Enclosure 2

MFN 10-314

NEDO-33312-A, Revision 2, "ESBWR Steam Dryer Acoustic Load Definition"

Non-Proprietary Information

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This is a non-proprietary version of the document NEDE-33312P-A, Revision 2, from which the proprietary information has been removed. Portions of the document that have been removed are identified by white space within double square brackets, as shown here [[ ]].

GE Hitachi Nuclear Energy

NEDO-33312-A
Revision 2
Class I
DRF 0000-0073-3923
October 2010

Licensing Topical Report

ESBWR STEAM DRYER ACOUSTIC LOAD DEFINITION

NON-PROPRIETARY INFORMATION NOTICE

This is a public version of NEDE-33312P-A, Revision 2, from which the proprietary information has been removed. Portions of the document that have been removed are indicated by white space within double square brackets, as shown here [[ ]].

IMPORTANT NOTICE REGARDING THE CONTENTS OF THIS REPORT

Please Read Carefully

The information contained in this document is furnished for the purpose of supporting the NRC review of the certification of the ESBWR, with the information here being used as ESBWR supporting reference. The only undertakings of GE Hitachi Nuclear Energy (GEH) with respect to information in this document are contained in contracts between GEH and participating utilities, and nothing contained in this document shall be construed as changing those contracts. The use of this information by anyone other 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.

SUMMARY OF CHANGES

NEDO-33312-A Revision 2

Location	Comment
All	"-A" is added to the document number for this revision denoting NRC acceptance of this revision for ESBWR design certification.
Page vii	Updated the revision number of NEDO-33312 referenced in the ABSTRACT.
S1.0	Deleted a redundant "the" from last bullet.
S1.0	Revised in response to NRC audit comment #1; see MFN 09-621 dated October 8, 2009.
S2.2	Revised in response to NRC audit comment #12; see MFN 09-621 dated October 8, 2009.
S4.1	Revised in response to NRC audit comments #4, #13 and #14; see MFN 09-621 dated October 8, 2009.
S6.0	Updated References 2, 3 and 4 for accuracy.
Attachment 1	Added the NRC letter describing the acceptance of this revision of this Licensing Topical Report. The NRC letter as well as Enclosure 1 of the letter, which contains the Final Safety Evaluation for this Licensing Topical Report, has been added to the end of this document.

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ABSTRACT

This document describes the GE Hitachi Nuclear Energy (GEH) approach used to develop the ESBWR flow induced vibration load (FIV) definition for the ESBWR steam dryer. There has been much development in FIV load modeling in the last several years, including techniques developed using measurements taken from several operating plants. Events in the industry including technical developments and regulatory interactions have dictated that GEH further develop the ESBWR Steam Dryer Load Definition approach. The current GEH approach to load definition is defined as the Plant Based Load Evaluation (PBLE) method.

Revision 2 of this report describes the ESBWR Steam Dryer Load Definitions with the PBLE method. The GEH approach to the ESBWR FIV load definition focuses on utilizing an ABWR-based steam dryer design, allowing the use of instrumented ABWR in-plant steam dryer test data to form the basis for the ESBWR load definition. This basic load definition will then be further improved through comparison with testing and operating experience gained from GEH Extended Power Uprates (EPUs) conducted on several operating plants.

The development of the FIV loads as described here are in accordance with Regulatory Guide 1.20 Revision 3. The FIV loads will be used in combination with other design loads in qualifying the steam dryer as described in Topical Report NEDE 33313P.

1.0 INTRODUCTION

This document describes the Flow Induced Vibration (FIV) loads for the ESWR steam dryer. The development of the FIV loads as described here are in accordance with Regulatory Guide 1.20 Revision 3. The FIV loads will be used in combination with other design loads in order to qualify the steam dryer as described in NEDE-33313P.

The FIV loads are unsteady differential pressure loads created by the unsteady flow adjacent to the steam dryer (hydrodynamic FIV loads) and from acoustic pressure waves present in the reactor dome and steam lines that create unsteady differential pressure forces on steam dryer components (acoustic loads). The loads addressed here are associated with normal operation of the plant.

There is no purely analytical methodology for accurately predicting the FIV loads resulting from hydrodynamic and acoustic load sources in a complex system such as the Reactor Pressure Vessel (RPV) reactor dome and steam lines. Therefore, the approach used on the ESBWR includes the following:

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2.0 ESBWR DRYER CONFIGURATION

2.1 Dryer and RPV Geometry

A key aspect in the development of the ESBWR FIV load definition is to incorporate the ABWR dryer geometry. By minimizing the geometrical differences between the ABWR and the ESBWR steam dryers, this approach will build on the successful operating experience of the ABWR steam dryer and will allow the ABWR steam dryer measurement data to be used in developing the FIV load definition for the ESBWR. The ESBWR and ABWR have the same RPV inside diameter (ID) and main steam line outlet nozzle configuration. Both plants have the venturi-flow restrictor as a component of the MSL nozzle. Figure 2.1-1 provides a comparison of the ABWR and ESBWR vessel in the steam dome region.

The six bank dryer used in the ESBWR will have similar vane height, skirt length, and water submergence as the ABWR steam dryer. The ESBWR steam flow rate will be approximately 15% higher than the ABWR. There is less neck down in the vessel head flange region of the ESBWR than in the ABWR. This will provide additional clearance allowing a larger dryer diameter and longer vane banks (more vanes) to be used in the ESBWR dryer steam.

[[

]] There is less vessel neck-down at the vessel flange; therefore, the plenum area between the dryer and vessel above the MSL nozzles is larger.

The vessel head for ABWR is hemispherical; the ESBWR uses a torispherical head, [[

]] The effect of these differences on the acoustic response will be evaluated as discussed in Sections 3.1 and 3.2 of this report.

The ABWR steam dryer, shown in Figure 2.1-2, was instrumented as part of the ABWR startup and power ascension test program. This instrumentation provides test data that can be used as a benchmark for the ESBWR FIV design loads. There have been no identified FIV problems with the in-service ABWR steam dryers. As shown in Figure 4.1-1, the ABWR steam dryer test data indicates that the amplitudes of acoustic loads in the ABWR dome are low.

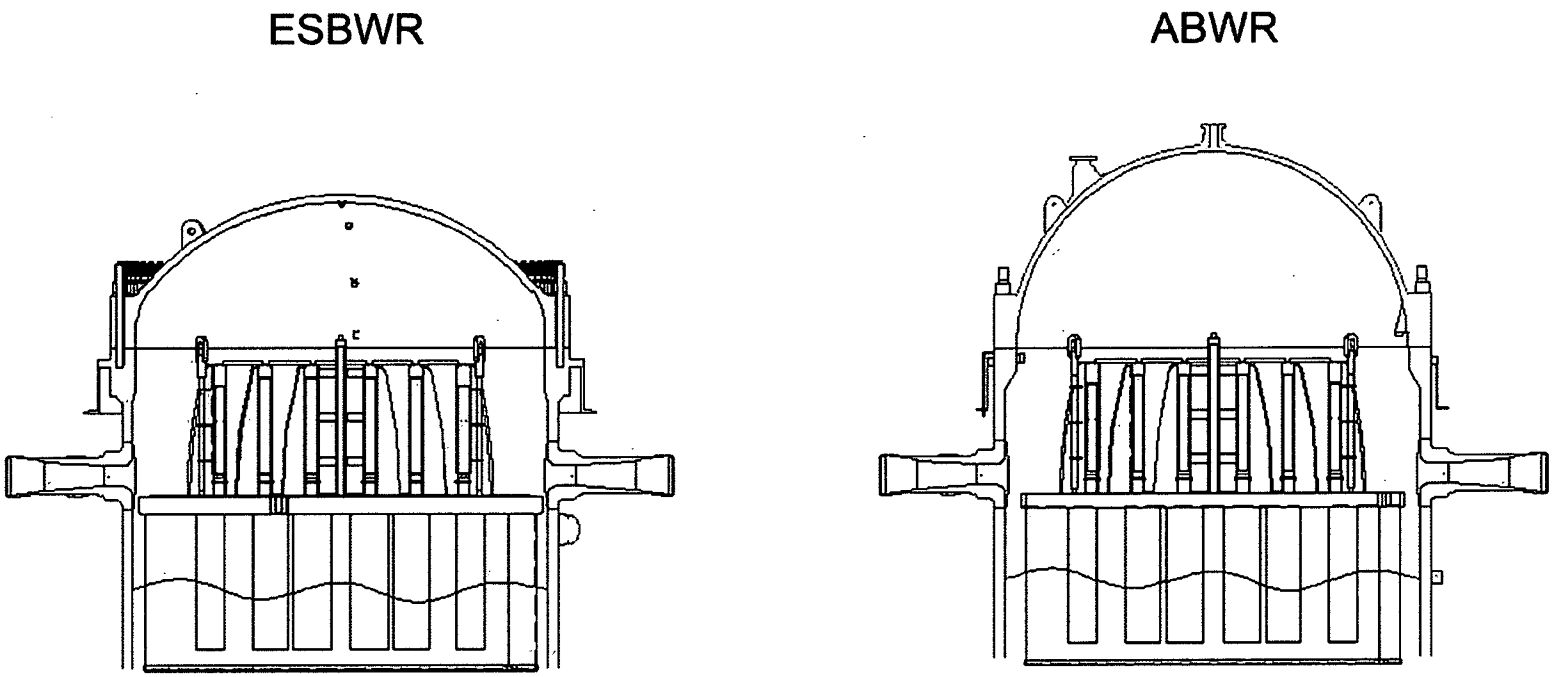

Figure 2.1-1. Comparison of Planned ESBWR and Typical ABWR Vessel Steam Regions

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Figure 2.1-2. Depiction of ABWR Steam Dryer with Test Instrumentation
P: Pressure Transmitter
S: Strain Gage
A: Accelerometer

2.2 Comparative CFD Analysis

A comparison of the ABWR and ESBWR geometry and flow changes to the flow patterns and hydrodynamic loads on the steam dryer is further evaluated with computational fluid dynamics (CFD). The steam dome, outlet nozzle and a portion of the downstream steam line of the ABWR and ESBWR is modeled with CFD. The CFD study [[

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3.0 ACOUSTIC FINITE ELEMENT MODELING OF THE RPV AND STEAM-LINES

3.1 RPV Steam Dome Acoustic Finite Element Model

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3.2 Coupled RPV Steam Dome and Main steam Lines Acoustic Finite Element Model

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4.0 FIV LOAD DEFINITION BASED ON DATA FROM PLANT INSTRUMENTATION

4.1 FIV Loads Developed from Data from Multiple Plants

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Figure 4.1-1 includes comparison of instrumented steam dryer data for [[

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Table 4.1-1 provides a comparison of geometry and flow parameters for the ESBWR, the ABWR at full power and the BWRs at extended power uprate conditions.

Figure 4.1-1 includes a comparison of PBLE load projections based on test data from both [[

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More information on the PBLE pressure loads and test data at test instrument locations of the BWR/3 and BWR/4 steam dryers is included in Reference (4). [[

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Figure 4.1-1 also includes the PSD curves for the measured differential pressure for the ABWR steam dryer at 100% power. [[

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A comparison of the RMS values of the selected plant data sets and the ABWR test data shown in Figure 4.1-1 is included in Table 4.1-2. The design loads RMS values are approximately 50% higher than the factored measured ABWR data.

The ESBWR steam dryer loads are generated by [[

]].

The structural assessment for each set includes a +/-10% frequency variation to provide a range of applied load frequencies. [[

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A frequency dependent bias and uncertainty evaluation is included in the structural evaluation for areas of the steam dryer with the highest alternating stress.

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]] This methodology identifies the acoustic load frequencies and associated steam dryer structural response modes that are most affected by FIV loads. [[

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Table 4.1-1 Comparison of Geometry and Flow Parameters

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Table 4.1-2 RMS Comparison of Loads and Test Data

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				]]

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Figure 4.1-1. PSD Comparison of Loads and Test Data

5.0 FIV LOAD MITIGATION

5.1 FIV Load Mitigation Through Design

As described in Section 3, [[

]]

5.2 (Deleted)

Figure 5.2-1. (Deleted)

Figure 5.2-2. (Deleted)

6.0 REFERENCES

[1] Regulatory Guide 1.20, "Comprehensive Vibration Assessment Program For Reactor Internals During Preoperational And Initial Startup Testing," March 2007.

[2] GE Hitachi Nuclear Energy, "Steam Dryer - Structural Evaluation," NEDE-33313P, Revision 1, Class III (Proprietary), July 2009, and NEDO-33313, Revision 1, Class I (Non-Proprietary), July 2009.

[3] GE Hitachi Nuclear Energy, "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology," NEDC-33408P, Revision 1, Class III (Proprietary), July 2009, and NEDO-33408, Revision 1, Class I (Non-proprietary), July 2009.

[4] GE Hitachi Nuclear Energy, "ESBWR Steam Dryer - Plant Based Load Evaluation Methodology Supplement 1," NEDC-33408P, Supplement 1, Revision 2, Class III (Proprietary), July 2010, and NEDO-33408, Supplement 1, Revision 2 Class I (Non-Proprietary), July 2010.

NEDO-33312-A Revision 2

Attachment 1

NRC SAFETY EVALUATION

ESBWR STEAM DRYER ACOUSTIC LOAD DEFINITION

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 23, 2010

Rec. 9/27/10

10-286

Mr. Jerald G. Head
Senior Vice President, Regulatory Affairs
GE Hitachi Nuclear Energy
3901 Castle Hayne Road MC A-18
Wilmington, NC 28401

SUBJECT: FINAL SAFETY EVALUATION FOR GE-HITACHI NUCLEAR ENERGY FOR LICENSING TOPICAL REPORTS NEDE-33312P, NEDC-33408P, AND NEDC-33408P SUPPLEMENT 1

Dear Mr. Head:

On August 24, 2005, GE-Hitachi (GEH) Nuclear Energy submitted the Economic Simplified Boiling Water Reactor (ESBWR) design certification application to the staff of the U.S. Nuclear Regulatory Commission. Subsequently, in support of the design certification, GEH submitted license topical reports (LTR) NEDE-33312P, NEDC-33408P, and NEDC-33408P Supplement 1. The staff has now completed its review of NEDE-33312P, NEDC-33408P, and NEDC-33408P Supplement 1.

The staff finds NEDE-33312P, NEDC-33408P, and NEDC-33408P Supplement 1, acceptable for referencing for the ESBWR design certification to the extent specified and under the limitations delineated in the LTR and in the associated safety evaluation (SE). The SE, which is enclosed, defines the basis for acceptance of the LTR.

The staff requests that GEH publish the revised proprietary and non-proprietary versions of the LTRs listed above within 1 month of receipt of this letter. The accepted versions of the topical reports shall incorporate this letter and the enclosed SE and add an "-A" (designated accepted) following the report identification number.

If NRC's criteria or regulations change, so that its conclusion that the LTR is acceptable is invalidated, GEH and/or the applicant referencing the LTR will be expected to revise and resubmit its respective documentation, or submit justification for continued applicability of the LTR without revision of the respective documentation.

Document transmitted herewith contains sensitive unclassified information. When separated from the enclosures, this document is "DECONTROLLED."

Pursuant to 10 CFR 2.390, we have determined that the enclosed SE contains proprietary information. We will delay placing the non-proprietary version of this document in the public document room for a period of 10 working days from the date of this letter to provide you with the opportunity to comment on the proprietary aspects only. If you believe that any additional information in Enclosure 1 is proprietary, please identify such information line by line and define the basis pursuant to the criteria of 10 CFR 2.390.

The Advisory Committee on Reactor Safeguards (ACRS) subcommittee, having reviewed the subject LTR and supporting documentation, agreed with the staff's recommendation for approval following the August 16, 2010 ACRS subcommittee meeting.

Sincerely,

for

David B. Matthews, Director
Division of New Reactor Licensing
Office of New Reactors

Docket No. 52-010

Enclosure:
1. Safety Evaluation (Non-Proprietary)
2. Safety Evaluation (Proprietary): Applicant only

cc: See next page

cc:

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Safety Evaluation Report
GEH Licensing Topical Reports
NEDE-33312P, NEDC-33408P, and NEDC-33408P Supplement 1

This safety evaluation report (SER) documents the U.S. Nuclear Regulatory Commission (NRC) evaluation of three licensing topical reports (LTRs) provided by GE-Hitachi Nuclear Energy (GEH or the applicant) to explain, substantiate, and benchmark its procedure for computing oscillating pressure loads acting on the steam dryers in economic simplified boiling-water reactor (ESBWR) nuclear power plants. The applicant applies a plant-based load evaluation (PBLE) method, which is based on its experiences with existing boiling-water reactor (BWR) plants, including the advanced boiling-water reactor (ABWR) on which the ESBWR design is based. The reports benchmark the PBLE method against measurements made in two existing BWR plants.

This SER provides the evaluation of the applicant's LTRs and the applicant's responses to several requests for additional information (RAIs) associated with the LTRs. The final LTRs submitted by the applicant reflect the resolution of all RAI resolutions. As discussed in more detail below, the staff finds the applicant's PBLE procedure to be well substantiated, suitably benchmarked, and conservative, since the applicant will include appropriate correction factors based on benchmark bias errors and uncertainties. The staff also finds the applicant's plans for updating the procedures and modeling parameters for the ESBWR plant based on future prototype plant measurements to be well substantiated and conservative.

1.0 Regulatory Criteria

The staff applied the following regulatory requirements to the three LTRs:

- Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50 (Ref. 1), "Domestic Licensing of Production and Utilization Facilities," and 10 CFR 50.55a, "Codes and Standards," as they relate to codes and standards

- General Design Criterion (GDC) 1, "Quality Standards and Records," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, as it relates to structures and components being designed, fabricated, erected, constructed, tested, and inspected to quality standards commensurate with the importance of the safety function to be performed

- GDC 2, "Design Bases for Protection against Natural Phenomena," of Appendix A to 10 CFR Part 50, as it relates to systems, components, and equipment important to safety being designed to withstand appropriate combinations of the effects of normal and accident conditions with the effects of natural phenomena, such as the safe-shutdown earthquake

- GDC 4, "Environmental and Dynamic Effects Design Bases," of Appendix A to 10 CFR Part 50, as it relates to systems and components important to safety being appropriately protected against the dynamic effects of discharging fluids

Enclosure 1

- Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," to 10 CFR Part 50, as it relates to design quality control

The staff applied the following guidelines as acceptance criteria for the three LTRs:

- Regulatory Guide (RG) 1.20, Revision 3, "Comprehensive Vibration Assessment Program for Reactor Internals during Preoperational and Initial Startup Testing," issued March 2007 (Ref. 2)

2.0 Summary of Technical Information

The applicant provided two LTRs and an LTR supplement that describe its PBLE method for defining dynamic loads on the ESBWR steam dryer design. The first LTR, NEDE-33312P, Revision 1, "ESBWR Steam Dryer Acoustic Load Definition," issued July 2009 (Ref. 3), describes the ESBWR steam dryer load definitions based on the PBLE method. The second LTR, NEDC-33408P, Revision 1, "ESBWR Steam Dryer—Plant Based Load Evaluation Methodology," issued July 2009 (Ref. 4), describes the method the applicant uses to define unsteady hydrodynamic loads acting on the ESBWR steam dryer.

[[

]]. The supplement to the second LTR, NEDC-33408P, Supplement 1, Revision 1, "ESBWR Steam Dryer—Plant Based Load Evaluation Methodology Supplement 1 (Ref. 5)," provides additional benchmarking of the PBLE method, as well as a modified PBLE approach [[

]].

NEDE-33312P, Revision 1, provides an overview of the approach and methodology that will be used to define the final dynamic loading on the ESBWR steam dryer during normal operation conditions. This load definition will then be used, in combination with other design loads, to design the steam dryer. [[

]]. The results of these measurements will then be used to further validate and refine the method for defining steam dryer loads.

2.1 Flow-Induced Loads for Steam Dryer Design

The flow-induced vibration (FIV) loading on the dryer consists of (1) hydrodynamic forces resulting from flow unsteadiness in the reactor pressure vessel (RPV) (upstream and downstream of the dryer) and (2) acoustic loading associated with pressure waves generated inside the RPV or propagating upstream from the MSLs. Since no purely analytical method is available at present to estimate these loads, the applicant proposed a PBLE method, which is briefly addressed in LTR NEDE-33312P, Revision 1. NEDC-33408P, Revision 1, and its Supplement 1, Revision 1, provide additional details and are described below.

The proposed FIV load definition process for the ESBWR steam dryer consists of the following basic steps:

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In Section 5.0 of NEDE-33312P, Revision 1, the applicant explained that it is currently developing methods and devices to mitigate flow-induced excitations such as the acoustic resonance mechanism of safety/relief valve (SRV) standpipes. In previous BWR plants, acoustic resonances within SRV standpipes locked in to flow-induced vortices over the standpipe openings, generating extremely powerful acoustic pulsations within the MSLs, which subsequently impacted the steam dryers, leading to fatigue cracking and the eventual generation of large loose metal parts within the RPV. The applicant will ensure, through careful design using established practices, that such flow-induced resonance behavior will not occur in ESBWR plants at all standard operating conditions.

In NEDC-33408P, Revision 1, dated July 2009, the applicant introduced a PBLE method for defining the unsteady loads acting on the ESBWR steam dryer. A structural finite element analysis will use the defined PBLE to determine the steam dryer alternating stresses, as addressed in NEDE-33313P (Ref. 6), which is evaluated by the staff and addressed in a separate SER (Ref. 7). NEDC-33408P, Revision 1, focuses on the development of the PBLE method, its validation against Quad Cities Unit 2 (QC2) measurements on an instrumented replacement dryer, and the associated biases and uncertainties resulting from both the benchmarking of the model and the uncertainties in the model input parameters.

2.2 Flow-Induced Vibration Load Definition Process

The PBLE method is [[

]]. The applicant contends that [[

]].

The acoustic finite element code, SYSNOISE, is a well-established commercial code that has been used widely for more than 15 years. [[

]]

[[

]]. This assumption, while not perfectly accurate, is reasonable, and any inaccuracies are accounted for in the bias errors and uncertainties derived from benchmark comparisons.

2.2.1 Load Definition by [[ ]]

Pressure measurements [[

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In the final section of NEDC-33408P, Revision 1, the applicant presented a study of the bias and uncertainty expected in the predictions made using the PBLE method. The study examined the effects of uncertainties in the following parameters on the load definition uncertainties:

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-]]

Finally, all uncertainties are combined, [[

]].

2.2.2 Load Definition by Main Steamline Instrumentation

Supplement 1, Revision 1, to NEDC-33408P describes an additional load solution method that [[ ]]. The applicant presented two approaches for performing a PBLE using [[ ]]. The first approach, which is not used for the prototype ESBWR load definitions, relies solely [[ ]]. The second approach, which the applicant plans to use for ESBWR power ascension, [[ ]].

The method of performing PBLE [[ ]] takes into account [[ ]]. For example, it accounts for the effect of [[ ]]. In addition, [[

]] is summarized below.

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2.2.3 Plant-Based Load Evaluation Benchmark Data

The method of PBLE [[ ]], which is benchmarked against QC2 data in NEDC-33408P, Revision 1, is also benchmarked in Supplement 1, Revision 1, to NEDC-33408P against the [[ ]]. The bias and uncertainty errors are analyzed in a way that is similar to that used for QC2 benchmarking.

Supplement 1, Revision 1, also describes the method used to calculate the bias and uncertainty errors associated with the PBLE dryer load definition for a plant-specific application. Calculation of bias and uncertainty errors is based on two elements:

(1) The benchmark evaluation for both [[ ]], which is based on QC2 and SSES measurements, provides the basis for the generic PBLE application bias and uncertainty values.

(2) A plant-specific sensitivity assessment for the PBLE input parameters (Appendix G (for QC2) and Appendix H (for SSES) to NEDC-33408P, Supplement 1, Revision 1) is performed to establish the applicability of the generic PBLE application bias and uncertainty values to the plant under consideration and, if necessary, to determine the appropriate PBLE input parameter values needed to ensure that the plant-specific PBLE load predictions are sufficiently conservative.

Appendix I to Supplement 1, Revision 1, of NEDC-33408P summarizes the analysis of [[

]].

2.2.4 Plant-Based Load Evaluation Bias Errors and Uncertainty

Finally, Supplement 1, Revision 1, of NEDC-33408P summarizes the average as well as the maximum and minimum values of bias and uncertainty that are expected for both the PBLE [[ ]]. Tables 1 and 2 give the maximum and minimum values. The applicant computes the minimum bias and uncertainty as the most nonconservative value over all frequency bands (indicating that PBLE underpredicts the dryer loads) and [[

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3.0 Staff Evaluation

The staff evaluated the information provided by the applicant to determine whether it was adequate to satisfy the guidance of Section 3.9.2, Revision 3, issued March 2007, of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (Ref. 8); RG 1.20, Revision 3; and the relevant requirements of GDC 1 and 4, in particular, as well as the applicable portions of the other regulatory criteria listed in Section 1.0 of this SER.

3.1 Evaluation of NEDC-33312P, Revision 1

As discussed in more detail below, the applicant's approach is technically sound as it combines system modeling with extensive in-plant measurements of the steam dryer stresses, vibrations, and pressure loading. Several areas, however, warranted clarification and are discussed below. Also, the applicant had not initially provided the actual acoustic loads and plans to apply to its ESBWR steam dryer design.

The ESBWR steam dryer will be based on the design of the ABWR steam dryer, which to date has not experienced any fatigue cracking during commercial operation in Japan. [[

]].

3.1.1 ESBWR and ABWR Comparison

The ESBWR steam flow rate is projected to be approximately 15 percent higher than that of the ABWR. In addition, the ABWR steam dome is hemispherical, whereas that of the ESBWR is torispherical, which will result in different flow patterns in the steam dome region. In

RAI 3.9-205 (Ref. 9), the staff asked the applicant to provide the rationale for the change in the steam dome geometry from hemispherical, as in the ABWRs and BWRs, to torispherical geometry. In its response to RAI 3.9-205 (Ref. 10), the applicant stated that economic reasons drove the design change from hemispherical to torispherical, and reduced reactor building height. The applicant evaluated the steam flow in the new dome geometry, confirming that the changes in steam flow will not affect the dryer loads. However, since the flow velocity in the lower part of the outer hood region will be 15 percent higher than that of the ABWR, in RAI 3.9-206 S01 (Ref. 11) the staff asked the applicant to confirm that any ABWR-based dryer loads will be increased accordingly. The staff therefore closed in favor of RAI 3.9-206 S01, which is discussed below.

Although the applicant intends to perform computational fluid dynamics (CFD) simulation of the steady flow through the dryer and the steam dome, it was not clear how it would use this steady flow analysis to evaluate dynamic loading resulting from the unsteady flow component. In RAI 3.9-206 (Ref. 9), the staff asked the applicant to compare the steam flow velocities issuing from the dryer banks, in the steam plenum, and in the MSLs with those in the ABWR. If any of these velocities is higher in the ESBWR, the staff asked the applicant to explain how the steam dryer load definitions will account for these higher velocities. In its response to RAI 3.9-206 (Ref. 12), the applicant stated that [[

]]. It was not clear to the staff how the applicant will account for this flow increase. Therefore, in RAI 3.9-206 S01, the staff asked the applicant to clarify the scaling process of the dryer load from the ABWR data to the new ESBWR design. The staff also asked the applicant to provide additional information to assure the staff that no FIV mechanisms would be initiated at these higher flow velocities. In its response to RAI 3.9-206 S01 (Ref. 13), the applicant stated that it [[

]].
The applicant referred to the data obtained during the ABWR startup, which [[
]]. The applicant also referred to the design load values, which are approximately [[ ]] than the extrapolated ABWR load.

[[
]]. While the applicant's response to followup RAI 3.9-206 S01 was acceptable, it did not specify the acceptable level for FIV stresses, and in NRC RPV Internals Audit (Ref. 14) Comment 5 the staff asked the applicant to provide that level. The applicant stated in its response to NRC RPV Internals Audit Comment 5 (Ref. 15) that the [[

]]. These fatigue stress limits meet the fatigue stress criteria in the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section III, Subsection NG (Ref. 16), that are applicable to the design of RPV internals. The applicant modified Section 3L4.6 of DCD Tier 2, Chapter 3, Appendix L to state that NEDE-33312P and NEDE-33313P include additional information on power ascension testing, acceptance criteria, benchmarking loads, and finite element benchmarking for the first and subsequent ESBWR units. Because the applicant has provided acceptable fatigue stress limits in the DCD, RAI 3.9-206 and NRC RPV Internals Audit Comment 5 are closed.

In RAI 3.9-207 (Ref. 9), the staff asked the applicant to explain how *steady* CFD analysis can be used to assess differences in the dryer *dynamic* loading that may be caused by differences in flow patterns in the steam dome. In its response to RAI 3.9-207 (Ref. 12), the applicant stated that it will use the CFD simulation to [[

]].

Since the applicant clarified that it will use the CFD model to guide general design improvements and not to generate inputs to the steam dryer load definition, and since other RAIs deal with the differences between the flow patterns in and around the ESBWR and ABWR dryers, RAI 3.9-207 is closed.

NEDE-33312P mentions that the CFD model is being used to "[[ ]]." In RAI 3.9-208 (Ref. 9), the staff asked the applicant to elaborate on the steady-state parameters that would indicate any changes (a reduction or an increase) in the acoustic excitation level or frequency. In its response to RAI 3.9-208 (Ref. 12), the applicant referred to its response to RAI 3.9-207 and reiterated that the intent of the CFD is to look [[

]] sources affecting the ESBWR dryer, RAI 3.9-208 is closed.

In RAI 3.9-209 (Ref. 9), the staff asked the applicant to submit the CFD analyses of the ABWR and proposed ESBWR flows for review. The staff asked the applicant to clearly state in its response all methodologies and assumptions, along with bias errors and uncertainties. In its response to RAI 3.9-209 (Ref. 17), the applicant stated that it [[

]]. Therefore, the applicant did not submit its CFD analyses. Since the CFD results are not used for defining dryer loads, and since other RAIs question the differences in flow patterns within and around the ESBWR and ABWR dryers, RAI 3.9-209 is closed.

3.1.2 Acoustic Resonance Mitigation Devices

NEDE-33312P also includes [[

]]. In RAI 3.9-210 (Ref. 9), the staff asked the applicant to provide sufficient details on the design and performance of any FIV mitigation device if it is to be implemented in the MSL design. In its response to RAI 3.9-210 (Ref. 18), the applicant stated that [[

]]. RAI 3.9-210 is therefore closed.

3.1.3 Steam Dryer Acoustic Loads

NEDE-33312P did not include the acoustic loading that the applicant plans to apply to its ESBWR steam dryer design. In RAI 3.9-211 (Ref. 9), the staff asked the applicant to submit the acoustic loading for review, including the components of the loading that are derived from different plants (ABWR and BWR), and all bias errors and uncertainties. In its response to RAI 3.9-211 (Ref. 19), the applicant referenced dryer loading for [[

]]. The applicant provided an example of loading curves for the dryer skirt, which includes a factor [[ ]] to reflect bias and uncertainties in the PBLE method. The applicant also discussed the peaks in the loading curves and noted that [[

]]. The applicant did not clearly describe the final dryer loading, however, and did not include this description in its load definition report.

Therefore, in RAI 3.9-211 S01 (Ref. 11), the staff asked the applicant to provide its final dryer load definition over key portions of the dryer surfaces. In its response to RAI 3.9-211 S01 (Ref. 20), the applicant stated that it would revise NEDE-33312P to include the final dryer load definition. The applicant revised Section 4.1 and Figure 4.1.1 of NEDE-33312P to include a design dryer load definition that is determined by applying the PBLE method to [[

]]. The applicant also included additional references to topical reports that describe the PBLE method and its benchmarking, but it did not fully explain how the overall loading for the ESBWR dryer is derived. Section 4.1 of the revised NEDE-33312P also includes a new table (Table 4.1.1), which compares the plant data for the ABWR, ESBWR, BWR/4 replacement dryer at EPU, and BWR/3 replacement dryer at EPU. This comparison includes the flow velocity in the MSL, but it does not include the more relevant information about the Strouhal numbers based on the branch pipe diameter. Therefore, in NRC RPV Internals Audit Comment 13, the staff asked the applicant to include the Strouhal number data in Table 4.1.1 of NEDE-33312P. In its response, the applicant modified Section 4.1 of NEDE-33312P to clarify that the ESBWR design loads will be based on test data from BWR/3 and BWR/4 plants. Appendices A.2 and F of NEDC-33408P, Supplement 1, include PSD load projections based on both dryers. Since the applicant has clarified the ESBWR dryer design loads, RAI 3.9-211 and NRC RPV Internals Audit Comment 13 are closed.

3.2 Evaluation of NEDC-33408P

3.2.1 Plant-Based Load Evaluation Validation Benchmarks

The PBLE method of defining steam dryer loads is based on in-plant measurements from instrumentation mounted on an [[ ]]. However, measurements from only one operating plant were used to benchmark the method. Since the applicant plans to design the ESBWR dryer using in-plant pressure measurements for an existing ABWR dryer and another BWR/4 dryer, the staff asked the applicant in RAI 3.9-220 (Ref. 9) to submit additional validation studies using measurements from those dryers operating at EPU conditions. The applicant provided the validation studies for the QC2 and SSES BWR dryers in MFN 08-827, "NEDC-33408P, Supplement 1—ESBWR Steam Dryer Plant Based Load Evaluation Methodology—Additional Benchmarking", dated October 24, 2008. In its response to RAI 3.9-220 (Ref. 21), the applicant stated that validation data for ABWR plants are not available and will not be used to further validate the PBLE. However, limited ABWR plant data will be used as part of the ESBWR plant load definition, with loads increased to account for the 15 percent increase in MSL steam flow over ABWR flow rates. The applicant also provided a table of flow rates and geometric properties of the ABWR, ESBWR, SSES and QC2 BWRs but did not include this information in the DCD or LTR. In RAI 3.9-220 S01 (Ref. 11), the staff asked the applicant to revise the DCD or LTR (either NEDC-33408P or NEDE-33312P) to include the table provided in its RAI response. In its response to RAI 3.9-220 S01 (Ref. 20), the applicant agreed to revise NEDC-33312P as requested by the NRC staff. The staff confirmed this change in the LTR; therefore, RAI 3.9-220 S01 is closed.

3.2.2 Plant-Based Load Evaluation Acoustic Model

The material properties used in the acoustic finite element model (such as the speed of sound, the attenuation coefficient, and the steam density) are functions of the steam wetness fraction and the water droplet size. The analysis uses the theoretical values of the speed of sound (a) and the attenuation coefficient (α) based on Equations 13 and14 in the LTR. While the usage of input parameters based on the steam quality is appropriate, the report includes no experimental validation of these equations. Therefore, in RAI 3.9-221 (Ref. 9), the staff asked the applicant to provide experimental validation of Equations 13 and 14. In its response to RAI 3.9-221 (Ref. 22), the applicant stated the following:

[[

]].

The applicant complied with the guidance of RG 1.20 by adopting the wet steam wave propagation model of Reference 23 of NEDC-33408P that provides that the load prediction methodology should be based as much as possible on physical properties and should not include any plant-specific tuning. In this context, the model in Reference 23 was considered the most suitable for acoustic simulations in the RPV. Confidence in the model is further increased by the good agreement between measurements and predictions as presented in Section 3 and Appendices A and B of NEDC-33408P.

Although it is difficult to perform two-phase flow tests to confirm the steam acoustic properties, the applicant could have addressed this RAI by discussing the effect of reasonable variations in the steam properties on the dryer load. Therefore, the staff determined that the applicant's response was incomplete and in RAI 3.9-221 S01 (Ref. 11) asked the applicant to explain [[

]]. In its response to RAI 3.9-221 S01 (Ref. 25), the applicant summarized [[

]].

The staff agrees with the applicant that the updated sensitivity analysis of the steam wetness effect and the resulting regionally based PBLE bias errors and uncertainties are likely to be more reliable than the original spatially averaged analysis. However, as discussed in the evaluation of the applicant's response to RAI 3.9-260 (Ref. 25), this analysis is based on [[ ]]. In NRC RPV Internals Audit Comment 16, the staff asked the applicant to repeat this analysis over [[ ]]. Therefore, the staff closed RAI 3.9-221 S01 pending resolution of NRC Audit Comment 16 discussed later in this report. After further analysis by the applicant [[ ]], NRC RPV Internals Audit Comment 16 was closed. Section 3.3.2 of this SER provides further details about the staff evaluation of this issue.

The acoustic finite element model uses different properties of sound waves (sound speed and attenuation) for the regions upstream and downstream of the dryer. [[

]]. In RAI 3.9-222 (Ref. 9) the staff asked the applicant to explain this insensitivity to the steam properties in the dryer banks. In its response to RAI 3.9-222 (Ref. 22), the applicant stated the following:

[[

]].

[[

]].

Therefore, the staff finds the applicant's response acceptable and agrees that the steam properties in the steam dryer banks will become important only at frequencies higher than those of interest here. Therefore, RAI 3.9-222 is closed.

3.2.3 Plant-Based Load Evaluation Bias Error and Uncertainty Calculation

Uncertainty and bias errors are computed from benchmarking the PBLE method against the steam dryer measurements at QC2. In estimating the bias and uncertainty, the PSDs of all 27 pressure transducers are added for each frequency band. This results in spatially averaged bias and uncertainty errors. The level of "local" errors is therefore masked by this averaging process. In RAI 3.9-223 (Ref. 9), the staff asked the applicant to assess the levels of local bias and uncertainty errors in comparison to the average values given in the report. The staff later issued a similar RAI, RAI 3.9-260 (Ref. 26), for NEDC-33408P, Supplement 1. Therefore, the staff closed RAI 3.9-223 pending resolution of RAI 3.9-260 discussed later in this report.

In the Design of Experiments for uncertainty study, [[

]]. In RAI 3.9-224 (Ref. 9), the staff asked the applicant to explain and illustrate the effect of wetness fraction and droplet size on the acoustic resonance frequencies. In its response to RAI 3.9-224 (Ref. 27), the applicant stated the following:

> [[
>
>]]

The applicant indicated that, [[

]].

The applicant also explained that the [[

]]. The staff reviewed the applicant's response and finds the explanation of the effect of the steam properties on the resonance frequencies in the FRF shown in Figure 22 to be acceptable because [[

]]. RAI 3.9-224 is therefore closed.

In the above-mentioned Design of Experiments study, a refined mesh is considered to assess the mesh size effect on PBLE uncertainties. [[

]]. In RAI 3.9-225 (Ref. 9), the staff asked the applicant to illustrate that further refinement of the mesh to satisfy the criterion of six elements per wavelength up to 250 Hz would not increase the PBLE uncertainties. In its response to RAI 3.9-225 (Ref. 27), the applicant stated the following:

> In Figure 2 of NEDC-33408P, [[
>
>]]. As shown in Figure 3 of NEDC 33408P, having a detailed model in this area [[
>
>]]. Figure 2 of NEDC 33408P shows that the [[
>]].

The applicant also explained that [[

]].

Therefore, based on the benchmarking results, the staff accepts the [[

]].

The staff reviewed the applicant's response as well as Supplement 1 of NEDC-33408P. Although the clarifications provided by the applicant seem reasonable, NEDC-33408P and its Supplement 1 [[

]]. Therefore, the staff finds the applicant's response incomplete and asked, in RAI 3.9-225 S01 (Ref. 11), requested the applicant to amend NEDC-33408P and its Supplement 1 to indicate the regions where this criterion can be relaxed and provide the minimum acceptable number of elements per wavelength in those regions. The staff also asked the applicant to substantiate the adequacy of the chosen minimum number of elements. In its response to RAI 3.9-225 S01 (Ref. 28), the applicant stated that the original intent in NEDC-33408P [[

]]. The applicant also stated that [[

]]. The staff finds the applicant's response and the revisions made to NEDC-33408P acceptable; therefore, RAI 3.9-225 S01 is closed.

Table 6 of NEDC-33408P summarizes the bias and uncertainty errors obtained from the benchmark against plant measurements as well as the uncertainties in PBLE resulting from uncertainties in the acoustic model input parameters. The bias in the first row of the table [[

]]. In RAI 3.9-226 (Ref. 9), the staff asked the applicant to comment on this discrepancy. In its response to RAI 3.9-226 (Ref. 22), the applicant stated the following:

> [[
>
>]].

Since the applicant has clarified the differences between OLTP and EPU based data, and the staff review of NEDC-33408P substantiates the applicant's response, RAI 3.9-226 is closed.

In RAI 3.9-227 (Ref. 9), the staff asked the applicant to specify the final bias error and uncertainty it will apply to dryer loads estimated for the ESBWR design. It also asked the applicant whether the bias errors and uncertainties are based on QC2 benchmark data, the Design of Experiments data, or both, and whether any conservative bias errors are credited. In its response to RAI 3.9-227 (Ref. 27), the applicant stated the following:

> [[
>
>]].

The staff reviewed Revision 0 of Supplement 1 of NEDC-33408P and determined that despite the considerable effort devoted to the bias and uncertainty analysis, the final values of bias error

and uncertainty and their implementation in the final design load of the steam dryer were still not clear. For example, it was not clear whether the same values would be applied over the whole frequency range, or whether frequency-dependent bias and uncertainty would be implemented. In addition, the discussion on page 92 concerning the [[
]]. The staff also discussed these concerns in RAI 3.9-260 associated with Supplement 1. Therefore, RAI 3.9-227 is closed as superseded by RAI 3.9-260, which is discussed later in this report.

3.2.4 Matrix Singularity Factors and Their Effects on Load Predictions

In RAI 3.9-228 (Ref. 9), the staff asked the applicant to explain whether singularities in the acoustic FRF matrices lead to nonconservative errors in the computed loading, such as sharp dips at certain frequencies. If so, the staff asked the applicant how it will account for the errors. In its response to RAI 3.9-228 (Ref. 27), the applicant stated the following:

> From benchmarking results provided in both NEDC-33408P and NEDC-33408P Supplement 1, GEH found that loads were generally [[
>]]. GEH has performed benchmarking that included multiple frequency bands that included bands that [[
>]]. The range in PBLE (Plant Based Load Evaluation) error from narrow frequency bands is summarized in section 4.5.3 of NEDC-33408P Supplement 1. [[
>
>]].

The staff reviewed the applicant's response, including the detailed descriptions of the applicant's approach in NEDC-33408P, Supplement 1, and agrees that non-conservative errors should not be caused by the matrix singularities. Therefore, RAI 3.9-228 is closed.

3.2.5 Acoustic Model Computer Program Analysis Methods

In RAI 3.9-229 (Ref. 9), the staff asked the applicant to describe the options used in SYSNOISE for its acoustic modeling as well as the interface between SYSNOISE and MATLAB. In its response to RAI 3.9-229 (Ref. 27), the applicant described the SYSNOISE options, [[
]].
The applicant also cited the SYSNOISE manual for more detail. The applicant stated that [[

]]. The staff reviewed the applicant's response and finds it acceptable, since it explains the SYSNOISE options and SYSNOISE/MATLAB interface. Therefore, RAI 3.9-229 is closed.

In RAI 3.9-230 (Ref. 9), the staff asked the applicant to provide a detailed description of the analysis procedure, including (1) [[ ]], (2) implementation of frequency-dependent damping, (3) formulation of the finite element method for the wave equation, (4) determination of damping matrix coefficients, and (5) how velocity fields are computed via differentiation of pressure fields. In its response to RAI 3.9-230 (Ref. 27), the applicant referenced [[

]]. The staff's assessment of the materials supplied by the applicant reveal that the direct response analysis method, implementation of frequency dependent damping, basic formulation of the wave equation, and determination of damping matrix coefficients are applicable to steam dryer acoustic loading analysis. The applicant also indicated how velocity fields are computed, which is also applicable to dryer analysis. Based on these documents, the staff's experience with the acoustic modeling methods, and the applicability of the SYSNOISE analysis procedure to steam dryer acoustic loading modeling, the staff finds the elements of the applicant's acoustic analysis procedure acceptable. Therefore, RAI 3.9-230 is closed.

In RAI 3.9-231 (Ref. 9), the staff asked the applicant to provide the basis for the [[
]] and explain how that criterion is conservative. In its response to RAI 3.9-231 (Ref. 27), the applicant cited the [[
]]. The applicant also cited [[

]]. Finally, this criterion is addressed in more detail in the discussion about RAI 3.9-225 addresses this issue in more detail. Therefore, RAI 3.9-231 is closed based on the resolution of RAI 3.9-225.

In RAI 3.9-232 (Ref. 9), the staff asked the applicant to provide further details about the analysis method, including [[

]]. In its response to RAI 3.9-232 (Ref. 27), the applicant stated the following:

> [[
>
>]].

The staff reviewed the applicant's response and finds it acceptable, since the requested descriptions were provided and are reasonable based on the staff's experience and judgment. Also, [[

]].

Therefore, RAI 3.9-232 is closed.

3.3 Evaluation of NEDC-33408P, Supplement 1

3.3.1 Plant-Based Load evaluation Benchmark Comparison to Operating Boiling-Water Reactor Data

The measurements made at QC2 are used to [[

]].

Although the applicant imposed [[

]], the methodology and the [[ ]] are benchmarked against the data of only one plant (QC2). On page 52 of NEDC-33408P, Supp. 1, the applicant stated but did not substantiate, its claim that the [[ ]]. In RAI 3.9-256 (Ref. 26), the staff asked the applicant to submit validation of the methodology against measurements from other plants, [[

]]. The applicant noted that [[

]]. Since the applicant will rebenchmark the method using the prototype first plant ESBWR data before applying it to other ESBWR plants, RAI 3.9-256 is closed.

Regarding the [[

]]. Since the dome geometry of the ESBWR reactor is torispherical, which is different from the [[ ]], it is not clear why the geometry of the reactor dome does not influence the [[ ]]. In RAI 3.9-257 (Ref. 26), the staff asked the applicant to compare the flow patterns, velocities, and turbulence intensities and length scales in the reactor domes of the ESBWR [[ ]] and substantiate the assumption that these coefficients remain the same. The staff also asked the applicant to compare the acoustic modes within the RPV for the ESBWR [[ ]] geometries, particularly those modes with high amplitudes in the skirt/dome annulus and near the MSL inlets, and confirm the assumption that the [[ ]] are conservative when applied to the ESBWR loads.

In its response to RAI 3.9-257 (Ref. 31), the applicant stated that [[

]]. The applicant explained that the [[

]]. The staff finds the proposed approach to [[

]] acceptable. However, in NRC Audit Comment 12, the staff asked the applicant to update NEDC-33408P, Supplement 1, to [[

]]. In its response to Audit Comment 12, the applicant committed to [[ ]]. Also, the applicant updated Section 9.1 of NEDE-33313P to reflect this commitment. Therefore, [[ ]]. Since the applicant has committed to update NEDC-33408P, Supplement 1, by [[ ]] by the staff, RAI 3.9-257 and NRC Audit Comment 12 are closed.

In the event a future nonprototype ESBWR MSL design configuration deviates from the prototype, the applicant explained in its supplementary response to RAI 3.9-144 S02 (Ref. 32) that the MSL measurements in the follow-on plant(s) would be compared to those from the lead plant. At that point, [[ ]], subject to NRC staff review, and would be [[ ]]. Since the applicant will update its bias errors and uncertainties should the MSL layout change, the response to RAI 3.9-144 S02 (Ref. 33) is acceptable and RAI 3.9-144 S02 is closed.

Based on the results shown in Figures 15 and 16 of NEDC-33408P, Supplement 1, the applicant [[ ]]. The staff determined that this [[ ]] was not clear from the figures. Therefore, in RAI 3.9-258 (Ref. 26), the staff asked the applicant to provide additional data substantiating this conclusion. In its response to RAI 3.9-258 (Ref. 34), the applicant provided its calculations to justify assuming the dependence of the [[ ]]. While the calculation and explanation are reasonable, the applicant did not add them to the DCD or LTR. Therefore, in RAI 3.9-258 S01 (Ref. 35), the staff asked the applicant to add the information to NEDC-33408P, Supplement 1. In response to RAI 3.9-258 S01 (Ref. 36), the applicant updated Sections 3.1.2 and 3.1.3 of NEDC-33408P, Supplement 1, Revision 1, to include the requested information. The staff confirmed these changes and, therefore, RAI 3.9-258 is closed.

As mentioned in the summary of NEDC-33408P, Supplement 1, in order to [[ ]]. However, the report did not explain how the applicant [[ ]] of the plant data. In RAI 3.9-259 (Ref. 26), the staff asked the applicant to explain how the [[ ]]. In its response to RAI 3.9-259 (Ref. 37), the applicant stated that the [[

]]. Accordingly, the staff finds this approach reasonable, and RAI 3.9-259 is closed.

3.3.2 Calculation Methods for Determination of Total Bias Error and Uncertainty

In both PBLE methods, based on [[ ]], the assessment of uncertainty and bias errors is based on Equation 46 of NEDC-33408P, Supplement 1, which [[ ]]. The staff observed as follows; this procedure results in [[ ]] bias and uncertainty errors. The level of local errors is therefore masked with this [[ ]]. For example, [[ ]] small bias. [[ ]]. In RAI 3.9-260 (Ref. 26), the staff asked the applicant to analyze the local bias and uncertainty errors and compare them with the [[ ]]. The applicant also [[ ]] in the pressures acting on the dryer, potentially filtering out some of the worst-case loads. The staff, however also determined that worst-case loads generating the largest alternating stress intensity for use in the dryer fatigue analysis needed to be calculated considering all time segments together (see Section 4.1, page 9, section entitled "ESBWR Steam Dryer Acoustic Load Definition," of NEDE-33312P);") since loads averaged over time segments do not represent the worst-case loads. Therefore, the staff also asked the applicant to submit bias and uncertainty estimates based on worst-case dryer loads [[ ]].

In its response to both RAIs 3.9-223 (Ref. 25) and 3.9-260 (Ref. 25), the applicant provided Enclosure 3, Attachment 1, which summarizes steam dryer pressure loading bias errors and uncertainties computed for the QC2 and SSES benchmarks. The applicant computed the errors and uncertainties over [[ ]]. In addition, the applicant computed the errors and uncertainties at [[ ]]. The applicant provided Table 5 (which will be included in a revision of NEDC-33408P, Supplement 1), which summarizes the updated PBLE [[ ]].

Although the regionally based PBLE bias errors and uncertainties were an improvement over the original nonregional values, the applicant's [[ ]] was not supported by the data shown in Table 2 of Attachment 1, Appendix 1, to the response to RAIs 3.9-213 (Ref. 38) and 3.9-217 S01 (Ref. 38). [[

]]. These nonconservative bias errors are also evident in the spectra shown in the figures of Attachment 1. Therefore, in NRC RPV Internals Audit Comment 16 (Ref. 15) the staff asked the applicant to [[

]].

The applicant submitted proposed Revision 2 of Supplement 1 to NEDC-33408 that incorporated in Section 3.4 the [[
]]. The applicant also submitted proposed Section 5.2 in NEDE-33313P, Revision 2, to reflect four methods that it will use to apply end-to-end bias errors and uncertainties to ESBWR dryer stress calculations (Ref. 15). The staff found the proposed revision acceptable for incorporation into the approved version of the LTR. [[

]]. The applicant's new methods for assessing [[
]], conservative (since the [[
]], and therefore acceptable. Therefore, RAI 3.9-260 (and associated NRC RPV Internals Audit Comment 16) are closed.

3.3.3 Measurement of Pressure Fluctuations in Main Steam Piping

Figure 337 in Appendix I to NEDC-33408P, Supplement 1, compares a [[

]]. The applicant attributed these peaks [[ ]]. However, the array of [[
]] should [[ ]] except those generated by hoop stresses. In RAI 3.9-261 (a) (Ref. 26), the staff asked the applicant to comment on this observation and explain why the pipe resonant vibrations are [[
]]. The MSL strain gage measurements are made to estimate acoustic pressures (related to hoop stress). Although the opposite strain gages at each of the eight MSL locations are connected in a half Wheatstone bridge so that the bending strains are cancelled out, the signals may include some bending strains. In addition, the acoustic pressures are quite small and require strain gages with a high signal-to-noise ratio for reliable measurements. Because of these limitations, the staff was concerned about how reliably the strain gage measurements estimate the acoustic pressure. The applicant had previously suggested the use of pressure sensors (microphones) to measure the MSL acoustic pressure. The staff asked the applicant in RAI 3.9-261 (b) if it [[
]].

In its response to RAI 3.9-261 (Ref. 39), the applicant provided a [[

]]. While not mentioned by the applicant, geometry and material property imperfections in a pipe can also inhibit filtering of mechanical vibrations from the summed strain gage array signal. The staff finds the applicant's explanation reasonable and accepts its reluctance to use microphones in the MSLs of ESBWRs, considering the safety risks associated with drilling holes in the MSL walls, which constitute primary coolant pressure boundary. Therefore, RAI 3.9-261 is closed.

Page 77 of NEDC-33408P, Supplement 1, includes a brief discussion of possible [[ ]] so that it can be used in cases when [[ ]]. Although [[ ]] may require this, the present [[ ]]. In RAI 3.9-262 (Ref. 26), the staff asked the applicant to express explicitly that the [[ ]]. The staff also indicated that any extensions of the PBLE method should be submitted to NRC staff for approval before implementation. In its response to RAI 3.9-262 (Ref. 40), the applicant agreed with the staff's request in RAI 3.9-262 and revised NEDC-33408P, Supplement 1, to explicitly state that extensions of the PBLE method must be submitted to the NRC staff for approval before implementation. Therefore, RAI 3.9-262 is closed.

Page 37 of Supplement 1 made another statement that needed clarification. The applicant stated that [[ ]] In RAI 3.9-263 (a) (Ref. 26), the staff asked the applicant to explain this statement. In RAI 3.9-263(b), the staff asked the applicant to provide or explain any plant measurements that support its statement on page 36 that [[ ]].

In its response to RAI 3.9-263 (a) (Ref. 41), the applicant explained that the analysis [[ ]]. This response clarifies which acoustic sources were referred to by the applicant and the reasoning for [[ ]]. The staff finds this response acceptable, and therefore RAI 3.9-263 (a) is closed.

In response to RAI 3.9-263 (b), the applicant explained that the moisture carryover is measured for the steam exiting the dryer. This information is [[ ]]. Therefore, the applicant [[ ]]. The staff finds this response reasonable. Also, since any errors associated with inaccuracies in the wetness fraction modeling are accounted for in the benchmark bias errors and uncertainties. RAI 3.9-263 (b) is closed.

On page 80 of NEDC-33408P, Supplement 1, under the section entitled "PBLE Script Preparation and Load Generation," third bullet, the applicant stated that [[ ]]. In RAI 3.9-264 (Ref. 26), the staff asked the applicant to explain how it [[ ]] to ensure computation of a conservative load and how it ensures that its selection approach supports the applicant's proposed 60-year reactor design life (a conservative design goal relative to the 40-year license term). In its response to RAI 3.9-264 (Ref. 42), the applicant stated that it discussed time segment selection in its response to RAI 3.9-219 (Ref. 43). In its final response to RAI 3.9-219, the applicant proposed revisions to Section 5.2.4 of NEDE-33313P, Revision 1 (Ref. 12), to clearly define time intervals chosen for its stress analysis. Since multiple sets of test data, [[ ]], were analyzed, the staff finds that conservative loads have been computed. Therefore, RAI 3.9-264 is closed.

In Section 4.4.3.2 of NEDC-33408P, Supplement 1, the applicant neglected plant measurement uncertainty of [[ ]], which is small compared to other uncertainty values. In RAI 3.9-265 (Ref. 26), the staff asked the applicant to include the plant measurement uncertainty, even if it is small, in its overall load modification factor. In its response to RAI 3.9-265 (Ref. 25), the applicant stated that the final PBLE dryer load uncertainties now include a pressure transducer uncertainty of [[ ]]. The response also explains that the pressure transducer measurements should include negligible bias errors, since they are dynamic, not static, transducers. The staff finds this response acceptable, and therefore RAI 3.9-265 is closed.

Appendices A–F to NEDC-33408P, Supplement 1, show comparisons for the last [[ ]] by the applicant. In RAI 3.9-266 (Ref. 26), the staff asked the applicant to provide instead the worst-case load PSDs, based on cumulative summations over all time segments, [[ ]]. In its response to RAI 3.9-266 (Ref. 25), the applicant provided Appendices 1–17 as an attachment. However, the applicant used a different procedure to compute worst-case load PSDs, as described in Section 5.2 of NEDE-33313P, Revision 1. The applicant selected a worst-case time interval based on an assessment of [[ ]]. Since the worst-case interval cannot include peak loads over all frequencies, the applicant also included a [[ ]]. Since the applicant has provided the data requested and has provided an acceptable procedure, since it uses time interval bias factors, for ensuring that worst-case loads are applied to the dryer model, RAI 3.9-266 is closed.

3.3.4 Consideration of Plant Background Noise on Instrumentation Output

The QC2 [[ ]] but also signals caused by plant background noise; that is, the [[ ]]. The applicant used these contaminated signals without filtering out the plant noise to calculate the [[ ]], which may be applied to the steam dryer analyses at other ESBWR/ABWR/BWR plants. However, the staff observed that different plants are likely to have different characteristics for their MSL acoustic pressures and different plant noise, which raised a concern about the applicability of the [[ ]] that are based on the QC2 measurements to other plants. Such applications could be nonconservative for a plant, for example, having the same acoustic pressure signals but lower plant noise as compared to QC2.

Therefore, in RAI 3.9-267 (Ref. 26), the staff asked the applicant to account for the nonconservative effects of this background noise on any future ESBWR or BWR dryer load estimates based on MSL signals.

In response to RAI 3.9-267 (Ref. 44), the applicant [[

]] The staff determined that while this assessment is useful for ruling out any nonconservative influence of incoherent background noise on the [[ ]], it does not address the impact of any coherent background noise, such as that caused by electrical fields or other operating plant machinery. During the NRC audit, the staff asked the applicant to address the nonconservative effects of coherent plant background noise on its PBLE [[ ]]. The applicant addressed this question in a supplemental response to RAI 3.9-144 S02 by updating Section 9.1 of NEDE-33313P, adding a background noise measurement for [[ ]] to be made [[ ]]. The applicant set a lower limit of [[ ]] for its noise floors. The applicant's commitment and update of NEDE-33313P close RAIs 3.9-144 S02 and 3.9-267.

3.3.5 Extent of Plant-Based Load Evaluation Benchmarking

Section 3.0 of NEDC-33408P, Supplement 1, provides benchmarking for fully coupled analysis based on the QC2 data for [[ ]]. The staff understood that the applicant will use this benchmarked procedure at the plants where only [[ ]]. For example, after the first prototype ESBWR, the applicant [[ ]]. For the operating plants, the analyses will also be based on [[ ]]. The staff identified a concern about the applicability of the benchmarked procedure to these plants because the benchmarking is based on the data from [[ ]]. Therefore, so that the benchmarked procedure can be applied with confidence to BWRs, ABWRs and ESBWRs, in RAI 3.9-268 (Ref. 26), the staff asked the applicant to provide (1) an assessment of the benchmarked procedure by applying it to one or more plants [[ ]] where [[ ]] were measured during the power ascension for EPU operation, and (2) the plans for such assessments in the future.

In its response to RAI 3.9-268 (Ref. 45), the applicant explained that its PBLE benchmarking included benchmarking data from all dryers that it is authorized to use. The applicant also noted that the prototype ESBWR dryer will be used [[ ]]. Since the applicant will use the prototype ESBWR data to update its procedure, RAI 3.9-268 is closed.

4.0 Conclusions

For the reasons set forth above, the staff finds that the subject LTRs for the ESBWR comply with the requirements of GDC 1, 2, and 4 in Appendix A to 10 CFR Part 50 and 10 CFR 50.55a. The applicant's submissions show that the ESBWR steam dryer acoustic loading derived from application of the PBLE method should be conservative. This conclusion is based on the following findings:

- The applicant has submitted sufficient information describing its modeling approaches for specifying acoustic loads acting on the ESBWR dryer. The PBLE approaches—[[ ]]—have been benchmarked against [[ ]]. The benchmarking data show that the PBLE dryer load estimates are generally conservative. Where the dryer loads are not conservative, bias errors and uncertainties have been defined for both PBLE methods and are found reasonable after staff review, as described in this SER.

- The terms used in the PBLE models ([[ ]]) will be confirmed as conservative, or updated, following new benchmarks based on measurements of the instrumented prototype ESBWR dryer. The [[ ]] PBLE method, which will be applied to all subsequent ESBWR plants, will use the [[ ]] and will be conservative provided that the RPV, dryer, MSL, and MSL valve configurations remain essentially identical to those of the baseline plant. Any [[ ]] PBLE application to subsequent plants will include the(prototype) plant. The effects of differences in plant-to-plant background noise levels in the [[ ]] will be accounted for, as discussed in this SER. Finally, the instrumentation data for the prototype dryer will also provide confidence that alternating stress levels are below allowable fatigue limits.

The staff cannot, however, approve the use of the [[ ]] PBLE in followon ESBWR plants which differ from the configuration of the steam dryer, RPV, MSL, or MSL valve designs of the prototype plant. In such cases, a factor of safety may be applied to the computed dryer alternating stress ratios computed using the MSL-based PBLE. This factor of safety will be determined following review of additional applicant LTR submissions regarding the use of the [[ ]] PBLE for existing BWRs.

5.0 References

1. U.S. Code of Federal Regulations, *Title 10, Energy*, Part 50, "Domestic Licensing of Production and Utilization Facilities."

2. RG 1.20, Revision 3, "Comprehensive Vibration Assessment Program for Reactor Internals during Preoperational and Initial Startup Testing."

3. Transmittal of GEH Licensing Topical Report (LTR), "ESBWR Steam Dryer Acoustic Load Definition," NEDC-33312P, Revision 1, July 2009 (ADAMS Accession No. ML092170657).

4. Transmittal of GEH Licensing Topical Report (LTR), "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology," NEDC-33408P, Revision. 1, July 2009 (ADAMS Accession No. ML092190422).

5. Transmittal of GEH Licensing Topical Report (LTR), "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology Supplement 1," NEDC-33408P, Supplement 1, Revision 1, August 2009 (ADAMS Accession No. ML092460354).

6. Transmittal of GEH Licensing Topical Report (LTR), "ESBWR Steam Dryer Structural Evaluation," NEDC-33313P, Revision 1, July 2009 (ADAMS Accession No. ML092170644).

7. NRC, Safety Evaluation Report for GEH LTR NEDE-33313P. September 2010. (Agencywide Documents Access and Management System (ADAMS) Accession No. ML102640389).

8. NRC, NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," March 2007, (ADAMS Accession No. ML070660036).

9. Letter from Chandu Patel, (NRC) to Robert 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 - RAI Numbers 3.9-205 through 3.9-246," July 29, 2008 (ADAMS Accession No. ML082060534).

10. Letter from Richard E. Kingston, GEH, to NRC, "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 Number 3.9-205," October 10, 2008. (ADAMS Accession No. ML082890610).

11. Letter from Zahira Cruz Perez, (NRC), to Jerald G. Head, (GEH), "Request for Additional Information Letter No. 339 Related to ESBWR Design Certification Application - RAI Numbers 3.9-206 S01, 3.9-211 S01, 3.9-212 S01, 3.9-214 S01, 3.9-215 S01, 3.9-216 S01, 3.9-217 S01, 3.9-219 S01, 3.9-220 S01, 3.9-221 S01, 3.9-225 S01, 3.9-244 S01, 3.9-245 S01, 3.9-246 S01," May 26, 2009 (ADAMS Accession No. ML091400731).

12. Letter from Richard E. Kingston, (GEH), to NRC, "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 3.9-206 through 3.9-208," January 6, 2009 (ADAMS Accession No. ML090060693).

13. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. 339 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Number 3.9-206 S0I," July 13, 2009 (ADAMS Accession No. ML091950621).

14. NRC, "Report of the August 25, 2009 NRC Staff Audit on RPV Internals," September 15, 2009 (ADAMS Accession No. ML0925704291).

15. Letter from Richard E. Kingston, (GEH), to NRC, "Response to NRC Report of the August 25, 2009, and September 9, 2009, Regulatory Audit of Reactor Pressure Vessel Internals of the Economic Simplified Boiling Water Reactor," October 8, 2009 (ADAMS Accession No. ML092860177).

16. American Society of Mechanical Engineers, "Boiler and Pressure Vessel Code, Section III, Subsection" NG, Divisions 1 2001 Edition and Addenda through 2003, New York, NY, 2004.

17. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. Design Certification Application – DCD Mechanical Systems and Components; RAI 220 Related to ESBWR Tier 2, Section 3.9 - Number 3.9-209," January 30, 2009 (ADAMS Accession No. ML090340673).

18. Letter from Richard E. Kingston, (GEH), to NRC, "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 Number 3.9-210," January 21, 2009 (ADAMS Accession No. ML090270710).

19. Letter from Richard E. Kingston, (GEH), to NRC, "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 Number 3.9-211," February 10, 2009 (ADAMS Accession No. ML090430215).

20. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. 339 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Numbers 3.9-211 S01, - 212 S01, -215 S01 Part D, -219 S01, -220 S01, -244 S01 & -246 S01," June 18, 2009 (ADAMS Accession No. ML091730173).

21. Letter from Richard E. Kingston, (GEH), to NRC, "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 Number 3.9-220," January 5, 2009 (ADAMS Accession No. ML090070143).

22. Letter from Richard E. Kingston, (GEH), to NRC, "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 3.9-221, 3.9- 222, 3.9-224, 3.9-225, 3.9-226, 3.9-227, 3.9-228, 3.9-229, 3.9-230, 3.9- 231, & 3.9-232," November 6, 2008 (ADAMS Accession No. ML083150742).

23. V. Petr, "Wave propagation in Wet Steam", Proc. Instn. Mech. Engrs Vol 218 Part C 2004, p 871-882.

24. Transmittal of GEH Licensing Topical Report (LTR), "ESBWR Steam Dryer Plant Based Load Evaluation Methodology – Additional Benchmarking," NEDC-33408P, Supplement 1, October 24, 2008 (ADAMS Accession No. ML083050333).

25. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. 220, 338 and 339 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Numbers 3.9-223, 3.9-260, 3.9-265, 3.9-266 and 3.9-221 S01," July 31, 2009 (ADAMS Accession No. ML092160844.)

26. Letter from Zahira Cruz Perez, (NRC), to Jerald G. Head, (GEH), "Request for Additional Information Letter 338 Related to ESBWR Design Certification Application - RAI Numbers 3.9-256, 3.9-257, 3.9-258, 3.9-259, 3.9-260, 3.9-261, 3.9-262, 3.9-263, 3.9-264, 3.9-265, 3.9-266, 3.9-267, and 3.9-268," June 10, 2009 (ADAMS Accession No. ML091530615).

27. Letter from Richard E. Kingston, (GEH), to NRC, "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 3.9-221, 3.9- 222, 3.9-224, 3.9-225, 3.9-226, 3.9-227, 3.9-228, 3.9-229, 3.9-230, 3.9- 231, & 3.9-232," November 6, 2008 (ADAMS Accession No. ML083150742).

28. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. 339 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Number 3.9-225 S01," July 13, 2009 (ADAMS Accession No. ML091960163).

29. Desmet, W., and Vandepitte, D., "Finite Element Modeling for Acoustics." ISAAC13-International Seminar on Applied Acoustics, Leuven, ISBN 90-73802-73-3. 2002

30. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. 338 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Number 3.9-256," July 20, 2009 (ADAMS Accession No. ML092030111).

31. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. 338 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Number 3.9-257," July 13, 2009 (ADAMS Accession No. ML091960160).

32. Letter from Zahira Cruz Perez, (NRC), to Robert Brown, (GEH), "Request for Additional Information Letter No. 314 Related to ESBWR Design Certification Application – Request for Additional Information (RAI) Clarification - RAI 3.9-144 S02," March 18, 2009 (ADAMS Accession No. ML090770791).

33. Letter from Richard E. Kingston, (GEH), to NRC, "Revised Supplemental Response to NRC RAI Letter No. 314 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Number 3.9-144 S02," April 14, 2010 (ADAMS Accession No. ML101060575).

34. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. 338 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components;. RAI Number 3.9-258," July 20, 2009 (ADAMS Accession No. ML092030110).

35. Letter from Zahira Cruz Perez, (NRC), to Jerald G. Head, (GEH), "Request for Additional Information No. 392 Related to ESBWR Design Certification Application - RAI Numbers 3.9-212 S02, 3.9-214 S02, 3.9-219 S02, 3.9-245 S02, and 3.9-258 S01," November 5, 2009 (ADAMS Accession No. ML093090208).

36. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. 392 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Numbers 3.9-212 S02, 3.9-219 S02 & 3.9-258 S01," December 4, 2009 (ADAMS Accession No. ML093410604).

37. Letter from Richard E. Kingston, GEH, to NRC, "Response to Portion of NRC RAI Letter No. 338 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Number 3.9-259," July 14, 2009 (ADAMS Accession No. ML091960419).

38. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. 220 and 339 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Numbers 3.9-213 and 3.9- 217 S01," July 31, 2009 (ADAMS Accession No. ML092300515).

39. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. 338 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Number 3.9-261," July 20, 2009 (ADAMS Accession No. ML092030112).

40. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. 338 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Number 3.9-262," July 6, 2009 (ADAMS Accession No. ML091890525).

41. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. 338 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Number 3.9-263," July 20, 2009 (ADAMS Accession No. ML092030114).

42. Letter from Richard E. Kingston, (GEH) to NRC, "Response to Portion of NRC RAI Letter No. 338 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Number 3.9-264," July 9, 2009 (ADAMS Accession No. ML091940126).

43. Letter from Richard E. Kingston, (GEH), to NRC, "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 3.9-218 and 3.9-219," January 9, 2009 (ADAMS Accession No. ML091400731).

44. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. 338 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components;- RAI Number 3.9-267," July 29, 2009 (ADAMS Accession No. ML092120254).

45. Letter from Richard E. Kingston, (GEH), to NRC, "Response to Portion of NRC RAI Letter No. 338 Related to ESBWR Design Certification Application - DCD Tier 2, Section 3.9 - Mechanical Systems and Components; RAI Number 3.9-268," July 16, 2009 (ADAMS Accession No. ML092010099).

Enclosure 3

MFN 10-314

Affidavit

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, Mark J. Colby, state as follows:

(1) I am the Manager, New Plants Engineering 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 10-314, Mr. Richard E. Kingston to U.S. Nuclear Regulatory Commission, entitled *Submittal of Accepted Versions of NEDE-33312P, "ESBWR Steam Dryer Acoustic Load Definition,"* dated October 14, 2010. GEH text proprietary information in Enclosure 1, which is entitled *NEDE-33312P-A, Revision 2, "ESBWR Steam Dryer Acoustic Load Definition"* is identified by a dotted underline inside double square brackets. [[This sentence is an example.{3}]] Figures and large equation objects containing GEH proprietary information 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 that provides the basis for the proprietary determination. Note that the GEH proprietary information in the NRC's Final Safety Evaluation, which is enclosed in NEDE-33312P-A, Revision 2, is identified with underlined text inside double square brackets. [[This sentence is an example.]]

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GEH relies upon the exemption from disclosure set forth in the Freedom of Information Act (FOIA), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for trade secrets (Exemption 4). The material for which exemption from disclosure is here sought also 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 identifies detailed GE ESBWR design information. GEH utilized prior design information and experience from its fleet with significant resource allocation in developing the system over several years at a substantial cost.

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

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

the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH. The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial. GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing 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 14th day of October 2010.

Mark J. Colby

Mark J. Colby
GE-Hitachi Nuclear Energy Americas LLC