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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 08-961

Docket No. 52-010

December 19, 2008

U.S. Nuclear Regulatory Commission
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Subject: **Response to Portion of NRC RAI Letter No. 220 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.9 – Mechanical Systems and Components; RAI Numbers 3.9-233 through 3.9-236, 3.9-238,and 3.9-242**

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) letter number 220 sent by NRC letter dated July 29, 2008 (Reference 1). RAI Numbers 3.9-233 through 3.9-236, 3.9-238 and 3.9-242 are addressed in Enclosure 1.

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 non-proprietary 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 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

D068
NRO

Reference:

1. MFN 08-609 Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 220 Related to NEDE-33312P, "ESBWR Steam Dryer Acoustic Load Definition," NEDE-33313P, "Steam Dryer Structural Evaluation," NEDC-33408P, "ESBWR Steam Dryer-Plant Based Load Evaluation Methodology," NEDE-33259P, "Reactor Internals Flow Induced Vibration Program," and ESBWR Design Control Document, Revision 5*, dated July 29, 2008

Enclosures:

1. Response to Portion of NRC RAI Letter No. 220 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.9 – Mechanical Systems and Components; RAI Numbers 3.9-233 through 3.9-236, 3.9-238,and 3.9-242, Proprietary Version

2. Response to Portion of NRC RAI Letter No. 220 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.9 – Mechanical Systems and Components; RAI Numbers 3.9-233 through 3.9-236, 3.9-238,and 3.9-242, Public Version

3. Affidavit

cc:	AE Cubbage	USNRC (with enclosures)
	RE Brown	GEH/Wilmington (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	eDRF	0000-0094-7835 R1 (RAI 3.9-233 through – 236, 3.9-238 & 3.9-242)

Enclosure 2

MFN 08-961

Response to Portion of NRC Request for

Additional Information Letter No. 220

Related to ESBWR Design Certification Application

Mechanical Systems and Components

RAI Numbers 3.9-233 through 3.9-236, 3.9-238,and 3.9-242

Public Version

NRC RAI 3.9-233

Summary: Elaborate on the design and modeling of the chimney supports

Elaborate on the design and modeling of the chimney supports at the top guide (lower supports) and upper reactor pressure vessel (RPV) restraints (upper supports) as they relate to FIV structural dynamic analysis and the insertion and removal of the Chimney and/or partitions during initial fabrication and refueling. In particular, are the physical supports/gaps adjustable and how are the supports modeled (as simple supports or supports with gaps?) in dynamic structural analysis? If the eight lateral restraints are not engaged, what are the modal characteristics of the shroud/chimney/separator structure? What is the uncertainty that the beam model of the support employed in the modal analysis is representative of the physical support? What are the uncertainties in the calculated stresses to account for any ambiguities in the upper chimney supports and FIV excitation sources? In particular, what are the stresses and loads, comparable to those reported in Table 5 of NEDE-33259P, Rev.1, if the eight upper lateral restraints on the chimney are not engaged?

GEH Response

As described in the response to RAI 3.9-238, the chimney partition is structurally separated from the chimney cylinder except at the top of the partitions. In view of this structural feature, the chimney partitions and chimney cylinder are modeled as separate beams. The chimney partition beam model is structurally connected to the chimney cylinder beam model at the top and to the top guide at the bottom through the locating pins. The chimney cylinder beam model is connected to the RPV beam model at the eight top lateral restraints. The upper chimney support where the chimney is restrained by the RPV is modeled as simply supported. Since the dimensional tolerances at the chimney cylinder restraints are such that it is possible for the chimney lugs to be touching the RPV bracket, modeling the chimney top as simply supported is realistic, When the tolerance stack-up is at the other extreme, a small gap is possible and the chimney cylinder behaves like a cantilevered beam. In such a situation, the system becomes nonlinear and theoretically a modal analysis to obtain the natural frequencies and mode shapes, is not appropriate. In a nonlinear system, depending on the nature of the forcing function, the response may be periodic. However, the period is dependent upon the amplitude of the vibration. To overcome this theoretical barrier, analysts have made use of the method of "equivalent linearization". In the equivalent linearization process, vibration amplitude is first assumed and an equivalent linear spring is determined for that particular amplitude. The equivalent linear spring rate for a particular vibration amplitude is a rate which minimizes the error between the real spring rate (a bi-linear curve in the case of a gap) and the linear spring rate. This equivalent linear spring rate is then used in a linear model to calculate the vibration response amplitude per the description in the LTR (Ref, 1). The response amplitude is then compared to the assumed amplitude. If there is reasonable agreement, the process is

terminated. If the amplitudes do not agree, an iterative process is started until there is reasonable agreement.

For the ESBWR chimney FIV response analysis, a linear model with a calculated stiffness to simulate a simple support is developed. For the other extreme where the chimney cylinder behaves as a cantilever, a zero spring rate is used. For the case where the gap may be closed during part of a vibration cycle, equivalent linear stiffnesses of 50% and 10% of simply supported case stiffness is determined. The results from these cases are shown in Table 1.

[[

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From the results in the above Table, it can be readily concluded that the effect of the gap is minimal. The small displacement due to FIV forces is consistent with the intent of the chimney restraint support, i.e. it is meant to resist seismic forces, not FIV forces. The effect of a large gap may increase stresses in the shroud but the stresses are negligibly small and any increase is of little significance.

DCD Impact

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

NRC RAI 3.9-234

Summary: Discuss potential fluid forces created by the Head/Steam Separators

Elaborate on the potential fluid forces created by the Head/Steam Separators and their possible effects on FIV excitation of the ESBWR Shroud/Chimney/Separator Structure.

GEH Response

Please see response to RAI 3.9-236.

DCD Impact

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

NRC RAI 3.9-235

Summary: Identify the loads transmitted to the RPV

In the case that the upper restraints are engaged, what are the loads transmitted to the RPV and the stresses in the upper chimney restraints? What are the uncertainties in the calculated stresses to account for ambiguities in the support provided by restraints excitation sources?

GEH Response

Please see response to RAI 3.9-233.

DCD Impact

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

NRC RAI 3.9-236

Summary: Provide the rationale for the change to the new flat-shaped chimney head/separator assembly design.

Provide the rationale for the change to the new flat-shaped Chimney Head/Separator Assembly design in the ESBWR, the pertinent details of the structural design as they relate to structural dynamic analysis, the pertinent details of the internal flow conditions and their potential for FIV excitation. Also, discuss the stresses in the Chimney Head Separator Assembly's separator/standpipe "forest" and individual separator/standpipe units that are caused by internal flow. The response to RAI 3.9-51 does not address the concerns.

GEH Response

The chimney head/separator assembly is essentially designed as a slightly curved plate in order to optimize the performance of the reactor internals. In performing the TRACG analysis, maximization of the water volume outside and above the core boundary was necessary to assure that the water level in the core could be maintained within the design criteria. Therefore, a change from a dome shaped head to an essentially flat head optimized the amount of fluid on the exterior to the core and increased the inventory of available fluid to flood the core. The head design has a slight curvature in order to reduce stresses within the structure and to lower the overall weight of the structure.

The dominant FIV excitation of the separators/separator head comes from the turbulence of the two-phase flow inside the separator. There is a small periodic forcing function due to the swirling flow behaving like a unbalanced wheel. The force is zero if swirling flow is uniform. Due to flow turbulence, the flow is slightly non-uniform. The non-uniformity is random and thus random forces act and they have different phases. Thus the aggregate effect on the separator head is minimal.

From the beam model, the maximum stress occurs at the end of the standpipes and is less than [[ ]] This is negligibly small when compared to the allowable of 68.9 MPa.

For the reliability of the individual separators, please see the response to RAI 3.9-239.

DCD Impact

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

NRC RAI 3.9-238

Summary: Elaborate on the design of the chimney partition and its connection to the chimney

In response to RAI 3.9-140, which questioned the details of the chimney partition testing, the FEM model of the partition was reported to assume the outermost ends of the partition were essentially fixed ends. The response to RAI-140(c)(sic) implies that the partition is attached along the entire length of the chimney. However, the design of these connections was in progress to provide such rigidity. Elaborate on the design of the chimney partition and it's (sic) connection to the chimney, the sensitivity of the boundary condition assumptions on the calculated partition stresses, and explain why motion of the chimney due to flow in the annulus between the chimney and the PV does not create additional significant stresses in the partition.

GEH Response

As identified in subsection 9.1.4.15 of DCD rev. 5, the chimney partitions are designed to be removable for refueling. To facilitate proper alignment at the lower end of the chimney partitions to the top guide structure, alignment pins are necessary. Therefore, there is a secure lateral support at the lower end of the chimney partitions at the pin interface with the top guide. There is also a secure lateral support at the top of the chimney partitions that can be readily released for chimney removal. At the edges of the peripheral chimney partitions there are vertical plates attached to the partitions to stiffen and reduce stresses at the outer partition locations. Therefore, the only interface with the chimney cylinder is at the top of the chimney partitions, since contact along the length of the partition structure is not expected. The chimney partition is restrained laterally at the bottom by the top guide through the locating pins.

The chimney partition is free to move in the axial direction but restrained in the radial and tangential directions by the chimney cylinder. The fluid forces acting on the outer chimney cylinder surfaces are derived from the ABWR measurement as described in Section 5.2.1 of the LTR (Ref. 1). The vibration of the chimney cylinder resulting from these forces is transmitted to the chimney partition through the restraints. As described in the response to RAI 3.9-233, the chimney partition is modeled as a beam separated from the chimney cylinder beam except at the top of the chimney partition where they are connected. Thus, any chimney cylinder vibration induced by the flow between the RPV and the shroud/chimney annulus is transmitted to the partition through this upper connection. Thus, the partition vibration stresses induced by the cylinder vibration are automatically accounted for in the chimney partition and chimney cylinder models.

The boundary conditions at the top and bottom of chimney partitions are clearly defined. From the beam model the maximum partition stress is [|]]. This is negligibly small when compared to the allowable of 68.9 MPa. In view of the small value of these

stresses, any possible increase as a result of alternate boundary conditions is not of any significance.

DCD Impact

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

NRC RAI 3.9-242

Summary: Provide rationale for the selection and location of Sensors

Elaborate on the rationale for the selection and location of the sensors to be placed on the shroud above the support bracket and provide predicted stresses. If these are not the maximum stresses provide the value and location of the maximum stresses for the Shroud/Chimney/Separator Assembly.

GEH Response

The shroud support design has been changed from "shroud support brackets" to "shroud support legs". As before, strain gages will be placed near the points of maximum calculated principal stresses. Placement of strain gages near the principal stress locations will obviate the need for extrapolation of stresses based on the results of finite element model analyses.

Based on the loads generated by the beam model described in the response to RAI 3.9-233 the maximum bending stresses are less than [[ ]] MPa and occur at the lateral brace location on the shroud leg.

DCD Impact

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

MFN 08-961

Enclosure 3

Affidavit

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, David H. Hinds, state as follows:

(1) I am the Manager, New Units 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 1 of GEH letter MFN 08-961, Mr. Richard E. Kingston to U.S. Nuclear Regulatory Commission, entitled *Response to Portion of NRC RAI Letter No. 220 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.9 – Mechanical Systems and Components; RAI Numbers 3.9-233 through 3.9-236, 3.9-238,and 3.9-242* dated December 19, 2008. The GEH proprietary information in Enclosure 1, which is entitled *Response to Portion of NRC RAI Letter No. 220 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.9 – Mechanical Systems and Components; RAI Numbers 3.9-233 through 3.9-236, 3.9-238,and 3.9-242, Proprietary Version,* is delineated by a [[dotted underline inside double square brackets.{3}]]. Figures and large equation objects are identified with double square brackets before and after the object. In each case, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination. A non-proprietary version of this information is provided in Enclosure 2, *Response to Portion of NRC RAI Letter No. 220 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.9 – Mechanical Systems and Components; RAI Numbers 3.9-233 through 3.9-236, 3.9-238,and 3.9-242, Public Version.*

(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 GE ESBWR design information. GE 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 19th day of December 2008.

David H. Hinds
GE-Hitachi Nuclear Energy Americas LLC