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**Proprietary Notice**

This letter forwards proprietary information in accordance with 10CFR2.390. Upon the removal of Enclosure 1, the balance of this letter may be considered non-proprietary.

MFN 08-841 Revision 1

Docket No. 52-010

March 26, 2009

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

Subject: **Revised Response to Portion of NRC Request for Additional Information Letter No. 234 – Related to ESBWR Design Certification Application – RAI Number 21.6-120**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by the Reference 1 NRC letter.

The revised GEH response to RAI Number 21.6-120 is addressed in Enclosures 1, 2 and 3. This revised response supersedes the original response that was submitted in the Reference 2 GEH letter.

Enclosure 1 contains GEH proprietary information as defined by 10 CFR 2.390. GEH customarily maintains this information in confidence and withholds it from public disclosure. Enclosure 2 is the public version, which does not contain proprietary information and is suitable for public disclosure.

The affidavit contained in Enclosure 3 identifies that the information contained in Enclosure 1 has been handled and classified as proprietary to GEH. GEH hereby requests that the information in Enclosure 1 be withheld from public disclosure in accordance with the provisions of 10 CFR 2.390 and 10 CFR 9.17.

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

Sincerely,

Richard E. Kingston  
Vice President, ESBWR Licensing

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NRO*

References:

1. MFN 08-629 Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 234 Related To ESBWR Design Certification Application*, dated August 5, 2008
2. MFN 08-841 Letter from Richard E. Kingston, GEH to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 234 – Related to ESBWR Design Certification Application – RAI Number 21.6-120*, dated November 4, 2008.

Enclosures:

1. MFN 08-841 Revision 1 – Revised Response to Portion of NRC Request for Additional Information Letter No. 234 – Related to ESBWR Design Certification Application – RAI Number 21.6-120 – GEH Proprietary Information
2. MFN 08-841 Revision 1 – Revised Response to Portion of NRC Request for Additional Information Letter No. 234 – Related to ESBWR Design Certification Application – RAI Number 21.6-120 – Public Version
3. MFN 08-841 Revision 1– Revised Response to Portion of NRC Request for Additional Information Letter No. 234 – Related to ESBWR Design Certification Application – RAI Number 21.6-120 – Affidavit

cc: AE Cabbage      USNRC (with enclosures)  
RE Brown          GEH/Wilmington (with enclosures)  
DH Hinds          GEH/Wilmington (with enclosures)  
eDRF                0000-0091-1643/R1

**Enclosure 3**

**MFN 08-841 Revision 1**

**Revised Response to Portion of NRC Request for  
Additional Information Letter No. 234  
Related to ESBWR Design Certification Application  
RAI Number 21.6-120  
Affidavit**

# GE-Hitachi Nuclear Energy Americas LLC

## AFFIDAVIT

I, David H. Hinds, state as follows:

- (1) I am Manager, New Units Engineering, GE Hitachi Nuclear Energy ("GEH"), and 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 1 of GEH's letter, MFN 08-841 Revision 1, Mr. Richard E. Kingston to U.S. Nuclear Energy Commission, entitled "*Revised Response to Portion of NRC Request for Additional Information Letter No. 234 – Related to ESBWR Design Certification Application – RAI Number 21.6-120,*" dated March 26, 2009. The proprietary information in enclosure 1, which is entitled "*MFN 08-841 Revision 1 – Revised Response to Portion of NRC Request for Additional Information Letter No. 234 – Related to ESBWR Design Certification Application – RAI Number 21.6-120 – GEH Proprietary Information,*" is indicated as the content contained between opening double brackets ([[) and closing double brackets (]]). Figures and large equation objects are identified with double square brackets before and after the object. In each case, the superscript notation <sup>(3)</sup> refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.
- (3) In making this application for withholding of proprietary information of which it is the owner or licensee, 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's 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 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) is classified as proprietary because it contains details of GEH's design and licensing methodology. The development of the methods used in these analyses, along with the testing, development and approval of the supporting methodology was achieved at a significant cost to GEH.
- (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 and obtaining 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 26<sup>th</sup> day of March 2009.



David H. Hinds  
GE-Hitachi Nuclear Energy Americas LLC

**Enclosure 2**

**MFN 08-841 Revision 1**

**Revised Response to Portion of NRC Request for  
Additional Information Letter No. 234  
Related to ESBWR Design Certification Application**

**RAI Number 21.6-120**

**Public Version**

**NRC RAI 21.6-120**

*Tube side and secondary side heat transfer uncertainty.*

*NEDE 33083P, Supp. 3:, Chapter 5, Table 5-1 - Bounding input Q2 and Q5:*

*In Table 5-1 (page 40), the bias and deviation for Q2 tube-side condensation capacity is listed as [[                   ]]; and for Q5 secondary-side heat transfer are [[                   ]], respectively. However, the comments indicate bounding input [[                   ]]. The discussion on page 54 in Section 5.1 for Q2 IC tube side condensation capacity, Q5 IC secondary side heat transfer also seems to indicate that the uncertainty in these heat transfer correlations is bounded by a design basis [[                   ]]. Are the Kuhn-Schrock-Peterson and the Forster-Zuber heat transfer correlations ignored? Is it assumed that the design basis fouling factor bounds these heat transfer correlation uncertainties?*

**GEH Response**

The discussion on the value of tube side and secondary side heat transfer uncertainty is extraneous and will be removed from Reference 1 and 4.

Instead, above two questions can be addressed by the following statement.

In the TRACG analysis, the heat removal output from each Isolation Condenser (IC) train under normal operating pressure is assured to be equal to or less than 33.75 MWt, which is the minimum design heat removal capacity for each IC unit (Reference 5). Periodic technical specification surveillance requirements (Reference 2) provide assurance that each IC train is capable of removing the required heat load. Also, the ESBWR ITAAC, Table 2.4.1-3 of Reference 3, requires that the acceptance criterion for the Isolation Condenser System (ICS) heat removal capacity for each IC train is greater than or equal to 33.75 MWt for the reactor at or above normal operating pressure.

Most of the IC mission time is under quasi-steady state or steady state conditions, and the transient time is only a very short period. Figure 2 in Reference 6 shows that the TRACG results are very close to the qualification test data in terms of the IC heat transfer rate for a wide range of pressure variation that could occur in the transient of IC operation. Therefore, it is assured that under conditions of pressure variation, the same trend will hold for heat removal in TRACG analysis as in the IC test data.

IC performance at pressures below normal is not a critical sensitivity, because it will not result in SRV operation & discharge to the suppression pool. The IC is tested at normal operating pressure to avoid the possibility of spurious SRV operation. The TRACG trend with pressure is very close to the test data as shown by Figure 2 in Reference 6. Therefore there is no significant uncertainty in the IC heat transfer capacity in the most important (high) pressure range.

IC heat transfer uncertainty in the presence of non-condensable gas has been discussed in the GEH response to RAI 21.6-55 S02. (Reference 7)

The uncertainty in the IC periodical testing program is taken into account while determining the allowable limit of the IC heat removal.

Licensing Topical Reports (Reference 1 and 4) will be revised according to the above description.

### **References**

1. NEDE-33083P, Supplement 3, "TRACG Application for ESBWR Transient Analysis", December 2007.
2. 26A6642BR, ESBWR Design Control Document/Tier 2, Revision 5, Chapter 16, page 3.5.4-2, May 2008.
3. 26A6641AB, ESBWR Design Control Document/Tier 1, Revision 5, Table 2.4.1-3, May 2008.
4. NEDE-33083P, Supplement 2, "TRACG Application For ESBWR Anticipated Transient Without Scram Analyses", Revision 1, February 2008.
5. 26A6642AR, ESBWR Design Control Document/Tier 2, Revision 5, Chapter 5, Table 5.4-1, May 2008.
6. MFN 07-168 Supplement1, Response to Portion of NRC Request for Additional Information Letter No. 66 Related to ESBWR Design Certification Application—RAI Number 21.6-55 S01
7. MFN 08-843, Response to Portion of NRC Request for Additional Information Letter No. 239 and Letter No. 234 — Related to ESBWR Design Certification Application — RAI Numbers 21.6-55 Supplement 2 and 21.6-119.

### **DCD or LTR Impact**

No DCD changes will be made in response to this RAI.

Changes to NEDO-33083, Supplement 2 and NEDO-33083, Supplement 3 are shown in the attached markup.

**Attachment**

**Revision Pages for NEDO-33083, Supplement 2  
and  
Revision Pages for NEDO-33083, Supplement 3**

separation of droplets from the steam in the dryer, and therefore evaluates the steam line response with dry steam. This conservatively maximizes the velocity of sound in the steam line and produces a bounding power peak for the pressurization event.

**Q2 IC Tube Side Condensation Capacity, H; Q5 IC Secondary Side Heat Transfer, H**

In the TRACG analysis, the heat removal output from each IC train under normal operating pressure is assured to be equal to or less than 33.75 MWt, which is the minimum design heat removal capacity for each IC unit (Table 5.4-1 in Reference 39). Periodic technical specification surveillance requirements (Chapter 16 in Reference 39) provide assurance that each IC train is capable of removing the required heat load. Also, the ESBWR ITAAC, Table 2.4.1-3 of Reference 38, requires that the acceptance criterion for the ICS heat removal capacity for each IC train is greater than or equal to 33.75 MWt for the reactor at or above normal operating pressure.

**~~Q2 — Isolation Condenser Capacity~~**

~~Full scale tests were performed of an Isolation Condenser (IC) module in the PANTHERS test facility. Comparisons with TRACG results showed a negative bias of {{ }} and a 1 $\sigma$  uncertainty of {{ }} in the total heat removal rate [15].~~

**~~Q5 — Isolation Condenser Secondary Side Heat Transfer~~**

~~The uncertainties in the secondary side heat transfer are included in the data for the overall condenser heat removal (Q2) above.~~




]]



The baseline model also has conservatisms included in it to bound model phenomena or certain plant component specifications. [[

]]

- 10-26 Supplemental Information for Plant Modifications to Eliminate Significant In-Core Vibrations", NEDE-21156, Jan 1976
- 10-27 B. S. Shiralkar and R. E. Gamble, "ESBWR Test and Analysis Program Description", NEDC-33079P, August 2002 (section 3.3).
- 10-28 J. P. Walkush, "High Pressure counterflow CHF", EPRI Report 292-2, January 1975
- 10-29 V. P. Carey, Liquid-Vapor-Phase-Change Phenomena, Hemisphere Publishing, 1992.
- 10-30 R. E. Dimenna, et al., RELAP5/MOD2 Models and Correlations, NUREG/CR-5194 (EGG-2531), August 1988.
- 10-31 D. C. Groeneveld, S. C. Cheng and T. Doan, 1986 AECL-UO Critical Heat Flux Lookup Table, Heat Transfer Engineering 7, 1986 (pp. 46-62).
- 10-32 B. S. Shiralkar, et al., The GESTR-LOCA and SAFER Models for the Evaluation of the Loss-of-Coolant Accident, Volume III: SAFER/GESTR Application Methodology, NEDE-23785-1-PA, Rev. 1, October 1984.
- 10-33 P. Saha, A Study of Heat Transfer to Superheated Steam in a 4x4 Rod Bundle, NEDE-13462, June 1976
- 10-34 B. S. Shiralkar, et al., SBWR Test and Analysis Program Description, NEDC-32391P, Rev.C, August 1995.
- 10-35 Takashi Hara, et al., *TRACG Application to Licensing Analysis*, (ICONE-7311), 7<sup>th</sup> International Conference on Nuclear Engineering, Tokyo, April 19-23, 1999.
- 10-36 R. D. Blevins, Applied Fluid Dynamics Handbook, Van Nostrand, 1984.
- 10-37 G. B. Wallis, One-Dimensional Two-Phase Flow, McGraw-Hill, 1969.

10-38	<u>GE Hitachi Energy Nuclear, ESBWR Design Control Document, Tier 1.</u>
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10-39	<u>GE Hitachi Energy Nuclear, ESBWR Design Control Document, Tier 2.</u>
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correlations in TRACG [8] predict smooth pipe pressure drop in single-phase flow with an accuracy of [[ ]] and rough pipe data within [[ ]]. Based on this data, it was judged that, [[ ]]

**L2X Steam Line Acoustic Effects, H**

Sudden closure of the turbine stop valves or control valves results in the propagation of a pressure pulse at sonic speed from the valve to the steam dome. The timing of the arrival of the pressure pulse has a significant impact on the severity of the transient. The propagation of the pulse may be affected by uncertainty in the sonic propagation velocity for the steam. [[ ]]

]]

**Q1 IC Pressure drop, H**

This determine the cold water drainage from the IC in the initial part of the actuation, [[ ]]

**Q2 IC Tube Side Condensation Capacity, H; Q5 IC Secondary Side Heat Transfer, H**

~~TRACG utilizes the Kuhn-Schrock-Peterson correlation [69] for the calculation of condensation heat transfer inside tubes. [[ ]]~~

~~]]~~

~~The IC secondary side heat transfer is controlled by the nucleate pool boiling phenomenon, which is modeled by the Forster-Zuber correlation in TRACG. The Forster-Zuber correlation typically falls in the middle of other well-known correlations used for pool boiling. [[ ]]~~

~~]] This is not the limiting resistance for heat transfer across the IC tube wall, and the sensitivity to the assumed uncertainty is small.~~

~~Comparisons with prototypical PANTHERS data [49] have shown good agreement between the measured and predicted heat transfer. The IC heat removal rate was calculated with [[ ]]~~

~~]] [49].~~

~~Uncertainties in the wall conduction are also included in this PIRT. It should be noted that the PANTHERS tests were carried out with clean tubes and do not include the effect of crud formation that may occur with continued IC operation. [[ ]]~~

‡

In the TRACG analysis, the heat removal output from each IC train under normal operating pressure is assured to be equal to or less than 33.75 MWt (Table 5.4-1 in Reference 75), which is the minimum design heat removal capacity for each IC unit. Periodic technical specification surveillance requirements (Chapter 16 in Reference 75) provide assurance that each IC is capable of removing the required heat load. Also, the ESBWR ITAAC, Table 2.4.1-3 of Reference 74, require that the acceptance criterion for the ICS heat removal capacity for each IC train is greater than or equal to 33.75 MWt for the reactor at or above normal operating pressure.

**R1 Flow Dynamics, H; R2 Temperature Dynamics, H**

In the ESBWR these can affect the response of the transients because the sub-cooling transients are limiting, therefore bounding parameters will be used for the analysis of the transients affected by the FW dynamics and temperature.

**8.2.3 Plant Parameters**

As described in Section 6.3, critical plant parameters will be set at a bounding value (for example the APRM flux scram setpoint will be set to the maximum value in the analysis). This process is described in the procedure that defines the critical Operating Parameters for Licensing (OPL) for transient analysis. [[

]] Only the OLMCPR defining events will assume the statistical scram/SCRRRI speed. Table 8-27 shows the sensitivity of the LRHBP and LFWH-SCRRRI event to control rods speed insertion. Based on these results the scram/SCRRRI speed uncertainty is added to the parameters in the statistical analysis.

**Table 8-27  
Scram Speed Uncertainty Results**

[[		
		]]

In TRACG analysis, the heat removal from each IC train under normal operating pressure is assured to be equal to or less than the minimum design heat removal capacity specified in the Table 5.4-1 of Reference 75. ESBWR ITAAC (Table 2.4.1-3 of Reference 74), provide acceptance criterion and assurance for heat removal of each IC train, which is greater than or equal to the required IC heat load for the reactor at or above normal operating pressure. Plant technical specifications (Chapter 16 of Reference 75) require periodic testing to assure that each IC train is capable of removing the required heat load.

**8.2.4 Summary of Initial Conditions and Plant Parameter**

The conclusions from the initial conditions and plant parameter analysis form the basis of the plant specific analysis process. The following can be concluded based on the initial condition and plant parameter analysis results:

**8.2.4.1 Pressurization Events:**

- Analysis must consider the full range of operating core power, core flow, and operating pressure. The MSIVF overpressure analysis is limiting at the maximum core power and operating pressure and minimum core flow.
- The EOC (all-rods-out) condition is limiting. EOC must always be analyzed. Exposures prior to MOC are most limiting when black-and-white rod patterns are assumed. A

NEDO-33083, Supplement 3

JSME/ASME Joint International Conference on Nuclear Engineering, New Orleans, March 1996.

- [64] A. M. C. Chan, Void Fraction Measurements in Large Diameter Pipes with Thick Metal Walls or Complex Internal Geometries, Proceedings of the National Heat Transfer Conference, American Nuclear Society, 1992 (pp. 236-244).
- [65] A. M. C. Chan and D. Bzovey, Measurements of Mass Flux in High Temperature High Pressure Steam-Water Two-Phase Flow using a Combination of Pitot Tubes and a Gamma Densitometer, Journal of Nuclear Engineering and Design, V. 122, 1990 (pp. 95-104).
- [66] J. F. Wilson, R. J. Grenda and J. F. Patterson, Steam Volume Fraction in a Bubbling Two-Phase Mixture, Trans. ANS 4(2), 1961 (pp. 356-357).
- [67] G. G. Bartolomei, V. A. Suvorov and S. A. Tevlin, Hydrodynamics of Steam Generation in a Two-Circuit Nuclear Power Plant, Teploenergetika 10(1), 1963 (pp. 52-57).
- [68] M. Petrick and E. A. Spleha, Thermal Hydraulic Performance Characteristics of EBWR, ANL 6693, May 1963.
- [69] S.Z. Kuhn, V.E. Schrock, and P.F. Peterson, Final Report on U. C. Berkeley Single Tube Condensation Studies, University of California, Berkeley Report UCB-NE- 4201, August 1994.
- [70] Congdon, Bentley, Bolger, LTR GE14 for ESBWR – Critical Power Correlation, Uncertainty, and OLMCPR Development, March 2006.
- [71] S. B. Shelton, LTR GE14 for ESBWR Fuel Rod Thermal-Mechanical Design Report, NEDC-33242P, Rev. 1, February 2007.
- [72] GE-Hitachi Nuclear Energy, “ESBWR Feedwater Temperature Operating Domain Transient and Accident Analysis”, NEDO-33338 Class I, Revision 0, October 2007.
- [73] GENE, “ESBWR Heat Balance 100% Power, 102%Power, 104.2% Power/105% Rated Steam Flow,” neDRF Sec. 0000-0034-6115, March 10, 2005.

[74] GE Hitachi Nuclear Energy, ESBWR Design Control Document, Tier 1.

[75] GE Hitachi Nuclear Energy, ESBWR Design Control Document, Tier 2.