

Enclosure 3

MFN 12-043, Revision 1

Final Response to RAI 3.9-269

Public Version

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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 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, PBLE01 Model Description," 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 and BWR/4 plants had experienced high pressure loads under extended power uprate operating conditions.*
- Section 3L.4.4 is revised to remove references to 3L-9.
 - *References 3L-8 and 3L-9 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-9-8 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-9-8 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. ~~The methodology provides accurate predictions of main steamline phenomena occurring downstream of the main steamline sensors, valve whistling (safety relief valve branch line) and broadband excitations (venturi, main steam isolation valve turbulence). The methodology also accurately predicts the dryer pressure loads resulting from vessel hydrodynamic phenomena.~~
- Section 3L.4.6 is modified as follows:
 - Two types of ~~impact~~ frequency response tests are performed on the steam dryer: ...
 - The distribution of ~~steamline 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 instrument layout permits steam dryer load development with steam dryer data alone, steamline data alone, or a combination using both sets of data.~~ 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. ~~and Subsections 4.4.3.1 and 4.4.4 of Reference 3L-9.~~ ...
 - ~~In addition to the instrumentation on the steam dryer, the main steamlines are instrumented in order to measure the acoustic pressures in the main steamlines. The main steamline pressure measurements with the steam dryer pressure measurements are used as input to an acoustic model for determining the pressures acting on the steam dryer in order to provide a pressure load definition for use in performing confirmatory structural evaluations.~~ ...
 - It is expected that subsequent ESBWR units will ~~be monitored using the main steam lines pressure data~~ follow the same FIV monitoring process using on-dryer instrumentation.
- In Section 3L.6, Reference 3L-8 is revised to be consistent with the revised report. 3L-8 GE Hitachi Nuclear Energy, "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology, ~~PBLE01 Model Description,~~" NEDC-33408P-A, Revision 24, Class III (Proprietary), ~~February 2013~~ October 2010, and NEDO-33408, Revision 24, Class I (Non-proprietary), ~~February 2013~~ October 2010.
- 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 will be noted as changes in response to RAI 3.9-

~~292.) 3L-9 GE Hitachi Nuclear Energy, "ESBWR Steam Dryer – Plant Based Load Evaluation Methodology Supplement 1," NEDC-33408, Supplement 1P-A, Revision 2, Class III (Proprietary), October 2010, and NEDO-33408, Supplement 1-A, Revision 2, Class I (Non-Proprietary), October 2010.~~