ENCLOSURE 2

M170165

Additional TRACG LOCA LTR Analyses to Satisfy NRC Final Safety Evaluation Limitation 10.7

Non-Proprietary Information– Class I (Public)

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 [[ ]].

APPENDIX B

Additional TRACG LOCA LTR Analyses to Satisfy NRC Final Safety Evaluation Limitation 10.7

1.0 Background and Purpose

The NRC issued a final Safety Evaluation (SE) for NEDE-33005P Revision 0, "TRACG Application for Emergency Core Cooling Systems / Loss-of-Coolant-Accident Analyses for BWR/2-6," by letter dated February 14, 2017 (Reference B-1). The final SE was subsequently incorporated into NEDE-33005P-A Revision 1 dated February 2017. In this letter, the NRC staff found that NEDE-33005P Revision 0 is acceptable for referencing in licensing applications for nuclear power plants to the extent specified and under the limitations delineated in the LTR and in the final SE. The final SE defines the basis for the NRC acceptance of the LTR.

The NRC limitations for NEDE-33005P are listed in Section 10 of the NRC final SE enclosed in NEDE-33005P-A Revision 1. This appendix has been prepared to satisfy Limitation 10.7, which states:

> **10.7. BWR/3-6 FIRST-OF-A-KIND APPLICATION**
>
> The NRC staff review effort included a detailed review of TRACG-LOCA as applied to a BWR/2, and as such, the application of TRACG-LOCA to Nine Mile Point Nuclear Station, Unit 1, is acceptable without further limitation. However, the NRC staff notes that the demonstration analyses and nodalization sensitivity studies supporting application of TRACG-LOCA to BWR/3- 6 plants, were not updated to reflect the increased core detail and revised statistical approach that were revised as a result of the NRC staff review. As such, the NRC staff requires that GEH perform updated demonstration analyses for each of a BWR/4 and BWR/6, and an update to the BWR/4 nodalization sensitivity studies, and provide them for NRC staff review and acceptance, prior to first-of-a-kind application of TRACG-LOCA to a BWR/3-6. Specifically, the jet pump plant nodalization studies should be updated/reviewed/accepted prior to application to a jet pump plant. The BWR/4 demonstration studies should be updated/reviewed/accepted prior to application to a BWR/3-4, and similarly, the BWR/6 demonstration studies should be updated/reviewed/accepted prior to application to a BWR/5-6. This limitation can be satisfied by revising the jet pump plant nodalization studies documented in LTR Section 5.2, Table 5.2-1 and Figures 5.2-1 through 5.3-9[1] and the key summary demonstration analyses documented in LTR Chapter 8, Figure 8.1-29 for the BWR/4 and Figure 8.2-18 for the BWR/6.

The limitation clearly prescribes what actions are needed to satisfy this limitation. In this appendix, the following additional TRACG analyses requested in this limitation have been performed:

(1) Nodalization studies documented in LTR Section 5.2, Table 5.2-1 have been performed using updated detailed BWR/4 core model and the corresponding figures (Figures 5.2-1 through 5.2-9) were updated;

(2) LTR Figure 8.1-29 has been updated using a detailed BWR/4 model; and

(3) LTR Figure 8.2-18 has been updated using a detailed BWR/6 core model.

[1] This figure number should be 5.2-9.

The results show that the conclusions drawn in NEDE-33005P-A Revision 1 dated February 2017 remain valid.

Based on completion of the updated calculations requested by the NRC, GEH requests that the NRC remove Limitation 10.7.

2.0 Analysis Method

2.1 Detailed Core Modeling

The detailed core modeling for BWR/4 was discussed in the response to NRC Request for Additional Information (RAI) 4 in NEDE-33005P-A Revision 1. [[

]] In order to be consistent with the approved TRACG Loss-of-Coolant Accident (LOCA) methodology, the following additional modifications are introduced to the base LTR modeling to be fully compliant with the SE requirements and resulting LTR commitments:

(1) The PRIME-based thermal conductivity model together with fuel parameter inputs supplied by the PRIME code is used. This is specified in Section 6.1 of the NRC SE in NEDE-33005P-A Revision 1.

(2) Hot channel modeling was updated to comply with the requirement listed in Section 10.2.2 of the SE in NEDE-33005P-A Revision 1 (SE Limitation 10.2.2). The specifics of the hot channel modeling is based on the RAI 73 response in NEDE-33005P-A Revision 1 (also Table 6.2-2 of NEDE-33005P-A Revision 1).

The detailed core modeling for BWR/4 is shown in Table B2-1. [[

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The same modifications are made to the original BWR/6 core. The detailed core modeling for a BWR/6 is shown in Table B2-2. [[

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2.2 LTR Section 5.2 Nodalization Studies

For the nodalization studies in Table 5.2-1, a [[ ]] (Section 6.4 of NEDE-33005P-A Revision 1) was performed for [[

]] are reported in Table B5.2-1.

2.3 LTR Section 8 Figure 8.1-29 and Figure 8.2-18 Studies

As prescribed in the SE and as committed in the LTR, de-biased break spectrum analyses were performed for a BWR/4 and a BWR/6 at break sizes with sufficient resolution to permit overlap considering the TRACG critical flow uncertainty (SE Limitation 10.2.3).

Full perturbation statistical analyses are performed at each break selected, which is a subset of the break spectrum analysis break sizes. For each break, 124 statistical TRACG trials are executed (125 with the nominal de-biased case); 59 or 60 trials with the nominal case were executed in the LTR. The maximum values are reported (Limitation 10.4.1: Limiting Break Sizes in the NRC SE in NEDE-33005P-A Revision 1).

2.4 Other Updates

For all calculations in this appendix, 102% thermal power is used. This is specified in SE Limitation 10.2.6: Calorimetric Power Uncertainty.

Small and full perturbation statistical overlays are re-generated using the same PIRT table basis utilized in the responses to RAIs 103 and 104 in NEDE-33005P-A Revision 1 as well as the Nine Mile Point Unit 1 (NMP1) TRACG LOCA application.

3.0 TRACG Analysis Results

3.1 Table 5.2-1 Nodalization Study Results

TRACG analyses for all nodalization cases in Table 5.2-1 of NEDE-33005P-A Revision 1 were performed using the updated BWR/4 detailed core model. Table B5.2-1[2] summarizes the added detail of the noding sensitivity and corresponding PCT results as differences to the average value from [[ ]] Figures B5.2-1 through B5.2-9[3] provide a visual comparison of [[

[3] The curves labeled "VSSL" in Figures B5.2-1 through B5.2-3 represent the results of vessel axial nodalization (VSSL Axial Nodalization in Table B5.2-1), which combines all nodalization changes made for lower plenum, bypass, upper plenum and steam dome.

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3.2 LTR Figure 8.1-29 and Figure 8.2-18 Updates

LTR Figure 8.1-29 has been updated using the updated BWR/4 detailed core modeling. The updated results are shown in Figure B8.1-29, which provides a summary of the PCT results for nominal, trials minimum, trials maximum, and trials mean.

LTR Figure 8.2-18 has been updated using the updated BWR/6 detailed core modeling. The updated results are shown in Figure B8.2-18, which provides a summary of the PCT results for nominal, trials minimum, trials maximum, and trials mean.

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A similar observation can be made for the BWR/6 results in Figure B8.2-18. The overall trend of the break spectrum and statistical results using the updated BWR/6 detailed core model is similar to the one using the original coarse core model. The PCTs using the updated core model are also higher for the same reason explained for BWR/4.

4.0 Reference

B-1 Letter from Kevin Hsueh (NRC) to Jerald G. Head (GEH), "Final Safety Evaluation for GE Hitachi Nuclear Energy – Americas, LLC Topical Report NEDE-33005P and NEDO-33005, Revision 0, "Licensing Topical Report TRACG Application for Emergency Core Cooling Systems / Loss-of-Coolant-Accident Analyses for BWR/2-6" (CAC No. ME5405)," February 14, 2017.

Table B2-1: TRACG Channel Grouping for Detailed BWR/4 Model

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Table B2-2: TRACG Channel Grouping for Detailed BWR/6 Model

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Table B5.2-1: Summary of Nodalization Sensitivity Studies for Jet Pump Plants

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Figure B5.2-1: Vessel Axial Nodalization Sensitivity for Large-Break LOCA

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Figure B5.2-2: Vessel Axial Nodalization Sensitivity for Intermediate-Break LOCA

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Figure B5.2-3: Vessel Axial Nodalization Sensitivity for Small-Break LOCA

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Figure B5.2-4: Vessel Radial and Azimuthal Nodalization Sensitivity for Large-Break LOCA

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Figure B5.2-5: Vessel Radial and Azimuthal Nodalization Sensitivity for Intermediate-Break LOCA

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Figure B5.2-6: Vessel Radial and Azimuthal Nodalization Sensitivity for Small-Break LOCA

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Figure B5.2-7: Channel Axial Nodalization Sensitivity for Large-Break LOCA

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Figure B5.2-8: Channel Axial Nodalization Sensitivity for Intermediate-Break LOCA

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Figure B5.2-9: Channel Axial Nodalization Sensitivity for Small-Break LOCA

Figure B8.1-29: Summary of BWR/4 Statistical Analyses at Various Break Sizes

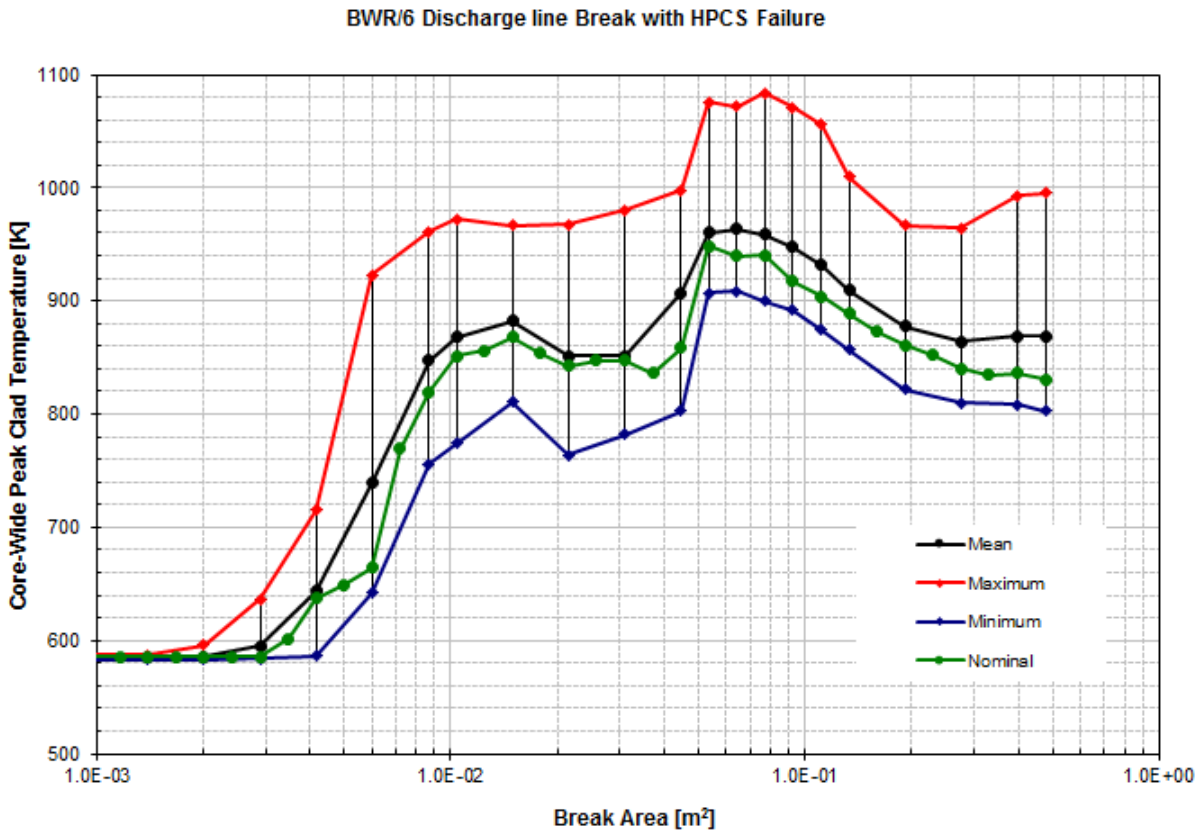

Figure B8.2-18: Summary of BWR/6 Statistical Analyses at Various Break Sizes