UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

April 17, 2014

The Honorable Allison M. Macfarlane
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: SUPPLEMENTAL FINAL SAFETY EVALUATION REPORT ON THE GENERAL ELECTRIC-HITACHI NUCLEAR ENERGY (GEH) APPLICATION FOR CERTIFICATION OF THE ECONOMIC SIMPLIFIED BOILING WATER REACTOR (ESBWR) DESIGN

Dear Chairman Macfarlane:

During the 613th meeting of the Advisory Committee on Reactor Safeguards (ACRS), April 10-11, 2014, we reviewed the supplemental Final Safety Evaluation Report (FSER) for certification of the ESBWR passive nuclear power plant design. In particular, we reviewed the staff's evaluation of the revised analysis procedure for the structural and functional integrity of the ESBWR steam dryer. In our review and our subcommittee meeting on March 5, 2014, we had the benefit of discussions with representatives of the NRC staff. We also had the benefit of the documents referenced.

CONCLUSIONS

The ESBWR steam dryer design is adequate, and the associated structural analysis and planned startup test program are acceptable. There is reasonable assurance that the ESBWR design can be constructed and operated without undue risk to the health and safety of the public.

BACKGROUND

The NRC staff issued the ESBWR FSER on March 9, 2011, to document their review of the ESBWR design. Subsequent to the issuance of the ESBWR FSER, the staff raised additional questions with respect to the GEH analysis procedure for computing oscillating pressure loads acting on the ESBWR steam dryer during normal operation. Following an audit, the staff concluded that there were errors and omissions in the referenced licensing topical reports (LTRs) that GEH needed to correct in order to support the ESBWR application and the final issuance of the design certification.

Steam dryer structural analyses and associated power ascension testing are an integral part of any extended power uprate (EPU) for current boiling water reactors (BWRs). In these plants with increased power, the increased steam flow velocities might cause flow-induced vibrations that generate oscillating pressure loads acting on the steam dryer during operation at higher thermal power, potentially leading to high cycle fatigue failure. Although the steam dryer does not perform a safety function, it must retain its structural integrity to avoid generating loose parts that can affect operation of other components such as the main steam line isolation valves.

We reviewed the supplemental FSER with respect to the ESBWR steam dryer analysis. This FSER supplement documents the NRC staff's review of the changes to the steam dryer analysis process. The overall design of the ESBWR and its steam dryer was not changed.

DISCUSSION

GEH withdrew the initial LTRs and submitted revised engineering reports to explain, substantiate, and benchmark their procedure for computing oscillating acoustic pressure loads acting on the steam dryer. GEH applied a plant-based load evaluation method, which is based on operating experience from existing BWR plants, as well as the advanced boiling water reactor (ABWR) steam dryer design on which the ESBWR steam dryer design is based.

The basic process for determining the acoustic structural loads on the dryer is similar to previous analyses that we have reviewed for EPUs. Acoustic pressure sources are postulated at the junction of the main steam lines and the reactor vessel to determine the relationship between these sources and dryer structural load response. However, in contrast to some steam dryer analyses performed to date, the strength of these acoustic sources is not determined from strain gage measurements on the main steam lines, but rather from direct measurements on the dryer. The design procedure still calls for acoustic analyses of the main steam lines, but only for the purpose of avoiding any resonant conditions.

The detailed design of the ESBWR dryer will be based on estimates of acoustic loads derived from measurements on existing plants. Conservative procedures will be used to develop the design loads from the available data. Final acceptance of the steam dryer is dependent on successful completion of a startup test program for confirming the steam dryer design analysis results as the plant performs power ascension testing. Prior to startup, the acceptance criteria for the peak design stresses will include a factor of two margin relative to ASME Code allowable stresses. This gives a high likelihood that when the startup measurements are made, actual stresses will be below the ASME allowable limits. The engineering reports provide a good description of this analysis process.

After the initial plant startup is complete, the pressure sensor and strain gage instrumentation on the dryer may no longer be available, as has been the case for most of the plants with instrumented dryers during EPU startup testing. We agree with the staff position that once it is verified that the acoustic loads are acceptable in the initial cycle, there is no further need for such instrumentation.

The bias and uncertainties determined from the strain gage measurements on the steam dryer provide confidence in the adequacy of the overall model. However, the overall model may not adequately characterize peak stresses, which are strongly influenced by very local geometries. In response to the staff audit and request for additional information, GEH has improved its requirements for demonstrating adequacy of finite element analysis mesh refinement. Even detailed mesh refinement cannot completely characterize the geometries that affect the peak stresses because they can be affected by local imperfections in welds. Thus, empirical fatigue strength reduction factors are introduced in the refined models. The magnitudes of the factors depend on the detail of the finite element analysis. Such an approach is consistent with usual ASME Code design practice and is acceptable.

In summary, the ESBWR steam dryer design is adequate, and the associated structural analysis and planned startup test program are acceptable. The process agreed to by the staff and GEH provides a good basis for satisfactory operation of the ESBWR steam dryer. In light of this reevaluation, there is reasonable assurance that the ESBWR design can be constructed and operated without undue risk to the health and safety of the public.

Sincerely,

/RA/

John Stetkar
Chairman

REFERENCES

1. Supplemental Safety Evaluation Report for the Economic Simplified Boiling-Water Reactor Standard Plant Design, February 12, 2014 (Ml13330A950)

2. Final Safety Evaluation Report for the Economic Simplified Boiling-Water Reactor Standard Plant Design, March 9, 2011 (ML103470210)

3. NRO Memorandum, Subject: Economic Simplified Boiling-Water Reactor, Design Certification – Supplemental Safety Evaluation, February 12, 2014 (ML14042A261)

4. GE Hitachi Nuclear Energy, “ESBWR Steam Dryer Acoustic Load Definition,” NEDE-33312P, Class III (Proprietary), Revision 5, December 2013 (ML13344B163), and NEDO-33312, Class I (Non-proprietary), Revision 5, December 2013 (ML13344B157)

5. GE Hitachi Nuclear Energy, “ESBWR Steam Dryer Structural Evaluation,” NEDE-33313P, Class III (Proprietary), Revision 5, December 2013 (ML13344B164), and NEDO-33313, Class I (Non-proprietary), Revision 5, December 2013 (ML13344B158)

6. GE Hitachi Nuclear Energy, “ESBWR Steam Dryer – Plant Based Load Evaluation Methodology, PBLE01 Model Description,” NEDE-33408P, Class III (Proprietary), Revision 5, December 2013 (ML13344B176 and ML13344B175), and NEDO-33408, Class I (Non-proprietary), Revision 5, December 2013 (ML13344B159)

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