HITACHI

Proprietary Notice

This letter forwards proprietary information in accordance with 10 CFR 2.390. Upon the removal of Enclosure 1, the balance of this letter may be considered non-proprietary.

GE Hitachi Nuclear Energy

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MFN 12-051, Revision 2

Docket number: 05200010

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US Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555-0001

Subject: **NRC Requests for Additional Information (RAI) Related to the Audit of the Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design Methodology Supporting Chapter 3 of the ESBWR Design Control Document – GEH Final Response to RAI 3.9-280**

References:

1. MFN 12-037, Letter from USNRC to Jerald G. Head, GEH, Subject: Request for Additional Information Letter No. 414 related to ESBWR Design Certification Application (DCD) Revision 9" received May 1, 2012

2. MFN 12-051, Letter from Jerald G. Head, GEH to USNRC, Subject: NRC Requests for Additional Information (RAI) Related to the Audit of the Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design Methodology Supporting Chapter 3 of the ESBWR Design Control Document – Draft Response for RAI 3.9-280, dated June 13, 2012

3. MFN-12-051, Revision 1, Letter from Jerald G Head, GEH, to USNRC, Subject: NRC Requests for Additional Information Related to the Audit of the Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design Methodology Supporting Chapter 3 of the ESBWR Design Control Document – Draft Response for RAI 3.9-280, dated October 3, 2012

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NRO

In regard to the Requests for Additional Information transmitted in your May 1, 2012 Letter, Reference 1, to support the NRC ESBWR Steam Dryer Methodology Audit conducted March 21–23, 2012, Docket 05200010, please find attached the final response to RAI 3.9-280, which revises the draft responses provided in References 2 and 3.

Enclosure 1 contains the complete response, with proprietary information identified within brackets [[ ]], and designated in red and dotted underline text, to assist in identification. The proprietary information, as identified by GE Hitachi Nuclear Energy, Americas LLC, should be protected accordingly.

Enclosure 2 contains the response with the proprietary information redacted, and is acceptable for public release. Enclosure 3 provides an affidavit which sets forth the basis for requesting that Enclosure 1 be withheld from the public.

If you have any questions concerning this letter, please contact Peter Yandow at 910-819-6378.

I declare under penalty of perjury that the foregoing information is true and correct to the best of my knowledge, information, and belief.

Sincerely,

Jerald G. Head
Senior Vice President, Regulatory Affairs

Commitments: No additional commitments are made in this response.

References:

Enclosures:

1. GEH Final Response to RAI 3.9-280 - Proprietary Version
2. GEH Final Response to RAI 3.9-280 - Public Version
3. Affidavit for MFN 12-051, Revision 2

cc: Glen Watford, GEH
Peter Yandow, GEH
Patricia Campbell, GEH
Mark Colby, GEH
Tim Enfinger, GEH
Gerald Deaver, GEH
eDRF Section: 0000-0147-3902 Rev 1

Enclosure 2

MFN 12-051, Revision 2

GEH Final Response to RAI 3.9-280

Public Version

This is a non-proprietary version of Enclosure 1, from which the proprietary information has been removed. Portions of the document that have been removed are identified by white space within double brackets, as shown here [[ ]].

IMPORTANT NOTICE REGARDING CONTENTS OF THIS DOCUMENT

Please Read Carefully

The information contained in this document is furnished solely for the purpose(s) stated in the transmittal letter. The only undertakings of GEH with respect to information in this document are contained in the contracts between GEH and its customers or participating utilities, and nothing contained in this document shall be construed as changing that contract. The use of this information by anyone for any purpose other than that for which it is intended is not authorized; and with respect to any unauthorized use, GEH makes no representation or warranty, and assumes no liability as to the completeness, accuracy, or usefulness of the information contained in this document.

NRC RAI 3.9-280

GEH is requested to provide a description of the [[ ]], including a description of how the dimensions (length and thickness) of the layer plate elements, [[ ]], is determined. GEH is also requested to clearly describe the criterion for how the [[ ]], is determined. Additionally, GEH should address [[ ]] concerns identified in letters from Entergy in support of the Grand Gulf EPU license amendment and [[ ]].

GEH Response Summary:

The steam dryer Finite Element Model (FEM) is primarily made of shell elements. There are dryer components, such as the [[ ]], which are modeled using solid elements. In order to properly transfer the moments between the shell elements and solid elements, [[ ]] are used to model the transition interface between the two types of elements.

As part of GEH's continuous improvement program, efforts have been applied to refine, standardize, and document the steam dryer analysis process. To this end, a study was performed to provide a basis for the appropriate [[ ]] applied in dryer finite element models. The results from the study validate the [[ ]] used in the GGNS model. The [[ ]] is a modeling technique that the dryer team will apply to an ESBWR dryer model. This technique and the thickness criterion are part of the design process and controlled by internal procedures.

GEH Response:

The steam dryer structural finite element model (FEM) is primarily made of shell elements. In the Susquehanna Steam Electric Station (SSES) replacement dryer global FEM, there are dryer components, such as the [[ ]] shown in Figure 1, which are modeled by solid elements. The shell elements have three translational and three rotational degrees of freedom (DOF) on each node. However, the solid elements do not have the rotational DOFs. In order to properly transfer the moments between the shell elements and solid elements, [[ ]] are used to model the transition interface between the two types of elements. Figure 2 shows the interface locations, where dryer components [[( ]] are connected to the support ring solid elements through .]]. The ratio of numbers of [[ ]] to numbers of structural shell elements is about [[ ]]

Additional Questions:

1. *Figure 2 of the response shows the interface locations where the dryer shell elements are connected to the supporting ring solid elements. A ratio of [[ ]] to numbers of structural shell elements is also provided. What is the number of [[.] in a typical ANSYS Steam Dryer model? Does this number vary significantly between QC2, SSES, GGNS and ESBWR model? If so, what is basis for differences?*

GEH response:

A typical ANSYS steam dryer model has about [[

]] The number of [[ ]] connected to the support ring in SSES and GGNS models [[ ]].

[[

]]

Figure 1: [[ ]]

[[

]]

Figure 2: [[ ]] **Connected to Dryer Components**

The lengths of the [[ ]] are determined by the element size of the solid element as shown in Figure 3. A [[ ]] was selected for all [[ ]] for SSES replacement dryer based on engineering judgment in consideration of the high peak stress in the interface between the base plate and support ring.

Additional Questions:

2. *On page 3 of the response it states [[*

]]

was selected for all [[ ]] based on by engineering judgment in consideration of the [[

]] What is the meaning of the following, "based on by engineering judgment in consideration of the [[

]]

GEH response:

The [[ ]] was initially used in the SSES replacement dryer model. It was based on the facts that the [[

]].

[[

]]

Figure 3: [[ ]] **Element Length**

Later, GEH performed a study to assist the engineer in identifying appropriate [[

]]

[[

]]

Figure 4: [[ ]]Finite Element Model

Additional Questions:

3. *Figure 3 appears to depict the [[ ]] in the solid element, based on the arrows shown. Figure 4 of the response depicts the [[{3}]] as being on the surface of the solid element. Please reconcile these two figures, and clearly indicate how the [[ ]] connect shell elements to solid elements. If more than one method is used describe. Also describe the size of the element.*

GEH Response:

Both [[ ]] were used in the SSES model. The upper structural components are connected to the support ring by [[ ]], and the lower structural components are connected by [[

]].

Additional Questions:

4. *Is the model shown in Figure 4 of the response used to develop the parametric study results presented in Figure 8 of the response? If not please describe, in detail, the model used to generate the results presented in figure 8.*

GEH Response:

Yes, the results presented in Figure 8 are based on the model shown in Figure 4.

Additional Questions:

7. *The FEM presented in Figure 4 of the response depicts a solid element grid size of approximately 1" X 1"on the surface. This is distorted in the shell attachment area to accommodate the [[ ]] length. Since [[ ]] explain (why) the solid element surface grid size was not specified as 2.5" X 2.5". Has the sensitivity of the results to the parameter been evaluated?*

GEH Response:

In the FEM presented in Figure 4, the [[ ]] mesh was locally modified while keeping 1" by 1" mesh density for the rest of solid elements. To evaluate the impact of mesh density and element shape distortion on the conclusion [[ ]], another sensitivity study was performed based on the revised model as shown in Figure 9. The mesh size of the solid elements in the revised model is [[ ]] without any element distortion. More details on the model and analysis results of the new sensitivity study are provided in the response to Question 6. The results from the new study further validate the conclusion on the selection of appropriate [[ ]] that was obtained from the original sensitivity study.

The goal of the study was to determine the appropriate thickness of the [[ ]] For the structure shown in Figure 4, the analytical tip displacement is [[ ]] An initial [[ ]] As a result of the study GEH believes, as a rule of thumb, that the thickness of the [[ ]] should be chosen to be the [[ ]]

[[

]]

[[

]]

[[

]]

Figure 7: Rotation of [[ ]] from Finite Element Analysis

The complete results from the study are shown in Figure 8. The inputs required are the average shell element thickness (plate thickness in Figure 8), and average [[ ]] size (edge length in Figure 8) from the FE model.

The average size of the shell elements in SSES global FEM is [[ ]] By approximation, this is equivalent to a [[ ]]As mentioned before, the shell-to- solid interface transition was primary based on the base plate with [[ ]] plate thickness. From Figure 8, the thickness of the [[ ]].

The criterion to determine the [[ ]] based on Figure 8 was addressed in Grand Gulf Nuclear Station (GGNS) replacement dryer Finite Element model. The criterion is also applicable to SSES replacement dryer global FE Model discussed in NRC RAI 3.9-283.

[[

]]

Additional Questions:

5. *Confirm that each curve in Figure 8 for [[ ]] that produced a classical cantilever beam deflection, assuming zero rotation, at the built-in end. For example, for the 0.5" plate thickness, do all combinations on the curve give 29.117" tip deflection?*

GEH Response:
In Figure 8, each curve corresponds to different plate thickness. Therefore, the target displacement is the same for all combinations on each curve.

Additional Questions:

6. *Based on the information provided in Figure 7 of the response, [[ ]] "the rigid body" deflection at the tip is approximately 0.83" (0.023264" X 36".) Therefore the classical cantilever beam component of the Finite Element results in 29.117"-0.83". To achieve the classical results at the end, the 0.83" needs to be added to the target deflection. This gives a target deflection around 29.95". From Figure 5 of the response, this would correspond to an [[ ]] thickness of around 0.4". However, decreasing the [[ ]] to 0.4" will likely lead to an increase of rotation at the built-in end. This would further increase the target deflection. Provide a revised set of study results that accounts for or eliminates the influence of the rigid body rotation on the tip deflection provided by the FE model.*

GEH Response:

[[ ]].The four corners of the solid blocks are fixed. By using this FE model together with boundary conditions, there is rigid body deflection at the tip which is unavoidable in this geometry.

To eliminate the influence of the rigid body rotation on the tip deflection, another study is performed on [[ ]]. Two models are run in this study:

- Model with all shell elements. A benchmark model with all shell elements is first analyzed. The target tip displacement (1.720E-01 in) and stress (1.005E+03 psi) at the center of the plate were obtained from this shell FE model.
- [[

]].

[[

]].

The solid-shell connection using the [[.]]. From this study model, it concludes that [[

]].

[[

]]

[[

]]

[[

]]

[[

]]

By examining the structural shell thicknesses shown in Figure 2, [[

]]

To evaluate the effect of the [[ ]] for these two dryer components, [[

]] shown in Figure 13.

The locations of these sensors are not in the support ring regions. From Figures 14 to 17, the structural responses at these sensor locations are [[

]]. In other words, the use of [[
]] at the gage locations for benchmarking the [[
]].

[[

]]

[[

]]

[[

]]

[[

]]

[[

]]

Additional Questions:

8. *From various statements made throughout the response, there appears to be considerable inconsistency in applying the conclusions of the parametric study. From Figure 2 of the response there is a considerable range of shell thicknesses attached to the supporting ring. On page 3 it states that a single thickness was selected for all [[{3}]], based on the base plate. On page 5, it states "In order not to artificially increase the overall structural stiffness from the [[ ]], a 'minimum' thickness should be selected. As a result of the study GEH believes, [[*

]] "Has GEH conducted an analysis of an ANSYS SD model that addresses the effect of using [[

]] should match the structural SE thickness?

GEH Response:

The SSES replacement dryer analysis assumed [[ ]]. The SSES replacement dryer was the [[ ]], so the GGNS dryer licensing analysis carried forward the [[ ]]. The sensitivity studies that concluded that the [[ ]] were performed after the completion of the GGNS licensing analysis. [[

]].

[[

]]. The stresses are high in the region where the [[ ]] The [[ ]] modeling uses transition elements for the connection to the solid elements of the support ring. Aside from the [[ ]], several other plate components are connected to the mid support ring using transition elements. [[ ]] provide appropriate transfer of forces and moments between the shell elements and solid elements. The only plate component that is thicker than [[ ]] to transfer forces and moments is [[ ]]. The maximum stress location along [[

]]. Because of the constraint provided by the [[ ]], the stress is not dominated by [[ ]] is minimized. In addition, the most limiting stress location for the [[ ]] Therefore, the [[ ]] is considered acceptable and does not impact the fatigue evaluation of this component. Given that [[ ]] GEH expects that conclusion from [[ ]].

Additional Questions:

9. *Page 8 of response states "By examining the structural shell thicknesses shown in Figure 2, [[*

]].

To evaluate the effect of the [[ ]] due to these two dryer components, [[

]]. From Figures 9 to 12, the structural responses at these sensor locations are [[

]] The location of the sensors are not identified. By inference from the last sentence, underlined, they are not close to the interface regions. It is precisely the local effect of the SD element that needs to be qualified and evaluated. If local stresses at the interface are reduced, then the fatigue evaluation is invalid.

GEH has failed to address the important consideration, namely, how does use of the [[ ]] approach affect the prediction of local stresses at the attachment locations? Is there a consistent pattern that stress increase or decrease? Has this been factored into the Bias and Uncertainty assessment?

GEH Response:

In response to RAI 3.9-269 for the ESBWR steam dryer methodology, GGNS analysis is now to be used as [[
]] For both GGNS and SSES, [[
]] [[
]]. In the case that the shell model is not capable of determining the peak stress along the solid-shell interface region, the peak stress will be re-evaluated using [[ ]] according to the current steam dryer analysis guidelines. In ESBWR RAI 3.9-283, it further explains that [[
]]. Also, the study of the [[

]]

Licensing Basis Changes

No changes are proposed for the DCD or referenced Engineering Reports.

Enclosure 3

MFN 12-051, Revision 2

Affidavit

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, **Jerald G. Head**, state as follows:

(1) I am the Senior Vice President, Regulatory Affairs of GE-Hitachi Nuclear Energy Americas LLC (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 12-051, Revision 2, Jerald G. Head (GEH) to U.S. Nuclear Regulatory Commission, entitled "NRC Requests for Additional Information (RAI) Related to the Audit of the Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design Methodology Supporting Chapter 3 of the ESBWR Design Control Document – GEH Final Response to RAI 3.9-280," dated February 15, 2013. The proprietary information in enclosure 1, entitled "GEH Final Response to RAI 3.9-280 - 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.

GEH does not consider this document to be transmitted to the NRC as a record. Rather, the document is provided solely for purposes of facilitating NRC/GEH discussions in a timely manner. GEH will submit final responses using its normal process and include a separate affidavit accordingly. Providing this affidavit to cover proprietary information that the NRC may have in its possession for purposes of performing a review of information during said discussions is consistent with NRC guidance (see NRC MC 0620).

(3) In making this application for withholding and determination 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 qualifies 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, 975 F2d 871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F2d 1280 (DC Cir. 1983).

(4) The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a and (4)b. Some examples of categories of information that 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 GEH and/or other companies.

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

c. Information that reveals aspects of past, present, or future GEH customer-funded development plans and programs, that may include potential products of GEH.

d. Information that discloses trade secret and/or potentially patentable subject matter for which it may be desirable to obtain patent protection.

(5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to the 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, not been disclosed publicly, and not been made available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary and/or confidentiality agreements that provide for maintaining the information in confidence. The initial designation of this information as proprietary information and the subsequent steps taken to prevent its unauthorized disclosure are as set forth in the following paragraphs (6) and (7).

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

(8) The information identified in paragraph (2) above is classified as proprietary because it communicates sensitive business information regarding commercial communications, plans, and strategies associated with future actions related to GEH's extensive body of ESBWR technology, design, and regulatory information.

(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 15th day of February 2013.

Jerald G. Head
GE-Hitachi Nuclear Energy Americas LLC