September 16, 2009

Mr. Jerald G. Head
Senior Vice President, Regulatory Affairs
GE Hitachi Nuclear Energy
3901 Castle Hayne Road MC A-18
Wilmington, NC 28401

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO. 369 RELATED TO ESBWR DESIGN CERTIFICATION APPLICATION

Dear Mr. Head:

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 Amy Cubbage at 301-415-2875 or amy.cubbage@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

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Enclosure:
Request for Additional Information
cc: See next page
Distribution: See next page

ADAMS ACCESSION NO. ML092590199 NRO-002

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SUBJECT: REQUEST FOR ADDITIONAL INFORMATION LETTER NO.369 RELATED TO ESBWR DESIGN CERTIFICATION APPLICATION DATED SEPTEMBER 16, 2009

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Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD), Revision 6

RAI Number	Reviewer	RAI Summary	RAI Text
3.6-6 S04	Y. Li	Additional clarification on RELAP5 and CFX codes use.	A) Related to RAI 3.6-6 S03 Part (a): (1) In its RAI response, GEH stated that for high energy line breaks, it will conduct a thermal hydraulic analysis using the RELAP5 code to compute the mass flow rate and pipe reaction force time history through the break, along with the fluid conditions at the break. Using the mass flow rate and fluid conditions computed with RELAP5, and considering a worst-case displaced pipe configuration (aligned to maximize jet impact on the target structure), GEH will conduct CFD analyses using CFX or FLUENT to compute the time history of the jet loads on the target. The CFD analysis will consider fluid compressibility, and capture the flow effects associated with the jet unsteadiness, nonlinearity, feedback amplification, and jet reflections. In addition, GEH will use ANSYS finite element software to model the target structure, and use the jet load time history computed from steps 1 and 2 as input to the ANSYS analysis. Should the target have any resonances near the dominant frequencies of the jet loading, the resonant amplification and increased structural stresses will be captured in the analysis. The staff finds GEH's clarified approach for modeling jet impingement loads from high energy line breaks acceptable. However, GEH is requested to explain how they will account for uncertainty in the resonance frequencies of the target finite element structural model. As an example, in other dynamic structural modeling approaches used by GEH for ESBWR design (such as those associated with the steam dryer), the loading time histories are stretched or compressed in 2.5 percent increments spanning a +-10 percent uncertainty before they are applied to the structural FE model, ensuring that the worst-case structural response is computed and used to assess structural integrity.

			(2) GEH stated that RELAP5 will be used to compute mass flow rates and pipe reaction forces at break locations, along with fluid conditions at the break to be used as inputs to unsteady CFD analyses. However, in GEH Technical Report 0000-0105-2955-R3, GEH uses TRACG to perform these calculations for their example problem of a MSL line break. GEH is requested to clarify/ amend their approach in the DCD to allow for using either RELAP5 or TRACG or some other suitable code that have been previously accepted by the staff. B) Related to RAI 3.6-6 S03 Part (b): In its response to the RAI, GEH provided a Technical Report 0000-0105-2955-R3, which describes the modeling procedure they plan to apply to ESBWR high energy line breaks unsteady jet calculations. The report includes (1) GEH's general calculation procedure as applied to an unsteady jet configuration measured by Ho and Nosseir (J. Fluid Mech., Vol. 105, pp. 119-142, 1981) and (2) a demonstration of how GEH plan to use this procedure to model unsteady jets from high energy line breaks in ESBWR design calculations. The staff reviewed the information included in this technical report and found that while GEH's procedures are a significant improvement over the previous approach using ANS 58.2, they still have not been sufficiently proven to be conservative methods for computing unsteady resonant jet loads. GEH is requested to address the following staff's concerns. (1) The current Ho and Nosseir simulations do not demonstrate the key behavior of unsteady jets with strong feedback phenomena. Specifically, the GEH simulations show that the unsteady loads decrease when feedback occurs (Mach number of 0.9) instead of increasing. GEH is requested to further analyze the Ho and Nosseir problem to establish CFD solutions which demonstrate realistic physical behavior, such as increasing unsteady pressures when jet instabilities occur (such as near a Mach Number of 0.9). GEH is also requested to demonstrate the sensitivity of the CFD solution with respect to critical parameters, such as distance between the jet and impingement surface, jet source boundary conditions (pressure and temperature), external

			conditions, and any other parameters which have a strong influence on the unsteady jet behavior. In summary, GEH is requested to demonstrate that their procedure is a conservative means of bounding the worst-case unsteady jet loads that may occur in an ESBWR high energy line break event. (2) GEH is requested to establish that solution from the ESBWR MSL B jet flow demonstration is converged with respect to grid/mesh and time step resolution. A mesh convergence study showing that the strong degree of anisotropy in the existing grid does not influence the results would be useful. (3) GEH is requested to modify the short formal description in the DCD (referencing GEH Technical Report 0000-0105-2955-R3 for further details) of the general procedure that GEH will use to assess dynamic blowdown forces caused by impinging jets emanating from high energy line breaks (the current description is on pages 3.6-21 – 22 of Rev. 6 of the DCD). In particular, GEH is requested to include information such as the bullets on page 4 of GEH Technical Report 0000-0105-2955-R3, and some of the information in Tables 2-7 of that report. GEH is also requested to include guidelines and rules of thumb they will apply to generating meshes and grids, and for running FLUENT. Also, GEH is requested to include a description of the procedure they will apply for assessing convergence of their solutions (such as grid resolution studies), and for assessing the sensitivity of their solutions to uncertainties in problem parameters, such as physical distances between jets and impingement surfaces, jet boundary conditions, and external conditions. Finally, GEH is requested to formally list any bias errors and uncertainties they plan to apply to unsteady loads computed using their procedure. C) Related to RAI 3.6-6 S03 Part (d): GEH responded to the RAI in MFN 09-298 Enclosure 1, dated 12 May 2009, and agreed to include tables pertaining to pipe break locations in the DCD, including pipe break data. However, GEH stated that it will not include all the technical

			data that GEH had previously provided in the responses to RAI 3.6-6 S02 (Tables 1 &2), RAI 3.6-13 S01 (Tables 1 &2), and RAI 3.6-16 S01, (Tables 1&2) since the information contained in these tables has GEH proprietary information. The staff also noted that in its response to RAI 3.6-16 S02, GEH stated that no DCD changes will be made in response to this RAI other than those described in the responses to RAIs 3.6-6 S03 and 3.6-13 S02. Based on its review of the information included in GEH's responses to RAIs 3.6-6, -13 and -16 and their associated tables as well as provided in ESBWR DCD Revision 6, the staff determines that the information pertaining to consideration of jet reflections and analysis procedure that GEH plans to use for each postulated break should be included in Tables 3.6-5 through 7 of the DCD. Therefore, GEH is requested to include the following in additional columns and/or notes in Tables 3.6-5 through 7 of the DCD: (a) whether jet reflections will be considered in the jet impingement analyses and (b) the analysis procedure GEH plans to use for each potential pipe break (CFD and FE as described in GEH's response to RAI 3.6-6 S03 (a) or ANS 58.2).
3.6-11 S03	Y. Li	Revision of DCD to include modeling procedure of blast wave calculations.	In its RAI response, GEH provided a Technical Report 0000-0102-6265-R0, which describes in detail the modeling procedure they plan to apply to ESBWR blast wave calculations. GEH demonstrates a calculation of a blast wave induced by a high energy line break inside containment of ESBWR feedwater piping. The blast wave propagates into the annular region between the Reactor Pressure Vessel (RPV) and the shield wall, and reflects between the boundaries of the annulus. GEH established that a two-dimensional (2D) approximation of the annulus is conservative by comparing 2D pressure amplitudes with those computed using a 3D model. GEH will use 2D models where applicable in ESBWR calculations. GEH also established that the mesh discretization used in their example is conservative by comparing pressures and velocities to those from a model generated with a coarser mesh. While the staff accepts the technical approach described in the report, GEH has not referenced the report in a revised version of the DCD. GEH is therefore, requested to reference GEH Technical Report 0000-0102-6265-R0 and briefly describe the modeling procedure discussed in the report in a revised version of Section 3.6.2.6 of the DCD.

cc:

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