April 24, 2012

Dr. J. Sam Armijo, Chairman
Advisory Committee on Reactor Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: CHAPTERS 6, 7, 11, 13, 15, 16, AND 18 OF THE SAFETY EVALUATION REPORT WITH OPEN ITEMS ASSOCIATED WITH THE U.S. EVOLUTIONARY POWER REACTOR DESIGN CERTIFICATION APPLICATION

Dear Dr. Armijo:

Thank you for your letter dated March 15, 2012, regarding the safety evaluation report (SER) with open items (OIs) associated with the U.S. Evolutionary Power Reactor (US EPR) design certification application. As discussed during the 592nd meeting of the Advisory Committee on Reactor Safeguards (ACRS) on March 8, 2012, the staff is currently working to resolve the OIs associated with the review of Chapter 6, “Engineered Safety Features,” (except for Section 6.2.1.2, “Subcompartment Analysis," and Section 6.2.2, “Containment Heat Removal”) Chapter 7, “Instrumentation and Controls,” Chapter 11, “Radioactive Waste Management,” Chapter 13, “Conduct of Operations,” Chapter 15, “Transient and Accident Analysis,” (except for Section 15.6.5, “Loss of Coolant Accidents Resulting from Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary”) and Chapter 16, “Technical Specifications.” The SER for Chapter 18, “Human Factors Engineering,” contains no OIs.

The U.S. Nuclear Regulatory (NRC) staff is pleased that you have concluded that the staff has adequately identified OIs that must be resolved before finalizing the SER. We are also pleased that you agree with the staff that pathways are available to resolve these OIs. You also identified four more issues that the staff should consider as we resolve OIs. The ACRS recommendation and the staff response to the resolution of these four additional issues are discussed below.

ACRS Recommendation 1

Digital safety systems in the U.S. EPR use software-based processing for computations and voting units in each division. Common-cause failure can lead to a "lockup" of these systems. To avoid safety hazard from such "lockups," the applicant has incorporated so called "watchdog" timers. The documentation provided to us is inadequate to assure that the designs for these watchdog timers are immune to software common-cause failure. It is not evident how the timers will accomplish their trip functions. We have not been convinced that the Target System Hardware Interface that accesses the watchdog timers will not compromise their independence.

Response

The NRC staff issued a Phase 4 request for additional information (RAI) to address this issue. This RAI requests that the applicant provide consolidated descriptions on the interactions between the watchdog timer and the TXS system software, and both architectural and logic diagrams that illustrate how the TXS watchdog timer executes the reactor trip function if the voting units in each division were to "lockup." This issue will be tracked as an OI in the U.S. EPR SER until the applicant can demonstrate that the watchdog timer is not susceptible to software common-cause failures that could prevent it from executing the reactor trip function if the voting units lockup.

ACRS Recommendation 2

The applicant has identified risk-important human actions to be considered in the human factors engineering design. They have, however, weighted the assessment of the importance of human actions by the frequencies of the plant operating modes. Human actions that can endanger the safety of the plant need to be identified regardless of the duration of the pertinent plant operating mode.

Response

The staff agrees with the ACRS recommendation that human actions that can endanger the safety of the plant need to be identified, regardless of the duration of the pertinent plant operating mode. The staff has identified some risk-significant activities that are identified in Chapter 19, "Probabilistic Risk Assessment …," which the applicant did not include in Chapter 18, "Human Factors Engineering [HFE]." Therefore, the staff has issued a Phase 4 RAI to the applicant requesting justification for excluding these risk-significant activities in HFE. This issue will be tracked as an OI to be addressed in Phase 4 of the EPR design certification review.

ACRS Recommendation 3

The U.S. EPR design allows for up to two hours of operation with only three reactor coolant pumps. Our experience indicates that staff should review this provision by carefully considering the effects of reverse flow in the idle coolant loop, reductions in the reactor coolant system flow, and the lack of symmetry in flow across the plane of the lower core distribution plate.

Response

The U.S. EPR technical specifications allow for up to 2 hours of operation with three of the four reactor coolant pumps operational, provided the thermal power is reduced to ≤ 60 percent rated thermal power within 15 minutes. This 2-hour window is designed to avoid a forced reduction to MODE 3 by allowing for a restart of the reactor coolant pump for simple problems. The analysis supporting the restart (FSAR Section 15.4.4, "Startup of an Inactive Reactor Coolant Pump at an Incorrect Temperature") directly models reverse flow in the idle coolant loop and reductions in the reactor coolant system flow. It also accounts for the lack of symmetry in flow across the plane of the lower core distribution plate with penalties derived from scaled tests of three loop flow operation. Because this analysis does not capture all potential operating conditions, the staff has issued a Phase 4 RAI to address this issue. The RAI requests that the applicant

provide an analysis to demonstrate departure from nucleate boiling rate (DNBR) margin is maintained for the most limiting operation allowed by this technical specification. This issue will be tracked as an OI to be addressed in Phase 4 of the EPR design certification review.

ACRS Recommendation 4

The algorithm used to determine the minimum DNBR utilizes measured values for the core inlet temperature, total core flow, reactor pressure, and local neutron flux. The DNBR algorithm does not appear to account for the possibility of non-uniform flow within the core channels which might be caused by a lower plenum flow anomaly or three-loop operation.

Response

The online algorithm used to determine the minimum DNBR includes a global three loop operation signal to protect against asymmetric events. When this signal is received, the flow rate input is changed from the normal reference volumetric flow rate (derived from the RCP speed sensors) to a constant lower volumetric flow rate consistent with three pump operation. The staff has issued a Phase 4 RAI to the applicant to determine if the lower flow rate captures the penalties associated with nonuniform flow. This issue will be tracked as an OI to be addressed in Phase 4 of the EPR design certification review.

The staff appreciates the willingness of the ACRS to review the staff's SER with OIs on a chapter-by-chapter basis during this phase of the review process and looks forward to the next meeting.

Sincerely,

/RA by Martin J. Virgilio for/

R. W. Borchardt
Executive Director
for Operations

cc: Chairman Jaczko
Commissioner Svinicki
Commissioner Apostolakis
Commissioner Magwood
Commissioner Ostendorff
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