September 15, 2015

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
LICENSING TOPICAL REPORTS NEDE-33005P AND NEDO-33005,
"LICENSING TOPICAL REPORT TRACG APPLICATION FOR EMERGENCY
CORE COOLING SYSTEMS / LOSS-OF-COOLANT-ACCIDENT ANALYSES
FOR BWR/2-6" (TAC NO. ME5405)

Dear Mr. Head:

By letter dated January 27, 2011 (Agencywide Documents Access and Management System
(ADAMS) Accession No. ML110280323), GE Hitachi Nuclear Energy – Americas, LLC (GEH)
submitted for U.S. Nuclear Regulatory Commission (NRC) staff review Licensing Topical
Reports (LTRs) NEDE-33005P and NEDO-33005, "Licensing Topical Report TRACG
Application for Emergency Core Cooling Systems / Loss-of-Coolant-Accident Analyses for
BWR/2-6" (ADAMS Accession No. ML110280321). 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) questions. On July 23, 2015, James Harrison, GEH Vice President, Fuels Licensing,
Regulatory Affairs, and I agreed that the NRC staff will receive your response to the NRC staff's
RAI questions within 120 days of receipt of this letter.

J. Head   - 2 -

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:
Request for Additional Information

cc w/encl: See next page

J. Head   - 2 -

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:
Request for Additional Information
cc w/encl: See next page

DISTRIBUTION:
PUBLIC
RidsNrrDpr
RidsNrrDprPlpb
JGolla
AMendiola
DHarrison
JDean

ADAMS Accession No.: ML15204A582   *** via e-mail   NRR-106**

OFFICE	NRR/DPR/PLPB	NRR/DPR/PLPB*	NRR/DSS/SNPB	NRR/DPR/PLPB	NRR/DPR/PLPB
NAME	JGolla	DHarrison	JDean	AMendiola (MHoncharik for)	JGolla
DATE	8/20/2015	8/18/2015	9/11/2015	9/15/2015	9/15/2015

OFFICIAL RECORD COPY

cc:

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

Mr. James F. Harrison
GE-Hitachi Nuclear Energy Americas LLC
Vice President - Fuel Licensing
P.O. Box 780, M/C A-55
Wilmington, NC 28401-0780
james.harrison@ge.com

Ms. Patricia L. Campbell
Vice President, Washington Regulatory Affairs
GE-Hitachi Nuclear Energy Americas LLC
1299 Pennsylvania Avenue, NW
9th Floor
Washington, DC 20004
patriciaL.campbell@ge.com

Mr. Brian R. Moore
Vice President, Fuel Engineering, Acting
Global Nuclear Fuel–Americas, LLC
P.O. Box 780, M/C A-55
Wilmington, NC 28401-0780
Brian.Moore@gnf.com

SECOND SET OF REQUEST FOR ADDITIONAL INFORMATION (RAI) QUESTIONS

BY THE OFFICE OF NUCLEAR REACTOR REGULATION

NEDE-33005P, "LICENSING TOPICAL REPORT TRACG APPLICATION FOR EMERGENCY

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

GE HITACHI NUCLEAR ENERGY – AMERICAS, LLC (TAC NO. ME5405)

PRIOR RAI SET: The numbering convention resumes from RAI Set 1, which ended at 66.

SNPB RAI-67)   Licensing Topical Report (LTR) Figure 5.2-8 appears to be an inadvertent repetition of Figure 5.2-5. Please provide the corrected figure.

SNPB RAI-68)   Recent staff experience, in combination with the previous response to RAI 8 (regarding the treatment of evaluation model (EM) errors and changes) suggests that additional information is required concerning the treatment of input changes, plant modifications, and code changes. The treatment requires discussion both in the context of estimating the effect of an error or change, and in the context of performing a reanalysis, whether in fulfillment of a Title 10 of the *Code of Federal Regulations* (10 CFR) 50.46(a)(3)(ii) commitment or statement to "include with the report a proposed schedule for providing a reanalysis," or simply for the purpose of developing a new baseline to eliminate an extensive error/change rackup list, or to analyze a major plant change like a fuel design change or operating domain extension. Discuss, or provide applicable procedures or modeling guidance that explains, how to discern between changes that may be estimated using engineering principles, using revision analysis (such as analyzing the effect of a change using the same population sample), or using more comprehensive techniques, such as generating a new sample or re-analyzing the break spectrum/operating domain.

SNPB RAI-69)   The uncertainty analysis appears to be based on correlations being used only within their applicable limits. Please explain what code features or processes ensure that correlations are used within applicable limits. For example: Does the code flag if correlations are used outside of their range of applicability? Are correlation ranges of applicability checked and validated by the analyst as part of the calculation process, or by a reviewer as part of the quality assurance process?

SNPB RAI-70)   Given the importance of the low pressure core spray (LPCS) system relative to the limiting peak cladding temperature (PCT) loss-of-coolant accident (LOCA) analyses, provide additional justification of the adequacy of the existing suite of LPCS benchmark tests included in the TRACG benchmark data in Table 4.4-1 of the Qualification Report, addressing the following specific topics:

a.   Explain how the database addresses system variability, such as varying nozzle designs.

b.   Is the channel power distribution in the testing bounding relative to the BWR/2 design?

c.   Explain how the uncertainty from 6x6 through 8x8 fuel data scales to modern 10x10 fuels.

d.   Explain how the uncertainty and model corrections discussed in the Qualification Report are applied in the emergency core cooling systems (ECCS) EM.

SNPB RAI-71)   Please clarify the methodology for validating the acceptability of changes to the generic nodalization in the LTR for plant-specific calculations (as discussed in Section 5.2 of LTR), and justify its sensitivity for distinguishing the potential for nodalization changes to affect the determination of 95/95 upper tolerance limits for assessing compliance with the criteria of 10 CFR 50.46.

SNPB RAI-72)   The logic for selecting hot channels for TRACG simulations in the LTR prescribes **[**

] However, particularly for BWRs with jet pumps, it is not clear that **[**

] Please justify that the existing hot bundle selection logic in the LTR is adequate to determine the limiting bundle for LOCA analysis or propose **[**

]

SNPB TAI-73)   Please provide technical basis to support **[**

], addressing the following specifics:

a. Please summarize the source of the data (e.g., size of database, number of plants, approximate time period represented, fuel types, etc.).

b. Please clarify the expected differences in **[**

] Please address in particular why **[**

]

c. Please clarify what verification would occur during the core design process and/or operating cycle to ensure that **[**

] is applicable to a given operating cycle for a particular plant and, **[**
]

d. Regarding the limited data **[**

], please justify that the scarcity of limiting bundles is supported by sufficient measurements in these regimes.

e. Given the **[**

]

f. Please clarify the acceptable tolerance limit in the footnote to Table 6.2-2

SNPB RAI-74)   Please define **[**

]. Please particularly address why **[**

] Please further clarify whether **[**

], or some other reference value, and additionally justify that a consistent reference is used relative to **[**   **].**

SNPB RAI-75)   Please clarify whether scram times under realistic LOCA conditions may be affected by the interference of control blades with core structures due to seismic- or LOCA-induced motion, or due to operational effects such as shadow corrosion-induced channel bow. If so, please clarify why an appropriate delay due to these effects need not be included in a best-estimate analysis.

SNPB RAI-76)   [Follow-on RAI-12] A passage in the response to RAI-12 discusses the difference between offsite power assumptions employed in the generic demonstration cases as compared to those that may be used in an actual application. Among the LTR demonstration calculations, the information contained in the RAI 12 response, and the information displayed in LTR Table 2.5-1 (bottom of Page 2-6), the LTR appears to lack a succinct description explaining GEH's proposed treatment of offsite power availability in plant-specific applications. Please include a brief passage in the LTR that describes how plant-specific applications will ensure that the offsite/onsite power availability requirements of GDC-35 are addressed.

SNPB RAI-77)   Please discuss the steady-state initialization process and what parameters and criteria are used to determine that the steady-state calculation has adequately converged prior to performing transient calculations.

SNPB-78)   How does TRACG-LOCA account for potential uncertainties in the flow regime?   Explain the analytic treatment for uncertainties associated with the transitioning from one type of flow to another?

SNPB-79)   Section 5.3.2 of the LTR states that feedwater flashing is a dominant phenomenon in the latter part of the blowdown phase of the integral LOCA tests, yet the phenomena identification and ranking table (PIRT) treatment of the feedwater system appears to assign a medium importance rank. Both the FIST and ROSA facilities included feedwater piping. Please provide additional detail concerning the TRACG modeling of these facilities, and the treatment of the feedwater system within the TRACG models. Provide additional discussion specifically characterizing the observed impacts of feedwater flashing, and discuss the results of the TRACG assessments with respect to this phenomenon. Explain what conclusions are drawn with regard to the validity of the TRACG-LOCA EM and its treatment of jet pump BWR feedwater piping.

SNPB RAI-80)   Please clarify the Steam Sector Test Facility test used in Figure 5.3-3.

SNPB RAI-81)   Please explain the difference between the early boiling transition peak calculated in TRACG in Figure 5.3-8 for the ROSA test and the measurements that do not show a peak.

SNPB RAI-82)   Section 5.3.3 of the LTR discusses the scaled integral LOCA simulation tests for non-jet pump plants. This discussion is supplemented by Section 5.5 of NEDC-32177P, Revision 3. In particular, Section 5.5 of NEDE-32177P notes that neither of the two integral tests described therein involved ECCS actuation.   It is not clear that the regulatory guidance is satisfied for this reactor design. In particular, Standard Review Plant (SRP) 15.0.2 notes that "Integral effects testing must be performed to demonstrate that the interactions between different physical phenomena and reactor coolant system components and subsystems are identified and predicted correctly." As the LTR refers to a suite of integral effects tests as supplemented by additional separate effects tests, explain how the TRACG-LOCA EM is qualified in an integral sense. One important aspect, for example, is the behavior of non-condensibles in the vessel and primary system.

SNPB RAI-83)   Please clarify whether sensitivities associated with fuel channel grouping were performed for the LOCA event as indicated in Section 6.1 of the LTR and summarize the analysis and results, particularly as pertaining to
[
                        ].

SNPB RAI-84)   Please clarify whether analysis is required for the increased core flow region of the power/flow map. If not, explain why not.

SNPB RAI-85)   Some LOCA-limited plants may not be BWR/2s; please ensure Table 6.2-2 reflects this consideration.

SNPB RAI-86)   Section 6.3 of the LTR indicates that more realistic distributions may be used for plant parameters than specified in Tables 6.3-1 and 6.3-2 if justified separately for plant-specific analysis. Please provide the following additional information regarding this topic:

a. Please clarify whether all parameters in Table 6.3-1 and Table 6.3-2 may be substituted with more realistic distributions, or only a subset thereof, and justify that the data supporting more realistic distributions taken under normal conditions is relevant to performance during a LOCA (e.g., scram times, pump coastdown times, etc.)

b. Please clarify the statistical requirements to support the use of more realistic distributions for plant parameters.

SNPB RAI-87)   Please clarify the code and LTR methodology (if applicable) used in the prediction of the containment pressure values used to characterize the drywell high pressure scram time, and contrast the results to times derived from existing licensing basis calculations. Please further clarify whether the hypothesis of normality was invoked in determining the 95/95 tolerance limit based on seven sample calculations performed at each break size.

SNPB RAI-88)   Please clarify whether the entries in Table 6.3-1 for automatic depressurization system (ADS) close/reopen/reclose on vessel pressure refer to the relief valve mode of operation of the safety relief valves (SRVs) used by the ADS. If not, please explain the intent.

SNPB RAI-89)   [Follow-on to RAI-31] In Section 7.3, please clarify why only the limiting nominal conditions (i.e., without consideration of uncertainty) are evaluated statistically. Because the uncertainty may vary substantially among different breaks, the limiting conditions with respect to the 95/95 tolerance limits used to assess compliance with the criteria of 10 CFR 50.46 may not necessarily correspond with the conditions that are nominally limiting. Further, the process used to obtain the biased results discussed in response to Set 1 RAI 31 is not clear. Finally, it would seem that a better way to address the concern would be to re-evaluate the demonstration analyses for several break sizes in close proximity to the nominally limiting break sizes to demonstrate the insignificance of identifying the limiting break size (and other properties) using a nominal analysis. Presently, LTR Figure 8.1-29 underscores the concern conveyed in this RAI question. Please base the justification provided in response to this RAI question on updated break spectrum analyses and explain whether the more detailed channel grouping has improved the TRACG-LOCA EM performance in this regard.

SNPB RAI-90)   Section 7.3.1 states a minimum bound for the number of simulations that may be increased to raise the confidence level of the desired statistical bound. Please clarify whether GE Hitachi Nuclear Energy – Americas, LLC (GEH) will require that the number of simulations be set prior to performing analysis in order to prevent degradation of the statistical confidence level.

SNPB RAI-91)   Please clarify the statement in Section 7.4.4 that TRACG underpredicts mixing in the VSSL component. It appears that the spread in lower plenum temperature predictions in the TRACG results are less than the data, and that the mean value of the lower plenum temperature is underpredicted by TRACG.

SNPB RAI-92)   In Section 7.4.5, Core Spray Heat Transfer (CSHT) Test 111 was chosen for comparison with TRACG results to justify the model parameter uncertainties and statistical combination process. Please address the following associated issues:

      a. Although most data for CSHT Test 111 is bounded by TRACG predictions, the peak temperatures for the hottest rods significantly exceed the mean of the TRACG predictions and in some cases even exceed the maximum value of the 59 TRACG predictions (e.g., Figure 7.4-18). Since it is the peak values that are of regulatory interest, please justify the LTR's conclusion that uncertainties proposed for modeling core spray are adequate.

      b. Please justify the selection of CSHT Test 111 for comparison and discuss whether the conclusions made in Section 7.4.5 of the LTR would hold if comparisons were instead made with additional CSHT tests such as Tests 112 and 121 (see Section 3.2.2 of the Qualification Report). Demonstrating that proposed uncertainty distributions provide a representative bound on tests such as CSHT is vital due to the lack of integral testing involving extended heatups characteristic of LOCA-limited BWRs.

SNPB RAI-93)   Regarding the statement in Section 8.1.1 that **[**

      ], please clarify the following:

      a.   **[**

      ]

      b. Please provide the basis for terminating the model at this point (e.g., post-LOCA system isolation point, sensitivity calculations demonstrate no further impact from extending model, etc.).

      c. Please justify that the modeling of the feedwater system is either best-estimate or conservative.

SNPB RAI-94)   [Follow-on to Set 1 RAI 20] The response to Set 1 RAI 20(a) states, in part, **[**

      ] Please clarify whether **[**

      ]

SNPB RAI-95)   Section 8.1.2.2 states that similar to results from the SSTF (e.g., as discussed in NUREG/CR-2566), it is possible for bundles in TRACG simulations to make a transition from the one mode **[**

      ] to the other during the transient, and that the results confirm

TRACG's capability to predict this behavior. Please clarify this statement relative to the results in Section 6.4 (particularly Figures 6.4-7 and 6.4-8), which appear to suggest very limited potential for transition between states beyond an initial bifurcation point.

SNPB RAI-96)   According to Figure 8.3-35 of NEDE-33005P, **[**

] Please provide an evaluation of this result, considering whether the value of this standard deviation is an appropriate indicator of the total uncertainty associated with this result. Consider, in particular, that the standard deviations associated with other break sizes on the same spectrum are much greater.

SNPB RAI-97)   Based on the NRC staff review, NEDE-33005P appears to contain little, if any, discussion on changes in fuel pellet geometry, integrity, and location following fuel cladding ballooning and rupture. Please describe and justify the analytic treatment of these phenomena, with due consideration for available experimental data, and the specific results predicted using the TRACG-LOCA EM, such as fuel and cladding temperatures, fuel rod burnup, extent of cladding deformation, and time of rupture.

SNPB RAI-98)   Provide additional information to describe the interrelationship among the interfacial shear, entrainment, and wall friction models in TRACG. Particularly, address the qualification of the code to predict two-phase flow and heat transfer behavior in fuel channels at high-void, low pressure conditions that would not otherwise be counter-current flow limited. Such conditions may exist in limiting channels at the point when the code predicts the termination of cladding heatup.