November 6, 2017

Mr. Jerald G. Head
Senior Vice President, Regulatory Affairs
GE-Hitachi Nuclear Energy
P.O. Box 780 M/C A-18
Wilmington, NC 28401

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION REGARDING REVIEW OF SATISFACTION OF LIMITATION 10.7 FOR NEDE-33005P, REVISION 0, LICENSING TOPICAL REPORT "TRACG APPLICATION FOR EMERGENCY CORE COOLING SYSTEMS / LOSS-OF-COOLANT-ACCIDENT ANALYSES FOR BWR/2-6" (CAC NO. MF9949; EPID L-2017-TOP-0036)

Dear Mr. Head:

By letter dated July 7, 2017, GE Hitachi Nuclear Energy, submitted for U.S. Nuclear Regulatory Commission (NRC) staff review, Satisfaction of Limitation 10.7 for NEDE-33005P, Revision 0, "Licensing Topical Report TRACG Application for Emergency Core Colling Systems / Loss-of-Coolant-Accident Analyses for BWR/2-6" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17188A085). Upon review of the information provided, the NRC staff has determined that additional information is needed to complete the review. Enclosed with this letter is a non-proprietary version of our Request for Additional Information (RAI). On October 17, 2017, James Harrison, GEH Vice President, Fuels Licensing, Regulatory Affairs, and I agreed that the NRC staff will receive your response to the enclosed Request for Additional Information (RAI) questions within 60 days of receipt of this letter. If you have any questions regarding the enclosed RAI questions, please contact me at (301) 415-1002.

Sincerely,

/RA/

Joseph A. Golla, Project Manager
Licensing Processes Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Project No. 710

Enclosure:
RAI Questions (Non-Proprietary)

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION REGARDING REVIEW OF SATISFACTION OF LIMITATION 10.7 FOR NEDE-33005P, REVISION 0, LICENSING TOPICAL REPORT "TRACG APPLICATION FOR EMERGENCY CORE COOLING SYSTEMS / LOSS-OF-COOLANT-ACCIDENT ANALYSES FOR BWR/2-6" (CAC NO. MF9949; EPID L-2017-TOP-0036) DATED: NOVEMBER 6, 2017

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ADAMS Accession No.: ML17290B197; *concurrence via e-mail **NRR-106**

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NAME	JGolla	DHarrison	RLukes	DMorey	JGolla
DATE	10/26/2017	10/24/2017	10/30/2017	10/31/2017	11/6/2017

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REQUEST FOR ADDITIONAL INFORMATION (RAI) QUESTIONS

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING REVIEW OF SATISFACTION OF LIMITATION 10.7 FOR NEDE-33005P,

REVISION 0, LICENSING TOPICAL REPORT "TRACG APPLICATION FOR EMERGENCY

CORE COOLING SYSTEMS / LOSS-OF-COOLANT ACCIDENT ANALYSES FOR BWR/2-6"

(CAC NO. MF9949; EPID L-2017-TOP-0036)

By letter M170165, dated July 7, 2017,[1] General Electric – Hitachi Nuclear Energy (GEH) submitted information required to satisfy Limitation 10.7 for NEDE-33005P, Revision 0, "Licensing Topical Report TRACG Application for Emergency Core Cooling Systems / Loss-of-Coolant Accident Analyses for BWR/2-6."[2] Among other things, this information specifically addressed TRACG model sensitivity to changes in noding detail, which had been previously evaluated in Section 4.3 of the U.S. Nuclear Regulatory Commission (NRC) staff safety evaluation (SE) approving NEDE-33005P.

In addition, the regulation established at Section 46, "Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors," to Part 50, "Domestic Licensing of Production and Utilization Facilities," of Title 10, "Energy," of the *U.S. Code of Federal Regulations* (10 CFR), requires that the uncertainties in the analysis method be accounted for, so that when the calculated emergency core cooling system (ECCS) cooling performance is compared to the criteria set forth in paragraph (b) of 10 CFR 50.46, there is a high level of probability that the criteria would not be exceeded. To that end, guidance provided in NRC Regulatory Guide (RG) 1.157, "Best-Estimate Calculations of Emergency Core Cooling Performance," provides guidance on assessing the potential for geometric discretization error to contribute to model uncertainty, stating, "Sensitivity studies and evaluations of the uncertainty introduced by noding should be performed."

The approach taken by GEH to assess the potential for uncertainty attributable to nodalization is to show, for successively increased levels of noding detail, that the variation in key results is insignificant when compared to similar variation introduced to the model through other means, such as by varying the minimum time step size, or by running so-called small perturbation analyses.

In both the original and the updated studies, heightened sensitivities to predicted peak cladding temperature (PCT) are illustrated when vessel and channel component noding detail is studied. These heightened PCT sensitivities suggest that GEH's conclusion that the uncertainties are sufficiently small as to be negligible is not adequately justified by the nodalization sensitivity studies alone.

Consider, for example, not only the PCT sensitivity to channel and vessel noding detail, but also the comparator: the PCT variability exhibited in the additional, small perturbation analyses

[1] Agencywide Document Access and Management System (ADAMS) Accession No. ML17188A083.
[2] ADAMS Package Accession No. ML17055A387.

performed to support M170165. The SE noted an expectation that variations in nodalization would effect changes in PCT on the order of about **[ ],** which was the approximate PCT variation shown in small perturbation analyses for the BWR/4 intermediate break event in response to Request for Additional Information (RAI) 6, as well as for the BWR/2 design basis event in response to RAI 9. The estimated magnitude of **[ ]** was repeated in response to RAIs 3 and 4. The additional studies in M170165 show not only the continued, heightened PCT sensitivity to the noding detail of certain components, but also increases in variability associated with the small perturbation analyses for other events.[3] In some cases, both PCT sensitivity to noding detail and small perturbation variability appear to approach the PCT magnitude that the NRC staff considers "significant" for other regulatory purposes (i.e., a change in PCT greater than 28 K as set forth in 10 CFR 50.46(a)(3)(ii)).

Noting (1) the heightened PCT sensitivity to vessel and channel noding detail, (2) the apparent increase in PCT variability associated with analyzing a broader array of events, and (3) the approach of PCT sensitivity to noding detail to 28 K, additional information is required to make a more general, appropriately qualified conclusion regarding the adequacy of model noding detail and the related contribution to overall uncertainty in analytic results. Further, additional discussion is required to supplement the SE, as the **[ ]** order of magnitude that formed a partial basis for the NRC staff decision making appears technically inaccurate in light of the information provided in M170165.

Provide additional information to justify that the noding uncertainty is an acceptably small contributor to overall model uncertainty as to be neglected when analyses are performed using the standard nodalization, or propose, and justify, an allowance to include for this potential source of discretization error. Such justification could be strengthened by addressing, specifically, any combination of the following points:

- Add a column to Table B5.2-1 to distinguish between the first and second peaks in the small break analysis.
- Provide additional detail regarding the small perturbation analyses:
    - Provide the min and max PCT for each of the break sizes and large-break peaks.
    - Provide PCT spaghetti plots analogous to NEDE-33005P-A, Revision 1, Figure 6.4-9, for each of the small perturbation analyses shown in Table B5.2-1.
    - Provide the sample size for the small perturbation analyses.
    - Explain why the small perturbation analyses in M170165 exhibit greater PCT range than those previously discussed in the RAI responses for NEDE-33005P-A.
- Regarding Figure B5.2-5, explain why some cases initiate a cladding heatup earlier than others. Also explain why this behavior isn't exhibited in the small perturbation analyses.

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[3] The optical resolution of the figures provided in M170165 makes it difficult to quantify the exact, small perturbation variability.

- Regarding Figure B5.2-7, explain what drives the significantly earlier achievement of stable quench and return to nucleate boiling in the model with increased hot channel axial detail.

- In TR Figures 5.2-10 and 5.2-11, explain similar trends in the BWR/2 overall transient to those noted above in B5.2-7.

- Provide comparisons to other figures of merit that may better explain the model sensitivities. Consider:

    - Minimum temperature for stable film boiling (Tmin) at time of quench.

    - Time of PCT (for a given peak, if large- or small-break).

    - Maximum local oxidation.

- Provide a more academic evaluation of solution independence to nodalization. Use three successively increased levels of detail to demonstrate (or at least evaluate) grid-asymptotic behavior.

- Consider whether the nodalization-associated PCT behavior may be attributed to attributes of specific models or associated uncertainty treatments, for example in the case of CHAN axial nodalization, the falling film quench front model.