October 10, 2006

Mr. David H. Hinds, Manager, ESBWR
General Electric Company
P.O. Box 780, M/C L60
Wilmington, NC 28402-0780

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 66 RELATED TO ESBWR DESIGN CERTIFICATION APPLICATION

Dear Mr. Hinds:

By letter dated August 24, 2005, General Electric Company (GE) submitted an application for final design approval and standard design certification of the economic simplified boiling water reactor (ESBWR) standard plant design pursuant to 10 CFR Part 52. The Nuclear Regulatory Commission (NRC) staff is performing a detailed review of this application to enable the staff to reach a conclusion on the safety of the proposed design. The NRC staff has identified that additional information is needed to continue portions of the review. The staff's request for additional information (RAI) is contained in the enclosure to this letter.

RAI questions 4.2-8 through 4.2-14 relate to Chapter 4, "Reactor," and RAI question 14.3-68 relates to Chapter 14, "Initial Test Program," of the ESBWR design control document (DCD), Tier 2, Revision 1. These questions were sent to you in draft form via electronic mail on September 26, 2006. You did not request a telecon and agreed to respond to this RAI set on November 22, 2006.

RAI questions 15.5-5 through 15.5-12 relate to Station Blackout, as discussed in the ESBWR DCD, Tier 2, Revision 1, Chapter 15, "Safety Analyses." These questions were emailed to you in draft form on September 12, 2006, and discussed with your staff on a telecon on September 25, 2006. Upon clarification, one RAI question was withdrawn. You agreed to respond to RAI questions 15.5-5 through 15.5-12 on November 22, 2006.

RAI questions 21.6-55 through 21.6-65 relate to NEDE-33083P, "TRACG Application for ESBWR Anticipated Transient Without Scram (ATWS)," were emailed to you in draft form on July 11, 2006, and discussed with your staff on a telecon on September 21, 2006. You agreed to respond to this RAI set on November 22, 2006.

RAI questions 21.6-66 through 21.6-75 relate to NEDE-32176P, Rev. 3, "TRACG Model Description," and were emailed to you on July 11, 2006, and discussed with your staff on a telecon on September 29, 2006. You agreed to respond to RAI questions 21.6-66 through 21.6-68, and 21.6-72 through 21.6-75 on October 20, 2006. You agreed to respond to RAI questions 21.6-69 through 21.6-71 on November 22, 2006.

RAI questions 21.6-78 through 21.6-89 relate to NEDE-32176P, Rev. 3, "TRACG Model Description," and NEDC-33239P, "GE14 for ESBWR Nuclear Design Report." These RAI questions were emailed to you on September 19, 2006, and discussed with your staff on a telecon on September 25, 2006. You agreed to respond to this RAI set on November 22, 2006.

RAI questions 21.6-90 and 21.6-91 relate to the ESBWR ATWS event, and 4.3-6 relates to the stability evaluation, as discussed in the ESBWR DCD, Tier 2, Revision 1, Chapter 4D. These RAI questions were emailed to you on September 26, 2006. You did not request a telecon and agreed to respond to this RAI set on November 22, 2006.

If you have any questions or comments concerning this matter, you may contact me at (301) 415-4115 or mcb@nrc.gov or you may contact Amy Cubbage at (301) 415-2875 or aec@nrc.gov.

Sincerely,

/RA/

Martha C. Barillas, Project Manager
ESBWR/ABWR Projects Branch
Division of New Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 52-010

Enclosure: As stated

cc: See next page

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Sincerely,

/RA/

Martha C. Barillas, Project Manager
ESBWR/ABWR Projects Branch
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ACCESSION NO. ML062790238

OFFICE	NESB/PM	NESB/BC
NAME	MBarillas	JColaccino
DATE	10/06/2006	10/10/2006

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Distribution for RAI Letter No. 66 dated October 10, 2006

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Request for Additional Information (RAI)
ESBWR Design Control Document (DCD), Revision 1
Tier 1 Sections 2.8 and 2.9, and Tier 2 Section 4.2 and Appendices 4B and 4C Regarding the Fuel System Design

RAI Number	Reviewer	Question Summary	Full Text
4.2-8	Clifford P	Identify control rod design requirements in DCD Appendix 4C.	Similar to RAI 4.2-5, DCD Tier 2, Rev. 1, Appendix 4C should define specific Tier 2 and Tier 2* control rod design requirements. The current text appears to be an overview of a control rod design change process and should be revised. Section 4C.1 states, "...designs meeting the following acceptance criteria are considered to be approved and do not require specific NRC review". The NRC staff disagrees with this statement. The control rod design employed in the initial core (Cycle 1) in any facility referencing the ESBWR certified design must be specifically reviewed and approved by the NRC if the design deviates from the control blade design approved in the design certification. Accordingly, the staff requests that GE mark the requirements as Tier 2* information in the next DCD revision.
4.2-9	Clifford P	Identify reactivity requirement for control rod design.	DCD Tier 2, Rev. 1, Section 4.2.4.9 states, "Subsequent Marathon designs or absorber section loadings will be within ±5 percent Δk/k of the initial ESBWR Marathon design". The control rod design employed in the core in any facility which adopts the ESBWR certified design must be specifically reviewed and approved by the NRC if the design deviates from the control blade design approved in the design certification. Clarify what is meant by "subsequent" and explain the intent in providing this statement in Section 4.2.4.9 of the DCD, Tier 2, Rev. 1.

Enclosure

RAI Number	Reviewer	Question Summary	Full Text
4.2-10	Clifford P	Clarification of lead surveillance control rod requirement	DCD Tier 1, Rev. 1, Section 2.9 and Tier 2, Revision 1, Appendix 4C.1, include a control rod design requirement which states that "...lead surveillance control rods may be used". Please clarify what is meant by the phrase "may be used," (i.e., what type or magnitude of design change would warrant in-reactor service prior to batch implementation.) Please revise the design requirement accordingly.
4.2-11	Clifford P	Material compatibility and shadow corrosion	DCD Tier 1, Rev. 1, Section 2.9 under principal design criteria states, "The material of the control rod will be compatible with the reactor environment". In recent years, the phenomena shadow corrosion has been identified. This phenomena is partly due to the interaction between the zircaloy channels and stainless steel control blades. Discuss the implementation of this principle design criteria with respect to shadow corrosion.
4.2-12	Clifford P Yarsky P	Accounting for uncertainties in the LHGR limit	Describe what factors in the determination of the maximum linear heat generation rate limit that ensure the value is conservative based on uncertainties in the plant nuclear instrumentation and calibration as well as uncertainties and biases in the bundle peaking factors and uncertainties and biases in the 3D MONICORE PANAC11 computational engine? Justify any credit taken for adaption or relative improvement in LPRM instrument accuracy based on gamma thermometer calibration, as compared to TIP calibration.
4.2-13	Clifford P	Clarification on Tier 1 fuel design requirements	DCD Tier 1, Rev. 1, Section 2.8 defines six principal requirements. Provide clarification on whether these six requirements are, in fact, Tier 1 fuel design requirements. Note that the licensing approach for these ESBWR requirements appears to differ from the ABWR DCD Tier 1, Section 2.8.1 design requirements.

RAI Number	Reviewer	Question Summary	Full Text
4.2-14	Clifford P	Structural versus material properties.	DCD Tier 1, Rev. 1, Section 2.9 and DCD Tier 2, Revision 1, Appendix 4C.1 defines principal design criteria for the control rod. One of the design criteria states that the stresses, strains, and cumulative fatigue will be evaluated to not exceed the ultimate stress or strain limit of the material. Certain BWR control rod designs include long axial welds between the square tubes and welds connecting the absorber wings to the handle and connector. In order to set design requirements on material properties, it must be demonstrated that structural properties (e.g., weld regions) are never more limiting than the material properties throughout the expected lifetime of the control rod. Provide evidence (e.g., mechanical testing) to demonstrate that the structural properties would never be more limiting or re-write the design requirement.
14.3-68	Clifford P	Need for ITAAC or startup test program to validate local core flow characteristics.	DCD Tier 1, Revision 1, Section 2.8 does not specify any ITAACs for the ESBWR fuel design. Further, DCD Tier 2, Revision 1, Chapter 14 does not specify any test programs directed at validating local core flow characteristics. The ESBWR reactor vessel design, with the absence of jet pumps (and significantly lower core mass flow rate), represents a departure from the current fleet of BWRs in the United States. The staff has concerns regarding the uncertainty in predicted local core flow characteristics due to (1) the absence of jet pumps, (2) the potentially higher sensitivity of local flow characteristics to local power conditions, (3) the ESBWR's 1132 fuel bundle core configuration, and (4) the lack of prototypical operational experience. An increase in the uncertainty to predict local flow characteristics would further challenge CPR fuel design limits during normal operation and AOOs. Justify the lack of an ITAAC or test program to address this potentially larger uncertainty in predicted local core flow characteristics. Alternatively, develop an ITAAC or test program which either directly or indirectly confirms core flow characteristics in different regions of the core.

Request for Additional Information (RAI)
ESBWR Design Control Document, Tier 2, Rev. 1, Chapter 15.5

RAI Number	Reviewer	Question Summary	Full Text
15.5-5	Parks B	Clarify operator actions in ATWS scenario.	On page 15.5-6 of the ESBWR Design Control Document, Tier 2, Rev. 1, it states: "If the Heat Capacity Temperature Limit is reached, the operator would depressurize the reactor via SRVs to maintain margin to suppression pool limits. This operation was not necessary in the ESBWR ATWS." It is not clear to the staff, based on the second sentence, whether the first sentence is crediting an operator action for depressurization for the ESBWR, or for a different BWR. Please revise the DCD to provide more clarity. Regarding the same information, it appears that the TRACG analysis of ATWS/MSIV closure does not assume operator action. Please clarify whether any of the sequence of events used in the TRACG analysis credits operator action.
15.5-6	Parks B	Confirm TRACG assumptions for SBO Analysis	Regulatory Guide (RG) 1.155, Station Blackout (SBO), regulatory position 3.2.1 states that analyses should assume the plant has been operating at 100 percent power for 100 days. Confirm whether this is the case for the ESBWR TRACG SBO analyses.
15.5-7	Parks B	Perform additional TRACG analyses for SBO	Regulatory position 3.2.4 of RG 1.155 states that design adequacy and capability of coping systems should be evaluated, including potential failures of equipment necessary to cope. Provide analysis results showing the ESBWR can cope with an SBO scenario assuming failure of a makeup system.

15.5-8	Parks B	Discuss valve position indication and closure	Regulatory position 3.2.7 of RG 1.155 states that the ability to maintain appropriate containment integrity during a loss of all ac power should be addressed. The applicant addresses containment integrity in terms of design limits on pressures and temperatures. Please add a discussion to section 15.5 of the ESBWR DCD explaining what provisions are present to assure valve position indication and closure for containment isolation valves that may be in the open position at the onset of a station blackout.
15.5-9	Parks B	Consider alternative coping period	10 CFR 50.63 requires the selection of a coping time based on site-specific criteria. GE has generically proposed an 8-hour coping time. Based on the guidance in RG 1.155, this value is nearly a maximum amount of time. However, some circumstances identified in the RG require 16 hours coping time. The staff considers selection of an 8 hour coping time to be conservative, although not bounding of all possible site characteristics. Address the performance of ESBWR during a 16-hour coping period.
15.5-10	Parks B	Extend length of time for SBO analysis	The staff is unable to confirm that TRACG results for SBO have reached a steady-state response in a 33-minute transient analysis provided. Please provide TRACG analysis results for a sufficient period to show that the reactor is in a safe condition for the duration of a 72-hour coping period.
15.5-11	Parks B	Explain differences between DCD 8B.4 and 15.5	The realistic SBO analysis presented in DCD Section 8B.4 credits 3 isolation condensers and control rod drive pumps, and assumes a single failure, whereas the analysis in DCD Section 15.5 does not explicitly assume a single failure, and only credits the passive isolation condenser system. Explain why these analyses are different, and whether updates to make the two consistent are planned.

15.5-12	Parks B	Explain control rod drive pump operation	The DCD Section 8B.4 SBO analysis credits control rod drive (CRD) pumps for vessel level recovery. Explain how this is possible without AC power and, if used after AC power is restored, state when, in the transient analysis, CRD pumps are credited for level makeup.

RAI Number	Reviewer	Question Summary	Full Text
21.6-55	Landry R Klein V	Provide additional information on the modeling of the isolation condenser using TRACG.	Provide the following additional information regarding the modeling of the isolation condenser using the TRACG code: A. Explain in detail how the isolation condenser is modeled. Provide a nodalization diagram illustrating which components are used. How is this different from the isolation condenser model used in the PANTHERS test discussed in Section 4.2 of NEDC-32725P "TRACG Qualification for SBWR"? B. Provide a discussion of how noncondensible gas generated by radiolytic water decomposition is treated during an event that requires the isolation condenser system (ICS). Is radiolytic noncondensible gas modeled using TRACG? If so, explain what uncertainties are included in the timing of the transport of the radiolytic noncondensible gas to the ICS. Comparison of TRACG calculations to PANTHERS data shows significant differences in the transport timing. If this is not included in the TRACG model, explain how the treatment in the TRACG modeling is conservative.
21.6-56	Landry R Klein V	Explain the use of a quasi-steady-state correlation used to predict boiling length for rapid transients.	GEXL is a quasi-steady-state boiling length correlation, which is used in TRACG to predict the critical power ratio (CPR). Provide the basis for using a boiling length quasi-steady-state correlation for rapid pressurization transients, such as load rejection with no bypass (LRNB).

21.6-57	Landry R Klein V	Provide additional information for the LRNB event.	Provide the following additional information about the load rejection with no bypass (LRNB) event: A. Table 4.7-1 states that the turbine valve closure scram is initiated at 0.08 seconds into the transient. What percentage of full open are the valves when you initiate a reactor scram? What is the delay time associated with the signal? Provide justification supporting the selection of your turbine control valve closure times and signal delay times. B. What is the amount of time from when the scram signal is initiated to when the rods actually begin to insert for the transient analyses? Justify this value. C. Provide a version of DCD Tier 2, Figure 15.3-5e magnifying the area between 0-2 seconds.
21.6-58	Landry R Klein V	Explain how numerical diffusion of the pressure waves was quantified.	A two-fluid finite difference donor cell model with a relatively coarse noding such as that implemented in the TRACG methodology tends to smear out or diffuse pressure waves. Explain how this numerical diffusion of the pressure wave has been quantified and factored into the TRACG uncertainty analysis for the rapid pressurization events.
21.6-59	Landry R Klein V	TRACG capability to calculate the propagation of a pressure wave through a two-phase mixture.	Provide additional information demonstrating that TRACG is capable of calculating the propagation of a pressure wave through a two-phase mixture. Identify the assessment calculations in which this is demonstrated.
21.6-60	Landry R Klein V	Explain why the Doppler coefficient not included as a high ranked phenomenon.	Provide additional information supporting why the Doppler coefficient was not included as a high ranked phenomenon in the PIRT for ESBWR transients.

21.6-61	Landry R Klein V	Justify the ranking for lower plenum stratification during cold water transients.	Mixing in the lower plenum is not listed in the PIRT for ESBWR transients as a high ranked importance phenomenon for cold water transients. Provide supplemental discussion to that provided in NEDC-33079P, Supplement 1, Revision 1, justifying the ranking for this phenomenon during cold water transients. Provide information such as noding studies that may have been performed with TRACG to investigate mixing for cold water transients. Discuss the radial difference in subcooling across the core for a feedwater controller failure (FWCF) event.
21.6-62	Landry R Klein V	Explain initiation from a higher initial power, the higher change in CPR, and the difference between NEDE-33083P (MFN 04-109) and the DCD Tier 2 for the FWCF event.	Regarding the Critical Power Ratio (CPR) calculation of the FWCF event, provide the following additional information: A. On page 4-47 of “ Demonstration Calculations for ESBWR AOOs (MFN-04-109),” the ΔCPR [change in critical power ratio] for this transient is provided and is higher than that for the LRNB event, because the transient initiates from a higher initial power. You state in both sections 4.7.1.1 and 4.7.1.2 on pages 4-46 and 4-47, respectively, that both transients are modeled at 100 percent power. Provide additional information explaining the statement that the “transient initiates from a higher initial power.” B. The power excursion for the FWCF event is much less severe than the LRNB event, yet the change in CPR is higher for the FWCF event. Provide an explanation for this behavior. C. Explain why Figure 15.3-2g of the DCD Tier 2 does not show the same ΔCPR for this transient. What is the difference between the FWCF analysis in NEDE-33083P (MFN 04-109) and that in the DCD Tier 2 that would cause the CPR to change?
21.6-63	Landry R Klein V	Explain differences in NEDE-33083P and the DCD Tier 2, Chapter 15.	Provide a description of all of the differences in the analyses performed in Chapter 4 of NEDE-33083P (MFN 05-017 and MFN 04-109) and Chapter 15 of ESBWR DCD Tier 2, Revision 1.

21.6-64	Landry R Klein V	Explain exclusion of medium ranked parameters in the uncertainty analysis.	In the topical reports NEDC-33083P Supplement 1 (Methodology to calculate stability margins for ESBWR using TRACG) and NEDE-32906P-A Rev. 2 (Methodology to perform transient analysis for BWR/2-6 using TRACG) both high and medium importance PIRT parameters were included in the uncertainty analysis. However, for the TRACG application for ESBWR AOOs, it appears that only high importance PIRT parameters are to be included in the uncertainty analysis with the exception of a few medium ranked parameters. D. Provide a basis explaining the exclusion of the medium ranked parameters from the uncertainty analysis. E. Why were some medium importance parameters included in the ESBWR transient uncertainty analysis and other PIRT parameters of medium importance not included? Explain the method for selecting the parameters included in the uncertainty analysis. F. Page 4-21 in Section 4.4 of NEDC-33083P-A states, “For some phenomena that have little impact on the calculated results, it is appropriate to simply use a nominal value or to conservatively estimate the bias and uncertainty.” Is a nominal value used for the medium ranked phenomena? If so, explain why bounding values were not used. Provide a discussion of how medium ranked phenomena are treated in terms of model uncertainty and bias.

21.6-65	Landry R Klein V	Nodalization for the transient analysis.	Page 4-32 in Section 4.4.2 of NEDC-33083P-A states "The adequacy of the nodalizations has been demonstrated and is supported by sensitivity studies. Standard nodalizations for modeling of ESBWR reactor vessels and other components have been presented in the *TRACG Qualification for SBWR* [24]." A. The staff was unable to locate any sensitivity studies in your reference pertaining to the radial channel grouping and azimuthal nodalization of the VESSEL component for the transient analysis. It appears that this nodalization is the same as that presented in NEDC-33083P Supplement 1 *TRACG Application for ESBWR Stability Analysis*. Confirm if this is true. Provide additional information discussing that this nodalization scheme is adequate for the transient analysis. Discuss how it is adequate to model the various transients. B. The staff understands that you are not using the CHAN nodalization described in your reference 24 (*TRACG Qualification for SBWR*). The staff understands that the nodalization that you are using appears to be the same as that described in NEDC-33083P Supplement 1 *TRACG Application for ESBWR Stability Analysis.* Confirm if this is true. Provide a basis explaining that this nodalization is adequate for performing the transient analysis. C. Provide diagrams illustrating the VESSEL axial, radial and azimuthal noding and channel grouping. Provide diagrams with nodalizations of all of the components connected to the VESSEL (such as the ICS, CHAN and steamlines) and show how (which nodes) these are connected to the VESSEL. D. Update your documentation to identify and describe in the same manor any other components that are nodalized differently than what is described in the *TRACG Qualification for SBWR* report.

NEDE-32176P, Rev. 3, "TRACG Model Description"

RAI Number	Reviewer	Question Summary	Full Text
21.6-66	Throm E	Editorial comment regarding NEDE-32176P, Rev. 3, Section 6.3.2	NEDE-32176P, Rev. 3, Section 6.3.2 starts a list with item 6. Is this a formatting error or is part of the list missing?
21.6-67	Throm E	Clarification of characteristic length for a free surface	In NEDE-32176P, Rev. 3, Section 6.5.8, the characteristic length (L) is defined for a plate. (a) Are other geometries considered, for example circular, and if so how is L defined for other geometries? (b) Since L is part of the Gr number, is k_2 in Eq. 6.5-21 typically 1/3, such that the value for L is not important in determining the heat transfer coefficient?
21.6-68	Throm E	Editorial comment regarding NEDE-32176P, Rev. 3, Page 6-135	On page 6-135 of NEDE-32176P, Rev. 3, should the reference to Figure 6-34 actually be to Figure 6-37?
21.6-69	Throm E	Clarification of sensitivity studies	On page 6-142 of NEDE-32176P, Rev. 3, the sensitivity to steam condensation in containment makes reference to studies performed for a main steam line break (MSLB) where the peak pressures and temperatures in containment occur very late in the accident. (a) Does this conclusion hold true for cases, such as the feedwater line break (FWLB), when the peaks occur early in the accident? (b) How is the phenomena identification and ranking table (PIRT) multiplier determined for use in a licensing analysis - is the value event specific?

RAI Number	Reviewer	Question Summary	Full Text
21.6-70	Throm E	Clarification regarding empirical modeling approach used	On page 6-156 of NEDE-32176P, Rev. 3, the alternate bounding approach to address the effects of the noncondensable distribution in the suppression pool is described. Mixing in the wetwell vapor space is also treated empirically, to conservatively evaluated the wetwell temperature and to model the region near the vacuum breakers in the upper wetwell vapor region. A discussion should be included, either in this section, or in Section 7.11.2.1 (with a pointer), to address the empirical modeling approach used.
21.6-71	Throm E	Clarification of bounding analysis	In Section 7.11.1.2 of NEDE-32176P, Rev. 3, reference is made to the bounding model used to address uncertainties in the amount and location of noncondensable gases in containment. The model as shown in Figure 7-43 does not include the features referenced to for the MSLB case. How does the current model address these uncertainties for each type of accident (MSLB, FWLB, etc.)
21.6-72	Throm E	Clarification of model description	In Section 7.11.2.1 of NEDE-32176P, Rev. 3, the text describes two axial levels while the reference figure shows three. How does the selection of the number of axial levels effect the natural circulation in this region, the amount of mixing which influence the wetwell gas temperature and pressure?
21.6-73	Throm E	Editorial comment regarding NEDE-32176P, Rev. 3, Section 7.11.7.5	Section 7.11.7.5 of NEDE-32176P, Rev. 3, contains two paragraphs which are nearly the same to describe the single-phase friction factor but vary in the method used to evaluate the Reynolds number. Please clarify and correct as appropriate - discuss separately for single-phase flow and two-phase flow conditions, with appropriate pointers to the models in Section 6.2.

RAI Number	Reviewer	Question Summary	Full Text
21.6-74	Throm E	Clarification regarding code version	Ref [8]: *TRACG Qualification for ESBWR*, NEDC-33080P, August 2002, was updated to Revision 1, dated May 2005 to reflect newer version of TRACG04A (9-Apr-2004). Why has GE chosen to use the outdated code version to support TRACG qualification for the ESBWR? (Also note that in ltr MFN 06-159, NEDC-33030P is dated November 2002: August 2002 is correct date.)
21.6-75	Throm E	Availability of Reference 7 to NEDE-32176P, Rev. 3	Ref [7]: *TRACG Qualification*, NEDE-32177P Rev 3, to be published June 2006. Please submit this reference.
21.6-78	Landry R Klein V (Spore J, ISL)	Explain the two options for calculating the CPR for transient conditions.	On page 7-47 of NEDE-32176P, Rev. 3 you state: "Two options exist for the calculation of the critical power ratio (CPR) for transient conditions." Why do you have two options for calculation of transient CPR? Is one method more accurate than the other? What are your guidelines for when to use which method for transient CPR calculations? Which method is used during an AOO calculation and during an ATWS calculation? On page 7-48 of the same document you state: "The assessment of the critical power calculation can be found in Section 3.6 of the *TRACG Qualification LTR*." The staff does not have Reference 6 (Rev. 3 of the *TRACG Qualification LTR*) which you state is to be published in June 2006. Provide the information from this document that may answer the above questions on the CPR calculation options for transient conditions.
21.6-79	Landry R Klein V (Spore J, ISL)	Correlation for minimum stable film boiling temperature.	In Section 6.6.7 of NEDE-32176P, Rev. 3, you describe the correlation in TRACG for calculating minimum stable film boiling temperature. You have three different options. Describe the conditions under which each of the three options is selected. On page 6-117, you state "The Shumway correlation, however, has a larger data base and captures the flow and pressure dependence better than the Iloeje correlation." The TRACG input decks submitted to the staff show that you have selected the Iloeje model for the ESBWR events. Explain the choice of this model.

21.6-80	Landry R Klein V (Spore J, ISL)	Number of decay heat groups.	The variable f in Eq. 9.3-2 in NEDE-32176P, Rev. 3, is described as the sum of the five decay heat group fractions, f_k. However, in the preceding paragraph you state that TRACG04 allows for a variable number (N_d) of decay heat groups. Please update your documentation to reflect this change.
21.6-81	Landry R Klein V (Spore J, ISL)	Questions related to distribution of channel power.	Please address the following questions related to distribution of channel power: E. Eq. 9.4-11 in NEDE-32176P, Rev. 3, includes Fco, which is the fraction of direct moderator heating that appears in the coolant in the bypass, water rod, and bundle coolant. In TRACG, the water rod coolant, the core bypass coolant, and the bundle coolant are simulated as separate flow paths. How is the direct moderator heating associated with Fco split up for these three different coolant regions within the BWR core? Please describe the basis of the model. F. Page 62 of NEDC-32965P, Rev. 0 (UM-0149, Rev. 0), describes the user input fractions for fission power and decay heat for direct moderator heating, fuel clad gamma heating and water rod(s) clad gamma heating as described in NEDC-32176, Rev. 3, page 9-35. The description for FDMN2 (direct moderator heating fraction for decay heat power) states “The prior practice of setting FDMH2=FDMH1 is discouraged since it is non-conservative with respect to post-scram evaluations of peak clad temperature.” Where FDMH1 is the direct moderator heating fraction for fission power. Please explain why you have set FDMH1=FDMH2 for all of the CHANs in the ESBWR TRACG decks for LOCA, AOO, ATWS and Stability given this statement in the user’s guide. G. You state that c_0 in Eq. 9.4-14 of NEDC-32176P, Rev. 3, is calculated based on MCNP analysis, and page 63 of NEDC-32965P, Rev. 0 (UM-0149, Rev. 0), provides a default value of this parameter (DMHZERO in TRACG) for GE11 fuel design. TRACG models for

			LOCA, AOO, ATWS and Stability use a different value for GE14 fuel. Is this number based on MCNP calculations for GE14 fuel? If not, provide the basis for assuming that c_0 does not change for the GE14 fuel design. H. How does the direct moderator heating model change based on the control fraction for a given CHAN component? How specifically is the user input for BPAPC (bypass area per channel) used in the direct moderator heating model? I. The fission power distribution model presented in section 9.4 in NEDE-32176P, Rev. 3, appears to assume no gamma heat of the pressure vessel walls. Explain how gamma heating of the pressure vessel walls is considered. J. a and b in Eq. 9.4-13 in NEDE-32176P, Rev. 3, are assumed constant for calculating the fractional deposition of fission power in the fuel clad, water rod clad, control blades, and channel wall. For the case of direct moderator heating you make the correction in Eq. 9.4-14 in NEDE-32176P, Rev. 3. Please provide justification that a and b are independent of the moderator density for fuel clad, water rod clad, control blades, and channel wall deposition, or that the correction made by Eq. 9.4-14 in NEDE-32176P, Rev. 3, adequately characterizes the moderator density dependence of a and b for the above. K. What is the normalization formula used to normalize Eq. 9.4-11 in NEDE-32176P, Rev. 3? If the energy distribution fraction Fco is decreasing because the moderator density is decreasing, how are the other fractions in Eq. 9.4-11 in NEDE-32176P, Rev. 3, adjusted to ensure that they sum to one? L. Does TRACG uncertainty analysis include uncertainty associated with a and b for c, f, w, bl, ch, and co?

21.6-82	Landry R Klein V (Spore J, ISL)	Transient Xenon	Section 9.1.3 in NEDE-32176P, Rev. 3, indicates that at the beginning of the calculation with the PANCEA wrapup, that the TRACG cross sections include the presence of Xenon. However, the transient calculation procedure does not indicate that the Xenon concentration is updated. The staff is aware that TRACG is capable of simulating transients with transient Xenon conditions, but is unable to locate any details about your models and calculation procedures. Please provide these details. Are transient Xenon conditions used in the simulation of any AOO and ATWS events? Include information on how the treatment of Xenon is conservative for these events.
21.6-83	Landry R Klein V	Axial nodalization studies for ESBWR ATWS analysis.	Provide nodalization studies justifying your axial nodalization described in NEDC-33083P, Supplement 2, of the vessel bypass in relation to boron transport and mixing for the ESBWR ATWS event.
21.6-84	Klein V	Comparisons between TGBLA06 and MCNP	In discussing the biases and uncertainties for the void coefficient in NEDE-32906P “TRACG Application for Anticipated Operational Occurrences (AOO) Transient Analyses” in response to Staff RAI 12 (MFN-06-046, dated 2/14/2006, ML0605305750) you state “When the PANAC11 model is implemented in TRACG it will be necessary to make a similar assessment TGBLA06 and MCNP and change the TRACG void coefficient model accordingly.” Please state if this has been done and provide the staff with the documentation that includes the details of the new evaluation.

RAI Number	Reviewer	Summary	Full Text
21.6-85	Yarsky P	Procedure for generating PANACEA Wrap-up file.	Describe the computational procedure used to generate a PANACEA Wrap up file for use with TRACG as applied in NEDC-33239P. Specifically explain what calculations are performed with PANAC11 and how these results are captured numerically in the PANACEA Wrap up file.
21.6-86	Yarsky P	Provide model for the determination of plutonium content.	The isotopic tracking in the PANAC11 code is discussed in NEDC-33239P. Please provide a prototypical calculational model (e.g., the differential equations) for the determination of plutonium content based on the nodal power, exposure, and moderator density history.
21.6-87	Yarsky P	Describe how PANAC11 calculates the bundle power where boiling transition occurs.	PANAC11 uses the GEXL correlation to determine critical quality for the purpose of calculating the minimum critical power ratio. Describe how PANAC11 calculates the bundle power where boiling transition occurs.
21.6-88	Yarsky P	Describe how the linear interpolation technique is used to determine bundle flow based on the characteristic bundle calculations.	The determination of the core flow distribution is described in NEDC-33239P. Describe how the linear interpolation technique is used to determine bundle flow based on the characteristic bundle calculations. Provide a description of the range of flow and power conditions enveloped by the characteristic bundle calculations. If there are cases where bundle flow is determined by extrapolation of parameters beyond the envelope of conditions in the characteristic bundle calculations, provide justification.
21.6-89	Yarsky P	Procedure for calculating detector response kernels.	Describe the procedure for calculating the detector response kernels that are used for simulated plant instrument response as discussed in NEDC-33239P.

Related to Anticipated Transient Without Scram and
Stability Evaluation described in Chapter 4D of the ESBWR DCD, Tier 2, Revision 1

RAI Number	Reviewer	Question Summary	Full Text
21.6-90	Klein V	Control blade dimensions in full out position.	In an ATWS event, the presence of control blades in the lower bypass will affect the boron distribution. Provide the height of the control blades above the top of the core plate when blades are in the full out position. Discuss how the presence of control blades in the lower bypass affects the boron distribution. If this is not accounted for in the TRACG analyses of an ATWS event, demonstrate that the presence of the control blades does not affect the ATWS analyses.
21.6-91	Klein V	TRACG Input decks	Provide the most recent version of all of your TRACG input decks with the next revision of the DCD. This should include input decks used for LOCA, AOOs, ATWS and stability.
4.3-6	Klein V March-Leuba J	Void Reactivity Coefficient	Provide the effective void reactivity coefficient calculated by PANACEA for BOC, MOC, and EOC at nominal operating conditions.

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