ENCLOSURE 2

MFN 12-088

Response to NRC RAIs - NEDO-32465-A, Supplement 1

Non-Proprietary Information – Class I (Public)

INFORMATION NOTICE

This is a non-proprietary version of Enclosure 1 to MFN 12-088, 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 - TRACG04 Configuration Options:

Please specify the required TRACG04 configuration options (where TRACG represents the Transient Reactor Analysis Code – GEH proprietary version) for DIVOM [Delta CPR over Initial MCPR Versus Oscillation Magnitude] calculations (e.g., full-core channel mapping, axial nodalization, semi-implicit method, etc.).

GEH Response:

The key TRACG04 configuration requirements for the DIVOM stability analyses are the following:

Thermal-Hydraulic Nodalization:

- [[

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Neutronics Nodalization:

- [[

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Numerics:

- [[

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References:

1-1 GE Hitachi Nuclear Energy, "TRACG Qualification," NEDE-32177P, Revision 3, August 2007.

1-2 GE Hitachi Nuclear Energy, "DSS-CD TRACG Application," NEDE-33147P-A, Revision 2, November 2007.

1-3 GE Hitachi Nuclear Energy, "Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications," NEDO-32465, Supplement 1, Revision 0, September 2011.

1-4 GE Hitachi Nuclear Energy, "TRACG Model Description," NEDE-32176P, Revision 4, January 2008.

1-5 GE Nuclear Energy, "TRACG Application for Anticipated Operational Occurrences Transient Analysis," NEDE-32906P-A, Revision 3, September 2006.

1-6 GE Hitachi Nuclear Energy, "Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for TRACG AOO and ATWS Overpressure Transients," NEDE-32906P, Supplement 3-A, Revision 1, April, 2010.

1-7 GE Nuclear Energy, "Steady-State Nuclear Methods," NEDE-30130P-A, April 1985.

1-8 Letter, S. A. Richards (NRC) to G. A. Watford (GE), "Amendment 26 to GE Licensing Topical Report NEDE-24011-P-A, GESTAR II Implementing Improved GE Steady-State Methods," (TAC No. MA6481), November 10, 1999.

RAI-2 – Approved Code Versions:

NEDO-32465, Supplement 1, Revision 0 states that "The NRC has examined the capability and qualification of P11/TGBLA06 through numerous applications" (where P11 represents PANAC11, a boiling water reactor core simulator methodology, coupled with TGBLA06, a fuel lattice physics methodology used to provide lattice input to nuclear design and analysis methods). Please provide a list of references of approved ("-A") licensing topical reports (LTRs) that use the P11/TGBLA06 methodology.

GEH Response:

TRACG has been reviewed and approved for Anticipated Operational Occurrences (AOOs) for operational boiling water reactors (BWRs) and ESBWRs. The following references used TRACG with P11/TGBLA06 methodology.

Approved LTR	Application
GE Hitachi Nuclear Energy, "Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for TRACG AOO and ATWS Overpressure Transients," NEDE-32906P Supplement 3-A, Revision 1, April 2010.	BWR/2-6 AOO and Anticipated Transient Without Scram (ATWS) Overpressure
GE Hitachi Nuclear Energy, "TRACG Application for ESBWR Transient Analysis," NEDE-33083 Supplement 3P-A, Revision 1, September 2010.	ESBWR AOO
GE Hitachi Nuclear Energy, "TRACG Application for ESBWR Stability Analysis," NEDE-33083 Supplement 1P-A, Revision 2, September 2010.	ESBWR Stability
GE Hitachi Nuclear Energy, "TRACG Application for ESBWR Anticipated Transient Without Scram Analyses," NEDE-33083 Supplement 2P-A, Revision 2, October 2010.	ESBWR ATWS
GE Hitachi Nuclear Energy, "Applicability of GE Methods to Expanded Operating Domains," NEDC-33173P-A, Revision 3, April 2012.	Extended Power Uprate (EPU) Application
GE Nuclear Energy, "TRACG Application for Anticipated Operational Occurrences (AOO) and Transient Analyses," NEDE-32906P-A, Revision 3, September 2006.	BWR/2-6 AOO

RAI-3 – Applicability to New Fuels:

Please describe the applicability of the DIVOM methodology with TRACG04/P11 (TRACG04 coupled with PANAC11) in NEDO-32465, Supplement 1 to new fuels and fuels from other vendors. Is a review process required for new fuels before application of P11/TGBLA06?

GEH Response:

The DIVOM methodology is plant- and cycle-specific. As such, the TRACG04/P11 analysis includes the detailed bundle design, whether it is from GEH/GNF or from other fuel vendors. Therefore, the TRACG04/P11 DIVOM methodology is applicable to current and new fuel designs from GEH/GNF and/or other fuel vendors. The qualification of P11/TGBLA06 to new fuel designs (GEH/GNF or other fuel vendors) involves a comparison of key parameters to the corresponding parameters produced with MCNP (Reference 3-1). These parameters include the infinite multiplication constant or eigenvalue, dynamic void coefficient, the cold control rod worth, the Boron worth, and the fission density distribution. A review process for the new fuels before application of P11/TGBLA06 is required. The requirements of the review process are described in Section 3, Item (1) of Reference 3-2.

References:

3-1 GE Nuclear Energy, "Methodology and Uncertainties for Safety Limit MCPR Evaluations," NEDC-32601P-A, August 1999.

3-2 Letter, F. Akstulewicz (NRC) to G. 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.

RAI-4 – Fuel Properties:

As part of the TRACG04 upgrade, PRIME (a fuel rod thermal mechanical code) is used to calculate fuel properties. What codes or methodologies were used to calculate the fuel properties in the sample cases in Figures 4-18 to 4-23?

GEH Response:

Figures 4-18 through 4-23 (Reference 4-1) show key results for the core-wide TRACG transient analysis. Figures 4-18 through 4-20 show results using TRACG02/PANAC10 with GESTR (Reference 4-2) to calculate fuel properties, whereas Figures 4-21 through 4-23 use TRACG04/PANAC11 with PRIME (Reference 4-3) to calculate fuel properties.

References:

4-1. GE Hitachi Nuclear Energy, "Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications," NEDO-32465, Supplement 1, Revision 0, September 2011.

4-2. Letter, C. O. Thomas (NRC) to J. S. Charnley (GE), "Acceptance for Referencing of Licensing Topical Report NEDE-24011-P Amendment 7 to Revision 6, 'General Electric Standard Application for Reactor Fuel," MFN-036-85, March 1, 1985.

4-3. GE Hitachi Nuclear Energy, "The PRIME Model for Analysis of Fuel Rod Thermal – Mechanical Performance Part 1 – Technical Bases," NEDC-33256P-A, Revision 1, "Part 2 – Qualification," NEDC-33257P-A, Revision 1, and, "Part 3 - Application Methodology," NEDC-33258P-A, Revision 1, September 2010.

RAI-5 – Channel Grouping:

As part of the new TRACG04 methodology, stability calculations are performed with full one-to-one channel mapping; however, old TRACG02/P10 applications used channel grouping (typically approximately 30 thermal-hydraulic channels). What channel grouping was used for the sample cases in Figures 4-18 to 4-23? Please describe any impact on DIVOM slopes of the new channel grouping strategy.

GEH Response:

It is the Detect and Suppress Solution – Confirmation Density (DSS-CD) TRACG04 methodology that implements the full core individual bundle model, in which each fuel bundle is modeled as an individual thermal-hydraulic channel in the system code thermal-hydraulic nodalization (References 5-1 and 5-2). The DIVOM requirements for channel grouping are provided in the response to RAI-1. The channel grouping requirements for TRACG04/PANAC11 DIVOM analyses are consistent with those used for the TRACG02/PANAC10 DIVOM analyses, which were based on studies showing that once the [[ ]] there is little sensitivity in the DIVOM slope. Because the DIVOM methodology, unlike DSS-CD, [[

]], it is not necessary to run the full core individual bundle model for TRACG DIVOM analyses.

The channel groupings used for the sample cases in Figures 4-18 to 4-23 are shown in Figure 4-16 and Figure 4-17 of Reference 5-3 for TRACG02/PANAC10 and TRACG04/PANAC11, respectively. The channel groupings documented in Figures 4-16 and 4-17 of Reference 5-3 are consistent with the [[

]].

A consistent methodology for channel grouping is maintained for TRACG04/PANAC11 with respect to TRACG02/PANAC10 applications. Therefore, there is no impact on DIVOM slopes because there is no new channel grouping strategy that is implemented.

References:

5-1 GE Hitachi Nuclear Energy, "GE Hitachi Boiling Water Reactor Detect and Suppress Solution – Confirmation Density," NEDC-33075P, Revision 7, June 2011.

5-2 GE Hitachi Nuclear Energy, "DSS-CD TRACG Application," NEDE-33147P, Revision 3, January 2011.

5-3 GE Hitachi Nuclear Energy, "Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for Reactor Stability Detect and Suppress Solutions Licensing

Basis Methodology for Reload Applications," NEDO-32465, Supplement 1, Revision 0, September 2011.

RAI-6 – Natural Circulation Hot Channel Oscillation Magnitude (HCOM):

Section 4.2 of NEDO-32465, Supplement 1 states that HCOM values at natural circulation are typically between 0.8 and 1.0. In Figure 5-4, a single HCOM value of approximately 1.05 is marked in the figure. How can a bounding DIVOM slope be defined with only one HCOM value instead of a range? Please explain the example of Figure 5-4.

GEH Response:

In the Option III Stability Long Term Solution (LTS) (Reference 6-1), Oscillation Power Range Monitor (OPRM) amplitude set points are established corresponding to a range of Hot Channel Oscillations Magnitudes (HCOMs). Within this range of HCOMs, a DIVOM slope is calculated which bounds all the DIVOM data points. In the Option 1-D Stability LTS, the stability protection is provided by the Average Power Range Monitor (APRM) flow biased SCRAM line. There is only one HCOM value of interest, which is defined by the distance from the 100% Original Licensed Thermal Power (OLTP) rod line at natural circulation to the APRM SCRAM line. Therefore, for 1-D plants, the DIVOM slope is calculated at this specific HCOM value. In Section 4.2, an analysis is provided to compare PANAC10/TRACG02 and PANAC11/TRACG04 methodologies for a plant in which the exact HCOM is not known. Therefore, the DIVOM slope is calculated over a 0.8 - 1.0 range in HCOM for comparison purposes only. In Section 5.3, a demonstration analysis using the PANAC11/TRACG04 methodology is provided for a typical Option 1-D plant in which the HCOM value is known. Therefore, the DIVOM slope is calculated such that it bounds this known HCOM value, which in this case was approximately 1.05.

References:

6-1. GE Hitachi Nuclear Energy, "Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications," NEDC-32465, Supplement 1, Revision 0, September 2011.