Request for Additional Information (RAI)
ESBWR Design Control Document (DCD) Revision 9

RAI Number	Reviewer	Question Summary	Full Text
RAI 3.9-269	Spicher T.	The staff's question is in regard to submitting 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 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 [[ ]].

RAI 3.9-270	Spicher T.	The staff's question is in regard to submitting an updated PBLE method 2 benchmark that resolves the errors and concerns raised by the NRC regarding the QC2 benchmark.	GEH is requested to submit an updated PBLE method 2 [[ ]] benchmark that resolves the errors and concerns raised by the NRC regarding the QC2 benchmark (such as [[ ]], geometric modeling errors, and nozzle errors). As part of this submittal, GEH is requested to provide the "[[ ]] Summary Statistics using [[ ]]," and GEH Engineering Calculation Sheet DRF 0000-0117-4341R0 (dated September 30, 2010). If the SSES platform is used for this benchmark, GEH should ensure that the nozzle area and other SSES issues are resolved. GEH is requested to provide both [[ ]] data, including plots of simulated and measured point pressure spectra.
RAI 3.9-271	Spicher T.	The staff's question is in regard to confirming that the PBLE method 1 and 2 benchmarks are performed using the same version of PBLE that will be used for the ESBWR certified design.	GEH is requested to confirm that the PBLE method 1 and 2 benchmarks are performed using the same version of PBLE that will be used for the ESBWR certified design. In the event an updated version of PBLE will be used for future ESBWR calculations, GEH is requested to provide a procedure for computing the updated version bias and uncertainties. Additionally, GEH is requested to describe the process for quality control of the PBLE program. In consideration of the significance of the PBLE program in providing confidence in the structural integrity of the ESBWR steam dryer, GEH is requested to address the need to describe the PBLE program in ESBWR DCD, Tier 2, Appendix 3D, "Computer Programs Used in the Design of Components, Equipment, and Structures."
RAI 3.9-272	Spicher T.	The staff's question is in regard to submitting the performance and results of the ongoing strain gage calibration studies.	GEH is requested to submit the performance and results of the ongoing strain gage calibration studies, with adjustments to the bias errors and uncertainties for strain gages. Accordingly, GEH is requested to specify applicable ESBWR Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) to confirm the accuracy of the strain gages prior to plant startup.
RAI 3.9-273	Spicher T.	The staff's question is in regard to describing the performance and	GEH is requested to describe the performance and results of the hammer tests on the SSES steam dryer, and the lessons learned for the FE model of the steam dryer.

		results of the hammer tests on the SSES steam dryer.	
RAI 3.9-274	Spicher T.	The staff's question is in regard to resolving the main steam line (MSL) strain gage calibration errors	GEH is requested to describe the resolution of the main steam line (MSL) strain gage calibration errors in support of the ESBWR design certification application. GEH should include the 'pipe and beam' calibration report and the procedure used to correct for differences between benchmark and future plant strain gage models and installation configurations. GEH is requested to specify applicable ITAAC to confirm the accuracy of the strain gages prior to plant startup.
RAI 3.9-275	Spicher T.	The staff's question is in regard to evaluating the strain measured on the SSES steam dryer during EPU operation in comparison to the strain calculated from the SSES steam dryer analysis.	GEH is requested to provide an evaluation of the strain measured on the SSES steam dryer during EPU operation in comparison to the strain calculated from the SSES steam dryer analysis. As part of this evaluation, GEH should address the failure of the skirt (and vessel support) on the SSES steam dryer during EPU operation, including an assessment of the stress in the region of the failure, and the lateral and torsional loading on the steam dryer. GEH should describe the lessons learned regarding the steam dryer design and the assessment methodology from the measured SSES steam dryer data.
RAI 3.9-276	Spicher T.	The staff's question is in regard to providing a specific analysis of the MSL nozzle location and size for the QC2 acoustic model and the SSES acoustic model.	GEH is requested to provide a specific analysis of the MSL nozzle location and size for the QC2 acoustic model and the SSES acoustic model, including the impact on the results of the analysis from the modeling errors in the location and size of the MSL nozzles.
RAI 3.9-277	Spicher T.	The staff's question is in regard to the use of specific types	GEH is requested to discuss the use of specific types of welds in the ESBWR steam dryer and the justification for fatigue and quality factors for each weld type. In addition, GEH is requested to discuss the [[

		of welds in the ESBWR steam dryer and the justification for fatigue and quality factors for each weld type.	]] in the ESBWR steam dryer as described in NEDE 33313P, Rev 2. During the audit, the staff asked GEH to address the [[ ]] in the ESBWR steam dryer design, and how [[ ]] will be conducted. At the audit, GEH made a definitive statement that the ESBWR steam dryer design [[ ]]. The staff noted that this is inconsistent with NEDE 33313P, Rev 2. Please provide clarification [[ ]].
RAI 3.9-278	Spicher T.	The staff's question is in regard to describing the potential for loose parts resulting from the failure of welds.	GEH is requested to discuss the potential for loose parts resulting from the failure of welds (such as partial penetration welds). GEH is requested to discuss the design criterion that the steam dryer must retain its structural integrity without the generation of loose parts in the reactor coolant and main steam systems. GEH is requested to discuss this design criterion in comparison to its evaluation of the report dated January 24, 2012, reviewed during the audit.
RAI 3.9-279	Spicher T.	The staff's question is in regard to describing the welds in the SSES structural model used as the validation benchmark.	GEH is requested to describe the welds in the SSES structural model used as the validation benchmark. Additionally, describe how the fatigue assessment of the partial penetration welds is performed and accounted for in the fatigue assessment of the SSES dryer.
RAI 3.9-280	Spicher T.	The staff's question is in regard to providing a description of the transition interface modeling.	GEH is requested to provide a description of the [[ ]], including a description of how the dimensions (length and thickness) of the layer plate elements, [[ ]], is determined. GEH is also requested to clearly describe the criterion for how the overlay shell thickness is determined. Additionally, GEH should address overlay shell elements concerns identified in letters from Entergy in support of the Grand Gulf EPU license amendment and the [[ ]].
RAI 3.9-281	Spicher T.	The staff's question is in regard to	GEH is requested to provide a description for SSES dryer components requiring further post evaluation to determine the stress reduction factors

		describing SSES dryer components requiring further post evaluation to determine the stress reduction factors.	(SRF). If applicable, GEH is requested to describe sub-model analysis and [[ ]] approach. GEH should also explain whether sub-modeling and/[[ ]] approach always provides [[ ]]. Additionally, GEH is requested to describe if the [[ ]].
RAI 3.9-282	Spicher T.	The staff's question is in regard to providing justification for applying dynamic analysis to unconnected nodes in CAR# 57911.	During the audit, the staff reviewed Corrective Action Report (CAR) 57911 that pertains to a submodel that contained two unconnected nodes. The staff noted that the justification for the unconnected nodes was based on a study using [[ ]]. The staff requests justification based on [[ ]] mentioned in CAR# 57911.
RAI 3.9-283	Spicher T.	The staff's question is in regard to providing additional justification for the submodel analysis used in GGNS, if a similar approach was applied to SSES steam dryer or validate the conclusion based on additional submodels.	During the audit, the staff discussed with GEH the GGNS summarized [[ ]]. The MPC approach resulted in higher stress with a difference greater than [[ ]] for the following several dryer components: [[ ]]. Entergy justified these high stress areas by performing a submodel analysis for [[ ]] showing that the submodel results are lower than the overlay and MPC approaches. However, that location is not the higher stress location in terms of magnitude [[ ]] or the higher percentage difference location [[ ]]. If a similar approach was applied to SSES steam dryer, GEH is requested to provide additional justification for the other significant locations noted above for the applicability of the submodel analysis conclusion, or validate the conclusion based on additional submodels.
RAI 3.9-284	Spicher T.	The staff's question is in regard to clarifying information included in Table 1 (on sheet 4 of DRF 0000-0087-2787,	During the audit, the staff inquired about changes made to the SSES ANSYS structural model during the SSES benchmarking effort. Following the exit meeting for the audit, the staff had the opportunity to review DRF 0000-0087-2787, "SSES Dryer FEM with [[ ]] Representations and Other Modifications", dated 09/20/2008. Based on its review, the staff requests the following clarifications of information included in Table 1

		"SSES Dryer FEM with Superelement Vane Bundle Representations and Other Modifications").	(on sheet 4 of the document): (1) Element Nos. 99 and 199 are specified as [[ ]]. In a subsequent table, the element thicknesses are listed as [[ ]]. There is no information about stiffness or mass associated with these elements. Based on the complete description, it appears that these [[ ]]. The staff requests GEH to (1) describe in detail the purpose of these elements and why they are needed; (2) confirm the thickness and specify the stiffness (E, nu) and mass density; (3) describe in detail the technical basis for determining that these [[ ]] do not affect the structural response of the steam dryer; and (4) if they do affect the structural response, provide the detailed technical basis for why this is acceptable. (2) Element No. 5 is specified as [[ ]], and is]]. The staff could not find information about the thickness, stiffness or mass associated with these elements. The staff requests GEH to (1) describe in detail the implementation of this technique to [[ ]], provide the detailed technical basis for why this is acceptable. (3) GEH is requested to provide the purpose for utilizing any fictitious]] . GEH is requested to specifically describe the extent to which the elements identified in items (1) and (2) above will be implemented in the ANSYS structural analysis of the ESBWR steam dryer. GEH should also discuss any planned changes for ESBWR, and the technical basis for the changes.
RAI 3.9-285	Spicher T.	The staff's question is in regard to	During the audit, the staff and GEH discussed at length the calculation methods identified in Section 4.1 and Figure 4-1 of Reference 1, related to the

		clarifying the “peak” stress from the shell model.	prediction of the alternating peak stress intensity for the fatigue evaluation of fillet welds. As an example, GEH described in detail its response to a GGNS RAI that addressed the same issue. The response to the GGNS RAI provided a single comparison between 2 methods discussed in NEDE 33313P, Rev 2 for fillet welds. These are method (1) calculation of a [[ ]]; and method (2) [[ ]]. The staff requested clarification of the “peak” stress from the shell model. GEH explained that this [[ ]]. In the example presented by GEH, there are [[ ]] sharing the target node. The local geometry is very complex. GEH picked the [[ ]]. This value is compared directly to the material fatigue endurance limit [[ ]]. Based on the one example presented, method (2) produced an acceptable result, compared to method (1). GEH has developed a post-processing procedure (which is discussed in the LTR on page 5 of 37) to calculate the [[ ]], for use in method (1). There was no theoretical basis presented for method (2). Based on GEH’s response to staff questions at the audit, there does not appear to be one. GEH apparently developed method (2) based on comparison of a very limited sample set. At this time, the staff is seeking a more comprehensive, quantitative technical basis for GEH’s conclusion that method (2) provides equal or greater conservatism, compared to method (1). To this end, the staff requests GEH to perform a series of simple confirmatory analyses that the staff can reference in its safety evaluation of this issue. The basic model is a T-connection of 304

			stainless steel plates, which may be considered to be of infinite longitudinal length. A unit strip may be used, reducing the problem to 2-D. The basic loading is in-plane membrane force and out-of-plane bending moment applied to the free end of the vertical (web) plate. The horizontal (flange) plate is constrained at both ends. The staff requests the applicant to conduct a parametric study, varying the lengths and thicknesses of the 2 plates, and the ANSYS shell element refinement. The shell element refinement should be varied by a factor of ten, and should envelope typical shell element lengths used in the steam dryer shell models. For each configuration, analyze a “unit” membrane force, a “unit” bending moment, and both applied simultaneously. Using the shell element stress results from the ANSYS analyses, calculate the peak alternating stress intensities using method (1) and method (2), for each permutation. In the method (1) calculation, assume a range of acceptable fillet weld sizes, based on the thicknesses of the plates being joined. In the method (2) calculation, tabulate the results with [[ ]] defined in the last paragraph on page 5 of 37 of Reference 1. Given the simplicity of the model and loading, an extensive parametric study should be designed and implemented, to confirm the validity of method (2). In addition, as a check on the implementation of method (1), compare the results of method (1) to alternating stress intensity predictions “using traditional weld stress formulas”, as defined in B. on page 5 of 37, assuming complete load reversal [[ ]], for a representative subset of cases.
RAI 3.9-286	Spicher T.	The staff’s question is in regard to developing alternating peak stress intensity predictions using the solid element submodel approach	During the audit, the staff and GEH also discussed the solid element submodel approach identified in Section 4.1 and Figure 4-1 of Reference 1, for predicting the alternating peak stress intensity for the fatigue evaluation of fillet welds. This method is applied when [[ ]] (top of page 6 of 37). In prior RAI responses, GEH has stated that the submodel approach is used when [[ ]], and that the

		for a representative set of cases, and to compare the results with the corresponding method (1) and method (2) results.	submodel approach leads to reduced stresses. The staff inquired how many submodels are typically developed. GEH indicated that for GGNS, there are [[ ]] developed. Alternating peak stress intensity at all other locations are based on the shell model results In a solid element submodel, the fillet is added. The fillet representation in the submodel is textbook – triangular with the design leg length. While multiple solid elements are used to [[ ]]. As stated in Reference 1, top of page 6 of 37, "…, [[ ]]." As an adjunct to the parametric study comparing methods (1) and (2) for shell models (see Question 4), the staff requests GEH to develop alternating peak stress intensity predictions using the solid element submodel approach for a representative set of cases, and to compare the results with the corresponding method (1) and method (2) results. Include one example calculation that demonstrates the procedure defined in the statement quoted in the preceding paragraph.
RAI 3.9-287	Spicher T.	The staff's question is in regard to describing the structural finite element model for the additional benchmark.	GEH is requested to describe the structural finite element model for the [[ ]] in support of the ESBWR design certification application. GEH should address concerns identified during review of the Grand Gulf EPU license amendment request and issues raised during the March audit. For example, GEH should discuss (a) resolution of unconnected nodes, (b) partial penetration welds, (3) dummy elements, and (d) load transfer concerns. Additionally, GEH is requested to update the dryer stresses to address the recently found errors (e.g., disconnected nodes, partial penetration welds, use of overlay) in the finite element model of SSES.
RAI 3.9-288	Spicher T.	The staff's question is in regard to submitting GEH's proposed technical approach to ensure that the ESBWR	NEDE-33313P, Rev 2, does not directly address how the modal properties of the ANSYS global shell model of the steam dryer will be evaluated to ensure that the mesh is sufficiently refined to produce an acceptably accurate response up to the highest frequency of interest. On page 10, NEDE-33313P discusses a mesh sensitivity study to ensure that the design-basis response to the dynamic loading has no more than a 5 percent error. This maximum

		steam dryer shell model has a sufficiently refined mesh to accurately respond at the highest loading frequency of interest.	5 percent error is then applied to the results as a "bias". While the [[ ]], ensuring that the structural model can adequately respond to the highest dynamic input frequency is equally necessary. On page 14, NEDE-33313P identifies this frequency to be [[ ]]. During the audit, GEH presented preliminary resultsof a hand calculation based on the Grand Gulf ANSYS shell model, and indicated that the ESBWR steam dryer shell model would have comparable mesh refinement. The staff requests GEH to submit its proposed technical approach to ensure that the ESBWR steam dryer shell model has a sufficiently refined mesh to accurately respond at the highest loading frequency of interest [[ ]].
RAI 3.9-289	Spicher T.	The staff's question is in regard to describing the process for the combined license (COL) licensee to satisfy ESBWR DCD Tier 1, Table 2.1.1-3, "ITAAC for the Reactor Pressure Vessel and Internals," in ITAAC 8.b.	ESBWR DCD Tier 1, Table 2.1.1-3, "ITAAC for the Reactor Pressure Vessel and Internals," specifies in ITAAC 8.b that the steam dryer will meet the requirements of ASME Boiler & Pressure Vessel Code, Subsection NG-3000 (except for weld quality and fatigue factors for secondary structural non-load bearing welds). GEH is requested to describe the process for the combined license (COL) licensee to satisfy this ITAAC.
RAI 3.9-290	Spicher T.	The staff's question is in regard to describing the process for the COL licensee to satisfy ESBWR DCD Tier 1, Table 2.1.2-3, "ITAAC for the Nuclear Boiler	ESBWR DCD Tier 1, Table 2.1.2-3, "ITAAC for the Nuclear Boiler System," specifies in ITAAC 36 that the MSL and safety relief valve (SRV) and relief valve (RV) branch piping geometry precludes first and second shear layer wave acoustic resonance conditions from occurring and avoids pressure loads on the steam dryer at plant normal operating conditions. GEH is requested to describe the process for the COL licensee to satisfy this ITAAC. GEH is also requested to address the process for the COL licensee to identify and resolve low frequency loads, such as those occurring at SSES during EPU operation.

		System," in ITAAC 36 and the process for the COL licensee to identify and resolve low frequency loads.	
RAI 3.9-291	Spicher T.	The staff's question is in regard to specifing the provision that will require the COL applicant to demonstrate that the FEA and post processing of peak stress has been performed to confirm that the ESBWR steam dryer is structurally acceptable as part of a COL Information Item.	ESBWR DCD Tier 2, Appendix 3L, "Reactor Internals Flow Induced Vibration Program," states in Section 3L.4.5, "Structural Evaluation," that a finite element analysis (FEA) is performed to confirm that the ESBWR steam dryer is structurally acceptable for operation. GEH is requested to specify the provision that will require the COL applicant to demonstrate that the FEA and post processing of peak stress has been performed to confirm that the ESBWR steam dryer is structurally acceptable as part of a COL Information Item.
RAI 3.9-292	Spicher T.	The staff's question is in regard to describing the changes that will be made to the topical reports for ESBWR steam dryer analysis.	GEH is requested to describe the changes to the topical reports for ESBWR steam dryer analysis that will be made to rely on the SSES steam dryer data to benchmark the steam dryer analysis in support of the ESBWR design certification application.
RAI 3.9-293	Spicher T.	The staff's question is in regard to describing the	GEH is requested to describe the conservatisms in the steam dryer assessment methodology in support of the ESBWR design certification application. For example, GEH should address conservatisms such as

		conservatisms in the steam dryer assessment methodology.	described in a letter from Entergy dated October 10, 2010, in support of the Grand Gulf EPU license amendment request.