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Proprietary Notice

This letter forwards proprietary information in accordance with 10CFR2.390. Upon the removal of Enclosures 1 and 2, the balance of this letter may be considered non-proprietary.

GE Hitachi Nuclear Energy

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MFN 12-043, Revision 2

Docket number: 05200010

August 9, 2013

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

Subject: NRC Requests for Additional Information Related to the Audit of the Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design Methodology Supporting Chapter 3 of the ESBWR Design Control Document – Response for RAI 3.9-269, Supplement 1

References:

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

2. MFN 12-043, Letter from GEH to USNRC, Subject: NRC Requests for Additional Information Related to the Audit of the Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design Methodology Supporting Chapter 3 of the ESBWR Design Control Document – Draft Response for RAIs 3.9-269 and 3.9-270, dated September 27, 2012.

3. MFN 12-043, Revision 1, Letter from GEH to USNRC, Subject: NRC Requests for Additional Information Related to the Audit of the Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design methodology Supporting Chapter 3 of the ESBWR Design Control Document – Final Response for RAI 3.9-269, dated February 7, 2013.

4. MFN 13-019, Email from USNRC to Jerald G. Head, GEH, Subject: ESBWR Supplemental RAIs, dated March 27, 2013.

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In regard to the Requests for Additional Information (RAI) that the NRC transmitted in its March 27, 2013, Email, Reference 4, to support the NRC ESBWR Steam Dryer Methodology Audit conducted March 21 – 23, 2012, Docket 05200010, please find enclosed the response for RAI 3.9-269, Supplement 1 (RAI 3.9-269 S01).

Enclosures 1 and 2 contain proprietary information. The proprietary information is contained within brackets [[ ]] and is designated in red font with dotted underline to assist in identification. This RAI contains proprietary information identified by GE Hitachi Nuclear Energy, Americas LLC, and should be protected accordingly.

Enclosure 1 contains the supplemental response (proprietary version). Enclosure 2 is a revised ESBWR steam dryer report, NEDE-33408P (proprietary version). Enclosure 3 is a duplicate of Enclosure 1 with the proprietary information redacted, and is acceptable for public release. Enclosure 4 is a duplicate of Enclosure 2 with the proprietary information redacted, and is also acceptable for public release. Enclosure 5 provides an affidavit which sets forth the basis for requesting that Enclosures 1 and 2 be withheld from the public.

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

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

Sincerely,

Jerald G. Head
Senior Vice President, Regulatory Affairs

Commitments: No additional commitments are made in this response.

Enclosures:

1. Response to RAI 3.9-269 S01 – Proprietary Version.

2. GE Hitachi Nuclear Energy, "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology, PBLE01 Model Description," NEDE-33408P, Revision 3 (Proprietary), September 2013 – Proprietary Version.

3. Response to RAI 3.9-269 S01 – Public Version.

4. GE Hitachi Nuclear Energy, "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology, PBLE01 Model Description," NEDO-33408, Revision 3 (Non-Proprietary), September 2013 – Public Version.

5. Affidavit for MFN 12-043, Revision 2.

cc: David Misenhimer, NRC
Glen Watford, GEH
Peter Yandow, GEH
Patricia Campbell, GEH
Mark Colby, GEH
Scott Bowman, GEH
Tim Enfinger, GEH
eDRF Section 0000-0146-9749, Rev. 1

Enclosure 3

MFN 12-043, Revision 2

Response to RAI 3.9-269 S01

Public Version

IMPORTANT NOTICE REGARDING CONTENTS OF THIS DOCUMENT

Please Read Carefully

Overview:

Immediately below is the original response to NRC RAI 3.9-269. It is repeated here for context. Engineering Report NED-33408, Revision 2 (February 2013), was submitted with the original response to NRC RAI 3.9-269, but is not resubmitted herein because it is revised for addressing NRC RAI 3.9-269, Supplement 1 (S01). That is, Engineering Report NED-33408, Revision 3 (September 2013), is submitted herein with the response to S01 (note that this engineering report is dated September 2013 to be consistent with the other two related engineering reports revision dates).

NRC RAI 3.9-269 S01 has six (6) subparts which are addressed separately in the response further below. Where applicable and as noted, the response to S01 may refer to the original RAI or RAI response. The ESBWR Design Control Document (DCD) changes described in the original response remain valid and are not repeated in the S01 response. Licensing basis changes that apply to the response to S01 are described further below. Except for the DCD changes in the original response, the response to S01 supersedes the original response, including a revision to NEDE-33408P, which is Enclosure 2 (a public version is provided in Enclosure 4 as NEDO-33408)(see Reference [3]).

NRC RAI 3.9-269

GEH is requested to submit an end-to-end frequency-dependent steam dryer strain simulation validation using steam dryer loads computed using the GEH Plant-Based Load Evaluation (PBLE) method 1 [[ ]], *along with described adjustments to the methodology and/or bias and uncertainty to ensure the strain gage spectra for an instrumented steam dryer are bounded.*

Specifically, GEH is requested to plot the upper envelopes of the simulated strain spectra at several locations on a steam dryer (based on calculations spanning [[ ]]*), augmented with PBLE, finite element (FE), and all other bias errors and uncertainties, and show that the measured strain spectra are bounded. The spectra for each time-shifted calculation should be shifted upward and downward in frequency accordingly* [[ ]], *and an upper bound generated. The upper bound should then be adjusted according to all bias errors and uncertainties and compared to the measurements.*

In the event the strains are not bounded, GEH is requested to provide and describe adjustments in bias error/uncertainty and/or the methodology to ensure they are bounded.

Also, GEH is requested to provide a pictorial set of links between the steam dryer strain gages and all high stress regions to establish the relevance of the benchmark.

Finally, if the steam dryer analysis for the [[
]] *EPU license amendment is used as the end-to-end platform to support the ESBWR design certification application, GEH should submit the reasons why fatigue cracks occurred near the* [[ ]].

GEH Original Response

GEH Summary Response

GEH submitted a draft response to this RAI 3.9-269 (as a combined draft response with RAI 3.9-270) in GEH letter MFN 12-043, September 27, 2012. The response herein is the final response. GEH has informed the NRC in public teleconferences and in correspondence that the ESBWR steam dryer methodology for the acoustic load determination using the PBLE would be based on the Grand Gulf Nuclear Station (GGNS) replacement steam dryer benchmark rather than the previous steam dryer benchmark. In letter MFN 12-130, dated December 12, 2012 (ML12348A139), GEH informed the NRC that the approach discussed in RAI 3.9-270 would not be used in the ESBWR design certification. GEH originally proposed to use this method for non-prototype ESBWR steam dryers following an initial prototype steam dryer which has been through startup testing with measurements obtained from on-dryer instruments. GEH has determined that the non-prototype method will not be part of the ESBWR design certification. GEH recognizes that, in the future, a non-prototype method may be developed, but NRC approval of such a method would be required prior to its use. Accordingly, the ESBWR steam dryers will otherwise be subject to the process for prototype steam dryers in the design certification licensing basis documents.

The GGNS replacement steam dryer is the first project to fully implement the GEH PBLE acoustic load methodology for predictive analysis and a final analysis with actual data. Therefore, using it as a benchmark for the ESBWR steam dryer allows a demonstration of the overall ESBWR steam dryer methodology process and shows how it would be implemented for an ESBWR project. In this manner, the benchmark, which is a complete end-to-end benchmark, establishes the ESBWR methodology process sufficiently for NRC review and represents the baseline for the NRC-approved process.

The detailed end-to-end benchmark analysis requested by this RAI is provided in the attached revised ESBWR steam dryer reports, GE Hitachi Nuclear Energy, "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology," NEDC-33408P, Revision 2, Class III (Proprietary), February 2013, and NEDO-33408, Revision 2, Class I (Non-proprietary), February 2013.

ESBWR Licensing Basis Documents Impacts

In addition to revising NED-33408, as described above and as is included in Enclosure 2 (proprietary version) and Enclosure 4 (public version), the following changes to the

ESBWR DCD are made to address the above described approach. Marked-up pages are included in Enclosure 5. Final markups will be in the GEH response to RAI 3.9-292.

- Section 3L.4.1 is modified to remove the reference to BWR/4 plants, as these plants have not been found to have abnormally high pressure loads under extended power uprate operating conditions. *Steam dryers recently tested and installed in BWR/3 plants had experienced high pressure loads under extended power uprate operating conditions.*

- Section 3L.4.4 is revised to remove references to 3L-9.

  - *Reference 3L-8 provides the theoretical basis of the methodology, describes the analytical model and provides benchmark and sensitivity comparisons of the methodology predictions with measured pressure data taken from instrumented steam dryers.*

  - *Reference 3L-8 provides the results of benchmarking and sensitivity studies of the pressure load definition methodology against measured pressure data taken during power ascension testing of a replacement steam dryer installed at an operating nuclear plant. Reference 3L-8 concludes that, based on comparisons of model predictions to actual measurements, the methodology predicts good frequency content and spatial distribution, and the safety relief valve resonances are well captured.*

- Section 3L.4.4 is revised to remove the last two sentences, which refer to Method 2.
- Section 3L.4.6 is modified as follows:
  - Two types of frequency response tests are performed on the steam dryer.
  - The distribution of steam dryer instruments is determined using the Plant Based Load Evaluation model (Reference 3L-8) to provide an adequate measure of the acoustic loading through the frequency range of interest. The approach used to determine the number and locations of pressure instruments is described in Subsections 2.3.2 and 4.4.2 of Reference 3L-8.

  - It is expected that subsequent ESBWR units will follow the same FIV monitoring process using on-dryer instrumentation.

- In Section 3L.6, Reference 3L-9 is being deleted since it describes PBLE method II, which is no longer used for the ESBWR. (Note, also, that references to the reports that are being revised, including NED-33408, will be changed in response to RAI 3.9-292.)

Below is the GEH response to RAI 3.9-269, Supplement 1.

NRC RAI 3.9-269 S01

Question Summary:

The staff's question is in regard to GEH's response to RAI 3.9-269.

Full Text:

GEH did not completely answer RAI 3.9-269 (MFN 12-043, Revision 1, February 7, 2013). GEH should specifically be sure to include the following in a revised response:

1. *RAI 3.9-269 contains four subparts. GEH's response does not appear to map to these four subparts. GEH may describe where the requested information is located in its response. As an alternative, GEH may supplement and resubmit the response.*

2. *GEH has not demonstrated (as the staff requested in the RAI) that the full range of structural strain analyses over [[ ]] and including the reported bias and uncertainty (B/U) has bounded measured data.*

3. *Report NEDE 33408 Rev. 2 is incomplete, and does not include sufficient description of the end-to-end benchmarking approach, particularly in Section 4.4.4. This description must be provided either in a revision to 33408, or via reference to other reports or design control document (DCD) sections.*

Also, the staff has follow-up questions based on the information provided in the response. They are:

4. *The [[ ]] demonstration is not prototypic of that to be used for the ESBWR dryer, since all pressure sensors [[ ]]. The resulting end-to-end B/U's appear to be very high. However, the response also contains plots of the CLTP pressure data which are based on the prototypic Plant Based Load Evaluation (PBLE) approach [[ ]]. Since the surface pressure comparisons for CLTP are far more representative of those expected for ESBWR design, GEH has the option to provide a CLTP-based [[ ]] as the basis for the ESBWR analysis and design approach.*

5. *The staff also notes that GEH, in its response to RAI 3.9-292, plans to take credit for [[ ]] in its ESBWR design. The staff does not have the information necessary to determine if taking credit for [[ ]] is acceptable. Reactor pressure vessel, MSL, and dryer geometry changes (which affect resonance frequencies) and differences in flow velocities (which affect the frequency-dependence of fluctuating surface loading on the dryer) between the [[ ]] and the ESBWR designs will shift dominant dryer alternating stress peak frequencies upward and/or downward, such that the [[ ]] may not be applicable for ESBWR. GEH is asked to quantitatively establish that taking credit for [[ ]] will not lead to nonconservative dryer alternating stress calculations in the ESBWR design. Providing [[ ]] at multiple plant power conditions (such as CLTP, discussed in item 4) would help establish the global conservatism of the bias errors. In the absence of further supporting information, GEH is asked not to include credit for conservative [[ ]] in future ESBWR dryer alternating stress calculations, with possible exemptions at and around postulated safety relief valve (Quad Cities Unit 2) and deadleg (Susquehanna) tonal frequencies, which are not expected to occur in the ESBWR plants per GEH design commitments.*

6. *GEH should address sensor redundancy in its ESBWR instrumented dryer plan to ensure that ESBWR benchmarking is not compromised in the manner that [[ ]] has been.*

GEH Response:

To address the RAI supplemental questions above, this response supersedes the original RAI 3.9-269 response in Reference [1], except for the DCD changes identified in the original response. Where appropriate, the detailed questions in the original RAI are repeated in the response to provide a clear mapping to the original questions. The GEH response is structured to align with the above number of RAI 3.9-269 S01. Engineering Report NEDE-33408P (Enclosure 2), and the public version NEDO-33408 (Enclosure 4), Reference [3], are submitted with this response.

GEH has informed the NRC in public teleconferences and in correspondence that the ESBWR steam dryer methodology for the acoustic load determination using the PBLE01 methodology would be based on the Grand Gulf Nuclear Station (GGNS) replacement steam dryer benchmark rather than the previous steam dryer benchmark. In letter MFN 12-130, dated December 12, 2012 (ML12348A139) [2], GEH informed the NRC that the approach discussed in RAI 3.9-270 would not be used in the ESBWR design certification. GEH originally proposed to use this method for non-prototype ESBWR steam dryers following an initial prototype steam dryer which has been through startup testing with measurements obtained from on-dryer instruments. GEH has determined that the non-prototype method will not be part of the ESBWR design certification. GEH recognizes that, in the future, a non-prototype method may be

developed, but NRC approval of such a method would be required prior to its use. Accordingly, the ESBWR steam dryers will otherwise be subject to the process for prototype steam dryers in the design certification licensing basis documents.

In that the "as-built" ESBWR steam dryer design will not be available for the COL applicant to perform a fatigue analysis prior to COL issuance, the COL applicant will need to follow the guidance in RG 1.206 to provide sufficient information to support the NRC licensing decision (such as successful implementation of the PBLE01 Method 1 on a sample steam dryer) and then rely on an ITAAC to complete the resolution of the COL Information Item. The application of the PBLE01 Method 1 for the fatigue analysis of the GGNS replacement steam dryer (including lessons learned from issues identified during the analysis of the steam dryer data) is presented in this response and in Reference [3] as an example of the successful implementation of the methodology. This will allow the COL applicant to incorporate by reference this information in its FSAR to satisfy RG 1.20.

The detailed end-to-end benchmark analysis and application demonstration requested by this RAI is provided in the enclosed revised ESBWR steam dryer reports, GE Hitachi Nuclear Energy, "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology, PBLE01 Model Description," NEDE-33408P, Revision 3, Class III (Confidential), September 2013 (Enclosure 2), and NEDO-33408, Revision 3, Class I (Non-proprietary), September 2013 (Enclosure 4) [Reference 3].

Subpart 1:

RAI 3.9-269 contains four subparts. GEH's response does not appear to map to these four subparts. GEH may describe where the requested information is located in its response. As an alternative, GEH may supplement and resubmit the response.

Response to Subpart 1:

To facilitate mapping of the GEH response to the original RAI 3.9-269 content, the four subparts are repeated below (numbering and formatting added for clarity).

i. *GEH is requested to submit an end-to-end frequency-dependent steam dryer strain simulation validation using steam dryer loads computed using the GEH Plant-Based Load Evaluation (PBLE) method 1* [[ ]], *along with described adjustments to the methodology and/or bias and uncertainty to ensure the strain gage spectra for an instrumented steam dryer are bounded.*

GEH has performed an end-to-end frequency-dependent steam dryer structural simulation of the GGNS replacement steam dryer at EPU conditions using steam

dryer loads computed with the GEH PBLE01 Method 1. The results of the simulation have been compared to the measured on-dryer strain gage and accelerometer sensor measurements and end-to-end bias and uncertainties have been determined (see the response to 1(ii) below for more detail). These end-to-end bias and uncertainties will be applied to the prototype ESBWR steam dryer structural analysis. The end-to-end benchmarking is described in detail in Reference [3], Section 4.5.3.

GEH has also applied the resultant end-to-end bias and uncertainties to the steam dryer structural response to project peak stress and ASME load case stress results as well as projected sensor responses. These results are presented as an example of a successful implementation of the methodology. The validation of the methodology through the determination of the peak stress and ASME load case stresses is described in detail in Reference [3], Section 4.5.

Licensing Basis Changes for Subpart 1(i):

Changes to the ESBWR licensing basis are identified in NEDE-33408P/NEDO-33408 (Reference [3]).

ii. *Specifically, GEH is requested to plot the upper envelopes of the simulated strain spectra at several locations on a steam dryer (based on calculations spanning* [[ ]]*), augmented with PBLE, finite element (FE), and all other bias errors and uncertainties, and show that the measured strain spectra are bounded. The spectra for each time-shifted calculation should be shifted upward and downward in frequency accordingly* [[

]], *and an upper bound generated. The upper bound should then be adjusted according to all bias errors and uncertainties and compared to the measurements.*

In the event the strains are not bounded, GEH is requested to provide and describe adjustments in bias error/uncertainty and/or the methodology to ensure they are bounded.

In summary, comparison plots of the strain and acceleration peak amplitudes and spectra for each of the GGNS replacement steam dryer sensors are provided in Figures G-2 through G-13 of Reference [3], Appendix G. These comparison plots show that the [[

]]. There are a few sensors where the measured amplitude [[ ]] GEH has revised the ESBWR licensing basis to include a MASR acceptance criterion of 2.0 for the ESBWR steam dryer design fatigue analyses (References [2] and [6]). This criterion will ensure there is sufficient margin in the ESBWR dryer design to address

uncertainties in the steam dryer fatigue analyses. In addition, as stated in the response to Part 5 of RAI 3.9-269 S01, GEH has committed to not include credit for [[ ]] in future ESBWR dryer alternating stress calculations. In other words, [[ ]]. These increases in the prescribed margin in the methodology are sufficient to ensure that the upper bound of the adjusted strains and accelerations in the fatigue analysis will bound measured strains and accelerations. A summary of this information is also provided in Section 4.5.4 of Reference [3].

Plots of the simulated strain and acceleration peak amplitudes and spectra for each of the GGNS replacement steam dryer sensors are provided in Figures G-2 through G-13 of Reference [3], Appendix G. The adjusted strain and acceleration amplitudes and spectra have been determined by [[ ]]. This has been performed for the [[ ]] representing the [[ ]] cases. An upper bound envelope was generated for the spectra based on the results of the [[ ]] including the bias errors and uncertainties. Figure G-1 is an example of the construction of the upper bound envelope from the [[ ]].

Also plotted on Figures G-2 through G-13 are the measured sensor responses over the analysis time period. The measured amplitude response curves (plotted in black) show the peak amplitude in each of the [[ ]] used in the demonstration benchmark analyses. The adjusted amplitude curves (plotted in red) are shown as a straight line across the [[ ]] time period and represent the results from the analysis time segment. The spectral plots compare the upper bound envelope of the adjusted strains and accelerations (plotted in red) to the measured signal spectra for the time segments that had the maximum amplitudes for the measured signals (plotted in black). For example, in Figure G-2 (sensor A1), the maximum amplitude occurs in time segment [[ ]]; the spectrum shows the frequency content for time segment [[ ]].

The peak amplitude plots show that the adjusted strains and accelerations bound the measured data for [[ ]]. The spectral plots for the sensors all show [[ ]]; however, since fatigue is dependent on the alternating stress intensity, the adjusted peak amplitude comparison is the proper metric for determining whether the measured response is bounded by the analysis. There are a few sensors where the measured amplitude [[ ]] GEH has revised the ESBWR licensing basis to include a MASR acceptance criterion of 2.0 for the ESBWR steam dryer design fatigue analyses (References [2] and [6]). This is also consistent with replacement steam dryer analyses where a MASR of 2.0 is applied to address uncertainties in steam dryer fatigue analyses.

In addition, as stated in the response to Part 5 of RAI 3.9-269 S01, GEH has committed to not include credit for [[ ]] in future ESBWR dryer alternating stress calculations. In other words, [[

]]. These increases in the prescribed margin in the methodology are sufficient to ensure that the upper bound of the adjusted strains and accelerations in the fatigue analysis will bound measured strains and accelerations.

Licensing Basis Changes for Subpart 1(ii):

Changes to the ESBWR licensing basis are as noted in the references below. Refer to Reference [6] for the final licensing basis changes that implemented the MASR acceptance criterion of 2.0. Refer to the response to Question 5 for this RAI for the licensing basis changes incorporating the commitment to not include credit for [[ ]].

iii. Also, GEH is requested to provide a pictorial set of links between the steam dryer strain gages and all high stress regions to establish the relevance of the benchmark.

Figures have been developed to show the location of the maximum stress locations. The stress contours and maximum stress locations for three of the limiting components are shown in Reference [3], Section 4.5, Figures 27, 28 and 29. Figures 30 and 31 of Reference [3], Section 4.5, show the dryer sensor locations (strain gages and accelerometers) and the seven highest stress locations.

The installed sensor locations were selected to provide good correlation with dryer high stress areas and redundancy such that multiple instruments will have good correlation with the high stress regions. The same approach was used to describe how the maximum stress locations at the [[ ]] benchmark test conditions are associated with the strain gages and accelerometers.

To select the strain gage and accelerometer locations, [[

]].The results [[ ]] are presented in Figures H-1 through H-7 of Reference [3], Appendix H, for the seven high stress locations depicted in Figures 30 and 31 of Reference [3]. The [[ ]] figures demonstrate that for the seven high stress locations, [[

]].

The sensors were located to measure the global dryer response [[

]]. The [[ ]] charts presented in Reference [3], Appendix H, illustrate that multiple sensors [[ ]] and support using [[

]].

Licensing Basis Changes for Subpart 1(iii):

Changes to the ESBWR licensing basis are identified in NEDE-33408P/NEDO-33408 (Reference [3]).

iv. Finally, if the steam dryer analysis for the [[ ]] *EPU license amendment is used as the end-to-end platform to support the ESBWR design certification application, GEH should submit the reasons why fatigue cracks occurred near the* [[ ]].

GEH is not proposing to use the [[ ]] plant data as the end-to-end platform to support the ESBWR design certification application. References to the [[ ]] steam dryer analysis have been removed from Reference [3].

Licensing Basis Changes for Subpart 1(iv):

Changes to the ESBWR licensing basis are identified in NEDE-33408P/NEDO-33408 (Reference [3]).

Subpart 2:

GEH has not demonstrated (as the staff requested in the RAI) that the full range of structural strain analyses over [[ ]] and including the reported bias and uncertainty (B/U) has bounded measured data.

Response to Subpart 2:

GEH has provided the additional requested information in response to Subpart 1 (ii) (above).

Licensing Basis Changes for Subpart 2:

See Subpart 1(ii) (above).

Subpart 3:

Report NEDE 33408 Rev. 2 is incomplete, and does not include sufficient description of the end-to-end benchmarking approach, particularly in Section 4.4.4. This description must be provided either in a revision to 33408, or via reference to other reports or design control document (DCD) sections.

Response to Subpart 3:

GEH has supplemented NEDE-33408P with additional description of the application of the steam dryer methodology to the GGNS replacement steam dryer in Section 4.5 of Reference [3]. This additional information includes the determination of the peak stress and ASME load case stress, [[ ]], figures showing the relationship between the peak stress locations and on-dryer sensors and a discussion of the lessons learned from the GGNS EPU analysis and how these are addressed for the ESBWR methodology. The revised engineering report is provided in Reference [3].

Licensing Basis Changes for Subpart 3:

Changes to the ESBWR licensing basis are identified in NEDE-33408P/NEDO-33408 (Reference [3]).

Subpart 4:

The [[

]] demonstration is not prototypic of that to be used for the ESBWR dryer, since all pressure sensors [[

]]. The resulting end-to-end B/U's appear to be very high. However, the response also contains plots of the CLTP pressure data which are based on the prototypic Plant Based Load Evaluation (PBLE) approach [[

]]. Since the surface pressure comparisons for CLTP are far more representative of those expected for ESBWR design, GEH has the option to provide a CLTP-based [[ ]] as the basis for the ESBWR analysis and design approach.

Response to Subpart 4:

The end-to-end B/U provided in Appendix F of Reference [3] from [[ ]] are adequate for use in the design of the ESBWR steam dryer as shown in the replacement dryer demonstration analysis results provided in Section 4.5 of Reference [3].

The demonstration benchmark analysis used all available pressure sensors for the load definition. As described in Reference [3], Section 4.4.2, [[

]].

Evaluations were performed in support of the GGNS EPU that compared the effect of using the EPU sensor combination [[ ]] to using just [[ ]] on the PBLE01 predictive capabilities at Previous Licensed

for the EPU sensor combination calibration [[ ]] did not impact overall pressure load bias values as much as using just four [[ ]]. The ability to [[

]].

[[ ]], it was noted that during the power ascension to EPU, the PBLE01 predictive capability was determined at [[ ]]. Comparison of the pressure load bias and uncertainties at the different power levels showed that in general PBLE01 pressure load bias and uncertainties were not heavily impacted [[ ]]. The only portion of the frequency spectrum that showed some difference in pressure load bias and uncertainties was around the [[ ]]. Based on these results, it is expected that performing [[ ]] will not result in substantially different end-to-end bias and uncertainty values than those determined at [[ ]]. Therefore, the end-to-end bias and uncertainty values provided in Reference [3] are adequate for use in the ESBWR dryer design process.

The demonstration analysis results presented in Section 4.5.6 of Reference [3] show that even with a load definition based on data [[ ]], the projected peak stress is below the fatigue limit. [[

]].

In general, improving the load definition will reduce the end-to-end B/U; therefore, using the [[ ]] will introduce substantial additional conservatism to the bias and uncertainty process. However, based on [[

]]. The stress results from the demonstration analysis show that the [[ ]]. Therefore, [[ ]] are adequate for use in the design of the ESBWR steam dryer.

Licensing Basis Changes for Subpart 4:

Changes to the ESBWR licensing basis are identified in NEDE-33408P/NEDO-33408 (Reference [3]).

Subpart 5:

The staff also notes that GEH, in its response to RAI 3.9-292, plans to take credit for [[ ]] in its ESBWR design. The staff does not have the information necessary to determine if taking credit for [[ ]] is acceptable. Reactor pressure vessel, MSL, and dryer geometry changes (which affect resonance frequencies) and differences in flow velocities (which affect the frequency-dependence of fluctuating surface loading on the dryer) between the [[ ]] and the ESBWR designs will shift dominant dryer alternating stress peak frequencies upward and/or downward, such that the [[ ]] may not be applicable for ESBWR. GEH is asked to quantitatively establish that taking credit for [[ ]] will not lead to nonconservative dryer alternating stress calculations in the ESBWR design. Providing [[ ]] at multiple plant power conditions (such as CLTP, discussed in item 4) would help establish the global conservatism of the bias errors. In the absence of further supporting information, GEH is asked not to include credit for conservative [[ ]] in future ESBWR dryer alternating stress calculations, with possible exemptions at and around postulated safety relief valve (Quad Cities Unit 2) and deadleg (Susquehanna) tonal frequencies, which are not expected to occur in the ESBWR plants per GEH design commitments.

Response to Subpart 5:

Bias and uncertainty values are a means to adjust analysis results, which effectively adds margin to the design. The NRC request highlights a concern [[ ]] may shift relative to the ESBWR design. However, the ESBWR design basis loads [[ ]] the expected ESBWR loads.[1] An examination of the [[ ]] values indicates that there are only a few potential ESBWR analysis [[

[1] A detailed discussion is provided in Reference [7]. The design approach for the ESBWR is to [[ ]].

]]. This range is not centered on the dead leg tonal frequencies and would not be expected to have a dramatic impact on calculated results using the design loads defined in Reference [7]. Therefore, GEH will not include credit for conservative [[ ]] in future ESBWR dryer alternating stress calculations. To be clear, [[

]].

In general, the intended results of any analysis can be conservative due to a combination of code inputs, modeling assumptions, the choice of design margins, and the selection of design limits. The end-to-end bias and uncertainty values are only a single element of the analysis that drives conservatism. The PBLE01-based analysis methodology incorporates conservative design basis loads, margin for bias and uncertainty, conservative model assumptions, and additional margin to the design limit (i.e., fatigue limit). This approach is sufficient to ensure that the ESBWR steam dryer design will be adequate. GEH has committed in the ESBWR DCD, Section 3.9.2.4 [9] and Appendix 3L [5] to the requirements specified in the Regulatory Guide 1.20 comprehensive vibration assessment program [8], which mandates that the overall program of analysis, measurement, and inspection will be used cooperatively to verify the structural integrity of the dryer.

Licensing Basis Changes for Subpart 5:

There are no proposed changes to the DCD. Changes proposed to NEDE-33312P, NEDE-33313P, and NEDE-33408P as a result of this RAI response are listed in Table 1, Table 2, and Table 3, respectively, below.

Table 1 – Proposed Changes to NEDE-33312P

Item	Section	Description
1	Title and cover page	Update the revision number and date for the new report version.
2	6.0	Update Reference 3 (new revision). Also, correct the report title to include the subtitle "PBLE01 Model Description."
3	Various sections	Change references to the Plant-Based Load Evaluation (PBLE) methodology from "PBLE" to "PBLE01."
4	1.0	Expand the 3rd bullet. Add a statement that the [[ ]].
5	4.1	Revise Table 4.1-1, "Comparison of Geometry and Flow Parameters." Add the relevant information for the [[ ]].

Table 2 – Proposed Changes to NEDE-33313P

Item	Section	Description
1	Title and cover page	Update the revision number and date for the new report version.
2	Various sections	Change references to the Plant-Based Load Evaluation (PBLE) methodology from "PBLE" to "PBLE01."
3	1.0	Expand the 3rd bullet. Add a statement that the [[ ]].
4	5.2.2	Revise the bias and uncertainty discussion to note that no credit is applied [[ ]].
5	11.0	Update Reference 1 (NEDE-33312P).
6	11.0	Update Reference 9 (new revision). Also, correct the report title to include the subtitle "PBLE01 Model Description."

Table 3 – Proposed Changes to NEDE-33408P

Item	Section	Description
1	Title and cover page	Update the revision number and date for the new report version.
2	Section 4.5.3 and Appendix F	Provide a note that [[ ]] for application to the ESBWR steam dryer.

Subpart 6:

GEH should address sensor redundancy in its ESBWR instrumented dryer plan to ensure that ESBWR benchmarking is not compromised in the manner that [[ ]] has been.

Response to Subpart 6:

The ESBWR steam dryer instrumentation plan is described in DCD Section 3L-4.2 (Reference [5], as updated in Reference [6]). Detailed guidance for determining the locations for the on-dryer pressure transducers is provided in Sections 2.3.2 and 4.4.2 of Reference [3]. A well-designed sensor layout based on the [[ ]] as recommended in Reference [3] will result in an instrumentation system that is tolerant of sensor failures. Detailed guidance for determining the locations for the on-dryer strain gages and accelerometers is provided in Section 9.1 of Reference [4]. In addition to [[ ]] in order to provide redundancy in the measurements. The fourth

paragraph of Section 9.1 of Reference [4] will be revised to include this additional recommendation.

Licensing Basis Changes for Subpart 6:

There are no proposed changes to the DCD. Changes proposed to NEDE-33313P are shown on the table below.

Proposed Changes to NEDE-33313P

Item	Section	Description
1	Section 9.1, Fourth paragraph	The fourth paragraph of Section 9.1 of Reference 4 will be revised to read: [[ ]] (NOTE: Added text is highlighted. The fourth sentence is added.)

References

1. MFN 12-043 Rev. 1, Jerald Head to the US Nuclear Regulatory Commission Document Control Desk, "NRC Requests for Additional Information (RAI) Related to the Audit of the Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design Methodology Supporting Chapter 3 of the ESBWR Design Control Document – GEH Final Response to RAI 3.9-269," February 7, 2013.
2. MFN 12-130, Jerald Head to the US Nuclear Regulatory Commission Document Control Desk, "Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design Methodology Supporting Chapter 3 of the ESBWR Design Control Document," December 12, 2012 (ML12348A139).
3. NEDE-33408P, Revision 3, "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology, PBLE01 Model Description," September 2013 *(Enclosure 2 herein)*; NEDO-33408, Revision 3 (Non-proprietary), September 2013 *(Enclosure 4 herein)*.

4. NEDE-33313P, Revision 3, "ESBWR Steam Dryer Structural Evaluation," February 2013. *Note that this Engineering Report will be revised and submitted with a date of September 2013.*
5. 26A6642AN, Revision 9, "ESBWR Design Control Document Tier 2 Chapter 3 Design of Structures, Components, Equipment, and Systems, Appendices 3G – 3L." *Note that Revision 10 will incorporate changes based on recent RAI responses.*
6. MFN 12-065 Rev. 1, Letter from Jerald G. Head, GEH, to NRC, "NRC Requests for Additional Information Related to the Audit of the Economic Simplified Boiling Water Reactor (ESBWR) Steam Dryer Design Methodology Supporting Chapter 3 of the ESBWR Design Control Document – GEH Final Response for RAI 3.9-293," February 8, 2013.
7. NEDE-33312P, Revision 3 "ESBWR Steam Dryer Acoustic Load Definition", February 2013. *Note that this Engineering Report will be revised and submitted with a date of September 2013.*
8. Regulatory Guide 1.20, "Comprehensive Vibration Assessment Program for Reactor Internals During Preoperational and Initial Startup Testing," Revision 3, March 2007.
9. 26A6642AK, Revision 9, "ESBWR Design Control Document Tier 2 Chapter 3 Design of Structures, Components, Equipment, and Systems, Section 3.9 – 3.11." *Note that Revision 10 will incorporate changes based on recent RAI responses.*