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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 140 Related to ESBWR Design Certification Application - Auxiliary Systems - RAI Number 9.3-42**

Enclosure 1 contains GEH's response to the subject RAI transmitted via Reference 1.

Should you have any questions about the information provided here, please contact me.

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

D068
NRO

Reference:

1. MFN 08-031, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 140 Related to the ESBWR Design Certification Application,* January 11, 2008.

Enclosure:

1. Response to NRC Request for Additional Information Letter No. 140 Related to ESBWR Design Certification Application - Auxiliary Systems - RAI Number 9.3-42

cc:	AE Cubbage	USNRC (with enclosure)
	RE Brown	GEH/Wilmington (with enclosure)
	LE Fennern	GEH/San Jose (with enclosure)
	GB Stramback	GEH/San Jose (with enclosure)
	eDRF	0000-0079-7800

Enclosure 1

MFN 08-074

Response to Portion of NRC Request for

Additional Information Letter No. 140

Related to ESBWR Design Certification Application

Auxiliary Systems

RAI Number 9.3-42

NRC RAI 9.3-42

DCD Tier 2, Section 9.3.5.3, 12th paragraph states:

"The overall requirements (Section I) of the GDC are applicable to the system-------."

Please change to state "The overall requirements of GDC 2, and 4 are applicable to the system-------."

GEH Response

The statement in question has been changed to read, "The overall requirements of GDC 2 and GDC 4 are applicable to the system, and the system equipment has been designed and installed in conformance with the presentations in Chapter 3."

DCD Impact

DCD Tier 2, Subsection 9.3.5.3 will be revised in Revision 5 as noted in the attached markup.

9.3.5.3 Safety Evaluation

The SLC system is an alternate reactivity control system that is required to be operable whenever the reactor is critical. The SLC system is also used to provide makeup water during a LOCA.

The redundant injection valves ensure the reliability of the SLC system. Adequate functioning of the system is ensured if one of the two injection valves in each train opens. 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.

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 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 on 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. This conservative approach results in an equivalent concentration of approximately 1100 ppm of natural boron to be injected into the reactor core to achieve cold shutdown. This concentration at hot shutdown is approximately 1600 ppm due to the volume of water.

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 from the core bypass 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, and 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.

The SLC system is evaluated against the applicable General Design Criteria (GDC) as follows:

The SLC system is designed to conform to the GDC of 10 CFR 50. The overall requirements ~~(Section I)~~ of ~~the~~ GDC 2 and GDC 4 are applicable to the system, and the system equipment has been designed and installed in conformance with the presentations in Chapter 3. For its function to provide makeup water to the RPV during a LOCA, the SLC system is designed to meet the requirements of GDC 17, 35, 36 and 37 and 10 CFR 50.46 in conjunction with the other ECC systems. Conformance to these criteria is discussed in Section 6.3, Emergency Core Cooling Systems. Other related GDCs are presented individually below: