMCPR penalty: [[ ]]. Provide an explanation for [[ ]] with exposure, and provide justification that the phenomena underlying [[ ]] will not ultimately manifest as [[ ]] with increasing power-to-flow ratio.

GNF Response

NEDC-32694P-A RAI II.3 (Reference 3-1) provides historical context for this expectation of [[ ]] with respect to exposure. The focus on [[ ]] with respect to the Safety Limit Minimum Critical Power Ratio (SLMCPR) calculation is justified in Section 2 of the Supplement 6 submittal. Namely, thermal margins to limits, including the Minimum Critical Power Ratio (MCPR), are computed using the [[ ]]. Thus, the [[ ]] is the sole component of the [[ ]] that affects the SLMCPR calculation.

[[ ]] are shown on the following pages. With respect to exposure, no discernible exacerbation of the [[ ]] in the MELLLA+ domain (RMS_MP) compared to the non-MELLLA+ domain (RMS_nMP) is observed.

This consistent behavior with respect to exposure, in combination with TIP measurements in the Supplement 6 submittal showing [[ ]] with respect to the Power-to-Flow (P/F) ratio, justifies that the phenomena underlying the [[ ]] will not ultimately manifest as a [[ ]] with increasing P/F ratio.

Reference

3-1 GE Nuclear Energy, "Power Distribution Uncertainties for Safety Limit MCPR Evaluations," NEDC-32694P-A, August 1999.

[[

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RAI-4

(Moderate) Of the data plotted in each of Figures 2-1 through Figure 2-12 in Supplement 6 of the IMLTR, approximately [[ ]] are associated with operation in the MELLLA+ domain. Of these data points, [[ ]] are associated with power-to-flow ratios greater than 42 MWt/(Mlbm/hr). The approach presented in Supplement 6 to justify removal of the SLMCPR penalty is [[ ]]. Provide justification that [[ ]] are statistically sufficient for demonstrating no adverse trends exist at power-to-flow ratios greater than 42 MWt/(Mlbm/hr).

GNF Response

As discussed in the pre-submittal meeting, the [[ ]] above the 42 MWt/(Mlbm/hr) were all collected as part of Maximum Extended Load Line Limit Analysis Plus (MELLLA+) startup testing. It is not typical for currently operating MELLLA+ plants to operate significantly above this Power-to-Flow (P/F) ratio, and therefore, the ability to collect additional data in this area of the P/F map is limited.

The [[ ]] above 42 MWt-hr/Mlbm are a subset of the overall population of Traversing In-Core Probe (TIP) Root Mean Square (RMS) data used to assess trends. The cutoff of 42 MWt-hr/Mlbm was identified as an upper bound of the previously submitted TIP RMS measurement data, not reflecting or implying any expected discontinuity in trending of physical data. Truncating the data population by removing points below 42 MWt-hr/Mlbm artificially neglects the majority of the basis for assessing trending; therefore, the entire data population is used to assess trends.

However, it is important to emphasize that [[

]] can therefore be considered statistically reliable for the corresponding core state and time of measurement. As discussed in Supplement 6 and as shown in Figure 2-13 through 2-15 in Supplement 6, these implementation tests provide outstanding data to look for trending as a function of P/F ratio in the MELLLA+ domain because they represent TIP comparisons where little is changing except for this ratio.

RAI-5

(Low) The plots of data in each of Figure 2-1 through Figure 2-12 in Supplement 6 of the IMLTR are too condensed for the NRC staff to thoroughly assess applicability of the data to MELLLA+ operating conditions and potential trends with power-to-flow ratio and void fraction. For the data points labeled as MELLLA+ in these figures, tabulate the RMS data with power, flow, exposure, core average void fraction, exit void fraction, and the average RMS used for normalization.

GNF Response

The requested data table is provided in the Excel file in Enclosure 4.

RAI-6

(High) The response to RAI SRXB-A-27 of letter BVY 05-072 for the review of the Vermont Yankee extended power uprate (Reference 1) discusses power distribution acceptance criteria. These acceptance criteria are listed as [[ ]] for radial TIP RMS%, [[ ]] for axial TIP RMS%, and [[ ]] for nodal TIP RMS%. Analysis of the tabulated data supplied in the response to RAI-5 of the initial round of RAIs indicates the average weighted axial and nodal TIP RMS% for all these data are [[ ]], respectively. If the data are broken down by thermal TIP and gamma TIP, then weighted axial and nodal TIP RMS% are respectively [[ ]] for the gamma TIP and [[ ]] for the thermal TIP. In each of these cases, the average weighted axial and nodal TIP RMS% exceed the referenced acceptance criteria. Additionally, when comparing the tabulated data to the historical database as presented in the interim methods topical report (IMLTR, Reference 2) and Supplement 2 of the IMLTR (Reference 3), the historical data meet the acceptance criteria. The NRC staff acknowledges that, as discussed in the response to RAI SRXB-A-27, the nodal TIP RMS% are not reflected in any licensing analysis. Nevertheless, the response also indicates any nodal RMS values greater than the [[ ]] "criterion" observed consistently require further explanation and review of the nuclear methods accuracy, and the NRC staff has observed that approximately [[ ]] supplied in the tabulated data for Supplement 6 exceed the criterion. This suggests the data provided in Supplement 6 do not fully support the continued adequacy of the nuclear methods, and the data are therefore inappropriate to justify the complete removal of the remaining SLMCPR penalty. Provide justification that the average weighted axial and nodal TIP RMS% of the Supplement 6 data demonstrate continued adequacy of the nuclear methods (and are acceptable for justifying the complete removal of the remaining SLMCPR penalty) despite exceeding the referenced acceptance criteria and their inconsistency with the performance of the historical database.

References

1. Entergy Letter (BVY 05-072) to NRC dated August 1, 2005, "Vermont Yankee Nuclear Power Station, Technical Specification Proposed Change No. 263, Supplement No. 30, Extended Power Uprate – Response to Request for Additional Information," (ADAMS Accession No. ML052170310 (Non-Publically Available))

2. NEDC-33173P-A, Revision 4, "Applicability of GE Methods to Expanded Operating Domains," November 2012, (Agency-wide Documents Access and Management System (ADAMS) Accession No. ML12313A107 / ML12313A106 (Publically Available / Non-Publically Available)).

3. NEDC-33173P-A, Supplement 2, Parts 1-3P-A, "Applicability of GE Methods to Expanded Operating Domains – Power Distribution Validation for Confrentes," April 2012, (ADAMS Package Accession No. ML121150469 (Publically Available)).

GNF Response

GNF's response is broken into three main components:

(1) Clarification on Threshold Value Used to Define "High" Axial and Nodal TIP RMS

(2) Justification for Acceptability of High Average Weighted Nodal TIPs in Supplement 6

(3) Demonstration of Continued Adequacy of Nuclear Methods

Clarification on Threshold Value Used to Define "High" Axial and Nodal TIP RMS

The values cited by the Nuclear Regulatory Commission (NRC) staff of [[ ]] for axial Traversing In-Core Probe (TIP) Root Mean Square (RMS) %, and [[ ]] for nodal TIP RMS% were not intended to be applied as acceptance criteria on a plant specific basis, and exceeding these values consistently in a subset of nuclear plants does not signify inadequacy of the nuclear methods for the purpose of Safety Limit Minimum Critical Power Ratio (SLMCPR) evaluations.

To support this statement, it is first important to note that the value of [[ ]] is cited incorrectly as a criteria related to axial TIP RMS in RAI-6; instead, it was originally observed in the response to Request for Additional Information (RAI) SRXB-A-27 of BVY 05-072 (Reference 6-1) that the average RMS difference (nodal implied) of all predicted to measured TIP responses is less than [[ ]] for the reference Boiling Water Reactors (BWRs). Thus, the [[ ]] value was never meant to be compared against either axial or nodal TIP RMS, but was merely a statement of observation.

Secondly, it is noted that the response to SRXB-A-25 of BVY 05-072 (Reference 6-1) provides a discussion on the topic of how methods uncertainty quantification has historically been developed and approved for use. In this response, it is emphasized that the use of an average RMS over a number of plants is the appropriate approach for quantifying overall methods performance and associated uncertainty. This is the case because of plant-to-plant variability that is observed in TIP comparisons, the causes of which are discussed in detail in Section 1.1 of Supplement 6. This point is reemphasized here because it is important to consider when trying to draw conclusions about overall methods adequacy over a subset of plants. These subsets are useful to help understand if trends exist in methods performance as a function of independent variables (e.g., power/flow as is done in Section 2, and particularly in Figure 2-13 through Figure 2-15, of Supplement 6); however, care should be taken when trying to compare a subset of TIP comparisons from a new population of plants to historical method performance observations on an absolute basis so as not to assign differences that are expected in plant-to-plant variability to differences in methods behavior.

Finally, and as noted in the RAI itself, [[

]].

As stated in the General Electric (GE) response to SRXB-28 of BVY 05-072 (Reference 6-1), [[

]]. The discussion of [[

]] is therefore not relevant to the current analysis supporting removal of the entire SLMCPR penalty.

Justification for Acceptability of High Average Weighted Nodal TIPs in Supplement 6

It is clear from RAI-6 that the additional data provided in RAI-5 has been processed by the NRC and has led to a desire for additional quantitative evidence for the appropriateness of the removal of the remaining SLMCPR penalties in the Maximum Extended Load Line Limit Analysis Plus (MELLLA+) domain. This section provides an expanded quantitative basis in the form of a relative comparison of TIP RMS values for non-MELLLA+ data points to MELLLA+ points to identify any deviation that might characterize the extended domain.

Table 6-1 provides a comparison of the total TIP RMS in non-MELLLA+ operational domain versus TIP RMS for the MELLLA+ operational domain. It includes up-to-date exposure accounting information beyond that which was included in Supplement 6, with a total of [[ ]] MELLLA+ TIP points presented at the most recent NRC Technology Update (August 2018) out of a total of [[ ]] data points.

Table 6-1. Quantification of Methods Performance – MELLLA+ vs. Non-MELLLA+

	Include	TIP Type	TIP RMS	Non-MELLLA+	#Non-MELLLA+	MELLLA+	# MELLLA+	MELLLA+ - Non-MELLLA+ (%)
Radial	[[	n	[[					
		n						
		g						
	]]	g						
	All							
	Gamma							
	Thermal							
Axial	[[	n						
		n						
		g						
	]]	g						
	All							
	Gamma							
	Thermal							
Nodal	[[	n						
		n						
		g						
	]]	g						
	All							
	Gamma							

	Include	TIP Type	TIP RMS	Non-MELLLA+	# Non-MELLLA+	MELLLA+	# MELLLA+	MELLLA+ - Non-MELLLA+ (%)
	Thermal							]]

The following SLMCPR-related points are noted from a review of this table:

1) Radial RMS values are generally consistent with the small population of historically reported values for thermal TIPs in MFN 05-029 (Reference 6-2) RAI-25 in both the MELLLA+ and non-MELLLA+ domain.

2) Radial RMS values for gamma TIPs are always within the expected [[ ]] value, and are generally consistent ([[ ]]) in the MELLLA+ domain compared to the non-MELLLA+ domain.

The consistent behavior of radial RMS comparisons in the MELLLA+ domain, and no evidence to suggest any adverse trending of radial RMS as a function of power/flow, justifies the complete removal of the remaining SLMCPR penalty for MELLLA+ operation.

In addition, the following non-SLMCPR-related points are noted:

3) Axial and nodal RMS values are generally consistent with the small population of historically reported values for thermal TIPs in MFN 05-029 (Reference 6-2) RAI-25 in both the MELLLA+ and non-MELLLA+ domain.

4) Axial and nodal RMS values are larger than historically reported values for gamma TIP reactors. The axial RMS in the MELLLA+ domain is slightly higher than the nominal RMS for Peach Bottom Unit 2 and significantly lower for Peach Bottom Unit 3 data. On average, the axial RMS is [[ ]] lower in the MELLLA+ domain.

It is important to emphasize that the [[ ]] gamma TIP plants from which the Supplement 6 TIP RMS data originated are unique in that their nodal TIP RMS statistics are consistently higher than the fleet average both before and after implementation of extended operating domains. In fact, no other plants in the fleet with gamma TIP instrumentation have exceeded the [[ ]] cycle average nodal TIP RMS level of concern in the last five available cycles. If a degradation of nuclear methods accuracy had occurred at any point, whether within extended operating domains or not, high TIP RMS statistics would be observed more generally across the nuclear fleet, especially in reactors with similar characteristics and similar fuel design loadings. This is further investigated in the final portion of this response.

<u>Demonstration of Continued Adequacy of Nuclear Methods</u>

The expanded comparisons suggested above are provided in the following evaluations.

First, TIP RMS statistics for Plants A, B, and C described in MFN 05-029 (Reference 6-2) RAI-25 were updated as provided in Table 6-2. These values provide an updated look at methods performance on a basis consistent with the historical database. No consistent degradation in TIP RMS statistics of these gamma TIP instrumented plants is observed in the time since those submittals, demonstrating consistency with the performance of the historical database.

Table 6-2. Nodal TIP RMS Statistics Update for Select Gamma TIP Plants

Plant	BWR Type	# of Bundles	Power Density	Legacy Nodal Average % RMS	Cycle Range	N	New Nodal Average % RMS	Cycle Range	N
A	BWR/4	368	58.7	[[	18-19	15	[[	19-24	86
B	BWR/6	748	56.8		9-10	44		13-17	90
C	BWR/4	240	51.7	]]	30	24	]]	41-45	70

Second, a similar plant to the [[ ]] has also been evaluated to understand if there is some plant-type specific behavior that [[ ]] data is demonstrating. This similar plant is hereafter named Plant G. Plant G is considered extremely similar to the [[ ]] because, like the [[ ]], it is a [[ ]] bundle core and has [[ ]] TIP instrumentation.

The rated power density of the Plant G cycles evaluated is 56.8 kW/L, which is higher than the pre-Extended Power Uprate (EPU) and pre-MELLLA+ power density of [[ ]] (pre-EPU and pre-MELLLA+ TIP statistics comprise 7 of 10 cycles evaluated below for the [[ ]]).

TIP RMS statistics are generated for Plant G for the last four completed cycles and are shown in Figure 6-1 as compared to the [[ ]] last five completed cycles. [[ ]] are the first cycles in which both EPU and MELLLA+ were implemented.

Visual examination of Figures 6-2 and 6-3 shows that no trending over cycles in TIP statistics is observed for Plant G or for the [[ ]]. This further illustrates that the high TIP RMS statistics seen in the [[ ]] are unique to [[ ]], does not reflect degraded nuclear methods accuracy, and demonstrates consistent performance with the historical database.

<u>References</u>

6-1 Letter, Robert J. Wanczyk (Entergy) to NRC Document Control Desk, "Vermont Yankee Nuclear Power Station Technical Specification Proposed Change No. 263 - Supplement No. 30 Extended Power Uprate - Response to Request for Additional Information," BVY 05-072, August 1, 2005.

6-2 Letter, Louis M. Quintana (GE Energy) to NRC Document Control Desk, "Responses to RAIs – Methods Interim Process (TAC No. MC5780)," MFN 05-029, April 8, 2005.

[[

]]

Figure 6-1. Nodal TIP RMS Comparison of Similar Plants

[[

]]

Figure 6-2. Nodal TIP RMS for Plant G

[[

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Figure 6-3. Nodal TIP RMS for Peach Bottom Units 2 and 3

RAI-7

(Moderate) Analysis of variance tests performed on the tabulated data supplied in the response to RAI-5 of the initial round of RAIs indicates the subsets of data belonging to thermal TIP plants constitute significantly different uncertainty distributions compared to that of the gamma TIP data subsets. The thermal radial TIP RMS% data subsets exhibit [[ ]] than that of the gamma radial TIP RMS% data subsets, [[ ]], suggesting thermal TIP plants may possess [[ ]] in comparison to gamma TIP plants. However, an assessment of the bundle power uncertainty evaluation described in NEDC-32694P-A (Reference 4) indicates the [[ ]] is a calculational uncertainty. That is, it is an uncertainty due solely to the calculational variability of the code methods when predicting bundle power, making it equally applicable to both thermal TIP and gamma TIP plants. Ideally, its value would not contain a measurement uncertainty component, and after examining the NEDC-32694P-A evaluation, it is the NRC staff's understanding that [[ ]]. Therefore, the disparity between the thermal and gamma radial Tip RMS% weighted means in the Supplement 6 data is due in part to the increased instrumentation (measurement) uncertainty that thermal TIP detectors have compared to gamma TIP detectors. This increased instrumentation uncertainty must be properly accounted for in GE's methods to accurately determine the margin to thermal limits.

NRC staff examined the SLMCPR method presented in NEDC-32601P-A (Reference 5) and identified TIP integral instrument uncertainty is [[ ]] and TIP random reading uncertainty is [[ ]]. These values are tabulated in Table 2.1 of NEDC-32601P-A. Figure 4.1 of NEDC-32601P-A indicates [[ ]]. However, to the best of the NRC staff's knowledge, the TIP values tabulated in Table 2.1 and [[ ]] have been determined for gamma TIP detectors. For plants operating in the MELLLA+ domain, it is necessary the correct TIP instrumentation uncertainties be applied. Quantify the instrumentation uncertainties associated with thermal TIP detectors. Conversely, provide justification that the existing TIP instrumentation uncertainties are applicable to thermal TIP detectors and justify that the disparity observed between thermal and gamma radial TIP RMS% does not constitute increased uncertainty in the determination of margin to thermal limits for thermal TIP plants.

References

4. NEDC-32694P-A, Revision 0, "Power Distribution Uncertainties for Safety Limit MCPR Evaluation," August 1999 (ADAMS Accession No. ML003740151 (Non-Publically Available)).

5. NEDC-32601P-A, "Methodology and Uncertainties for Safety Limit MCPR Evaluations," August 1999 (ADAMS Accession No. ML003740145 (Non-Publically Available)).

GNF Response

NEDO-20340 (Reference 7-1) discusses the relevant Traversing In-Core Probe (TIP) signal uncertainty (Section 3.1.2.1) instrument measurement uncertainty of 2.6%, which is a statistical superposition of the TIP geometrical (2.3%) and random noise uncertainties (1.2%). In the General Electric (GE) response to Request No. 7 of NEDO-20340 Amendment 1 (Reference 7-2), Oyster Creek is identified as the source of both the random and geometrical TIP signal uncertainties. The Oyster Creek reactor has a thermal TIP system. Therefore, the random noise and geometric mislocation TIP uncertainties of concern are conservative when applied to gamma detectors and representative of thermal TIP detectors.

References

7-1 General Electric Company, "Process Computer Performance Evaluation Accuracy," NEDO-20340, June 1974.

7-2 General Electric Company, "Process Computer Performance Evaluation Accuracy Amendment 1," NEDO-20340-1, December 1974.