July 29, 2008

Mr. Robert E. Brown
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GE Hitachi Nuclear Energy
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SUBJECT: 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

Dear Mr. Brown:

The U. S. Nuclear Regulatory Commission (NRC) staff informed you of the result of the acceptance review of NEDE-33312P, "ESBWR Steam Dryer Acoustic Load Definition," NEDE-33313P, "ESBWR Steam Dryer Structural Evaluation," NEDC-33408P, "ESBWR Steam Dryer-Plant Based Load Evaluation Methodology," NEDE-33259P, "Reactor Internals Flow Induced Vibration Program." The staff determined that the material presented in the topical reports is sufficient to begin a detailed review as part of the ESBWR design certification review.

The NRC staff has identified that additional information is needed to continue portions of the review. The staff's request for additional information (RAI) is enclosed.

Pursuant to 10 CFR 2.390, we have determined that the enclosed RAIs contain proprietary information. We have prepared a non-proprietary version of the RAIs (Enclosure 1) that does not contain proprietary information. The proprietary information is indicated in brackets and underlined in Enclosure 2. We will delay placing this document in the public document room for a period of ten (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 the enclosure is proprietary, please identify such information line by line and define the basis pursuant to the criteria of 10 CFR 2.390 before the public release date.

If you have any questions or comments concerning this matter, you may contact me at 301-415-3025 or Chandu.Patel@nrc.gov or you may contact Amy Cubbage at 301-415-2875 or Amy.Cubbage@nrc.gov.

Sincerely,

/RA/

Chandu Patel, Senior Project Manager
ESBWR/ABWR Projects Branch 1
Division of New Reactor Licensing
Office of New Reactors

Docket No. 52-010

Enclosure:
1. Request for Additional Information (Non-Proprietary)
2. Request for Additional Information (Proprietary)

cc: See next page (w/o enclosure 2)

If you have any questions or comments concerning this matter, you may contact me at 301-415-3025 or Chandu.Patel@nrc.gov or you may contact Amy Cubbage at 301-415-2875 or Amy.Cubbage@nrc.gov.

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ADAMS ACCESSION NO.: ML082060534 NRO-002

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DATE	07/29/2008	07/28/2008

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Requests for Additional Information (RAIs):
NEDE-33312P, "ESBWR Steams Dryer Acoustic Load Definition," Revision 0

RAI Number	Reviewer	Question Summary	Full Text
3.9-205	Sekerak P	Provide rationale for change in steam dome geometery from ABWR	In Report NEDE-33312P, GEH opts to maintain the geometry of the Economic Simplified Boiling Water Reactor (ESBWR) dryer similar to that of the ABWR. However, the steam dome of the ABWR is hemispherical, whereas that of the ESBWR is torispherical, which will result in different flow patterns in the steam dome region. Provide the rationale for the change in the steam dome geometry from hemispherical, as in boiling-water reactor (BWRs) and advanced boiling-water reactors (ABWRs), to torispherical geometry.
3.9-206	Sekerak P	Compare the steam flow velocities in ABWRs and ESBWR	GEH asserts that the design of the ESBWR dryer will be based on the operating experience of ABWRs and the available in-plant measurements of this reactor type. However, the ESBWR steam flow rate is projected to be approximately 15% higher than that of the ABWR. Compare the steam flow velocities: (a) issuing from the dryer banks; (b) in the steam plenum; and (c) in the main steam lines (MSLs) with those in the ABWR. If any of these velocities is higher in the ESBWR, explain how the higher velocities will be accounted for in the steam dryer load definitions.
3.9-207	Sekerak P	Explain how dynamic loading will be assessed	[[

RAI Number	Reviewer	Question Summary	Full Text
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3.9-208	Sekerak P	Elaborate on steady state parameters that would affect acoustic loads	[[ ]] Elaborate on the steady state parameters that would indicate any changes (a reduction or an increase) in the acoustic excitation level or frequency.
3.9-209	Sekerak P	Submit CFD analysis for review	Submit the CFD analyses of the ABWR and proposed ESBWR flows for review. All methodologies and assumptions should be clearly stated, along with bias errors and uncertainties.
3.9-210	Sekerak P	Provide details on the performance of any FIV mitigation device	[[ ]]
3.9-211	Sekerak P	Submit acoustic loading for review	The report does not include the acoustic loading that GEH plans to apply to its ESBWR steam dryer design. GEH should submit the acoustic loading for review, including the components of the loading that are derived from different plants (ABWR and/or BWR), and all bias errors and uncertainties.

Requests for Additional Information (RAIs)
NEDE-33313P, "ESBWR Steams Dryer Structural Evaluation," Revision 0

RAI Number	Reviewer	Question Summary	Full Text
3.9-212	Sekerak P	Provide comparison of ABWR and ESBWR dryer designs	Since the ESBWR steam dryer design is based on the ABWR dryer design, provide a comparison of these two designs and explain how the differences in the designs may affect the stress analysis results for ESBWR dryer. GEH should also provide the stress analysis results including fatigue evaluation for ABWR design. Also, discuss comparison of these calculated results with the measured results and provide the associated uncertainties and bias errors.
3.9-213	Sekerak P	Provide stress analysis and fatigue assessment results for BWR replacement dryers	In the April 17, 2008 meeting GEH told the staff that the ESBWR dryer modeling, stress analysis and fatigue assessment approach is being based on its application to the BWR replacement dryers. Therefore, GEH is requested to provide stress analysis and fatigue assessment results for those dryers. Also discuss comparison of these calculated results with the measured results and provide the associated uncertainties and bias errors.
3.9-214	Sekerak P	Describe the type of welds used in the design	GEH does not provide much information regarding fabrication of the dryer in NEDE-33313P, Rev. 0. Therefore, GEH is requested to describe the type of welds to be used in the design, their locations with respect to high-stress locations in the dryer, their inspection during fabrication, and any heat treatment they may receive.

RAI Number	Reviewer	Question Summary	Full Text
3.9-215	Sekerak P	Provide the basis for validation of weld factors	[[ ]] However, GEH does not explain how it will develop and validate these weld factors. Therefore, GEH is requested to provide the basis for validation of weld factors applied to the finite element model (FEM) analysis results.
3.9-216	Sekerak P	Provide information about mesh size used for modeling	In Section 5.1, NEDE-33313P, Rev. 0, GEH does not provide sufficient detail on their finite element modeling and analysis procedure for the staff to determine their adequacy. Provide information about the mesh size used for modeling different parts of the dryer. Also provide mesh convergence studies in high strain and stress regions in the ESBWR dryer to assess whether the dimensions and mesh spacing used for the model are adequate and determine the associated errors.

RAI Number	Reviewer	Question Summary	Full Text
3.9-217	Sekerak P	Uncerntainty and bias	[[ ]] The final uncertainty/bias should be applied directly to the dryer stresses.
3.9-218	Sekerak P	Discuss which analysis method may be more appropriate for the dynamic stress analysis	[[ ]]

RAI Number	Reviewer	Question Summary	Full Text
3.9-219	Sekerak P	Provide additional information regarding the method used for performing the stress analysis of the ESBWR	[[ ]] High cycle fatigue cracking has occurred in several operating BWR steam dryers after a long period of operation (more than 10 to 20 years). This implies that the frequency of the highest range of the alternating stress intensity experienced by these steam dryers is low (~1 cycle per 100s). [[ ]]
3.9-244	Sekerak P	Provide specific identification of ASME Code, Subsection NG requirements that constitute the design basis for the steam dryer	The last sentence of NEDE-33313P, Section 4.0 states, "The steam dryer is not an ASME Code component, but shall comply to the applicable requirements of ASME Code Subsection NG, to the extent possible." This statement is not acceptable as a basis for design certification, because it is vague, open to various interpretations, and does not specifically identify the design criteria that have been applied to the construction of the component. Clarification should be provided which would define the specific ASME Code requirements or Articles (e.g., Article NG-3000, Design) which have been selected as the design basis and acceptance criteria for construction of the steam dryer. The clarification discussion should be included in a revision to NEDE-33313P, Section 4.0.

Requests for Additional Information (RAIs)
NEDC-33408P, "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology," Revsion 0

RAI Number	Reviewer	Question Summary	Full Text
3.9-220	Sekerak P	Provide PBLE validation studies	In report NEDC-33408P, measurements from one plant only have been used to benchmark the plant based load evaluation (PBLE) method. The NRC Staff was informed that GEH will perform additional PBLE validation studies, using available dryer measurements from two ABWRs and another BWR at EPU operation. Provide these validation studies, including the geometry and flow parameters of the steam dryers.
3.9-221	Sekerak P	Provide experimental validation of equations 13 &14	The speed of sound (a) and [[.]]
3.9-222	Sekerak P	Clarify why the acoustic model is insensitive to an order of magnitude change in the steam properties	In the acoustic finite element model, [[.]] GEH is requested to clarify why the acoustic model is insensitive to almost an order of magnitude change in the steam properties in the dryer banks.

RAI Number	Reviewer	Question Summary	Full Text
3.9-223	Sekerak P	Assess the levels of local bias and uncertainty errors	In estimating the bias and uncertainty of PBLE predictions in comparison with QC2 measurements, the power spectra density (PSDs) of all 27 pressure transducers [[.]] Alternatively, the error can be [[ ]]
3.9-224	Sekerak P	Explain the effect of wetness fraction and droplet size on the resonance frequencies	[[.]]
3.9-225	Sekerak P	Provide more information to support the PBLE uncertainties assessment	GEH analyzed a refined mesh of the acoustic finite element model to assess the effect of mesh size on PBLE uncertainties. [[ ]]

RAI Number	Reviewer	Question Summary	Full Text
3.9-226	Sekerak P	Explain discrepancies between Table 6 and the conclusions section of QC benchmark	[[ ]] Explain this discrepancy.
3.9-227	Sekerak P	Specify the bias error and uncertainty applied to dryer loads estimated in the design	GEH should specify what final bias error and uncertainty GEH will apply to dryer loads estimated for the ESBWR design. Are they based on QC benchmark data? The Design of Experiments data? Both? Are any conservative bias errors credited?
3.9-228	Sekerak P	Explain whether singularities in the acoustic FRF matrices lead to non-conservative errors	GEH should explain whether [[ ]] lead to non-conservative errors in the computed loading, such as sharp dips at certain frequencies. If so, how will GEH account for the errors?
3.9-229	Sekerak P	Describe the options of SYSNOISE used in the analysis	Section 2.1 of NEDC-33408P: (a) Provide a description of the options of SYSNOISE used in the analysis. (b) Provide a description of the interface between SYSNOISE and MATLAB.

RAI Number	Reviewer	Question Summary	Full Text
3.9-230	Sekerak P	Provide detail description of analysis procedure	Section 2.2.1, NEDC-33408P: [[ ]] (b) Show how the Helmholtz form of the wave equation that includes the [[ ]]was obtained, or provide a reference where this may be obtained. (c) Provide the detailed formulation of the finite element implementation of the Helmholtz form of the wave equation leading to Equation 1 on Page 4, or provide a reference in the literature where this implementation may be found. (d) State the method for determining the [[ ]] of Equation 1. (e) Show the formulation for obtaining the velocity field by differentiation of the pressure field.
3.9-231	Sekerak P	Provide basis for the requirement selected	[[ ]]

RAI Number	Reviewer	Question Summary	Full Text
3.9-232	Sekerak P	Provide further details about the analysis method	[[ ]]

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Requests for Additional Information (RAIs)
NEDE-33259, "Reactor Internals Flow Induced Vibration Program," Revision 1

RAI Number	Reviewer	Question Summary	Full Text
3.9-233	Sekerak P	Elaborate on the design and modeling of the chimney supports	Elaborate on the design and modeling of the chimney supports at the top guide (lower supports) and upper reactor pressure vessel (RPV) restraints (upper supports) as they relate to FIV structural dynamic analysis and the insertion and removal of the Chimney and/or partitions during initial fabrication and refueling. In particular, are the physical supports/gaps adjustable and how are the supports modeled (as simple supports or supports with gaps?) in dynamic structural analysis? If the eight lateral restraints are not engaged, what are the modal characteristics of the shroud/chimney/separator structure? What is the uncertainty that the beam model of the support employed in the modal analysis is representative of the physical support? What are the uncertainties in the calculated stresses to account for any ambiguities in the upper chimney supports and FIV excitation sources? In particular, what are the stresses and loads, comparable to those reported in Table 5 of NEDE-33259P, Rev.1, if the eight upper lateral restraints on the chimney are not engaged?
3.9-234	Sekerak P	Discuss potential fluid forces created by the Head/Steam Separators	Elaborate on the potential fluid forces created by the Head/Steam Separators and their possible effects on FIV excitation of the ESBWR Shroud/Chimney/Separator Structure.
3.9-235	Sekerak P	Identify the loads transmitted to the RPV	In the case that the upper restraints are engaged, what are the loads transmitted to the RPV and the stresses in the upper chimney restraints? What are the uncertainties in the calculated stresses to account for ambiguities in the support provided by restraints excitation sources?

RAI Number	Reviewer	Question Summary	Full Text
3.9-236	Sekerak P	Provide rationale for the change to the new flat-shaped chimney head/separator assembly design	Provide the rationale for the change to the new flat-shaped Chimney Head/Separator Assembly design in the ESBWR, the pertinent details of the structural design as they relate to structural dynamic analysis, the pertinent details of the internal flow conditions and their potential for FIV excitation. Also, discuss the stresses in the Chimney Head/Separator Assembly's separator/standpipe "forest" and individual separator/standpipe units that are caused by internal flow. The response to RAI 3.9-51 does not address the concerns.
3.9-237	Sekerak P	Provide analyses that show stresses in the SLC Line are below design limits	Stresses in the SLC line due to the dynamics of the supports are not discussed. In Section 5.5, each standby liquid control (SLC) line is said to be supported at two locations on the RPV and four locations on the Shroud. Provide the analyses that show the stresses in the SLC line are below design limits, due to the relative dynamic motion of the Shroud and the RPV in higher vibration modes. [[ ]]. Because both longitudinal and lateral support of the SLC line is provided, both beam and shell mode induced motion of the supports appears important.

RAI Number	Reviewer	Question Summary	Full Text
3.9-238	Sekerak P	Elaborate on the design of the chimney partition and its connection to the chimney	In response to RAI 3.9-140, which questioned the details of the chimney partition testing, the FEM model of the partition was reported to assume the outermost ends of the partition were essentially fixed ends. The response to RAI-140(c) implies that the partition is attached along the entire length of the chimney. However, the design of these connections was in progress to provide such rigidity. Elaborate on the design of the chimney partition and it's connection to the chimney, the sensitivity of the boundary condition assumptions on the calculated partition stresses, and explain why motion of the chimney due to flow in the annulus between the chimney and the PV does not create additional significant stresses in the partition.
3.9-239	Sekerak P	Provide rationale for the location of the Instrumentation intended to confirm adequacy of the Steam Separator Assembly design	Elaborate on the rationale for and the location of the instrumentation intended to confirm the adequacy of the design of the Steam Separator Assembly. In light of RAI 3.9-236, comment on whether the instrumentation will measure/confirm stresses induced by internal flow in the individual separators.
3.9-240	Sekerak P	Identify the redundancy that the instrumentation on shroud/chimney structure provide	What redundancy does the instrumentation on the Shroud/Chimney structure provide, in the case of loss of one or more of the transducers? Does the instrumentation enable the calculation of the motion of the supports of the SLC lines?
3.9-241	Sekerak P	Provide rationale for location of the sensors to be placed on SLC Lines	Elaborate on the rationale for the selection and location of the sensors to be placed on the SLC lines. Will the motion measured by the Shroud/Chimney instrumentation and the accelerations measured on the SLC lines be comparable?

RAI Number	Reviewer	Question Summary	Full Text
3.9-242	Sekerak P	Provide rationale for the selection and location of Sensors	Elaborate on the rationale for the selection and location of the sensors to be placed on the shroud above the support bracket and provide predicted stresses. If these are not the maximum stresses provide the value and location of the maximum stresses for the Shroud/Chimney/Separator Assembly.
3.9-243	Sekerak P	Provide justification for extrapolating the stresses in ESBWR top Guide from stresses calculated in the ABWR	With respect to GEH response to RAI 3.9-77 S01, please provide the justification for extrapolating the stresses in the ESBWR top guide from stresses calculated in the ABWR, based on the guide plate lateral load results from the beam model analyses. In particular, comment on any differences in stress concentrations on the boundary and stress patterns on the boundary and interior in the ABWR and ESBWR top guides, all of which would have to be the same or very similar in the ABWR and the ESBWR for the extrapolation to provide a reasonable estimate of the stress in the ESBWR top guide.

Requests for Additional Information (RAIs)
ESBWR Design Control Document (DCD), Revision 5
Tier 2 Chapter 3.9.5, Reactor Pressure Vessel Internals

RAI Number	Reviewer	Question Summary	Full Text
3.9-245	Sekerak P	Provide justification for the 60 year design life for the ESBWR reactor pressure vessel internal structures, including the steam dryer.	The ESBWR reactor plant design life is based on sixty years of plant operation. Therefore, according to 10 CFR Part 50 Appendix A, General Design Criterion 4, the reactor pressure vessel internal structures, including the steam dryer, should be designed to accommodate the effects of the environmental conditions associated with normal plant operation for a duration of sixty years. Provide a description of the environmental conditions inside the reactor vessel, and explain how the design of the reactor vessel internals accounts for potential degradation due to environmental effects. Include in this discussion potential degradation due to environmental effects such as, intergranular and irradiation-assisted stress corrosion cracking of stainless steel and inconel components, thermal embrittlement of cast stainless steel components, and fatigue.

3.9-246	Sekerak P	Provide references in the DCD for the GEH Topical Reports that provide the bases for load definition and structural evaluation of the ESBWR steam dryer.	The GEH Topical Reports (TRs) which provide the design bases for the ESBWR steam dryer, including acoustic and flow-induced load definition and structural evaluation, are neither discussed nor referenced in DCD Section 3.9.5. The DCD should be revised to include reference, in the appropriate sections of DCD section 3.9.5, to the following GE-H Topical Reports: • NEDC-33408P, ”ESBWR Steam Dryer - Plant Based Load Evaluation Methodology,” Feb. 2008 • NEDE-33312P, “ESBWR Steam Dryer Acoustic Load Definition,” Nov. 2007 • NEDE-33313P, “ESBWR Structural Evaluation,” Nov. 2007 Additionally, these TRs should be listed in DCD Section 3.9.10, References.

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