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

RAI Number	Reviewer	Question Summary	Full Text
RAI 3.9-299	T. Scarbrough	Clarification of the steam dryer evaluation process in NEDE-33312, -33313, and -33408.	In response to several RAIs, GEH prepared NEDE-33312, 33313, and 33408, all Revision 4, to describe the process for ESBWR steam dryer evaluation. To ensure that the description in these documents is clear and consistent with RAI responses, as well as steam dryer evaluation processes recently reviewed and approved by the NRC staff, the following are requests to **clarify the description of the steam dryer evaluation process** in these documents. a. [[ ]] b. For consistency, in Section 1.0 of NEDE-33312, delete the description of the ESBWR steam dryer evaluation process and refer to the revised description in NEDE-33313. c. For consistency, in Section 1.0 of NEDE-33408, delete the description of the ESBWR steam dryer evaluation process and refer to the revised description in NEDE-33313.
RAI 3.9-300	T. Scarbrough	Clarification of the steam dryer evaluation methodology described in NEDE-33312, -33313, and -33408.	In response to several RAIs, GEH prepared NEDE-33312, 33313, and 33408 to describe the methodology used for the ESBWR steam dryer acoustic load definition and structural evaluation, as well as its benchmarking. The following are requests for information on the **ESBWR steam dryer evaluation methodology**. a. The NRC staff considers NEDE-33408 to include proper application of bias errors to the strain gage spectra shown in its Appendix G. However, the comparisons [[ ]]. To confirm that the procedure bounds the low-frequency signals, revise NEDE-33408 to include peak strain plots for the low frequency (LF) range. Also, the PBLE-only B/Us in NEDE-33408, Appendix J do not capture the [[ ]]. Therefore, specify in NEDE-33313 that worst-case stresses from analysis steps 1 and 2 will be retained and used in the definition of the power ascension limit curves. b. In Section 9.2 in NEDE-33313, Steps 4 and 5 of the [[ ]] for setting on-dryer limits are not clear. Clarify that the strain limit is defined as the [[ ]] and the accelerometer limit is defined as the [[ ]], rather than simply the [[ ]] (as stated). Also, clarify the different terminology used in NEDE-33313 (particularly Section 9.2) referring to measurement accuracy and instrument loop inaccuracy or uncertainty. c. Based on discussion during the November 1, 2013, public meeting, the NRC staff understands that only the [[ ]] will be used to establish on-dryer limits. Therefore, revise Section 9.2 in NEDE-33313 (and other locations, as appropriate) to delete references to the "[[

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			]]." d. In the response to RAI 3.9-285 on fillet welds, the comparison of Method 1 and 2 results in Tables 4 to 9 shows that [[ ]]. However, for some configurations (Configurations 2 and 5 in Tables 6 and 9), [[ ]] In addition, revise NEDE-33313 to clarify that for the as-designed dryer, weld joint geometries will be evaluated to confirm that they are within the range of applicability of Method 2. e. The response to RAI 3.9-286 states that the analysis demonstrated the adequacy of Method 3 in analyzing the fillet weld joint designs used in the ESBWR steam dryer. Clarify two aspects of the analysis: 1) For the critical path through the [[ ]] is applied to the linearized stress, whereas for the path through [[ ]] is applied. Explain the use of two different values of FSRFs for two different paths, as well as how such values have been successfully applied in other analyses. 2) In most load cases listed in Table 6 of the response to RAI 3.9-286 involving [[ ]] Revise NEDE-33313 to clarify that for representative submodels in the ESBWR steam dryer, Method 3 will be demonstrated to be more conservative than the ASME Code method before using Method 3 to [[ ]]. f. NEDE-33313 does not explicitly state how and when the mesh-convergence bias error will be applied. Revise the report to provide specific clarifications as follows: 1) [[ ]], bias errors associated with mesh convergence are applied to the predicted design stresses at high stress locations. 2) The stresses at high stress locations are recalculated using the [[ ]] at these locations. 3) For [[ ]] described in Table 5.1, the mesh convergence bias errors [[ ]]. 4) In Section 4.1 (second paragraph), it is stated, "The full power steam dryer highest stress, [[ ]], is then calculated." Specify that the [[ ]]. 5) Specify how the mesh convergence (or stress convergence) errors will be used in the analysis. g. The applicable engineering reports should specify that cumulative stress plots from at least the five most highly stressed locations on both the upper and lower dryer would be addressed when determining dryer stresses, with the dominant stress component at each location in the plots.

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			h. Section 4.1 in NEDE-33313 discusses the fatigue assessment of welds that may be present in the ESBWR steam dryer. Specific revisions to this section are requested for clarification as follows. 1) Include the content of Footnote 2 to Table 2 of the response to RAI 3.9-285 S01, specifically that the [[ ]]. 2) Include a figure to clearly define weld size (w) and intersecting plate thickness (ti). i. Revise NEDE-33313 as follows to be consistent with related RAI responses: 1) In Section 4.1, delete the second and third paragraphs on page 12 because these justifications for [[ ]] are not acceptable. NRC staff acceptance of the [[ ]] is based on favorable comparison to ASME Code methods, which use [[2) Clarify the following statement in the fourth paragraph on page 11 in Section 4.1 of NEDE-33313: "[[ ]]" The response to RAI 3.9-285 S01 specifically states: "The limitation on Method 2, however, is that the continuous member should be no more than [[ ]] times the weld size." Revise the statement in Section 4.1 of NEDE-33313 to be consistent with the RAI response. Include a figure showing this limitation, in which both weld size and flange thickness (or continuous member) are clearly defined. State whether this limitation will be implemented generically, or whether it only applies as a limitation on implementation of Method 2. 3) Clarify the following statement in the introduction paragraph on page 10 in Section 4.0 of NEDE-33313, as it relates to fillet-welded T-joints and other joints where fillet welds are used in the ESBWR steam dryer: "[[ ]]" Specify any restriction on the minimum fillet weld leg dimension, as a percentage of the thickness of the thinner plate member being joined. The staff's independent calculations for T-joints identified a lower limit of approximately 2/3 in order to ensure that Method 2 produces results at least equal to ASME Code method results. Below this limit, Method 2 appears to be nonconservative. Provide figures showing the applicable configurations and the dimensional limitations imposed by this criterion. 4) Clarify the following statement in the fifth paragraph on page 12 in Section 4.1 of NEDE-33313:

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			"[[ ]] the critical flaw size." To provide additional explanation for the design of the non-ASME Code steam dryer, describe how the critical flaw size will be determined, such that an infinite fatigue life (alternating peak stress intensity below the endurance limit) is assured. Specify whether the critical flaw size calculation is applicable to both full penetration welds and fillet welds. For fillet welds, specify the location of the assumed flaw. Specify how it will be ensured that the "[[ ]]" Explain the statement "[[ ]]." Specify whether [[ ]]. 5) Correct the following statement in the third full paragraph on page 13 in Section 4.2 of NEDE-33313: "[[ ]]" The technical basis for using [[ ]] to a higher standard than assumed by the Code. The other (non-technical) basis is that the steam dryer is not safety-related, and can be [[ ]]. The statement in Section 4.2 should be corrected based on this discussion. 6) Section 4.3 on page 13 currently states: "The ASME Code stress limits from Subsection NG of Reference 9 are listed in Table 4.1." However, ASME BPV Code, Figure NG-3221-1 shows different stress limits for Service Levels A and B that include Secondary Stress and Peak Stress limits, in addition to Primary Stress limits. For Service Levels C and D, the ASME Code only specifies Primary Stress limits, consistent with GEH Table 4.1. Therefore, expand Table 4.1 to incorporate the Secondary and Peak Stress limits for Service Levels A and B consistent with ASME BPV Code, Figure NG-3221-1. 7) Expand the first paragraph of Section 5.1 to include a discussion of the criteria applied in selecting which of the three methods for enforcing rotational compatibility is most appropriate. Specify the properties of the [[ ]]. Provide accompanying figures depicting each of the three methods. 8) The fifth through eighth paragraphs of Section 5.1 discuss the use of [[ ]]. In the response to RAI 3.9-292 S02, three distinct cases with four possible outcomes are described, depending on the characteristics of the [[ ]]. Only two cases are described in Section 5.1. Revise Section 5.1 to include (1) the additional outcomes described in the response to RAI 3.9-292 S02; and (2) appropriate plots for all 4 outcomes, showing the estimated stress convergence factor or lack of convergence, based on the trend of

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			data with [[ ]]. 9) In Section 5.2.4, the report states: "[[ ]]" [[ ]] Clarify that the SRSS method is used only when low and high frequency results are independent, and that an algebraic combination is used when they are not independent. 10) Section 7.1, "Fatigue Calculation" states: "[[ ]] These stresses will then be compared to the criteria from Section 4.1." The above statement is incomplete. Revise Section 7.1 to reference [[ ]] from Section 4.1; [[ ]] from Section 5.1; [[ ]] from NEDE-33312; and [[ ]] from NEDE-33408. 11) Section 7.2, "Frequency Content of the Structural Response," states: "In order to understand the structural [[ ]]." Section 7.2 needs to explain the information in Figure 7-1, and its use in understanding the structural response as indicated in this section. Alternatively, as Section 7.2 is not a key component of the current analysis approach, it can be deleted (along with references to it in other locations). 12) In Section 8.3, the report states: "The [[ ]]. These stresses will then be compared to the criteria from Section 4.3." Section 4.3 indicates that both [[ ]] are performed. The stress "[[ ]]" would address [[ ]]. Correct NEDE-33313 to indicate that [[ ]] as specified in Section 4.3.
RAI 3.9-301	T. Scarbrough	Description in the DCD of actions to be completed by the COL applicant to satisfy the COL Information	In its responses to RAIs 3.9-289, 290, 291, 291 S02, 291 S03, and 292 S03, GEH clarified the COL Information Items related to the ESBWR steam dryer. Clarify in the DCD or applicable engineering report the items that a COL applicant should provide in an "as-designed" ESBWR steam dryer analysis report, as shown in the following list. If the analysis cannot be completed prior to COL issuance, the COL applicant should follow the process in Regulatory Guide 1.206 to provide sufficient information for licensing and

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		Items, as well as clarification of the items that a COL applicant should provide in an "as-designed" ESBWR steam dryer analysis report.	propose appropriate post-licensing commitments (e.g., ITAAC) to confirm the acceptability of the design. a. Describe the as-designed ESBWR dryer, dryer loading, and dryer stress analysis results. b. Reference previously approved methodology in the ESBWR DCD and Engineering Reports NEDE-33408, NEDE-33312, and NEDE-33313. c. Describe application of the B/U as documented in the approved methodology. d. Describe how the alternating peak stress intensities at the high stress locations were calculated (i.e., Method 1, Method 2, or Method 3); and tabulate the predicted alternating peak stress intensities. e. Demonstrate final alternating stress ratios (MASRs) greater than or equal to 2.0. f. Include spectra and cumulative stress plots for the top five stress locations on the upper dryer and the top five stress locations on the lower dryer. g. Describe a dryer dynamic test plan including sensor and drive locations sufficient to extract important resonances, with regional frequency response functions sufficiently resolved to establish regional B/U for frequencies up to [[ ]]. h. Incorporate lessons learned from power ascension of previous ESBWR plants, as applicable.
RAI 3.9-302	T. Scarbrough	Description in the DCD of actions to be completed by the COL licensee to satisfy ITAAC.	In RAIs 3.9-289, 290, 291, and 291 S05, the NRC staff requested that GEH clarify the ITAAC applicable to the ESBWR steam dryer. Identify in the DCD or applicable engineering report the **actions to be completed by the COL licensee to satisfy each ITAAC** related to the ESBWR steam dryer. The following should be included in the actions to be taken by the COL licensee to satisfy the applicable ESBWR steam dryer ITAAC: a. In response to RAI 3.9-289, GEH described the process for the COL licensee to satisfy ITAAC 8.b in ESBWR DCD Tier 1, Table 2.1.1-3, "ITAAC for the Reactor Pressure Vessel and Internals," for the ESBWR steam dryer to meet ASME BPV Code, Subsection NG-3000 (except for weld quality and fatigue factors for secondary structural non-load bearing welds). Include this process in the DCD or the applicable engineering report consistent with the responses to RAIs 3.9-299 to 303. b. In response to RAI 3.9-290, GEH described the process for the COL licensee to satisfy ITAAC 36 in ESBWR DCD Tier 1, Table 2.1.1-3, for the main steam line and SRV/safety valve branch piping geometry to preclude first and second shear layer wave acoustic resonance conditions from occurring. Include this process in the DCD or the applicable engineering report consistent with the responses to RAIs 3.9-299 to 303. c. In its response to RAIs 3.9-291 and 291 S05, GEH stated that ITAAC 16 will be included in ESBWR

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			DCD Tier 1, Table 2.1.1-3, to specify that a report of the fatigue analysis of the as-built steam dryer exists and demonstrates that the maximum calculated alternating stress intensity provides at least a minimum MASR of 2.0 to the allowable alternating stress intensity of 93.7 MPa (13,600 psi). Revise the DCD or applicable engineering report to describe what must be included in the report to satisfy ITAAC 16. Specifically: 1) Describe changes between the as-designed and as-built steam dryers, including adjustments to the structural FE model, updated B/U based on testing, and updated stresses and stress ratios. 2) Demonstrate that the as-built ESBWR steam dryer with the assumed pressure loading satisfies the methodology to calculate the resulting dryer alternating stress with at least an MASR of 2.0 as described in the DCD and its engineering reports. 3) For the dryer dynamic testing, specify the minimum number of excitation locations to ensure adequate coverage of the dryer, and that enough resonances are extracted so that comparisons may be made to simulations up to [[ ]]. Specify how the dryer will be subdivided into sensor groups/regions, whether multiple excitation locations will be specified within a group/region, and how the different regional errors for different excitation locations will be addressed. 4) Address the uncertainties in the comparison of predicted mode shapes with those measured during the dryer dynamic testing (i.e., boundary conditions and dryer support). 5) Address differences of greater than [[ ]] between predicted resonance frequencies and those measured during the dryer dynamic testing to ensure worst case coupling between peak excitation and peak response is captured. 6) Identify on-dryer instrumentation sensor specifications, sensor locations (including at least [[ ]] and at least [[ ]]), and correlations between sensors and peak stress locations on the upper and lower dryer. 7) Identify all B/U associated with the sensors and data acquisition system. 8) Provide the acceptance limits for each sensor with supporting calculations (spectra and time histories). The limits should extend to 1 kHz based on the potential for high frequency excitation tones. Explain how the limits are derived from calculations using the minimum load case method described in Section 9 of NEDE-33313. Limit curves for power ascension will be based on the worst case of both the original calculations using end-to-end GGNS B/U, and those from the subsequent combined FE structural B/U and PBLE01 B/U. 9) Confirm that redundant pressure sensors will be present adjacent to each MSL inlet.

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			10) Describe the ESBWR steam dryer power ascension monitoring and inspection program.
RAI 3.9-303	T. Scarbrough	Description in the DCD of actions to be completed by the COL licensee related to the power ascension monitoring and inspection program.	In RAI 3.9-298, the NRC staff requested that GEH describe the power ascension monitoring and inspection program applicable to the ESBWR steam dryer. The NRC staff requests that GEH revise the DCD or applicable engineering reports to describe the **actions to be completed by the COL licensee related to the power ascension monitoring and inspection program** for the ESBWR steam dryer consistent with the following considerations. (Note: To the extent possible, these actions should be described without using proprietary language.) a. The ESBWR steam dryer power ascension monitoring and inspection program described by GEH should be revised to be consistent with those programs for BWR operating nuclear power plants that have recently received extended power uprate (EPU) license amendments (in particular, Grand Gulf nuclear power plant). The ESBWR steam dryer power ascension monitoring and inspection program should be consistent with the following general description (or the basis for differences should be addressed): *A Steam Dryer Monitoring Plan (SDMP) for each ESBWR steam dryer will be prepared and provided to the NRC no later than 90 days before startup of the applicable ESBWR unit. The SDMP will reflect industry experience with the performance of steam dryer power ascension testing. The SDMP shall include the following, which shall be augmented or modified as appropriate to address industry experience:* *(1) The SDMP will address the following:* • *Criteria for comparison and evaluation of projected strain levels with data obtained from the on-dryer instrumentation.* • *Acceptance limits developed for selected on-dryer strain gauge and accelerometer locations.* • *Tables of predicted steam dryer stresses at 100% power; strain amplitudes and power spectral densities (PSDs) at strain gauge locations; predicted acceleration amplitudes and PSDs at acceleration locations; and maximum stresses and locations.* • *Directions for establishing correlations between measured accelerations and strains and the corresponding maximum stresses.* • *Identification of steam dryer strain gauge locations for which limit curves will be developed, and criteria for selection of those locations.* • *Methodology for developing projected strain levels for the next power level and for full*

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			power. • *Specific assessment points during power ascension. While completing assessment, power will remain steady to determine if any actions need to be taken or if power may ascend to the next level.* • *Activities to be accomplished during assessment points.* • *Details of the installation and calibration of the steam dryer instrumentation with the instrumentation mounted and calibrated in accordance with the manufacturers' instructions to accurately measure the dynamic response.* *(2) The initial hold point during the first startup of each ESBWR plant will be at no more than 75 percent of full power. At this hold point:* *[[* *]]* *[[ ]]* *[[*

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			]]. *(7) At the initial hold point and the hold points at approximately 85 and 95 percent power, power ascension will not proceed for at least 72 hours after making the steam dryer data analysis and results available to the NRC, unless notified by the NRC that power ascension may proceed earlier.* *(8) After full power has been achieved, data at the full power level will be provided to the NRC within 72 hours, and a full stress analysis report and evaluation will be provided to the NRC within 90 days of reaching the full power level. [[ ]], to demonstrate that the steam dryer will maintain its structural integrity over its design life considering variations in plant parameters (such as reactor pressure and flow rate).* *(9) During the first two scheduled refueling outages after reaching full power conditions, a visual inspection will be conducted of all accessible areas and susceptible locations of the steam dryer in accordance with accepted industry guidance on steam dryer inspections. The results of these baseline inspections will be provided to the NRC within 60 days following startup after each outage.* *(10) At the end of the second refueling outage following full power operation, an updated SDMP reflecting a long-term inspection plan based on plant-specific and industry operating experience will be provided to the NRC within 180 days following startup from the second refueling outage.* b. The DCD, engineering reports, and RAI responses need to be consistent with the ESBWR steam dryer power ascension monitoring and inspection program based on this RAI. For example, GEH's proposal to submit the entire steam dryer power ascension test plan package (item c of COL item 3.9.9-1-A) to an NRC inspector 10 days prior to power ascension is not consistent with the provisions discussed in this RAI. c. The DCD or applicable engineering report should document the essential elements to be included in power ascension procedures for the ESBWR steam dryer, specifically: 1) Level 1 and Level 2 acceptance limits for on-dryer strain gages, and on-dryer accelerometers to be used up to 100% power 2) Specific hold points and their duration during 100% power ascension 3) Activities to be accomplished during hold points

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			4) Plant parameters to be monitored 5) Actions to be taken if acceptance criteria are not satisfied 6) Verification of the completion of commitments and planned actions.

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