

Errors in Topical Reports Associated with Economic Simplified Boiling-Water Reactor Dryer Modeling

During the U.S. Nuclear Regulatory Commission (NRC) Staff's review of the Grand Gulf Extended Power Uprate (EPU), errors were identified in GE Hitachi's (GEH) steam dryer topical reports (TRs). The same TRs were previously reviewed and approved to support the Economic Simplified Boiling-Water Reactor (ESBWR) Design Certification (DC) and are incorporated by reference in the ESBWR Design Control Document (DCD). The errors that were identified affect conclusions associated with steam dryer modeling that the NRC Staff made in its Final Safety Evaluation Report (FSER) supporting the ESBWR DC. Below is a summary of the key errors that have been identified to date:

Errors in Licensing Topical Report (LTR) NEDC-33408P-A, Revision 1, "ESBWR Steam Dryer-Plant Based Load Evaluation Methodology," issued July 2009.

1. LTR NEDC-33408P-A, Revision 1, describes the method GEH uses to define unsteady hydrodynamic loads acting on the ESBWR steam dryer. In this report, GEH uses a Quad Cities Unit 2 (QC2) acoustic finite element model to benchmark its proposed method. While LTR NEDC-33408P-A, Revision 1 states that a minimum mesh size of [[]] is appropriate for the ESBWR dryer, the staff accepted the modeling of the QC2 dryer with [[]] except in critical areas. However, the methodology still required that critical areas of the QC2 dryer needed to be modeled with a [[]]. Subsequently, during the NRC Staff's review of the Grand Gulf EPU, the staff discovered that GEH used a mesh size of [[]] in some critical areas of the QC2 acoustic model. Based on the above, the staff has determined that its conclusions in its FSER regarding GEH's modeling method and benchmark bias errors and uncertainties may no longer be valid and that the above issues need to be addressed by GEH in order for the ESBWR DC to proceed.
2. In LTR NEDC-33408P-A, Revision 1, GEH modeled the geometry of the QC2 steam dryer and other components important to the analysis of steam dryer performance. This modeling was performed in order to complete a benchmarking of the GEH proposed method against in-plant QC2 data measurements. During its review of these models in connection with the ESBWR, the NRC staff concluded that the modeling was acceptable. Subsequently, during its review of the Grand Gulf EPU, the NRC staff discovered that the modeling used in this LTR assumed incorrectly large main steam line (MSL) areas as compared to actual QC2 MSL areas. In addition, the NRC staff discovered that the modeling of the location of the QC2 MSLs with respect to the steam dryer is incorrect. The staff believes that the incorrect modeling of MSL area and location are applicable to the ESBWR and call into question the staff's conclusions regarding acceptability of the model. Based on the above, the staff has determined that its conclusions in its FSER regarding the modeling of the geometry of QC2 may no longer be valid and that the above issues need to be addressed by GEH in order for the ESBWR DC to proceed.

3. In LTR NEDC-33408P-A, Revision 1, GEH used a QC2 acoustic model to develop the QC2 frequency response function, develop the QC2 [[]], and perform final benchmarks to derive the QC2 bias and uncertainty calculations. GEH used this approach to provide assurance that the methods used by GEH for the ESBWR steam dryer are conservative. During its review of these models in connection with ESBWR, the NRC staff concluded that the QC2 acoustic model adequately addressed these areas and is conservative. Subsequently, during its review of the Grand Gulf EPU, the staff discovered that several areas of the QC2 acoustic model contained finite element modeling errors, including number of elements, size of elements, and load transfer between models. The staff believes that these errors are applicable to the ESBWR and call into question the staff's conclusions regarding the dryer loads. Based on the above, the staff has determined that its conclusions in its FSER regarding the dryer loads may no longer be valid and that the issues above need to be addressed by GEH in order for the ESBWR DC to proceed.
4. In LTR, NEDC-33408P-A, Revision 1, GEH discussed the model qualifications and boiling water reactor plant validation with the QC2 replacement dryer which included the procedure for QC2 benchmarks and bias and uncertainty calculations. During its review of this LTR in connection with ESBWR, the NRC staff concluded that the procedure for calculating bias and uncertainties was adequately represented and conservative for purposes of modeling ESBWR steam dryer performance. Subsequently, during its review of the Grand Gulf EPU, the staff discovered that GEH conducted an alternate benchmark approach that produced results that were not conservative. The staff believes that the alternate benchmark approach and its results are applicable to the ESBWR and call into question the staff's conclusions on the adequacy and conservative nature of the bias and uncertainty calculations. Based on the above, the staff has determined that its conclusions in its FSER regarding the benchmarking procedure and validation for calculating bias and uncertainties may no longer be valid and that the issues above need to be addressed by GEH in order for the ESBWR DC to proceed.

Errors in LTR, NEDC-33408, Supplement 1P-A, Revision 2, "ESBWR Steam Dryer—Plant Based Load Evaluation Methodology," issued July 2009.

5. In LTR, NEDC-33408, Supplement 1P-A, Revision 2, GEH discussed the effects of background noise on bias and uncertainties in the QC2 MSL strain gage measurements. GEH used these measurements, and the bias and uncertainties associated with them, for benchmarking the methods for evaluating ESBWR steam dryer performance. During its review of this LTR in connection with ESBWR, the NRC staff concluded that GEH's approach for addressing QC2 MSL strain gage bias and uncertainty due to background noise was acceptable. Subsequently, during its review of the Grand Gulf EPU, the staff discovered that QC2 MSL strain gage measurements have additional inaccuracies that were not previously addressed. The staff believes that these inaccuracies are applicable to the ESBWR and call into question the staff's conclusions regarding acceptability of strain gage measurements corrections used in the benchmarking. Based on the above, the staff has determined that its conclusions in its FSER regarding MSL strain gage measurement corrections may no longer be valid and that the issue discussed above needs to be addressed by GEH in order for the ESBWR DC to proceed.

LTR NEDE-33312P-A, "ESBWR Steam Dryer Acoustic Load Definition," Revision 2 and NEDE-33313P-A, "ESBWR Steam Dryer Structural Evaluation," Revision 2, were also related to the ESBWR steam dryer design and referenced in the ESBWR DCD. Resolution of the errors discussed above could impact related information in these TRs.