October 15, 2007

Mr. Robert E. Brown
Senior Vice President, Regulatory Affairs
GE-Hitachi Nuclear Energy Americas, LLC
3901 Castle Hayne Rd MC A-45
Wilmington NC 28401

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 111 RELATED TO ESBWR DESIGN CERTIFICATION APPLICATION

Dear Mr. Brown:

By letter dated August 24, 2005, GE-Hitachi Nuclear Energy Americas, LLC (GEH) 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.

To support the review schedule, you are requested to provide the requested additional information within 45 days of the date of this letter.

If you have any questions or comments concerning this matter, you may contact me at 301-415-6256 or djg3@nrc.gov or you may contact Amy Cubbage at 301-415-2875 or aec@nrc.gov.

Sincerely,

/RA/

Dennis Galvin, Project Manager
ESBWR/ABWR Projects Branch 1
Division of New Reactor Licensing
Office of New Reactors

Docket No. 52-010

Enclosure: Request for Additional Information

cc: See next page

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Distribution: See next page
ACCESSION NO. ML072690278

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SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 111 RELATED TO ESBWR DESIGN CERTIFICATION APPLICATION

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Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD), Revision 3

RAI Number	Reviewer	Question Summary	Full Text
6.2-46, Supplement No. 2, (MFN 06-264, Supplement No. 1, June 22, 2007)	Wagage H & Haider S	Correct the DCD Table 6.2-12	MFN 06-264 Supplement 1, Enclosure 1, Table 6.2-12 (Subcompartment Vent Path Designation) on Page 9 inconsistently reports "FORWARD" in the Flow Direction column, and "TWO WAY PATH" in the last (Comments) column, for Flow Path No. 6. A review of Figure 6.2-18 on Page 23 shows that Flow Path No. 6 joining Cells 6 and 7 is indeed a two-way path and not a blow-out panel. Therefore, "BOTH" should rather be reported for Flow Path No. 6 in the Flow Direction column of Table 6.2-12. DCD, Tier 2, Revision 3, should be revised accordingly.
6.2-58, Supplement No. 2, (MFN 06-348, September 29, 2006 and June 14, 2007)	Wagage H Notafrancesco A	List the single active failures considered and results for containment analyses	In RAI 6.2-58, Supplement 1, the staff stated the following: "In GEH's response to RAI 6.2-58 various single active failures were considered in regards to the emergency core cooling system analysis. However, the intent of this RAI was to identify the limiting sequence considering the worst single active failure with respect to peak containment pressure." In response to RAI 6.2-58, Supplement 1, GEH did not address the original RAI as intended. Please provide the list of single failures considered and the results to identify the limiting sequence considering the worst single active failure with respect to peak containment pressure.
6.2-98, Supplement No. 1, (MFN 07-312, June 20, 2007)	Wagage H Notafrancesco A	Modeling of the trapping and transient distribution of noncondensable gases in the drywell and subsequent transport to wetwell	RAI 6.2-98 was a followup to RAI 6.2-53 (MFN 06-215). The intent of these RAIs was to understand the TRACG calculation for the bounding scenario. ESBWR DCD Tier 2 provides limited information that is insufficient to understand the analyses. These RAIs focused on key phenomena–the trapping and transient distribution of noncondensable gases in the drywell and subsequent transport to the wetwell. (A) The limiting design basis accident changed from feed water line break (FWLB) to main steam line break (MSLB) as given in ESBWR DCD Tier 2 Revision 3. As a result, in RAI 6.2-141, the staff requested GEH to revisit RAIs that were affected by this change, specifically RAI 6.2-98. However, the GEH's response to RAI 6.2-98 was based only on the FWLB accident. The analyses results of the FWLB

RAI Number	Reviewer	Question Summary	Full Text
			accident are important because of their closeness to that of the MSLB accident and the fact that FWLB is the second limiting accident. Please provide the analyses results of the MSLB accident. (B) The addition of a double pipe connection, which was not modeled previously (MFN 06-215), significantly increased the transfer of nitrogen trapped in the GDCS during the GDCS period and subsequently released to the drywell and then to the wetwell. This modeling improvement reduced the amount of holdup of nitrogen in the GDCS from a ~ 10-12% of the total in the previous modeling to a ~ 5% of the total in the current modeling. The holdup of nitrogen of 5% of the total appears to result from the TRACG's inability to model mixing of gases in the GDCS tank open volume. Please (1) explain whether you chose the nodalization to minimize the nitrogen holdup in the GDCS pools and (2) quantify the effect of using a well mixed atmosphere in the GDCS pools open volume. (C) As shown on Figure 6.2-98-5, the noncondensable gas holdup in the drywell head region at 72 hours resulting in a pressure of 50 KPa is significant. Please (1) provide the mass of noncondensables held up in the drywell head region and (2) quantify the effect on the drywell pressure, if the noncondensables held up in the drywell head and GDCS pools were transferred to the wetwell. (D) After the opening of the DPVs, the long-term containment responses from FWLB accident to MSLB accidents are expected to be similar. However, the results show that they differ. Please (1) identify and justify the nodalization differences between FWLB and MSLB accidents and (2) explain the differences in results. (E) During a phone call with the staff on September 24, 2007, GEH discussed a potential design change to add a drywell gas recirculation system to the PCCS which will start operating three days after the

RAI Number	Reviewer	Question Summary	Full Text
			initiation of a LOCA to improve the PCCS's ability to remove thermal energy from the containment. In your response, please address the effect of the drywell gas recirculation system and any other systems that you plan to credit in your analyses.
6.3-10, Supplemental No. 2, (MFN 06-241 Supplement No. 3 dated May 29, 2007)	Wang W	Provide additional information related to the break spectrum study for MSL break and the control logic used for the Level 1 setpoint	GEH lowered the emergency core cooling system (ECCS) initiation signal to Level 1 from Level 1.5. Staff was concerned that since there is a delay in ECCS initiation, that the results may be non-conservative for events, such as a steam line break, where the core experiences level swell and the setpoint will be realized at a later time. In response, GEH performed a sensitivity study on the main steamline break size and provided the control logic for the level 1 setpoint in the TRACG model. A. In response to part B of RAI 6.3-10, Supplemental No. 1, GEH provided a study of the main steam line break and varied the size from 100% down to 10% of the double-ended guillotine break size. Staff has the following additional questions: 1. The figure of merit used for the study is described as "Minimum Chimney Static Head Level Above Vessel Zero." In the DCD this is calculated by collapsing the level in the chimney and adding it to the elevation of the bottom of the chimney such that the void fraction of the core is not accounted for in the calculation. Please clarify if "Minimum Chimney Static Head Level Above Vessel Zero" used in the RAI response accounts for the void fraction in the core.

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			2. Although the smallest value of the "Minimum Chimney Static Head Level Above Vessel Zero" is at 100% break size, there is a trend where it is decreasing as the break size gets smaller from 40%, 20% down to 10%. Provide additional information justifying that breaks smaller than 10% are not limiting. What is the maximum sized break that will not exceed the make-up system? B. In response to part C of RAI 6.3-10, Supplemental No. 1, GEH states that "The control logic used to model Level 1 setpoint in TRACG is a pure time delay, where the <u>performance specified time delay</u> for the installed control logic and the <u>confirmation time delay</u> are considered in TRACG analysis." Please define a performance time delay and a confirmation time delay.
6.3-45, Supplemental No. 1, (MFN 07-312 dated June 20, 2007)	Wang W	Provide justification that the inputs used for the RPV minimum water level calculation is conservative for long-term core cooling analysis	RAI 6.3-45 requested GEH to provide the differences between the TRACG input decks used to calculate minimum water levels and perform containment peak pressure analyses. GEH's response states: *"The table below lists the difference between the TRACG input decks used for the analyses presented in Chapter 6.2 of DCD, Tier 2, Revision 2 and Revision 3. These items are judged to have no impact on the minimum water levels, since they take effect at later stage of a loss-of-coolant accident (LOCA) event"* Provide justification that even though the input deck for calculating minimum water level lacks the modifications applied to the containment input deck, that the results are still accurate and conservative for the long-term core cooling analysis.

RAI Number	Reviewer	Question Summary	Full Text
9.1-9, Supplement No. 2 (MFN 06-309 Supplement No. 2, June 11, 2007)	Hernandez J	Describe how adequate cooling is provided for fuel stored in the reactor building buffer pool under accident conditions.	The intent of the RAI is to clarify how sufficient coolant inventory will be maintained in the reactor building buffer pool during accident conditions, such as the loss of the non-safety related forced cooling system for 72 hours. In its response to RAI 9.1-9 S01, GEH described how the fuel and auxiliary pools cooling system (FAPCS) is designed to withstand a single failure during normal refueling conditions. This response does not address the conditions identified in the RAI. Please provide an analysis to demonstrate that the volume provided by the buffer pool is sufficient to provide cooling and shielding without makeup. If the analysis relies on additional water inventory in the reactor building, such as from the reactor well and the dryer storage pool, please provide a description of the controls relied upon to ensure this inventory is available to the buffer pool whenever there is fuel present.
9.1-10 Supplement No. 2 (MFN 06-309 Supplement No.2, June 11, 2007)	Hernandez J	Specify how adequate decay heat removal capacity will be demonstrated for normal operating (i.e., non-accident) conditions.	In its response to RAI 9.1-10 S01 the applicant stated that the FAPCS cooling and cleanup trains are not used to satisfy GDC 44, and that GDC 44 is satisfied by passive pool boiling for 72 hours and subsequent makeup. The staff does not agree with this statement; GDC 44 and GDC 61 require an evaluation of the system under both normal operating and accident conditions. The water inventory may be credited for accident conditions; however, during normal conditions FAPCS provides forced cooling to the SFP and Reactor Building pools. Please provide a summary heat balance of the FAPCS including initial assumptions and performance requirements.
9.1-18 Supplement No. 2 (MFN 06-309 Supplement No. 2, June 11, 2007)	Hernandez J	Provide more details about safety-related SFP water level instrumentation	The RAI response was insufficient. The amount of water between the top of active fuel and the SFP low level alarm must be specified to ensure that the operators are able to detect a condition that may result in loss of decay heat removal or excessive radiation levels. Since the applicant stated that no operator actions are needed for 72 hours, the staff requests the applicant to demonstrate that the low level setpoint is set such that there are at least 72 hours before the top of active fuel is reached, assuming a loss of forced cooling during the maximum decay heat load conditions.

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9.1-19 Supplement No. 2 (MFN 06-309 Supplement No. 2, June 11, 2007)	Hernandez J	Provide the basis for successful actuation of FAPCS in the PRA	In its response to RAI 9.1-19 S01 the applicant provided a rationale to demonstrate that sufficient net positive suction head will be available to the FAPCS pumps when performing its low pressure injection and suppression pool cooling functions. However, the applicant did not provide an actual analysis for FAPCS. Since the applicant has not provided the performance criteria for FAPCS pumps, the staff is unable to perform an independent analysis. The NPSH required for these functions must be known in order to conclude that the pumps will be successful in performing the functions that are assumed in the PRA. Provide calculations to demonstrate adequate NPSH to the FAPCS pumps.
9.1-20 Supplement No. 2 (MFN 06-309 Supplement No. 5, July 11, 2007)	Hernandez J	Provide the basis for successful actuation of FAPCS in the PRA	In its response to 9.1-20 S01 the applicant stated that a single train of FAPCS is sufficient to perform the suppression pool cooling functions. However, the applicant did not provide the performance requirements nor was a method provided for calculating them. The staff is unable to perform an independent analysis. Provide calculations demonstrating that a single train of FAPCS is able to perform the RTNSS functions credited in the PRA.
9.1-41 Supplement No. 1 (MFN 07-341 June 18, 2007)	Hernandez J	Discuss how safety-related level instrumentation accuracy is affected during boiling conditions.	The RAI response indicates that boiling water in the spent fuel pool (SFP) may introduce some inaccuracy in water level, but any errors would be conservative. The staff is not clear as to how a decrease in density of water in the spent fuel pool, will result in a conservative water level measurement. Provide a detailed description of the instrumentation to be used, including the elevation of the instrumentation taps in the SFP relative to the top of active fuel, how it will be affected by the increase in temperature and the boiling conditions, and why this results in a conservative estimate.

RAI Number	Reviewer	Question Summary	Full Text
9.1-42 Supplement No. 1 (MFN 07-341 June 18, 2007)	Hernandez J	Clarify if FAPCS is RTNSS and describe the RTNSS treatment.	The RAI response indicates that some portions of the fuel and auxiliary pools cooling system (FAPCS) are safety-related and some are RTNSS. The response does not clearly specify what portions and functions of the FAPCS are safety-related. Provide a schematic identifying safety-related and RTNSS portions of the system. Include this figure in DCD Tier 2, Section 9.1. Also, for the safety-related portions identify the safety function.
9.1-43	Hernandez J	Address conformance of the fuel handling system with ANS 57.1.	Compliance with the requirements of GDC 61 and GDC 62 for the fuel handling system depends on adherence to the guidance of ANSI/ANS 57.1, 1992. However, Section 9.1.4 does not contain a statement to indicate that the fuel handling system conforms to the industry standards of ANS 57.1 and thereby meets the requirements of GDC 61 and GDC 62. Revise the DCD to address conformance with ANS 57.1 and compliance with GDC 61 and GDC 62 for the fuel handling system.
9.1-44	Hernandez J	Provide an analysis of the spent fuel pool without forced cooling for 72 hours.	DCD Tier 2 Revision 4, Section 9.1.3.2 states, "During a loss of the FAPCS cooling trains, the cooling to the Spent Fuel Pool and IC/PCC pools is accomplished by allowing the water to heat and boil. Sufficient pool capacity exists for pool boiling to continue for at least 72 hours post-accident, at which point post accident makeup water can be provided through safety-related connections to the Fire Protection System (FPS) or another onsite or offsite water source." However, the DCD does not identify the inventory of the water in the spent fuel pool or the amount of inventory that might be lost in 72 hours. Provide an analysis to demonstrate that the volume provided by the spent fuel pool is sufficient to provide cooling and shielding without makeup for 72 hours.

RAI Number	Reviewer	Question Summary	Full Text
9.2-11, Supplement No. 2 (MFN 06-417, Supplement No. 3 June 18, 2007)	Li C	Include COL holder Item in the DCD to address procedural requirements for avoidance of water hammer in the PSWS and RCCWS.	In RAI 9.2-11, the staff asked the applicant to discuss the potential for water hammer as well as operating and maintenance procedures for avoidance of water hammer in the PSWS and RCCWS. In its response, the applicant listed provisions to mitigate water hammer and included in DCD tier 2 Revision 3. The staff finds the above responses acceptable. However, the applicant has not identified a COL holder Item in the DCD to address the procedures discussed in the DCD. The staff looked into DCD Section 13.5.3, a COL information item for plant operating procedures; it refers to Section 13.5.3.4 of the DCD, which refers to the procedures as delineated in ANSI/ANS-3.2. RG 1.33 endorses ANS-3.2, and its Appendix A listed typical safety-related activities that should be covered by written procedures. Service water system and component cooling water system are listed in the Appendix A to RG 1.33. However, the PSWS and RCCWS in ESBWR are not safety-related, so the above generic COL information item may not cover the nonsafety-related systems such as PSWS and RCCWS in the ESBWR. If GEH decides to refer the generic COL information in DCD Section 13.5.3 as the resolution to RAI 9.2-11, some clarification or modification of DCD Section 13.5.3.4 would be needed to ensure the general plant operating procedures will include the PSWS and RCCWS.

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9.2-15	Li C	Describe how water hammer has been addressed in the design of the Chilled Water System	The Chilled Water System (CWS) is identified as RTNSS systems in the response to RAI 14.3.69. Electrical power is assumed to be unavailable for 72 hours and then returned to service for RTNSS systems. Restarting the CWS presents an opportunity for dynamic effects associated with water hammer. Describe how water hammer has been addressed in the design of the CWS so that the CWS can meet its post 72 hour cooling RTNSS cooling function.
9.4-5 Supplement No. 1 (MFN 06-460, December 1, 2006)	Forrest E	Identify applicable codes and standards for specific components of HVAC systems	DCD Rev 3 Table 9.4-17, consistent with the response to RAI 9.4-5, provides a generic list of codes and standards that may or may not be used in the design of HVAC systems. It is referenced in each section of 9.4 as the codes and standards by which the HVAC system are designed. This list does not clarify which components are designed to which codes and standards. Please identify, using a codes and standards table for each section, which codes are specific to components or structures in each of the systems and eliminate codes that are not applicable to that system.

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9.4-25, Supplement No. 1 (MFN 06-460, December 1, 2006)	Forrest E	Clarify compliance with recommendations of NUREG-0696	The RAI response states that ESBWR compliance with NUREG-0696 for the technical support center (TSC) design will be described in DCD Tier 2 Subsection 9.4.7, Revision 3. However, Revision 3 of the DCD is not clear on the extent that the TSC HVAC system will comply with the recommendations of NUREG-0696. Section 9.4.7 states in part, "NUREG-0696 requires the TSC to supply the same level of radiological protection as that supplied to the MCR under GDC 19; however, the TSC is not specifically committed to providing a safety-related environment in full compliance with GDC 19 that defines the Control Room habitability acceptance criteria." Of particular concern are the habitability requirements identified in NUREG-0696, Section 2.6, one of which states that the TSC shall have the same radiological habitability (less than 5 rem TEDE from GDC 19) as the control room under accident conditions. The operation of the TSC ventilation system (TSCVS) significantly affects the TSC meeting these requirements. Please clarify in DCD Section 9.4.7 whether the TSCVS system will comply with the recommendations of NUREG-0696 without exception. If GEH will take exception to NUREG-0696 for the TSC, please include justification for the exception.
9.4-51	Forrest E	Clarify if the fuel handling building is isolated during the movement of irradiated fuel.	In DCD, Tier 2, Section 9.4.2, the applicant states the safety-related Fuel Building boundary isolation dampers automatically close in the event of a fuel handling accident or other radiological accident. Identify whether the fuel handling building is isolated during the movement of irradiated fuel or can it be open for maintenance or other refueling activities such that closure of these valves would be ineffective at containing radioactive release? If so clarify the purpose of the isolation dampers.

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9.4-52	Forrest E	Evaluate the impact on the loss of ventilation in the fuel building.	In DCD, Tier 2, Section 9.4.2, the applicant states that the Fuel Building HVAC System (FBVS) is not required to operate during an SBO. Are there any components in the FB that could be affected by increases in temperature? Are there any provisions to providing cooling to areas of the FB when the FBVS is isolated? Has the impact of over heating and failure of any component been evaluated for the SBO condition?
18.10-1 Supplement 1 (NEDO-33275 Rev-1, February 28, 2007; MFN 06-445, November 21, 2006; MFN 07-334, June 27, 2007)	Bongarra J	Clarify simulators and scope of training program to be certified.	A. Revision 1 of the "ESBWR Training Development Implementation Plan" provides only very general information on simulators used for training in Section 4.1.4.5. NUREG-0711, Section 10.4.2 Criterion (3) states that "Facilities and resources such as plant-referenced simulator and part-task training simulators needed to satisfy training design requirements and the guidance contained in ANSI 3.5 and Regulatory Guide 1.149 should be defined." Please provide more details as follows: 1. GEH response to RAI 18.13-1 (F) renamed the Baseline Specific Simulator (BSS) as the Representative Training Simulator (RTS). The response to RAI 18.10-1 refers to a Reference Training Simulator (RTS). Are they the same? 2. Please provide a description of the various proposed simulators: the baseline simulator (BS), the part task simulator, the full scope simulator (FSS), and the representative or reference training simulator (RTS). Include the purpose, properties, scope, number (e.g., just one or one per each operating ESBWR plant), location and use of each. Also note which simulators will meet RG 1.149 and ANS 3.5. If some of this information is not yet available, please indicate when it will be.

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			B. The implementation plan addresses several of the NUREG-0711 criteria for training, but defers others to the COL holder. RAI 18.10.1 requested clarification on which aspects of the training development program were to be certified. In response to the RAI, GEH listed five items for which they were seeking design certification. Revision 1 of the "ESBWR Training Development Implementation Plan" is still not clear on what is being certified. It appears from a review of Revision 1 that potentially all aspects of training, addressed by NUREG-0711 criteria, could be certified at the implementation plan level except for Criterion (1) relating to the Chapter 13 review items. Please provide confirmation of what is desired to be certified.
18.10-2 Supplement 1 (NEDO-33275 Rev-1, February 28, 2007; MFN 06-445, November 21, 2006; MFN 07-334, June 27, 2007)	Bongarra J	Update standard reference	This RAI had three parts. Parts A and C were acceptably addressed in Rev. 1. Part B stated "NEDO-33275, Section 2.2, Codes and Standards, lists the 1976 version of ANS 3.2 but should refer to the current 1994 version (reaffirmed 1999)." Rev. 1 still refers to the 1976 version. Please update NEDO-33275 in the next revision to reflect current standards.

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18.10-3 (NEDO-33275 Rev-1, February 28, 2007; MFN 06-445, November 21, 2006; MFN 07-334, June 27, 2007)	Bongarra J	Specify organizational training responsibilities and associated qualifications.	NUREG-0711, Section 10.4.2, Criterion (1) states in part "The roles of all organizations, especially the applicant and vendors, should be specifically defined for the development of training requirements, development of training information sources, development of training materials, and implementation of the training program. …" This information was previously in Table 2 of Rev. 0, but is currently not provided in Rev. 1 of the Plan. Criterion (2) states "The qualifications of organizations and personnel involved in the development and conduct of training should be defined." This information is similarly not provided in Rev. 1. Please provide the necessary information.
21.6-101, Supplemental No. 1, (MFN 07-381 dated July 11, 2007)	Wagage H Wang W	How does the program library version of TRACG04 prediction of drywell annulus temperature compare to the data from the GIRAFFE Test STEP8_J8?	This RAI requested additional information regarding a comparison between data and TRACG04 for the GIRAFFE GS1 test from the TRACG04 Software Test Report (eECPER 0000-0009-7157-00) viewed during an audit of TRACG04 as applied to ESBWR LOCA analyses. The results showed TRACG04 significantly under predicts the dry well annulus temperature for long durations. From the RAI response in MFN 07-381, the staff understands that the comparisons were made with a prototype version of TRACG04. How does the program library version compare with this data? If there are no comparisons of this data to the program library version of TRACG04, how is this uncertainty accounted for in ESBWR LOCA and containment analyses?
22.5-19	Li C	Address whether or not the Makeup Water System is RTNSS. (Table 19A-2)	DCD Tier 2 Rev.3, Table 9.2-6, states that the Makeup Water System (MWS) is designed to provide makeup water for the Reactor Component Cooling Water System (RCCWS) and the Chilled Water System (CWS). These systems are identified as RTNSS systems in the response to RAI 14.3.69. Clarify whether the makeup to the RCCWS and CWS provided by the MWS is required to support the RCCWS and CWS cooling functions from 72 hours to 7 days in meeting the RTNSS selection Criterion B. If the MWS is selected for RTNSS then specify the corresponding regulatory treatment, including ITAAC.

cc:

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