HITACHI

GE Hitachi Nuclear Energy

Richard E. Kingston
Vice President, ESBWR Licensing

P.O. Box 780
3901 Castle Hayne Road, M/C A-65
Wilmington, NC 28402 USA

T 910.819.6192
F 910.362.6192
rick.kingston@ge.com

Proprietary Notice
This letter forwards proprietary information in accordance with 10CFR2.390. Upon the removal of Enclosure 3, the balance of this letter may be considered non-proprietary.

MFN 09-787 Supplement 3

Docket No. 52-010

February 25, 2010

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: **Supplemental Response to Portion of NRC RAI Letter Nos. 369 and 386 Related to ESBWR Design Certification Application – DCD Tier 2 Section 3.6 – Protection Against Dynamic Effects Associated with the Postulated Rupture of Piping; RAI Numbers 3.6-6 S04 Part B and 3.6-24**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) revised response to a portion of the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) letter number 369 sent by NRC letter dated September 16, 2009 (Reference 1) and letter number 386 sent by NRC letter dated November 2, 2009 (Reference 2).

GEH's original response was transmited via Reference 3 and resulted in several teleconferences with the staff to resolve comments and questions. As a result of staff interactions, our responses to RAI Numbers 3.6-6 S04 Part B and 3.6-24 transmitted in Reference 3 required revision. The GEH revised responses to RAI Numbers 3.6-6 S04 Part B and 3.6-24 are contained in Enclosure 1.

In addition, this transmittal letter provides supplemental information to Reference 3. Enclosure 3 provides a procedure to be used to perform 3-D computational analyses for high energy line breaks in ESBWR. This procedure will be included as Section 7.0 in Technical Report 0000-0105-2955 – ESBWR MSLB CFD Modeling: Jet Impingement During High Energy Line Breaks.

Enclosure 2 contains the DCD changes to Tier 2 as a result of GEH's response to these RAIs. Verified DCD changes associated with these RAI responses are identified in the enclosed DCD markups by enclosing the text within a black box. Changes associated with Revision 1 of this response are enclosed in red, clouded boxes.

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Enclosure 3 contains proprietary LTR markups to NEDE-33440P, Rev 2 and Section 7.0 - Analysis Methodology to be included in Proprietary Technical Report 0000-0105-2955 – CFD Modeling of Jet Impingement During ESBWR High Energy Line Break. Verified LTR changes associated with these RAI responses are identified in the attached markups by enclosing the text within a black box. Changes associated with Revision 1 of this response are enclosed in red, clouded boxes.

Enclosure 3 contains GEH proprietary information as defined by 10 CFR 2.390. GEH customarily maintains this information in confidence and withholds it from public disclosure. GEH has not submitted a nonproprietary version of Enclosure 3 in accordance with NRC Information Notice 2009-07, Requirements for Submittals, (2): "In instances in which a nonproprietary version would be of no value to the public because of the extent of the proprietary information, the agency does not expect a nonproprietary version to be submitted."

The affidavit contained in Enclosure 4 identifies that the information contained in Enclosures 3 has been handled and classified as proprietary to GEH. GEH hereby requests that the information in Enclosures 3 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390 and 9.17.

If you have any questions or require additional information, please contact me.

Sincerely,

Richard E Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

References:

1. MFN 09-601 Letter from U.S. Nuclear Regulatory Commission to J. G. Head, GEH, *Request For Additional Information Letter No. 369 Related to ESBWR Design Certification* dated September 16, 2009

2. MFN 09-688 Letter from U.S. Nuclear Regulatory Commission to J. G. Head, GEH, *Request For Additional Information Letter No. 386 Related to ESBWR Design Certification* dated November 2, 2009

3. MFN 09-787 Letter from R. E. Kingston, GEH to U.S. Nuclear Regulatory Commission to *Response to Portion of NRC RAI Letter Nos. 369 and 386 Related to ESBWR Design Certification Application – DCD Tier 2 Section 3.6 – Protection Against Dynamic Effects Associated with the Postulated Rupture of Piping; RAI Numbers 3.6-6 S04 Part B and 3.6-24* dated December 15, 2009

Enclosures:

1. Revised Response to a Portion of NRC RAI Letter Nos. 369 and 386 Related to ESBWR Design Certification Application – DCD Tier 2 Section 3.6 – Protection Against Dynamic Effects Associated with the Postulated Rupture of Piping; RAI Numbers 3.6-6 S04 Part B and 3.6-24.
2. Revised Response to Portion of NRC RAI Letter No. 369 and 386 Related to ESBWR Design Certification Application - DCD Markups for RAI Number 3.6-6 S04 Part B
3. Revised Response to Portion of NRC RAI Letter No. 369 and 386 Related to ESBWR Design Certification Application - LTR Markups for RAI Number 3.6-6 S04 Part B and Section 7.0 Analysis Methodology of Technical Report – ESBWR Main Steam Line Break CFD Modeling: Jet Impingement During ESBWR High Energy Line Break – GEH Proprietary Information
4. Affidavit

cc:		
	AE Cubbage	USNRC (with enclosures)
	JG Head	GEH/Wilmington (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	HA Upton	GEH/San Jose (with enclosures)
	eDRF Sections	0000-0110-6231, R1 (RAIs 3.6-6 S04 and 3.6-24)

Enclosure 1

MFN 09-787
Supplement 3

Revised Response to Portion of NRC Request for

Additional Information Letter Nos. 369 and 386

Related to ESBWR Design Certification Application

DCD Tier 2 Section 3.6 – Protection Against Dynamic

Effects Associated with the Postulated Rupture of Piping;

RAI Numbers 3.6-6 S04 Part B and 3.6-24

NRC RAI 3.6-6 S04, Part B

RAI Summary

Additional clarification on RELAP5 and CFX codes use.

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.

GEH Response to Item B (Original)

Response to B(1):

Section 3.4.2 of Technical Report 0000-0105-2955, Revision 5 (see attached DCD markups for a copy of the report), presents the results of the simulation of the Mach number 0.9 case. Figures 3.13 and 3.14 show the pressure responses predicted by the computational fluid dynamics (CFD) simulation and measured in the Nossier-Ho experiment, respectively. As shown, the CFD predictions are conservative relative to the experimental data by an order of magnitude. Given the conservative predictions of the revised model, there is no need to perform the additional sensitivity analyses requested in the RAI.

Response to B(2):

Section 3.4.4 of Technical Report 0000-0105-2955, Revision 5, discusses the results of the mesh independence study. The results indicate that the base mesh used in the analyses is sufficiently refined such that the predicted pressure response is not significantly impacted. As discussed above, given the conservative predictions of the revised model, there is no need to perform the time step resolution convergence studies requested in the RAI.

Response to B(3):

In lieu of including the requested information in the DCD, Technical Report 0000-0105-2955, Revision 5, will be included as Appendix B of NEDE-33440P, and DCD Tier 2, Section 3.6.2.3.1 will be revised to reference this NEDE report and to briefly summarize the contents of Technical Report 0000-0105-2955, Revision 5.

GEH Response to Item B (Revision 1)

Response to B(1):

Section 3.4.2 of Technical Report 0000-0105-2955, Revision 5 (forwarded by the original version of this response), presents the results of the simulation of the Mach number 0.9 case. Figures 3.13 and 3.14 show the pressure responses predicted by the computational fluid dynamics (CFD) simulation and measured in the Nossier-Ho experiment, respectively. As shown, the CFD predictions are conservative relative to the experimental data by an order of magnitude. Technical Report 0000-0105-2955 is currently being revised to include the attached analysis methodology for ESBWR pipe break analyses to ensure conservative predictions. When complete, the revised report will be formally provided by GEH in a separate MFN letter.

Response to B(2):

Section 3.4.4 of Technical Report 0000-0105-2955, Revision 5, discusses the results of the mesh independence study. The results indicate that the base mesh used in the analyses is sufficiently refined such that the predicted pressure response is not significantly impacted. Based on follow-up discussions, GEH has performed additional convergence studies. The results of these studies were provided to the NRC by MFN Letter 09-787 and will be included in the revised Technical Report 0000-0105-2955.

Response to B(3):

In lieu of including the requested information in the DCD, Technical Report 0000-0105-2955 will be included as Appendix B of NEDE-33440P, and DCD Tier 2, Section 3.6.2.3.1 will be revised to reference this NEDE report and to briefly summarize the contents.

DCD Impact (Revision 1)

DCD Tier 2, Section 3.6.2.3.1 and NEDE-33440P will be revised as noted in the attached markups. The attached analysis methodology will be added to Technical Report 0000-0105-2955. All DCD and NEDE-33440P changes are enclosed in black, rectangular boxes. Changes associated with Revision 1 of this response are enclosed in red, clouded boxes.

NRC RAI 3.6-24

GEH is requested to provide a description of how jet impingement loading calculations will be performed to capture the range of worst-case conditions throughout a blowdown process. For example, jets expand far more rapidly at the beginning of blowdown than at the end of blowdown, when the jets become long and narrow and can propagate over longer distances.

In addition, GEH is requested to provide a detailed description of the capabilities of GEH's analysis tool (Fluent) for modeling supersonic jets at conditions representative of those in postulated HELB events in an ESBWR reactor. The description should include citations to articles in the open literature as well as reports that confirm the tool's capabilities, preferably against analytic and/or measured data. The description should also explain and substantiate (with citations to articles and/or reports) GEH's choice of turbulence model for jet impingement modeling.

GEH Response (Original)

Technical Report 0000-0105-2955, Revision 5 (provided in the response to RAI 3.6-6 S04, Part B), provides the information requested in this RAI. Section 1.0 of the report summarizes the key points, and Sections 2.0 and 4.7 provide additional details. Section 2.0 discusses the results of a tank gun blast simulation using FLUENT with a solver configuration almost identical to the configuration used for the ESBWR Main Steamline analysis. The reference cited (from the open literature) documents the accuracy of the FLUENT predictions in modeling the propagation of shock waves in two and three dimensions. Section 4.7.3 of the report discusses how the impingement loading calculations will ensure the worst-case pressure loading conditions are used.

GEH Response (Revision 1)

Technical Report 0000-0105-2955, Revision 5 (provided in the original response to RAI 3.6-6 S04, Part B), provides the information requested in this RAI. Section 1.0 of the report summarizes the key points, and Sections 2.0 and 4.7 provide additional details. Section 2.0 discusses the results of a tank gun blast simulation using FLUENT with a solver configuration almost identical to the configuration used for the ESBWR Main Steamline analysis. The reference cited (from the open literature) documents the accuracy of the FLUENT predictions in modeling the propagation of shock waves in two and three dimensions. Section 4.7.3 of the report discusses how the impingement loading calculations will ensure the worst-case pressure loading conditions are used. In addition, Technical Report 0000-0105-2955 is currently being revised to include the analysis methodology to be used for ESBWR pipe break analyses to further ensure conservative predictions (see Revision 1 of the response to RAI 3.6-6 S04). When complete, the revised report will be formally provided by GEH in a separate MFN letter.

DCD Impact (Revision 1)

No DCD or LTR changes will be made in response to this RAI. Technical Report 0000-0105-2955 will be included in NEDE-33440P, as discussed in the response to RAI 3.6-6 S04, Part B.

Enclosure 2

MFN 09-787
Supplement 3

Revised Response to Portion of NRC Request for

Additional Information Letter Nos. 369 and 386

Related to ESBWR Design Certification Application

DCD Markups for RAI Number 3.6-6 S04 Part B

The technical report in Appendix B of Reference 3.6-10 documents a methodology for evaluating blowdown forces created by jet impingement as a result of a high energy line break. The report also documents the benchmarking of the methodology against experimental data and implements the methodology for an ESBWR Main Steamline break. The analysis methodology documented in this report will be used for the ESBWR to develop ~~pipe break~~ models during the detailed design phase that closely represent the geometry of the building volume and equipment being modeled.

Step 3: ANSYS Finite Element Analysis (FEA) Method. This program is used to model the target structure by FEA method. Using force time history as the input load resulting from the computational fluid dynamics analysis on the target structure, the transient dynamic analysis is performed. This dynamic time history analysis addresses the resonance (if any) with the input forcing function. To account for the uncertainty in the resonance frequencies of the target structure finite element model, input force time histories that are shifted in 2.5% increments spanning a ±10% uncertainty are applied to the structural FEA model, ensuring that the worst-case structural response is computed and used to assess structural integrity.

3.6.2.3.2 Pipe Whip Effects on Safety-Related Components

This subsection provides the criteria and methods used to evaluate the effects of pipe displacements on safety-related structures, systems, and components following a postulated pipe rupture.

Pipe whip (displacement) effects on safety-related structures, systems, and components can be placed in two categories: (1) pipe displacement effects on components (nozzles, valves, tees, etc.) which are in the same piping run that the break occurs in; and (2) pipe whip or controlled displacements onto external components such as building structure, other piping systems, cable trays, conduits, etc.

Pipe Displacement Effects on Components in the Same Piping Run

The criteria for determining the effects of pipe displacements on inline components are as follows:

- Components such as vessel safe ends and valves which are attached to the broken piping system and do not serve a safety function or failure of which would not further escalate the consequences of the accident need not be designed to meet ASME B&PV Code Section III-imposed limits for safety-related components under faulted loading.
- If these components are required for safe shutdown or serve to protect the structural integrity of a safety-related component, limits to meet the ASME B&PV Code requirements for faulted conditions and limits to ensure required operability are met.

  The operability qualification of active pipe mounted components is described in Subsection 3.9.3.
- The methods used to calculate the pipe whip loads on piping components in the same run as the postulated break are described in Subsection 3.6.2.2 under paragraph titled "Pipe Whip Dynamic Response Analyses".

MFN 09-787 Supplement 3

Enclosure 4

Affidavit

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, Larry J. Tucker, state as follows:

(1) I am the Manager, ESBWR Engineering, GE Hitachi Nuclear Energy ("GEH"), have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Enclosure 3 of GEH letter MFN 09-787 Supplement 3, Mr. Richard E. Kingston to U.S. Nuclear Regulatory Commission, entitled *Supplemental Response to Portion of NRC RAI Letter Nos. 369 and 386 Related to ESBWR Design Certification Application – DCD Tier 2 Section 3.6 – Protection Against Dynamic Effects Associated with the Postulated Rupture of Piping; RAI Numbers 3.6-6 S04 Part B and 3.6-24,* dated February 25, 2010. The GEH proprietary information in Enclosure 3, which is entitled *Revised Response to Portion of NRC RAI Letter No. 369 and 386 Related to ESBWR Design Certification Application - LTR Markups for RAI Number 3.6-6 S04 Part B and Section 7.0 Analysis Methodology of Technical Report – ESBWR Main Steam Line Break CFD Modeling: Jet Impingement During ESBWR High Energy Line Break – GEH Proprietary Information* and is delineated by the Proprietary Information header of each page. Paragraph (3) of this affidavit provides the basis for the proprietary determination. Non-proprietary versions of this information is not provided in accordance with NRC Information Notice 2009-07, Requirements for Submittals, (2): "In instances in which a nonproprietary version would be of no value to the public because of the extent of the proprietary information, the agency does not expect a nonproprietary version to be submitted."

(3) In making this application for withholding of proprietary information of which it is the owner, GEH relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for "trade secrets" (Exemption 4). The material for which exemption from disclosure is here sought also qualify under the narrower definition of "trade secret," within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH competitors without license from GEH constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals aspects of past, present, or future GEH customer-funded development plans and programs, resulting in potential products to GEH;

d. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a., and (4)b, above.

(5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GEH, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or subject to the terms under which it was licensed to GEH. Access to such documents within GEH is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2), above, is classified as proprietary because it identifies detailed GEH ESBWR design information. GEH utilized prior design information and experience from its fleet with significant resource allocation in developing the system over several years at a substantial cost.

The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GEH asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing these very valuable analytical tools.

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information, and belief.

Executed on this 25th day of February 2010.

Larry J. Tucker

Larry J. Tucker
GE-Hitachi Nuclear Energy Americas LLC