ENCLOSURE 2

M200074

Fulfillment of Limitation & Condition 23 for NEDC-33173P

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 [[ ]].

1. Purpose and Scope

The purpose of this letter report is to document the fulfillment of Limitation and Condition (L/C) 23 of NEDC-33173P (Reference 1). This L/C states:

> *In the first plant-specific implementation of MELLLA+, the cycle-specific eigenvalue tracking data will be evaluated and submitted to the NRC to establish the performance of nuclear methods under the operation in the new operating domain. The following data will be analyzed:*
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> - *Hot critical eigenvalue*
> - *Cold critical eigenvalue*
> - *Nodal power distribution (TIP Nodal RMS)*
> - *Bundle power distribution (TIP Radial RMS)*
> - *Thermal margins (3DM vs. offline)*
> - *Core flow and pressure drop uncertainties*
> - *Minimum Critical Power Ratio Importance Parameter (MIP)*

GEH's intended path forward to satisfy this L/C was clarified in a subsequent letter to the NRC (Reference 2). The Reference 2 letter also proposed to eliminate the MIP parameter from consideration. This letter was accepted by the NRC as documented in Reference 3.

Based on guidance in the Reference 2 letter, GEH has been providing and discussing Nuclear Methods performance in the MELLLA+ (Reference 4) domain for the parameters described above at annual NRC Technology Updates meetings. At this time, and as discussed in the 2019 Technology Update (Reference 5), sufficient information is available to provide the final data analysis to close this L/C requirement.

2. Comparison Approach

The nuclear power plants that have implemented MELLLA+ and are part of this comparison summary are identified in the plots by their alphanumeric label and their short names as follows:

- Monticello (EK1),
- Peach Bottom 2 (HE2)
- Peach Bottom 3 (HE3),
- Nine Mile Point 2 (KG1) and
- Grand Gulf (JB1)

The important parameters for the evaluation have been continuously discussed with the NRC staff over the course of several years with the most recent occasion being the Technology Update meeting held in July 2019. During these discussions, it was noted that the presentation of requested metrics based on operational data in the MELLLA+ domain has limited value without historical

context. Because of this, for each metric being compared the following is provided to help establish Methods performance on a comparative basis:

- Fleet data from IMLTR (Reference 2) or MELLLA+ submittals (if applicable)
- Previous 3 cycles of information for each plant
- Highlighted points where any cycle was operating in the MELLLA+ domain
  - Cold eigenvalues highlighted if any point in cycle is MELLLA+

The eigenvalues for several plants, at cold and hot reactor conditions, are presented in the attached plots as a function of core average exposure. The thermal margins (MFLCPR, MFLPD and MAPRAT) are presented also as a function of core average exposure. The definitions of the thermal margin parameters are as follows:

- MFLPD: maximum fraction of linear power density: ratio of the maximum rod linear heat generation rate (MLHGR) to the LHGR limit. This is based on the peak linear heat generation rate for any particular fuel rod.
- MAPRAT: ratio of maximum average node planar linear heat generation rate to the LOCA limit. This is a measure of the nodal power, as it is the average linear heat generation rate of all fuel pins at that axial elevation for that bundle.
- MFLCPR: maximum fraction of limiting critical power ratio (proportional to the inverse bundle power).

The ratio of On-line Core Monitoring System (noted as 3DM) to PANAC11 off-line evaluation – or "bias" – is presented.

The power distributions assessment uses Traversing In-Core Probe (TIP) statistics that include nodal and radial Root Mean Square (RMS) values of plant measured/calculated data as a function of core average exposure and void fraction, core exit void fraction and power-to-flow ratio (P/F in units of MWt - hr/Mlbm).

Plots for core flow and pressure drop uncertainties are separated by plant and cycle as a function of core average exposure.

For convenience and better visualization, the plots present values that represent MELLLA+ operation enclosed in purple circles or red colored (only thermal margins bias). TIP RMS plots present ratios to average plant values, as discussed in more detail in Reference 6.

3. Conclusions

The results provided demonstrate that Methods performance in the MELLLA+ domain continues to meet expectations set by prior submittals and historical data at non-MELLLA+ conditions. Therefore, the intent of Limitation & Condition 23 has been satisfied and no further reporting is required.

4. References

1. NEDC-33173P-A, Revision 4, "Applicability of GE Methods to Expanded Operating Domains," November 2012 (ADAMS Accession No. ML12313A107/ML12313A106 (Publicly Available/Non-publicly Available)).
2. GE Hitachi Nuclear Energy, "Clarification of Limitation and Condition 23 for NEDC-33173P, 'Applicability of GE Methods to Expanded Operating Domains'", MFN 15-066, J. Harrison, August 2015.
3. Nuclear Regulatory Commission, "Response to GE Hitachi Nuclear Energy Letter MFN 15-066 dated August 26, 2015 – Clarification of Limitation and Condition 23 for NEDC-33173P, 'Applicability of GE Methods to Expanded Operating Domains'", (TAC No. MF6665), MFN 15-097, November 2015.
4. General Electric Boiling Water Reactor, Maximum Extended Load Line Limit Analysis Plus, NEDC-33006P-A, Revision 3, June 2009.
5. GE Hitachi Nuclear Energy, "Technology Update Meeting, July 30, 2019, Final Presentations," B. R. Moore, M190175, October 2019 (NRC Accession # ML19297F485).
6. GE Hitachi Nuclear Energy, "Accepted Version of NEDC-33173P Supplement 6 Revision 0, Licensing Topical Report 'Applicability of GE Methods to Expanded Operating Domains – Removal of Safety Limit Minimum Critical Power Ratio (SLMCPR) Penalty,'" M190068, NEDC-33173P-A Supplement 6, Revision 1, August 2019.

Hot Critical Eigenvalues

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Figure 1: Historical Basis – Source IMLTR SE

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Figure 2: Monticello Hot Eigenvalues

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Figure 3: Peach Bottom 2 Hot Eigenvalues

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Figure 4: Peach Bottom 3 Hot Eigenvalues

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Figure 5: Nine Mile Point 2 Hot Eigenvalues

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Figure 6: Grand Gulf Hot Eigenvalues

Cold Critical Eigenvalues

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Figure 7: Historical Basis – Source IMLTR SE

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Figure 8: All plant Cold-to-Target Eigenvalue Difference

Thermal Margins:
Online Adapted (3DM) / Offline Non-Adapted (P11)
MFLCPR

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Figure 9-a: All plants MFLCPR Bias; Non-MELLLA+ data

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Figure 9-b: All plants MFLCPR Bias

Thermal Margins:
Online Adapted (3DM) / Offline Non-Adapted (P11)
MFLPD

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Figure 10-a: All plants MFLPD Bias; Non-MELLLA+ data

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Figure 10-b: All plants MFLPD Bias

Thermal Margins:

Online Adapted (3DM) / Offline Non-Adapted (P11)
MAPRAT

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Figure 11-a: All plants MAPRAT Bias; Non-MELLLA+ data

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Figure 11-b: All plants MAPRAT Bias

TIP Comparisons

Nodal and Radial Power Distributions v. Power to Flow Ratio

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Figure 12: All plants Nodal TIP RMS Ratio v. Power-Flow Ratio

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Figure 13: All plants Radial TIP RMS Ratio v. Power-Flow Ratio

TIP Comparisons

Nodal and Radial Power Distributions v. Core Exit Void Fraction

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Figure 14: All plants Nodal TIP RMS Ratio v. Core Exit Void Fraction

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Figure 15: All plants Radial TIP RMS Ratio v. Core Exit Void Fraction

TIP Comparisons

Nodal and Radial Power Distributions v. Core Average Void Fraction

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Figure 16: All plants Nodal TIP RMS Ratio v. Core Average Void Fraction

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Figure 17: All plants Radial TIP RMS Ratio v. Core Average Void Fraction

TIP Comparisons

Nodal and Radial Power Distributions v. Core Average Exposure

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Figure 18: All plants Nodal TIP RMS Ratio v. Core Average Exposure

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Figure 19: All plants Radial TIP RMS Ratio v. Core Average Exposure

Core Flow & Pressure Drop Uncertainties

Peach Bottom Unit 2

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Figure 20: HE2 Cycle 21 Core Inlet Flow and Pressure Drop Bias

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Figure 21: HE2 Cycle 22 Core Inlet Flow and Pressure Drop Bias

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Figure 22: HE2 Cycle 23 Core Inlet Flow and Pressure Drop Bias

Core Flow & Pressure Drop Uncertainties

Peach Bottom Unit 3

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Figure 23: HE3 Cycle 21 Core Inlet Flow and Pressure Drop Bias

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Figure 24: HE3 Cycle 22 Core Inlet Flow and Pressure Drop Bias

Core Flow & Pressure Drop Uncertainties

Nine Mile Point Unit 2

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Figure 25: KG1 Cycle 15 Core Inlet Flow and Pressure Drop Bias

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Figure 26: KG1 Cycle 16 Core Inlet Flow and Pressure Drop Bias

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Figure 27: KG1 Cycle 17 Core Inlet Flow and Pressure Drop Bias

Core Flow & Pressure Drop Uncertainties

Grand Gulf

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Figure 28: JB1 Cycle 22 Core Inlet Flow and Pressure Drop Bias