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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 95 –Auxiliary Systems– RAI Number 9.3-36**

Enclosure 1 contains GE's response to the subject NRC RAI transmitted via the Reference 1 letter.

If you have any questions or require additional information regarding the information provided here, please contact me.

Sincerely,

Kathy Sedney for

James C. Kinsey
Project Manager, ESBWR Licensing

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NRO

Reference:

1. MFN 07-204, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 95 Related to the ESBWR Design Certification Application*, March 27, 2007.

Enclosure:

1. MFN 07-288 – Response to Portion of NRC Request for Additional Information Letter No. 95 – RAI Number 9.3-36

cc: AE Cubbage USNRC (with enclosure)
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Enclosure 1

MFN 07-288

Response to Portion of NRC Request for Additional Information Letter No. 95 Related to ESBWR Design Certification

Auxiliary Systems

RAI Number 9.3-36

NRC RAI 9.3-36

DCD Tier 2, Revision 3, Section 9.3.5.3 states, "The safety functions of the standby liquid control system (SLCS) are powered from the Class 120 VAC electrical systems" Please revise the DCD to reflect that these systems are Class 1E systems.

GE Response

DCD Tier 2, Revision 4, Subsection 9.3.5.3 is to be revised to read, "The safe shutdown functions of the SLC system are powered from the Safety-Related 120 VAC electrical systems through the four divisions of Q-DCIS".

DCD Impact

DCD Tier 2, Subsection 9.3.5.3 is to be revised in Revision 4 as noted in the attached markup.

(ECCS) and the SLC system are designed to flood the core during a LOCA event to provide the required core cooling. By providing core cooling following a LOCA, the ECCS and the SLC system, in conjunction with the containment, limits the release of radioactive materials to the environment.

The shutdown functional performance requirements of the SLC system are bounded by the ATWS event performance requirements shown in Table 9.3-5. For ATWS events, the failure of control rods to insert in response to a valid trip demand is assumed. The SLC system automatically initiates by the Average Power Range Monitor (APRM) not downscale (≥ 6%) and one of the following conditions persisting for at least 3 minutes:

- High reactor dome gauge pressure of ≥ 7.76 MPa (≥ 1125 psig); and
- Low reactor vessel water level (≤ Level 2).

The three-minute delay provides time for completion of the FMCRD motor-driven run-function before initiation of the SLC system, thereby preventing the unnecessary injection of the boron solution into the reactor.

Sodium Pentaborate Solution injection ensures a timely accomplishment of hot shutdown. Subsequent injections as the reactor depressurizes ensure that cold shutdown can be achieved with no further occurrence of critical conditions. Refer to Section 15.5 for SLC system performance in the evaluation of ATWS events.

During a LOCA or an ATWS event, at the completion of the boron solution injection, redundant accumulator level measurement instrumentation using 2-out-of-4 logic close the two redundant injection line shut-off valves. The closing of these valves prevent the injection of nitrogen from the accumulator into the reactor vessel. In the event of a single shut-off valve failure, the remaining valve is sufficient to prevent the injection of nitrogen into the reactor vessel. An accumulator vent is also provided, which can be used to quickly reduce the pressure in the accumulator.

9.3.5.3 Safety Evaluation

The SLC system is mainly a reactivity control system that is maintained in an operable status whenever the reactor is critical. A large number of independent control rods are available to shutdown the reactor including redundant and diverse methods to insert the control rods, at any time during the core life.

Availability of the SLC system is ensured by redundancy in the injection valves. Adequate functioning of the system is ensured if one of the two injection valves open in each train. No other function is required for proper system operation. Addition of nitrogen to recover gas pressure after initial injection is not necessary for adequate functioning of the system.

The system is designed to bring the reactor from rated power to a cold shutdown condition at any time in core life. The reactivity compensation provided reduces reactor power from rated to zero and allows cooling of the nuclear system to less than the cold shutdown temperature with the control rods remaining withdrawn in the rated power pattern. These conditions (hot shutdown and cold shutdown) include, where applicable, the reactivity gains that result from complete decay of the rated power xenon. They include the positive reactivity effects from eliminating steam voids, changing water density from hot to cold, reduced Doppler effect in uranium, reducing neutron leakage from boiling to cold, and decreasing control rod worth as the moderator cools.

The minimum uniformly mixed equivalent concentration of natural boron required in the reactor core to provide adequate cold shutdown margin after operation of the SLC system is 760 ppm. Calculation of the minimum quantity of isotopically enriched sodium pentaborate to be injected into the reactor is based on the required 760 ppm equivalent natural boron concentration in the reactor coolant at 20°C (68°F) and reactor water level conservatively taken at the elevation of the bottom edge of the main steam lines. This result is then increased by a factor of 1.25 to provide a 25% general margin to discount potential non-uniformities of the mixing process within the reactor. This result is then increased by a factor of 1.15 to provide a further margin of 15% to discount potential dilution by the RWCU/SDC System in the shutdown cooling mode.

Cooldown of the nuclear system requires a minimum of several hours to remove the thermal energy stored in the reactor, reactor water, and associated equipment. The limit for the reactor vessel cooldown is 55.6°C/hr (100°F/hr) and the normal operating temperature is approximately 288°C (550°F). Use of the main condenser and the shutdown cooling systems normally requires 10 to 24 hours to decrease the reactor vessel temperature to 20°C (68°F). Although hot shutdown is the condition of maximum reactivity, cold shutdown condition is associated with the largest total water mass in which the particular shutdown concentration must be established and therefore, this condition determines the total mass of boron solution to be injected.

The extremely rapid initial rate of isotopically enriched boron injection ensures that hot shutdown boron concentration is achieved within several minutes of SLC system initiation based on initial reactor water inventory. Maintaining normal water level with the voids collapsed causes some dilution of this concentration but does not cause hot shutdown concentrations to be violated. As the reactor cools and begins to depressurize, completion of all boron solution injection occurs long before cold shutdown conditions are reached. The high injection velocity of the injection spargers and the natural circulation flow within the reactor vessel ensures efficient mixing and distribution of the boron throughout the reactor vessel.

The SLC system is designed to conform with the requirements for equivalent reactivity control capacity specified in 10 CFR 50.62(c)(4).

The SLC system equipment is Safety-Related for injection of boron solution into the reactor is designed as Seismic Category I for withstanding the specified earthquake loadings (refer to Section 3.7). The system piping and equipment are designed, installed, and tested in accordance with the requirements stated in Section 3.9.

The safe shutdown functions of the SLC system are powered from the Safety-Related 120 VAC electrical systems through the four divisions of Q-DCIS. Environmental conditions to prevent precipitation of solute do not require operation of the Reactor Building HVAC systems during the time that SLC operation is required.

The initial accumulator tank inventory of compressed nitrogen is adequate to ensure full injection of the boron solution inventory at a reactor pressure of 6.9 MPa (1000 psia). After the boron injection is complete, the redundant shut-off valves close to prevent the injection of nitrogen into the reactor vessel. A single shut-off valve is sufficient to prevent nitrogen from entering the reactor vessel. Protection against inadvertent premature operation of the shut-off valve is ensured by use of redundancy in the initiation signal for this function.