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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 34 Related to ESBWR Design Certification Application – Auxiliary Systems – RAI Numbers 9.3-3 through 9.3-10 and 9.3-12 through 9.3-23**

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

If you have any questions about the information provided here, please let me know.

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

D068

Reference:

1. MFN 06-198, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 34 Related to ESBWR Design Certification Application,* June 22, 2006

Enclosure:

1. MFN 06-216 – Response to Portion of NRC Request for Additional Information Letter No. 34 Related to ESBWR Design Certification Application – Standby Liquid Control System – RAI Numbers 9.3-3 through 9.3-10 and 9.3-12 through 9.3-23

cc:

WD Beckner	USNRC (w/o enclosures)
AE Cubbage	USNRC (with enclosures)
LA Dudes	USNRC (w/o enclosures)
GB Stramback	GE/San Jose (with enclosures)
eDRF	0000-0055-4099

Enclosure 1

MFN 06-216

Response to Portion of NRC Request for

Additional Information Letter No. 34

Related to ESBWR Design Certification Application

Standby Liquid Control System

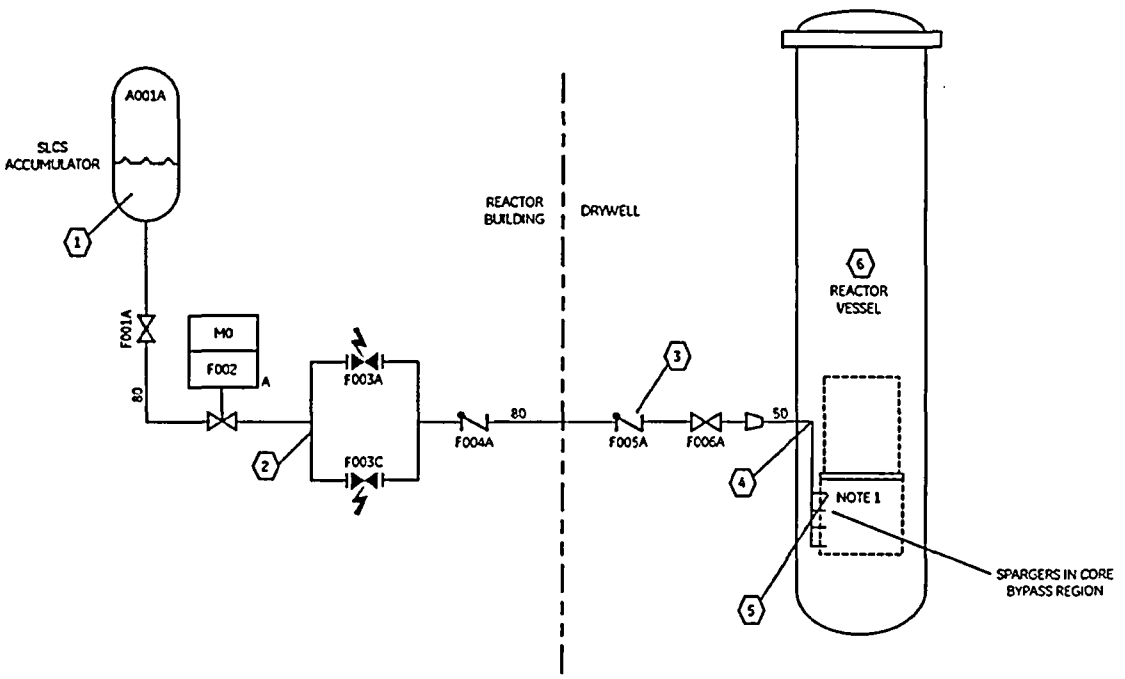
RAI Numbers 9.3-3 through 9.3-10 and 9.3-12 through 9.3-23

NRC RAI 9.3-3

Provide a process diagram showing the SLCS operating parameters: pressure, temperature and flow rates.

GE Response:

A simplified SLCS process diagram is provided in the attached figure. DCD Tier 2 Subsection 9.3.5 will be revised in the next update to incorporate this figure.



SYSTEM STANDBY MODE

LOCATION	⬡	1	2	3	4	5	6
PRESSURE	MPa Gauge (PSIG)	15.17 (2200)	15.20 (2204)	7.10 (1030)	7.10 (1030)	7.10 (1030)	7.10 (1030)
TEMPERATURE	°C (°F)	18 (65)	18 (65)	18 (65)	278 (533)	278 (533)	278 (533)

INJECTION MODE (RPV-HOT STANDBY)

LOCATION	⬡	1	2	3	4	5 NOTE 4	6
PRESSURE NOTE 3	MPa Gauge (PSIG)	12.1 (1755)	12.0 (1746)	11.9 (1719)	11.5 (1670)	9.6 (1390)	8.63 (1251)
TEMPERATURE	°C (°F)	-2.3 (+27.9)	18 (65)	18 (65)	18 (65)	18 (65)	298 (571)
AVERAGE VELOCITY NOTE 2	M/SEC (FT/SEC)	- -	8.9 (29.3)	8.9 (29.3)	21.5 (70.7)	34.2 (112.5)	- -

NOTES:

1. EACH SLCS INJECTION LINE CONNECTS TO A HEADER INSIDE THE REACTOR VESSEL THAT DIRECTS FLOW TO TWO DOWNCOMERS. EACH DOWNCOMER CONNECTS TO FOUR NOZZLES THAT DIRECT FLOW THROUGH THE SHROUD INTO THE CORE BYPASS REGION. THE NOZZLES ARE LOCATED AT FOUR DIFFERENT ELEVATIONS FOR A TOTAL OF EIGHT NOZZLES PER EACH SLCS LOOP.
2. AVERAGE VELOCITY DURING INJECTION OF THE FIRST HALF OF REQUIRED SOLUTION VOLUME.
3. PRESSURE CONDITIONS CORRESPOND TO TIME AT WHICH HALF THE SOLUTION VOLUME HAS BEEN INJECTED.
4. VELOCITY THROUGH A SINGLE NOZZLE HOLE. EACH NOZZLE HAS TWO HOLES.

Figure 9.3-3-1 Standby Liquid Control System Simplified Process Diagram

NRC RAI 9.3-4

DCD Tier 2, Rev.1, Section 7.4.1 states: "The Standby Liquid Control (SLC) system does not ensure any safety-related function, nor does it perform a safety-related function associated with any design basis event, as defined by 10 CFR 50.49(b)(1)(ii). However, for conservatism, the SLC system is classified as safety related."

Since SLCS is part of the emergency core cooling system (ECCS) in the ESBWR design, the above statement is not correct. Recommend changing the above statement in the DCD to "The SLCS performs safety-related functions, it is classified as safety-related and is designed as a Seismic Category I system."

GE Response

DCD Tier 2, Rev. 1, Subsection 7.4.1 is incorrect. The DCD will be revised to delete the following text at the next update:

"The Standby Liquid Control (SLC) system does not ensure any safety-related function, nor does it perform a safety-related function associated with any design basis event, as defined by 10 CFR 50.49(b)(1)(ii). However, for conservatism, the SLC system is classified as safety-related."

The SLCS is already defined as a safety related system in DCD Tier 2, Rev. 1, Subsection 9.3.5.1, which is referred to in Subsections 7.4.1.1 and 7.4.1.2. The safety evaluation discussion in 7.4.1.3 also indicates that the SLCS complies with the safety related requirements outlined in the applicable sections of DCD Chapter 3 (reference Table 3.2-1, Classification Summary) and Table 7.1-1, Regulatory Requirements Matrix, Part 1. There is no need to include a discussion at 7.4.1 duplicating this information. This approach is preferred because it will make Subsection 7.4.1 consistent with other subsections within Section 7.4 (for example, Subsection 7.4.4 for the ICS).

DCD Tier 2 Subsection 7.4.1 will be revised in the next update as noted above.

NRC RAI 9.3-5

Since SLCS is part of the ECCS, General Design Criteria (GDC): 2 (Seismic design), 5 (Sharing among units), 17 (Electric power), 27 (Capability to cool the core), 35 (Emergency core cooling), 36 (Inspection of ECCS) and 37 (Testing of ECCS) apply. Include application of these GDC in the DCD. Also, add 10 CFR 50.46, in regard to the ECCS being designed so that its cooling performance is in accordance with an acceptable evaluation model. We understand that the above GDC are included in DCD Section 6.3 for ECCS, but for clarity, refer to them in the corresponding sections of the DCD describing the individual ECCS systems.

Explain in detail how the SLCS meets GDC 4, as related to dynamic effects associated with flow instabilities and loads.

GE Response

DCD Tier 2, Rev. 1, Subsection 9.3.5.3 (page 9.3-12) references the applicability of Section I (Overall Requirements) of the GDC to the SLCS. This covers GDC 2, 4 and 5. Conformance with GDC 27 is also addressed in the DCD at the same location.

With respect to the remaining GDC cited in this RAI (GDC 17, 35, 36, 37 and 10 CFR 50.46), GE will add the following text to Subsection 9.3.5.3 (Safety Evaluation):

"For its function to provide makeup water to the RPV during a LOCA, the SLCS is designed to meet the requirements of GDC 17, 35, 36 and 37 and 10 CFR 50.46 in conjunction with the other ECCS systems. Conformance to these criteria is discussed in Section 6.3, Emergency Core Cooling Systems."

The statement in DCD Tier 2, Rev. 1, Section 6.3 regarding conformance to GDC 4 relating to dynamic effects associated with flow instabilities and loads (e.g., water hammer) is primarily directed to the GDCS. The GDCS functions at low pressure and does not have pumps or other equipment that will generate high differential pressures internal to its piping that can cause water hammer loads to be generated. Thus, the GDCS design eliminates the flow instabilities and water hammer loads that plants in the current operating fleet may experience with pump-driven ECCS systems.

For the SLCS, the discharge piping will be designed to accommodate the water hammer loads generated by the fast-opening squib valves and high pressure accumulator.

DCD Tier 2 Subsection 9.3.5.3 will be revised in the next update as noted above.

NRC RAI 9.3-6

The boron injection path to the core is not described in the DCD. Discuss flow pattern (injection geometry) and movement of injected boron solution through the bypass region. Provide a diagram showing spargers in the core bypass region and show the header, feeder pipes, nozzles, discharge ports and the jets. Describe, in detail, positions of the injection points relative to the active length of the core.

GE Response

Preliminary diagrams of the SLCS piping configuration internal to the RPV have been provided in MFN-06-076 dated March 27, 2006. A diagram specific to ESBWR with the requested information will be provided under separate cover in response to RAI 21.6-53.

NRC RAI 9.3-7

Anticipated transient without scram (ATWS) Rule 10 CFR 50.62(c)(4) is applicable to SLCS. Add a reference to the rule in the DCD.

GE Response

GE will add the following text to Subsection 9.3.5.3 (Safety Evaluation):

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

DCD Tier 2 Subsection 9.3.5.3 will be revised in the next update as noted above.

NRC RAI 9.3-8

The following sentences were included in DCD Section 9.3.5.2, Revision 0, but were deleted from Revision 1: "The bulk of the safety-related SLCS equipment is located within two divisionally separated compartments of the Reactor Building except for a portion of the injection lines that leads to the [reactor pressure vessel] RPV and therefore passes through containment."

Confirm that the divisional separation criteria is still met for the system.

GE Response

SLCS arrangement meets the divisional separation criteria. As described in the response to RAI 4.6-15, each train of the SLCS (tank and associated valves and equipment) is housed in its own room located at an upper elevation in the reactor building (Floor Elevation 17500). These rooms are located on opposite sides of the reactor (Rooms 1713 and 1723 shown on DCD Figure 1.2-7). This arrangement provides the required physical separation between each SLCS train and the safety related CRD System equipment.

No DCD changes will be made in response to this RAI.

NRC RAI 9.3-9

What is the rated pressure for the piping in the SLCS.

GE Response:

A design pressure of 17.24 MPaG (2500 psig) is applied to the accumulator and injection piping.

No DCD changes will be made in response to this RAI.

NRC RAI 9.3-10

DCD Tier 2, Section 9.3.5.2 states: "Each train provides 50% injection capacity." Clarify in the DCD that the capacity is in relation to the reactor shutdown function and not the ECCS function.

GE Response

Each SLCS train provides 50% capacity for all its functions. Operation of both trains is required to provide the reactor shutdown function and to provide the reactor with the additional liquid inventory water volume of 7.8 m^3 from each accumulator assumed in the ECCS-LOCA analysis (see DCD Tier 2, Rev.1, Table 6.3-1, Item B.4). Each train has redundant squib valves to ensure that a failure of one valve to open will not disable the train from performing its injection function.

No DCD changes will be made in response to this RAI.

NRC RAI 9.3-12

DCD Tier 2, Section 9.3.5.3 (Page 9.3-12) states: "The initial accumulator tank inventory of compressed nitrogen is adequate to ensure full injection of the solution inventory at a reactor pressure of 1000 psia."

The calculated reactor pressure during ATW S is 1426.1 psig as shown in DCD Tier 2, Table 15.5-4b, and in DCD Tier 1, Table 2.2.4-1 reactor pressure is shown as 1250 psia.

Does the reactor pressure refer to the steam dome pressure? Which reactor pressure is correct?

Describe the capability of the accumulators to provide sufficient driving head to ensure boron injection for a reactor pressure greater than 1000 psia and explain how the capability is provided.

GE Response

The reactor pressure refers to the steam dome pressure. Both values are correct. The peak ATWS pressure occurs prior to initiation of the SLCS. At the time of SLCS initiation the reactor dome pressure is approximately 8.6 MPa (1247 psig) and decreasing. This is described in Section 8.1, Baseline Analysis, of NEDE-33083P Supplement 2, TRACG Application for ESBWR Anticipated Transient Without Scram Analyses.

The SLCS accumulators are sized to (1) inject the initial 5.4 m^3 of solution against an initial reactor pressure of 1250 psig, and (2) complete the injection of the total SLCS volume of 7.8 m^3 against a final reactor pressure of 1000 psig or less.

No DCD changes will be made in response to this RAI.

NRC RAI 9.3-13

In DCD Tier 2, Section 9.3.5.3, SLCS is evaluated against Regulatory Guide (RG) 1.26.

Since SLCS is part of ECCS, the following statement is not correct "Because the SLCS is a defense-in-depth beyond design basis shutdown system, -----" Revise the RG 1.26 discussion in the DCD to state that SLCS is also an ECCS system.

GE Response

GE will revise the first sentence of the RG 1.26 discussion to read as follows:

"Because the SLCS is a defense-in-depth beyond design basis system and an ECCS system, all mechanical components required for boron injection are at least Quality Group B."

DCD Tier 2 Subsection 9.3.5.3 will be revised in the next update as noted above.

NRC RAI 9.3-14

DCD Tier 2, Table 9.3-3 states: " A poison solution line for initial charging and any necessary periodic makeup for each accumulator (KCM673)." What is "KCM673"?

GE Response

The bracketed term "[KCM673]' is a verification designation that should not appear in the issued DCD Tier 2. It will be deleted in the next revision.

DCD Tier 2 Table 9.3-3 will be corrected in the next update as noted above.

NRC RAI 9.3-15

The format of Table 2.2.4-1 is not consistent with the format required for ITAAC table with Design commitment, inspections, tests, analyses and acceptance criteria.

The information in ITAAC Table 2.2.4-1 is duplicated in Table 2.2.4-2 except for the jet velocities. If the velocities can be added to Table 2.2.4-2, Table 2.2.4-1 can be deleted.

GE Response

Table 2.2.4-1 is not an ITAAC table, but instead is a tabulation of design information to support the SLCS Design Description of DCD Tier 1, Rev. 1, Subsection 2.2.4. Table 2.2.4-2 provides the SLCS ITAAC information in the accepted format.

No DCD changes will be made in response to this RAI.

NRC RAI 9.3-16

Why are the following items are not included in the ITAAC:

(a) The SLCS can be manually initiated from the main control room

(b) Both trains of the SLC system are automatically initiated during an ATWS

(c) Injection valve shutoff after injection

(d) Accumulator relief valve set point

(e) Add the following if applicable: " In the SLC system, independence is provided between Class 1E divisions, and also between Class 1 E divisions and non-Class 1E equipment.

(f) Add the following: motor operated valves (MOVs) and squib actuated valves designated as having an active safety-related function open, close, or both open and close under system pressure, fluid flow, and temperature conditions.

(g) Physical Separation between trains

(h) PRA insights

(i) Seismic qualification

GE Response

The content and level of detail for the Tier 1 Design Descriptions and ITAAC is being addressed on a generic basis for all systems in the response to RAI 14.3-1 that will be provided under separate cover. The SLCS Tier 1 material will be revised and updated as necessary in accordance with the final response to RAI 14.3-1.

NRC RAI 9.3-17

DCD Tier 1, ITAAC Table 2.2.4-2, item # 2c, RPV inventory and reactor water cleanup (RWCU)/shutdown cooling (SDC) system values assumed in the calculations should be included in the ITAAC as in ABWR.

GE Response

DCD Tier 2, Rev, 1, Subsection 9.3.5.3 describes how the 25% margin for potential mixing non-uniformities in the reactor and the 15% margin for dilution by the RWCU/SDC in the shutdown cooling mode is applied to the minimum required 760 ppm equivalent natural boron concentration to establish the 1100 ppm requirement. The actual RWCU/SDC piping volume will not be established until the pipe routing is completed in the detailed design. At the time the ITAAC is confirmed, the as-built RWCU/SDC piping volume and RPV inventory will be applied to the analysis to confirm that the required 1100 ppm is provided. It is not necessary to include the assumed inventories in the ITAAC since the required concentration will be confirmed based on the as-built volumes.

No DCD changes will be made in response to this RAI.

NRC RAI 9.3-18

DCD Tier 1, ITAAC Description

Add a description of the Accumulator and the squib actuated valves.

GE Response

With regard to changes to Tier 1 content and level of detail, please see the response to RAI 9.3-16.

NRC RAI 9.3-19

DCD Tier 1, ITAAC Figure 2.2.4-1

Add accumulator relief valve FO30 in addition to the vent shown for the Accumulator. Also, add the set pressure of the relief valve to the ITAAC.

Add accumulator pressure indicator in addition to the level indicator, as pressure is a critical parameter. 2500 psia is indicated in the figure. Clarify whether the 2500 psia is the normal pressure in the accumulator, the design pressure of the accumulator, or the accumulator pressure assumed in the safety analyses. Also, clarify whether the 24.5 cubic meters indicated is the design capacity of the accumulator, or the accumulator capacity assumed in the safety analyses. If these parameters are to be verified by the ITAAC, these values should be included in the ITACC Table 2.2.4-2.

Note: The ITAAC values to be verified should be the values assumed in the safety analyses.

GE Response

With regard to changes to Tier 1 content and level of detail, please see the response to RAI 9.3-16.

The accumulator pressure of 2500 psig is the design pressure. The specified volume of 24.5 m^3 is the design value for the internal volume of the accumulator.

NRC RAI 9.3-20

DCD Tier 2, Section 9.3.5.2 states "The SLCS automatically initiates by the APRM not downscale (6%) and one of the following conditions persisting for at least 3 minutes." W hat is the basis for the three minutes?

GE Response

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

The FMCRD motor driven run-in time is at its maximum when the FMCRD is inserted at its slowest speed. The FMCRD positioning speed is 28 ± 5 mm/sec. The insertion time at minimum FMCRD speed for the full stroke of 2921 mm is:

Insertion time = 2921 mm / (28 – 5) mm/sec = 127 seconds

Three minutes provides the required delay time for this function with margin.

No DCD changes will be made in response to this RAI.

NRC RAI 9.3-21

DCD Section 9.3.5.2 states: "Environmental conditions to prevent precipitation of solute do not require operation of the Reactor Building HVAC systems during the time that SLCS operation is required."

How are the environmental conditions maintained without the operation of the Reactor Building HVAC?

GE Response

During normal plant operation, the Reactor Building HVAC maintains the SLCS equipment rooms above the precipitation temperature of the sodium pentaborate solution. The room temperature is monitored and alarmed when low. A backup electrical heater is provided in each SLCS accumulator room to ensure that the room temperature is maintained at or above the minimum required temperature in the event of the failure of the primary heating system.

No DCD changes will be made in response to this RAI.

NRC RAI 9.3-22

What would be the benefit in terms of reliability if several different batches of pyrotechnic booster chargers were used in the different squib valves for the SLCS injection lines? Briefly describe the testing program for the valves. How long are the valves in service before being replaced?

GE Response

The SLCS injection valve pyrotechnic charges are in service for two plant operating cycles. Replacement is on a staggered schedule such that half of the charges are replaced each outage with charges from a new batch. In the next outage the other half is replaced. The removed charges are subsequently actuated in a test facility to confirm their end of life capability to fire on demand. During normal plant operation, a small trickle current is used in the firing circuit to each squib charge to verify circuit continuity for receiving the firing signal.

Based on operating experience from the BWR fleet, the SLCS injection valve pyrotechnic charge has been shown to be a highly reliable device. No significant benefit, in terms of increased reliability, would be expected from requiring the use of several different batches of pyrotechnic charges in the different squib valves.

No DCD changes will be made in response to this RAI.

NRC RAI 9.3-23

From Drawing 105E3976, Sheet No. 2, it is not clear if MOV F002 is AC or DC powered. Is the power supply for the normally open MOV F002 AC or DC?

DCD Tier 1, ITAAC Figure 2.2.4-1 shows only one air-operated valve for the Accumulator vent line, but the P&ID shows two valves, which is correct?

GE Response

The power supply for MOV F002 is Class 1E 250 VDC.

The P&ID is correct showing two air-operated valves for the accumulator vent. The simplified schematics of DCD Tier 2, Figure 9.3-1 and Tier 1, Figure 2.2.4-1 show only one valve to represent the functional requirement for a vent line. It is not the intent of the simplified diagram to show all design details to the same level of the P&ID but to identify the main process flow paths and major equipment. This follows the approach shown on the schematic diagram of the SLCS in Appendix A of NEDC-33084P, Revision 1, ESBWR Design Description.

No DCD changes will be made in response to this RAI.