December 4, 2008

Mr. Robert E. Brown
Senior Vice President, Regulatory Affairs
GE Hitachi Nuclear Energy
3901 Castle Hayne Road MC A-50
Wilmington, NC 28401

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 278 RELATED TO ESBWR DESIGN CERTIFICATION APPLICATION

Dear Mr. Brown:

By letter dated August 24, 2005, GE Hitachi Nuclear Energy 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 U.S. 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.

If you have any questions or comments concerning this matter, you may contact me at 301-415-3808 or zahira.cruz@nrc.gov, or you may contact Chandu Patel at 301-415-3025 or chandu.patel@nrc.gov.

Sincerely,

/RA/

Zahira Cruz Perez, 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

December 4, 2008

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Zahira Cruz Perez, Project Manager
ESBWR/ABWR Projects Branch 1
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Enclosure:
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cc: See next page
Distribution: See next page

ADAMS ACCESSION NO. ML083310337 NRO-002

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SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO.278 RELATED TO ESBWR DESIGN CERTIFICATION APPLICATION DATED DECEMBER 4, 2008

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Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD), Revision 5

RAI Number	Reviewer	RAI Summary	RAI Text
RAI 3.8-121 S02	Chakrabarti S	Provide the technical basis for the design approach of composite floor modules.	As a result of the staff's review of the GEH response transmitted in GEH letter MFN 08-243, Supplement 2, dated October 13, 2008, supplemental information is needed for some of the responses provided. Therefore, GEH is requested to respond to the following two items: Part (a): The GEH response acknowledged that US Codes and Standards do not currently address modular composite construction where steel plates act as two orthogonal rebars. To justify the design approach used for the ESBWR plant, the RAI response indicated that the method used is based on the Japanese design guideline JEAG4618-2005, "Technical Guidelines for a Seismic Design of Steel Plate Reinforced Concrete Structures – Building and Structures," December 2005. This guideline has not been endorsed by the NRC staff for design of composite construction in US NPPs. If this approach is the basis for design of the ESBWR composite construction floor slabs, then GEH needs to present the sufficient technical basis for this approach, as was requested in the prior RAI 3.8-121, Supplement 2, Part (a), and the basis will have to be reviewed by the staff on an application-specific basis. This justification should include the actual Japanese guideline in English; a complete and self explanatory summary description of the design approach in the Japanese guideline; explanation of assumptions; description of the range of applicable parameters; justification for the particular equations and methods; comparison of the test configuration parameters (e.g., steel floor plate thickness, steel thickness to floor thickness ratios; stud diameters, diameter to length ratios of studs, stud spacing, etc.; reinforcement ratios for rebars at the top, and other key parameters) to the ESBWR design configuration. The technical basis should include test results as discussed later under Part (e) of this RAI. The test results should clearly show that the stiffness (bending and shear), yield, ultimate capacity, and ductility of the ESBWR composite configuration are comparable to or more conservative than those for the equivalent configuration of reinforced concrete members.

Enclosure

			Furthermore, the same equations in the Japanese guideline, if identical to those used in the ESBWR design, should be used to predict the section yield, capacity, and deformation in order to demonstrate the acceptability or conservatism of the design approach. Part (e): The RAI response provided a short summary of two experimental studies performed in Japan to establish the design code for NPP using a steel plate reinforced concrete (SC) structural element. In Part 18, “Behavior of Shear Deformation (Half Steel Plate Reinforced Concrete Structure),” of “Experimental Study on a Concrete Filled Steel Structure,” Architectural Institute of Japan (AIJ), 1998, a short summary of testing done on a Half SC (H-SC), SC, and reinforced concrete specimens for shear loading is given. Some configuration details are provided only for the H-SC test specimen, which are not compared to the ESBWR design configuration. The design details for the other specimens are not given and not compared to the H-SC specimen or to the ESBWR design configuration. Some test results and hand calculations are tabulated, but no explanation is given as to the basis of the equations used in the hand calculations. Also, no discussion is given on how these test and calculation results compare to the results using the design approach contained in the Japanese guideline or the ESBWR DCD method. Separately, Part 28, “Behavior Under Out of Plane Load (Outline of Experimental Study Plan and Result), of “Experimental Study on a Concrete Filled Steel Structure,” Architectural Institute of Japan (AIJ), 1999, provides a short summary of testing done on many specimens for out of plane loading. Most of these do not appear to be similar to the H-SC type structure used in the ESBWR plant. Very limited details are provided on the test specimen configurations and designs, many of the labeled text on the figures are not legible, and the three test specimens on Figure 3 do not appear to match the H-SC design used in the ESBWR plant. From the results provided in several figures, it is not clear how these demonstrate the adequacy of the design approach being used for the ESBWR plant. Also, no testing or demonstration of design adequacy is provided for connections of H-SC structural elements at the boundary of the floor slabs.

			In addition to the above, a short outline of the design guide for floor slabs in the Japanese guideline of steel plate reinforced concrete (SC) structures is given. From the limited information given in this outline, it is not possible to determine the technical basis for the design approach being used. Under each subsection of the outline, reference is made to an "Article" which is not provided, then some design approach is given with another reference to "Experimental Study" which is also not provided. Then additional information is given by reference for other Parts of the Japanese guideline, which are also not provided. Based on the above discussion and the information provided in the current RAI response, sufficient information has not been provided for the staff to review the design approach to obtain a reasonable assurance that the design methodology used for the ESBWR composite structural elements is technically acceptable. Therefore, if the GEH methodology will still rely on the Japanese guideline and the two tests described in the RAI response, then GEH needs to develop the technical basis in a rational and complete description which can stand on its own merit. Some of the needed elements to achieve this are described in the requested information under Part (a) above.
3.9-200 S01	Scarborough T Thomas G	GDCS check valve design attributes	A) In response to RAIs 3.9-200, 201, and 203, GEH specified design attributes for the Gravity Driven Cooling System (GDCS) check valves and valves in other plant systems in MFN 08-641 (dated August 18, 2008) and MFN 08-652 (dated August 26, 2008). The NRC staff will rely on those design attributes in reaching a safety finding on the ESBWR Design Certification application. Therefore, the staff requests that GEH include the design attributes for the GDCS check valves and other valves specified in its response to RAIs 3.9-200, 201, and 203 in Section 6.3 of the ESBWR Design Control Document (DCD) Tier 2. B) In RAI 3.9-200, the NRC staff requested that GEH provide information related to the evaluation of the potential impact of vertical orientation of GDCS check valves. The staff has reviewed the GEH responses to the individual paragraphs in RAI 3.9-200 and need the following information:

			1) In paragraph (a) in RAI 3.9-200, the NRC staff requested that GEH confirm that potential waterhammer loads from the reverse flow of water in the GDCS line closing the check valve following squib valve actuation will be evaluated. In its response to this RAI (MFN 08-641), GEH did not confirm that the design process for the GDCS piping will include this evaluation. In its RAI response, GEH stated that the open check valve will have a spring force that will exactly balance the weight of the disk to minimize the reverse flow and differential pressure to close it. However, the disk will be required to travel its stroke distance to close. The motion of the water column in the GDCS line will be equivalent to at least the swept volume of the disk, and additional water column displacement will result from drag force on the disk and uncertainties in the check valve performance. Significant loads could result from check valve closure following a water column displacement of only one pipe diameter. In addition, GEH stated that the reactor pressure during squib valve actuation following an accident is in the range of 58 to 218 psig; however, the ESBWR DCD specifies that the check valves and GDCS piping must be capable of stopping the reverse flow with full reactor pressure conditions following a spurious squib valve actuation. GEH is requested to verify that the design process will include an evaluation of the GDCS check valve closure loads. 2) In RAI 3.9-200(b), the NRC staff requested that GEH discuss the design and analysis of applicable components for loading due to the formation of steam in the GDCS piping during depressurization of the reactor coolant following a postulated accident. In its response to this RAI (MFN 08-641), GEH stated that the GDCS piping is a continuous loop seal that is expected to remain full of water without steam voids following a reactor depressurization. However, unless the water in the GDCS line is maintained below a temperature of 212 ˚F, some water will flash to steam when the reactor depressurizes. GEH did not provide information addressing the control of water temperature, or the loads resulting from the formation of steam. Steam that forms will tend to rise in vertically sloping piping or might mix with cooler liquid in the line, resulting in condensation-induced phenomena such as chugging flow and waterhammer. Further, if the loop seal section of the piping is not full of

			water, steam from the vessel will enter the GDCS piping and this countercurrent steam flow could result in flow instability, condensation-induced water hammer, and restriction of necessary GDCS cooling flow until the loop seal is refilled. Therefore, the NRC staff requests that GEH discuss the control of the water temperature in the GDCS line to prevent steam formation when the reactor depressurizes, or provide assurance that the steam that forms will not result in excessive loading to the GDCS or reduction in the necessary GDCS injection flow. 3) In RAI 3.9-200(c), the NRC staff requested that GEH discuss the force necessary for closure of the GDCS check valves. In its response to this RAI (MFN 08-861), GEH indicated that the GDCS check valves will be designed and qualified to ensure that they will remain open under normal operating conditions with no differential pressure, and will close under low reverse flow and differential pressure conditions. However, GEH did not provide information to provide assurance that the actual expected loads on the check valve and piping will be considered in the qualification process. Therefore, the NRC staff requests that GEH verify that the design process will include consideration of the expected reverse check valve closure loads in the qualification of the GDCS check valves, piping, and other components. 4) In RAI 3.9-200(e), the NRC staff requested that GEH discuss the potential for the GDCS check valves to remain partially open under slow pressure increase conditions of the reactor coolant system that could allow backflow to the cooling water pools. In its response to this RAI (MFN-08-641), GEH stated that there are no slow pressure increase conditions of the reactor coolant system under either normal or design basis conditions following actuation of the GDCS injection valves. GEH indicated that when the injection squib valves actuate, the pressure on the downstream side of the check valves will be decreasing. The NRC staff requests that GEH discuss the potential for a slow pressure increase to occur later during a postulated event that might cause the GDCS check valves to remain partially open.

3.9-201 S01	Scarborough T Hammer G	GDCS venting of gases	In RAI 3.9-201, the NRC staff requested that GEH address the need for high point venting of gases that could collect in the GDCS lines, and might cause binding or restriction of necessary injection flow. In its response to this RAI (MFN 08-652), GEH stated that there are no high points in the GDCS piping where gases can collect, the GDCS piping is self-venting, and the presence of a water-filled loop seal in the piping prevents entry of gases. However, GEH did not address the possible volume of gas that might come out of solution when the water depressurizes. Gases that come out of solution will need to vent to either the GDCS pool or to the reactor vessel, during which time the GDCS may be required to inject flow. The NRC staff requests that GEH discuss the potential effects on GDCS injection flow from gases in the system and their consideration as part of the design process.
3.9-202 S01	Scarborough T Hammer G	GDCS isolation from reactor coolant system	In RAI 3.9-202, the NRC staff requested that GEH describe how the GDCS configuration with a squib valve in series with a normally-open check valve meets the regulatory requirements for isolation of the reactor coolant pressure boundary. In its response to this RAI (MFN 08-635, dated August 14, 2008), GEH stated that the reactor coolant boundary ends with the squib valve (not including the check valve) and is similar to the sealed boundary Depressurization Valves. GEH further stated that the open check valve is considered an automatic isolation valve consistent with 10 CFR Part 50, Appendix A, General Design Criterion (GDC) 55. The NRC staff does not agree with GEH that the ESBWR GDCS configuration with a squib valve in series with one open check valve is similar to the configuration addressed by GDC 55. However, the staff agrees that the squib valve is much more likely to remain sealed and not leak compared to a conventionally seated valve (e.g., a gate or globe valve). Further, the spurious failure of the disk pressure retaining integrity (e.g., by spurious valve actuation) would not result in a loss of GDCS pressure integrity or loss of the GDCS safety function, provided the GDCS components are designed to accommodate the resulting loads. Therefore, the staff requests that GEH verify that the design process will address GDCS fluid dynamic loading as discussed in other supplemental RAIs to support the determination that the GDCS configuration with a squib valve in series with a check valve satisfies the NRC regulations for isolation of the reactor coolant system at the GDCS interface.

3.9-203 S01	Scarborough T	Design and procurement specifications for valves and other components.	In RAI 3.9-203, the NRC staff requested that GEH discuss any check valves or other valve types in vertical flow lines in ESBWR safety-related systems or those within the scope of regulatory treatment of nonsafety systems (RTNSS), and the provisions for functional design, qualification, and inservice testing of those valves. In its response to this RAI (MFN 08-641), GEH referenced NEDE-33271P, "NP-2010 COL Demonstration Project: Project Design Manual (PDM)," as providing the overall design methodology for ESBWR components. GEH stated that the PDM is available for review by the NRC upon request. The NRC staff requests that GEH make the PDM available for NRC review at the GEH Washington DC office.
5.4-59 S02	Thomas G Pohida M Jensen W Gilmer J	RWCU/SDC capability during Modes 4, 5, and 6, and Feedwater sparger detailed drawings.	A) The staff reviewed GEH's response to 5.4-59S01 and reviewed Section 5.4 of the DCD, Revision 5. The DCD does not document that vessel level at the first stage water spill of the steam separators is the analytical lower limit of shutdown cooling core circulation. As stated by GEH in the RAI response, vessel level below the analytical lower limit would result in thermal stratification. GEH further states in the RAI response: "shutdown core cooling would cease in this situation with the consequent onset of liquid volume heatup inside the shroud, chimney, and separator column regions of the vessel." GEH is requested to document the following items in the DCD: 1) Vessel level at the first stage water spill of the steam separators is the analytical lower limit of shutdown cooling core circulation for Modes 4, 5, and 6. 2) Vessel level below the analytical lower limit would result in thermal stratification. Shutdown core cooling would cease in this situation with the consequent onset of liquid volume heatup inside the shroud, chimney, and separator column regions of the vessel. 3) A COL action item to establish an administrative lower water level limit to build margin between the operating range for shutdown cooling and the analytical lower limit of the design for core circulation to meet the intent of GE SIL 357. This measure is needed to ensure that the frequency of the loss of the decay heat removal function during Modes 4, 5, and 6 does not impact the shutdown PRA results and the shutdown RTNSS evaluation.

			4) A risk insight in Table 19.2-3 of the DCD for the COL applicants to establish an administrative lower water level limit to build margin between the operating range for shutdown cooling and the analytical lower limit of the design for core circulation to meet the intent of GE SIL 357. This measure is needed to ensure that the frequency of the loss of the decay heat removal function during Modes 4, 5, and 6 does not impact the shutdown PRA results and the shutdown RTNSS evaluation. 2) GEH is also requested to provide the following: Evaluate the need for level instrumentation and annunciators alerting the operator when shutdown cooling core circulation is disrupted, or evaluate this failure in the shutdown PRA. Failure of the operator to maintain or to recover vessel level above the first stage spill over was not included in the Shutdown PRA or in the RTNSS assessment. 3) In addition, the staff is preparing a Computational Fluid Dynamics model to assess the capability of the RWCU/Shutdown Cooling System to remove decay heat. Additional details are needed for the Feedwater sparger. Provide a drawing showing the main ring internal diameter and pipe schedule, overall radius or diameter of the ring, entrance details from the external FW nozzle weld to the ring split (neckdown), nozzle type(s), locations, orientation and size, or, if drilled holes, the locations and size(s). Also, if there are any external components which may block the circulation path in the reactor vessel, such as a thermal sleeve, lift lugs, or supports, provide a drawing with sufficient details for CFD model input.

cc:

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