



# HITACHI

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### 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.

MFN 12-066, Rev. 1

Docket number: 05200010

June 7, 2012

Attn: David Misenhimer  
US Nuclear Regulatory Commission  
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 –Final Responses for RAIs 3.9-289, 3.9-290 and 3.9-291**

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 final responses for RAIs 3.9-289, 3.9-290 and 3.9-291.

Enclosure 1 contains the complete final responses, 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 responses with the proprietary information redacted, and is acceptable for public release. Enclosure 3 provides a brief history of previous draft responses with previous GEH letter numbers and dates provided. Enclosure 3 contains no proprietary information and is also acceptable for public release. Enclosure 4 provides an affidavit which sets forth the basis for requesting that Enclosure 1 be withheld from the public.

D068  
NRC

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: None

Reference:

1. 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

Enclosures:

1. Final Responses for RAIs 3.9-289, 3.9-290 and 3.9-291 - Proprietary Versions
2. Final Responses for RAIs 3.9-289, 3.9-290 and 3.9-291 - Non-Proprietary Versions
3. History of Draft Responses for RAIs 3.9-289, 3.9-290 and 3.9-291
4. Affidavit for MFN 12-066, Rev. 1

cc: Glen Watford, GEH  
Peter Yandow, GEH  
Patricia Campbell, GEH  
Mark Colby, GEH  
Tim Enfinger, GEH  
Gerald Deaver, GEH  
David Keck, GEH  
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eDRF Section: 0000-0147-3919

## **Enclosure 2**

**MFN 12-066, Rev. 1**

**Final Responses for RAIs 3.9-289, 3.9-290 and 3.9-291**

### **Non-Proprietary Versions**

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.

## INTRODUCTION

### Regulatory Process Description for RAIs 3.9-289, 3.9-290 and 3.9-291:

This response addresses three ITAAC/COL Information Items related Requests for Additional Information (RAIs) regarding the ESBWR steam dryer. The regulatory process associated with the ITAAC-related activities and COL Information Item is described in this introductory section, as it would apply to these three RAIs. Following the introduction, RAIs 3.9-289, 3.9-290 and 3.9-291 are addressed. For the purposes of this section, the RAIs are restated here:

*NRC RAI 3.9-289: ESBWR DCD [Design Control Document] Tier 1, Table 2.1.1-3, "ITAAC for Reactor Pressure Vessel and Internals," specifies in ITAAC 8.b that the steam dryer will meet the requirements of ASME Boiler & Pressure Vessel Code, Subsection NG-3000 (except for weld quality and fatigue factors for secondary structural non-load bearing welds). GEH is requested to describe the process for the combined license (COL) licensee to satisfy this ITAAC.*

Extracted from ESBWR DCD Tier 1, Table 2.1.1-3 (ref. 1)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
8b. The RPV internal structures listed in Table 2.1.1-1 (chimney and partitions, chimney head and steam separators assembly, and steam dryer assembly) meet the requirements of ASME B&PV Code, Subsection NG-3000, except for the weld quality and fatigue factors for secondary structural non-load bearing welds.	Inspections will be conducted of the as-built internal structures as documented in the ASME Code design reports.	The RPV internal structures listed in Table 2.1.1-1 (chimney and partitions, chimney head and steam separators assembly, and steam dryer assembly) meet the requirements of ASME B&PV Code, Subsection NG-3000, except for the weld quality and fatigue factors for secondary structural non-load bearing welds.

*NRC RAI 3.9-290: ESBWR DCD Tier 1, Table 2.1.2-3, "ITAAC for the Nuclear Boiler System," specifies in ITAAC 36 that the MSL and safety relief valve (SRV) and relief valve (RV) branch piping geometry precludes first and second shear layer wave acoustic resonance conditions from occurring and avoids pressure loads on the steam dryer at plant normal operating conditions. GEH is requested to describe the process for the COL licensee to satisfy this ITAAC. GEH is also requested to address the process for the COL licensee to identify and resolve low frequency loads, such as those occurring at SSES during EPU operation.*

Extracted from ESBWR DCD Tier 1, Table 2.1.1-3 (ref. 1)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
36. The main steam line and SRV/SV branch piping geometry precludes first and second shear layer wave acoustic resonance conditions from occurring and avoids pressure loads on the steam dryer at plant normal operating conditions.	Analysis of the as-built piping system and equipment analysis, for acoustic resonance at plant normal operating conditions, will be performed.	The main steam line and SRV/SV branch piping geometry precludes first and second shear layer wave acoustic resonance conditions from occurring and results in no significant pressure loads on the steam dryer at plant normal operating conditions.

*NRC RAI 3.9-291: ESBWR DCD Tier 2, Appendix 3L, "Reactor Internals Flow Induced Vibration Program," states in Section 3L.4.5, "Structural Evaluation," that a finite element analysis (FEA) is performed to confirm that the ESBWR steam dryer is structurally acceptable for operation. GEH is requested to specify the provision that will require the COL applicant to demonstrate that the FEA and post processing of peak stress has been performed to confirm that the ESBWR steam dryer is structurally acceptable as part of a COL Information Item.*

#### **Response to ITAAC Related Activity and COL Information Item**

In addition to information discussed in the ESBWR DCD Tier 1 (ref. 1) and Section 14.3 of Tier 2 (ref. 2), the ITAAC closure process has been the subject of numerous interactions between industry representatives and the NRC over the last several years with the purpose of establishing guidance and expectations as to how the process ITAAC closure will be implemented. RG 1.215 (ref. 3) endorses NEI 08-01 (ref. 4). It is expected that COL Licensees will use this guidance as a major element of an ITAAC Closure Plan. Also, as described in NRC Inspection Manual Chapter 2506 (ref. 5), NRC inspectors will closely monitor the status of ITAAC activities and will document oversight actions in NRC inspection reports.

#### **ITAAC Closure Plan**

The ESBWR Design-Centered Working Group has not yet developed an ITAAC Management Plan as discussed in NEI 08-01, also known as an ITAAC Closure Plan. Therefore, the information discussed herein is based on expectations of how the ITAAC closure process would be conducted.

The ESBWR Design-Centered Working Group will develop an ITAAC Closure Plan. As defined in NEI 08-01, this Closure Plan will address how to execute and document each ITAAC, including the methods to be used to perform required inspections, tests, and analyses, and the documentation necessary to demonstrate that specified acceptance criteria are met. Through this process, each ITAAC will be reviewed, activities necessary to complete the ITAAC will be identified, and the types of documentation that will need to be created will be listed.

### Description of Specific Actions

While ITAAC 8b specifies an inspection of the as-built steam dryer, and ITAAC 36 specifies analysis of as-built main steam piping, a number of activities will occur leading up to an inspection. The COL Licensee and NRC inspectors will coordinate throughout the period when ITAAC-related activities are underway so that NRC inspectors may select which activities to observe or what set of documentation to review as part of the NRC Construction Inspection Program activities for a particular ESBWR new reactor project. Although the NRC has not yet developed the "targeted ITAAC" listing for the ESBWR, GEH expects that activities for the subject ITAAC will be inspected, at a minimum for the prototype ESBWR steam dryer project. See IMC-2506 (ref. 6).

Tier 1, Table 2.1.1-3, ITAAC 8b: For ITAAC 8b, GEH will prepare an ASME Code design report that will include sufficient detail to show that the applicable stress limitations are satisfied in ASME BPV Code Section III Article NG-3000 (ref. 7) as applicable to the steam dryer when the component is subject to the loading conditions specified in the Design Specification. The NRC has indicated its intent to provide guidance for ITAAC closure verification of "complex" ITAAC, which include ASME BPV Code-related ITAAC. NRC presentation October 6, 2011, "Report ITAAC," identifies Interim Staff Guidance ISG-024 for providing such guidance. GEH expects that the ESBWR Design-Centered Working Group will use the future guidance in ISG-024 in developing the ESBWR ITAAC Management Plan.

According to ITAAC 8b, the COL Licensee will conduct an inspection of the fabricated, as-built steam dryer prior to its installation into the reactor pressure vessel (RPV). The inspection will include a comparison of the as-built steam dryer to the ASME Code design report, as well as supporting documentation for the design report, which will include documents such as the structural evaluation, construction drawings, deviations, repairs, procurement documentation with receipt inspection records, fabrication records. Prior to installation into the RPV, the COL Licensee will ensure that the NRC has conducted inspection of the steam dryer's numerous documents. NRC inspection activities associated with ITAAC will be described in NRC Inspection Reports. NEI 08-01 includes guidance regarding treatment in the ITAAC closure process of ITAAC-related findings that may be identified.

Once the steam dryer is installed in the RPV, final installation documentation would be added to the scope of documents in the ITAAC closure package of supporting information that demonstrate acceptance criteria are met. The NRC would have an opportunity to review the documents throughout the process and following installation. If any ITAAC findings are identified, those would be dispositioned prior to the COL Licensee issuing an ITAAC closure notification letter. Once ITAAC-related activities are completed, the COL Licensee would process a closure notification letter to the NRC in accordance with NRC-endorsed guidance and the ITAAC Closure Plan.

Tier 1, Table 2.1.2-3, ITAAC 36: For ITAAC 36, a similar process will be used. The COL Licensee will include documented evidence of an analysis in the ITAAC closure package. This ITAAC depends upon completion of piping design (addressed in Tier 1, Section 3.1), to ensure that the as-built piping and the piping branch-connected safety-relief and safety valves (SRV/SV) are designed to preclude first and second shear layer wave acoustic resonance conditions from occurring. Satisfying this design criterion avoids significant acoustic pressure loads on the steam dryer. The acceptance criteria for the piping and valves as-built dimensions will be contained in an acoustic resonance calculation that provides documented evidence that first and second shear layer wave resonances will not occur with final design dimensions. NRC inspectors will conduct inspections of the supporting information and documents as deemed necessary throughout the process (ref. 4). Once the main steam piping is installed, final documentation would be added to the list of documents in the ITAAC closure package of supporting information that demonstrate acceptance criteria are met. The COL Licensee would process a closure notification letter to the NRC in accordance with NRC-endorsed guidance and the ITAAC Management Plan.

COL Information Item for Assuring Structural Integrity of Steam Dryer: The ESBWR DCD description of the reactor internals COL Information Item is in 26A6642AK Subsection 3.9.2.4 (ref. 8).

The Combined License (COL) Applicant will classify its reactor per the guidance in RG 1.20 and provide a milestone for submitting a description of the inspection and measurement programs to be performed (including measurement locations and analysis predictions) and the results of the vibration analysis, measurement and test program (COL 3.9.9-1-A).

Subsection 3.9.9-1-A "Reactor Internals Vibration Analysis, Measurement and Inspection Program" repeats this information in the paragraph above. Per subsection 3.9.2.4 the details of the initial startup vibration test program are described in 26A6642AN Subsection 3L.4.6 for the steam dryer and Section 3L.5 for other reactor internals (ref. 9).

The ESBWR Design-Centered Working Group addresses COL 3.9.9-1-A as a commitment for completing after issuance of the COL and in accordance with NRC guidance in RG 1.20 (ref. 10). In addition, this commitment is consistent with NRC guidance in RG 1.206, Section C.III.4.3, Item 4 (ref. 11), for completing a COL Information Item, because it is described in the FSAR and a schedule for informing the NRC of and for completing the actions is included in the FSAR. As the NRC discusses in its guidance, closure of the COL Information Item would be subject to the NRC's construction inspection program:

RG 1.206, C.II.4.3 (4): The COL applicant describes in its application (e.g., within the appropriate section of the FSAR) the proposed approach to addressing a COL information item in sufficient detail to support the

NRC licensing finding and includes the requirements for updating the affected document (e.g., the FSAR update process) or otherwise informing the NRC staff of the final disposition of the COL information item. The descriptions provided should include implementation schedules to allow the coordination of activities with the NRC construction inspection program.

COL applicants should carefully review COL information items that cannot be resolved completely until after the issuance of a COL. The COL applicant should consider approaches such as those listed above to ensure all COL information items can be resolved sufficiently to support issuance of the COL. The applicant's ultimate closure of the COL information item, either through ITAAC or another approach, would be subject to the NRC's construction inspection program.

Similar to the ITAAC closure process, those activities associated with COL Information Item 3.9.9-1-A that are conducted prior to fuel loading (vibration assessment program development and submission to the NRC) would be subject to NRC construction inspection activities. Activities that occur during plant startup (implementation of the vibration assessment program, including instrumentation of the steam dryer and/or main steam lines and processing of data, summarizing test results, and submitting preliminary and final reports to the NRC) would be subject to the NRC oversight process for the operational period of the plant.

#### References

- 1.) 26A6642AB rev. 9 "ESBWR Design Control Document" Tier 1.
- 2.) 26A6642BN rev. 9 "ESBWR Design Control Document" Tier 2, Chapter 14 Initial Test Program.
- 3.) NRC Regulatory Guide (RG) 1.215, "Guidance for ITAAC Closure Under 10 CFR Part 52" (October 2009).
- 4.) NEI 08-01, "Industry Guideline for the ITAAC Closure Process under 10 CFR Part 52," Revision 3, January 2009 (ADAMS Accession No. ML090270415).
- 5.) NRC Inspection Manual Chapter 2506, "Construction Reactor Oversight Process, General Guidance and Basis Document".
- 6.) IMC-2506, "Construction Reactor Oversight Process General Guidance and Basis Document," for information regarding "targeted ITAAC."
- 7.) ASME BPV Code Section III, Subsection NCA, Division 1, Subsection NG, and Appendices - 2001 Edition with addenda to and including 2003.
- 8.) 26A6642AK rev. 9 "ESBWR DCD Tier 2, Chapter 3 Design of Structures, Components, Equipment and Systems", Sections 3.9 – 3.11.
- 9.) 26A6642AN rev. 9 "ESBWR DCD Tier 2, Chapter 3 Design of Structures, Components, Equipment and Systems", Appendices 3G – 3L.

- 10.) Regulatory Guide 1.20, Rev. 3 "Comprehensive Vibration Assessment Program for Reactor Internals during Preoperational and Initial Startup Testing," March 2007.
- 11.) Regulatory Guide 1.206, Rev. 0 "Combined License Applications for Nuclear Power Plants (LWR Edition), June 2007.

**NRC RAI 3.9-289**

*Summary: The staff's question is in regard to describing the process for the combined license (COL) licensee to satisfy ESBWR DCD Tier 1, Table 2.1.1-3, "ITAAC for the Reactor Pressure Vessel and Internals," in ITAAC 8.b.*

*ESBWR DCD Tier 1, Table 2.1.1-3, "ITAAC for the Reactor Pressure Vessel and Internals," specifies in ITAAC 8.b that the steam dryer will meet the requirements of ASME Boiler & Pressure Vessel Code, Subsection NG-3000 (except for weld quality and fatigue factors for secondary structural non-load bearing welds). GEH is requested to describe the process for the combined license (COL) licensee to satisfy this ITAAC.*

**GEH Response**

**References:**

- A. 26A6642AK rev. 9 "ESBWR DCD Tier 2, Chapter 3 Design of Structures, Components, Equipment and Systems", Sections 3.9 – 3.11.
- B. NEDE-33313P-A, Rev. 2, "ESBWR Steam Dryer Structural Evaluation", October 2010.
- C. NRC NUREG-0800, Standard Review Plan, Section 3.9.5, "Reactor Pressure Vessel Internals," Rev. 3 (March 2007).
- D. NEDE-33312P-A, Rev. 2, "ESBWR Steam Dryer Acoustic Load Definition", October 2010.
- E. NEDC-33408P-A, Rev. 1, "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology".
- F. AWS D1.1 D1.1/D1.1M:04 "Structural Welding Code – Steel".
- G. 26A6642AK rev. 5 "ESBWR DCD Tier 2, Chapter 3 Design of Structures, Components, Equipment and Systems", Sections 3.9 – 3.11.

**Summary:**

ITAAC 8b will be closed through the process described in the introduction section of this letter. The main ITAAC closure document will be the ASME Code design report. That report and supporting documents will be available for NRC inspection. The COL Licensee will verify that the as-built steam dryer conforms to the ASME Code design report and supporting documents.

Process Description:

ITAAC Item 8b in DCD Tier 1 Table 2.1.1-3 requires that an inspection be conducted of the as-built internal structures as documented in an ASME BPV Code Section III design report, references 1 and 7 from the introduction section of this response. For the steam dryer, the design commitment associated with this ITAAC is that the steam dryer assembly meets the requirements of the ASME B&PV Code Section III, Article NG-3000, except for the weld quality and fatigue factors for secondary structural non-load bearing welds. The origin of this requirement is DCD Tier 2 Subsection 3.9.5.4 (Ref. A). This design commitment stated in the ITAAC is consistent with NRC guidance in NUREG-0800 Section 3.9.5, "SRP Acceptance Criteria," ¶ 3 (Ref. C).

As described in DCD Tier 2 Subsection 3.9.5.4 (Ref. A), the reactor internal structures classified as nonsafety-related in Section 3.9.5 (which includes the steam dryer) are not ASME B&PV Code components, but their design complies with the requirements of ASME B&PV Code Section III, Article NG-3000, except for the weld quality and fatigue factors for secondary structural non-load bearing welds. Primary structural load bearing welds use quality and fatigue factors as given in Article NG-3000. The steam dryer structural evaluation process used for the design report is defined and discussed in Licensing Topical Report NEDE-33313P-A (Ref. B), which also provides the basis for weld quality and fatigue factor methodology. Applying NG-3000 is consistent with NRC guidance in Ref. C, as noted above.

This requirement was implemented in DCD Tier 2 in response to NRC RAI 3.9-252:

*(Ref. ESBWR DCD Section 3.9.5.4, Rev. 5) The final paragraph of DCD Section 3.9.5.4 requires additional explanation. The design requirements presented for equipment classified as non-safety related class internals are not consistent with requirements presented in other design basis related documents, e.g., Topical Report NEDE-33313P for the steam dryer. Additional discussion should be included in DCD Section 3.9.5.4 to clarify the following:*

*(a) Which non-safety related internals components use selected ASME Code requirements as their design basis.*

*(b) What are the specific ASME Code requirements adopted as the design basis for those components identified in (a) above.*

*(c) For those non-safety related internals components which do not use ASME Code requirements for their design, identify the "accepted industry or engineering practices" which are used for their design.*

GEH response for RAI 3.9-252:

The nonsafety-related reactor internal components are identified in DCD Tier 2, Section 3.9.5. These components are the chimney and partitions, chimney head and steam separator assembly, steam dryer assembly, feedwater spargers, RPV vent assembly, and surveillance sample holders. None of these components are

ASME Code components, but the designs will comply with the requirements of ASME Code Subsection NG-3000 except for the weld quality and fatigue factors for secondary structural non-load bearing welds. Primary structural load bearing welds use quality and fatigue factors as given NG-3000. The steam dryer assembly uses weld quality and fatigue factors as discussed in Subsections 4.1 and 7.1 of NEDE-33313P.

The response addressed weld requirements for non-safety related reactor internals and is reflected in the ITAAC 8b design commitment scope. The steam dryer LTR discusses the weld quality factors and weld fatigue factors for secondary structural non-load bearing welds. As shown, both the DCD and the LTR apply to the steam dryer.

To clarify, the [[  
]]. ASME BPV Code Section III paragraph NG-1122 "Internal Structures" states "...the construction of all internal structures is such as to not affect adversely the integrity of the core support structure". [[

]]. The appropriate weld factors are used, depending upon whether a particular member is primary or secondary. The design report would document which weld factors were used for each weld joint.

The design report is to contain calculations and sketches substantiating that the design is in accordance with the Design Specification and Article NG-3000 requirements as outlined in NEDE-33313P-A. This design report will include results of stress analyses and will document detailed design analyses completion.

LTR NEDE-33313P-A, ESBWR Steam Dryer Structural Evaluation," provides a description of the overall process for performing the structural evaluation of the ESBWR steam dryer in preparation for the design report:

- The finite element model (LTR Section 5) is used to predict stresses resulting from specified ASME load combinations (LTR Section 8 and as described in the design specification). The acoustic load definition in the design specification for the ESBWR steam dryer is described in LTR NEDE-33312P-A (ref. D) and is supported by LTR NEDC-33408P-A (ref. E) describing the analytical tool and

process for predicting fluctuating pressure loads on the steam dryer for use in the structural analysis.

- Describes material properties used in the analysis per ASME BPV Code (LTR Section 3),
- States design criteria with additional limits on the material fatigue strength and information on use of Fatigue Strength Reduction Factors (LTR Section 4)
- Describes vibration analysis and predicted component stresses (Section 6),
- Provides fatigue prediction (Section 7)

When ASME load combination analyses are performed, detail design iterations may need to be made to provide margins for demonstrating that the ESBWR steam dryer is structurally acceptable for its end use.

As specified in the ITAAC, the ASME Code design report showing acceptance to Article NG-3000 using weld quality and weld fatigue factors for secondary structural non-load bearing welds as provided in LTR NEDE-33313P-A will be used by the COL licensee in the ITAAC closure process defined in DCD Tier 2 Section 14.3 and information in Tier 1, Section 1, to demonstrate that the acceptance criteria of the ITAAC have been met. The COL Licensee will verify that the as-built steam dryer assembly conforms to the ASME Code design report.

**DCD Impact**

None.

**Licensing Topical Report Impact**

None.

**NRC RAI 3.9-290**

*Summary: The staff's question is in regard to describing the process for the COL licensee to satisfy ESBWR DCD Tier 1, Table 2.1.2-3, "ITAAC for the Nuclear Boiler System," in ITAAC 36 and the process for the COL licensee to identify and resolve low frequency loads.*

*ESBWR DCD Tier 1, Table 2.1.2-3, "ITAAC for the Nuclear Boiler System," specifies in ITAAC 36 that the MSL and safety relief valve (SRV) and relief valve (RV) branch piping geometry precludes first and second shear layer wave acoustic resonance conditions from occurring and avoids pressure loads on the steam dryer at plant normal operating conditions. GEH is requested to describe the process for the COL licensee to satisfy this ITAAC. GEH is also requested to address the process for the COL licensee to identify and resolve low frequency loads, such as those occurring at SSES during EPU operation.*

**GEH Response**

**Summary:**

ITAAC 36 will be completed in conjunction with completing ITAAC Table 2.1.2-3, Item 2b, with an analysis to verify that the as-built piping and connected SRV/SV dimensions preclude these resonance frequencies. For the low frequency loads, the ESBWR design does not include dead legs in the main steam piping system.

**Details:**

The ESBWR DCD, Section 3L.4.1, and NEDE-33312P-A, Section 4.1, address the main steam system design to preclude acoustic resonance. The referenced ITAAC Table 2.1.2-3, Item 36, was developed to address piping design features that will be factored into the ESBWR piping design to preclude acoustic resonance frequencies and avoid pressure loads on the steam dryer. These design features are based on lessons learned from industry experience. ITAAC Item 36 was initially added in response to NRC RAI 3.9-134 Supplement 02 (MFN 09-363, June 8, 2009). It was later discussed in the 2009 NRC reactor internals audit and modified in response to NRC reactor internals audit comment 4 (see MFN 09-621, October 8, 2009) to specifically address the first and second shear layer wave. See the GEH responses:

**NRC RAI 3.9-134 S02**

*The GEH response includes a discussion of their general design approach, stating that the main steam lines and branch connection piping for the safety relief valves will be designed to avoid the possibility of any acoustic resonance. However, GEH has not yet submitted the actual design parameters. GEH is requested to submit the actual design parameters of the main steam piping and SRV branch piping, or provide*

*additional detail (design requirements, criteria, methods) to provide assurance that the possibility of acoustic resonance will be avoided and provide associated ITAAC in order to verify this design commitment.*

GEH Response

The design of the main steam (MS), safety relief valve (SRV) and safety valve (SV) piping is not final at this time; therefore, an ITAAC will be added to DCD Tier 1 to verify that this piping is designed such that the structural integrity of the piping is not adversely affected by acoustic vibration. In addition, DCD Tier 2, Sections 5.4.9.2, 5.4.13.2 and Appendix 3L.4.1 will be revised to describe this design commitment.

GEH has performed preliminary acoustic resonance calculations for the MS, SRV and SV piping based on preliminary design information. These calculations show that the calculated Strouhal numbers are outside the range for which adverse impacts due to acoustic resonances would occur. The calculations were performed at 100% and 102% power.

NRC Comment 4

*The staff is concerned about the structural integrity of [[*

*]].*

GEH Response

To clarify that the ITAAC number 36 of Table 2.1.2-3 in Tier 1 applies to both the main steam piping components and the steam dryer, this ITAAC has been revised as shown in the attachment. The revised ITAAC also specifies that it is the first and second shear layer wave acoustic resonance of the main steam line and the SRV/SV standpipe that is specifically avoided. A corresponding change to Tier 2 section 3L.4.1 is also made as shown in the attachment to support the Tier 1 change. [[

*]].*

In both of the above responses, changes were made to the ESBWR DCD and LTRs as described in the attached marked-up pages in the two letters. In the March 2012 NRC audit, the preliminary acoustic resonance calculations mentioned in the responses quoted above were reviewed. These preliminary calculations, using preliminary piping design assumptions, indicate that [[

]].

The preliminary calculations also compare the [[

]] The ESBWR main steam system has two longer and two shorter main steam lines with 5 and 4 SRV/SVs mounted perpendicular to the main steam pipe centerline. [[

]] Also, consistent with the response to NRC  
Audit Comment 4 (above), [[

]]

The subject piping is ASME Code Class 1 piping in the main steam lines between the reactor pressure vessel and the second isolation valve outside containment. Thus, the piping is subject to preoperational and initial startup vibration testing in accordance with ASME OM S/G-2003.

The ITAAC specifies that an analysis of the as-built piping system and equipment analysis, for acoustic resonance at plant normal operating condition, will be performed. Accordingly, the COL Licensee will perform an analysis comparing the main steam line and SRV/SV branch piping final design geometry to the as-built installed piping and equipment to ensure that the design features are appropriately incorporated into the as-built piping.

Specific to the acceptance criteria, preclusion of first and second shear layer wave acoustic resonance in the main steam piping final design will be addressed during the detailed design phase through acoustic analysis calculations. The piping acoustic analysis is used in conjunction with the piping design ITAAC for optimizing results (see ITAAC 2b).

A design report will be prepared in accordance with ESBWR DCD Tier 1 Section 1.1.2.2 "Implementation of ITAAC" to satisfy the Acceptance Criterion for the standard plant design. The COL licensee will reference the design report in a COL submittal to satisfy Acceptance Criteria for ITAAC 36 of ESBWR DCD Tier 1 Table 2.1.2-3. This is in accordance with the process defined in Tier 2, Section 14.3.3.1, "Design of Piping Systems and Components," of the ESBWR DCD. Thus, the standard ITAAC closure process is applicable to ITAAC 36 and does not require special treatment by the COL applicant. Verification that resonance frequency does not impact the steam dryer will be

documented in the ASME Code design report and through startup testing discussed in response to RAI 3.9-289 above.

The high-amplitude low-frequency loads that have been unique to Susquehanna Steam Electric Station (SSES) are attributable to dead leg branches installed on the A and D main steam piping runs. The dead leg branches are acting as resonating chambers that amplify the steam piping acoustics at the frequency where a quarter-wavelength achieves resonance in the dead leg. Other than this frequency peak on the A and D steam piping runs, the acoustic amplitude profiles of all four SSES main steam piping runs are comparable.

The occurrence of high-amplitude low-frequency acoustic loads due to the amplification provided by branch piping dead legs, such as experienced at SSES, is precluded in the ESBWR main steam piping design because the ESBWR design does not have these dead legs. Therefore, an ESBWR will not experience the particular acoustic loads that are observed at SSES.

As described in Tier 2, Section 3L.4.6, "Instrumentation and Startup Testing," of the ESBWR DCD, the main steam lines for the prototype plant will be instrumented to measure the acoustic pressures in the steam lines during startup through normal plant operating conditions. These measurements will confirm that the ESBWR main steam line design precludes SRV and SV branch line acoustic resonances, as well as the high amplitude low frequency acoustic loads observed at SSES.

**DCD Impact**

None.

**Licensing Topical Report Impact**

None.

**NRC RAI 3.9-291**

*Summary: The staff's question is in regard to specifying the provision that will require the COL applicant to demonstrate that the FEA and post processing of peak stress has been performed to confirm that the ESBWR is structurally acceptable as part of a COL Information Item.*

*ESBWR DCD Tier 2, Appendix 3L, "Reactor Internals Flow Induced Vibration Program," states in Section 3L.4.5, "Structural Evaluation," that a finite element analysis (FEA) is performed to confirm that the ESBWR steam dryer is structurally acceptable for operation. GEH is requested to specify the provision that will require the COL applicant to demonstrate that the FEA and post processing of peak stress has been performed to confirm that the ESBWR steam dryer is structurally acceptable as part of a COL Information Item.*

**GEH Response**

**References:**

- A. 26A6642AK rev. 9 "ESBWR DCD Tier 2, Chapter 3 Design of Structures, Components, Equipment and Systems", Sections 3.9 – 3.11.
- B. 26A6642AN rev. 9 "ESBWR DCD Tier 2, Chapter 3 Design of Structures, Components, Equipment and Systems", Appendices 3G – 3L.
- C. NEDE-33313P-A, Rev. 2, "ESBWR Steam Dryer Structural Evaluation", October 2010.
- D. Regulatory Guide 1.20, Rev. 3 "Comprehensive Vibration Assessment Program for Reactor Internals During Preoperational and Initial Startup Testing," March 2007.
- E. ASME BPV Code Section III, Subsection NG - 2001 Edition with addenda to and including 2003

**Summary:**

The COL Licensee will implement a vibration assessment program in accordance with 26A6642AK COL Information Item 3.9.9-1-A (ref. A). Per subsection 3.9.2.4 the details of the initial startup vibration test program are described in 26A6642AN Subsection 3L.4.6 (ref. B) for the steam dryer which references NEDE-33313P-A (ref. C) for determining if structural frequencies may coincide with existing forcing functions to cause resonance conditions which could cause high stresses in the steam dryer. NEDE-33313P-A describes the post processing of peak stresses (i.e. high stresses

caused from typical peak resonance or other loading conditions). The [[

]]. These stresses will then be compared to the criteria from 26A6642AK section 3.9.2.3 to confirm the ESBWR steam dryer is structurally acceptable.

Details:

COL Information Item COL 3.9.9-1-A implements guidance in NRC Regulatory Guide 1.20 (ref. D). DCD 26A6642AK Section 3.9.2.4 describes the initial FIV startup testing for reactor internals, referencing 26A6642AN 3L.4.6 for details related to the steam dryer.

According to RG 1.20, for the purpose of "verifying the structural integrity of reactor internals for flow-induced vibrations prior to commercial operation", the licensee will submit a summary of the vibration analysis program and description of the vibration measurement (including measurement locations and analysis predictions) and inspection phases of the comprehensive vibration inspection program to the NRC approximately six months prior to implementation. The preliminary and final reports, which together summarize the results of the vibration analysis, measurement and inspection programs are to be submitted to the NRC within 60 and 180 days, respectively, following the completion of the programs.

26A6642AN Subsection 3L.4.6 is part of the steam dryer evaluation program, which references NEDE-33313P-A (ref. C) for determining if structural frequencies may coincide with existing forcing functions to cause resonance conditions. The resonance could cause high stresses in localized areas of the steam dryer. The FEA model and analysis of applied loads is described in Section 5 of NEDE-33313P-A. Section 7.1 "Fatigue Calculation" describes the post processing of peak stresses. The term "peak stress" is used throughout the steam dryer analysis referring to a high stress caused from peak resonance or other loading conditions. For the steam dryer FEA results, the "peak stress" is not the same as defined by ASME BPV Code Section III (ref. E), i.e. stress due to local discontinuities or local thermal stress including the effects of stress concentrations. The stress concentration factors for steam dryer analysis [[

]].

These stresses will then be compared to the criteria from Section 4.1 to confirm the ESBWR steam dryer is structurally acceptable. Section 4.1 "Fatigue Criteria" agrees with 26A6642AK section 3.9.2.3:

*Extensive predictive evaluations have been performed for the steam dryer loading and structural evaluation. These evaluations are described in Appendix 3L.4. In the dryer design and in the development of the initial strain and accelerations acceptance limits used during startup, the fatigue analysis performed for the ESBWR steam dryer uses a fatigue limit stress amplitude of 93.7 MPa (13,600 psi). For the outer hood component, which is subjected to higher pressure loading in the region of the main steamlines, the fatigue limit stress amplitude is 74.4 MPa (10,800 psi).*

The DCD, Section 3.9.2.3, provides a summary of the overall process for verifying structural integrity for reactor internals, including the steam dryer, and is designated as Tier 2\* material. Tier 2\* designation means the portion of the Tier 2 information, designated as such in the generic DCD, which is subject to the change process in paragraph VIII.B.6 of a design certification rule. This designation expires for some Tier 2\* information, in accordance with the provisions of VIII.B.6. For purposes of the discussion herein, the material in Section 3.9.2.3 would require NRC approval of departures or changes for the prototype ESBWR steam dryer. See ESBWR Design Certification, Proposed Rule, 76 Fed. Reg. 16549 (March 24, 2011).

**DCD Impact**

None.

**Licensing Topical Report Impact**

None.

**Enclosure 3**

**MFN 12-066, Rev. 1**

**History of Draft Responses for  
RAIs 3.9-289, 3.9-290 and 3.9-291**

History of GEH Draft Responses for RAIs 3.9-289, 3.9-290 and 3.9-291

RAI Number	GEH Letter Number and Date	
	First Draft Response	Second Draft Response
3.9-289	MFN 12-066, 5/25/12	N/A
3.9-290	MFN 12-061, 5/10/12	MFN 12-066, 5/25/12
3.9-291	MFN 12-066, 5/25/12	N/A

**Enclosure 4**

**MFN 12-066, Rev. 1**

**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 and have determined that it should be withheld from public disclosure for reason(s) identified in paragraph (4).
- (2) The information sought to be withheld is contained in enclosure 1 of GEH's letter, MFN 12-066, Rev. 1, Mr. Jerald G. Head 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 –Final Responses for RAIs 3.9-289, 3.9-290 and 3.9-291," dated June 7, 2012. The proprietary information in enclosure 1, entitled "Final Responses for RAIs 3.9-289, 3.9-290 and 3.9-291 - Proprietary Versions," is delineated by a [[dotted underline inside double square brackets<sup>{3}</sup>]]. 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.
- (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 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

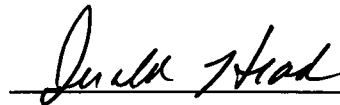
comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate 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 7<sup>th</sup> day of June 2012.



Jerald G. Head

GE-Hitachi Nuclear Energy Americas LLC