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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 85 - Containment Systems and Emergency Core Cooling Systems - RAI Numbers 6.2-144, 6.2-145, 6.2-146, 6.2-147, and 6.3-66**

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

If you have any questions or require additional information, please contact me.

Sincerely,

Kathy Sedney for

James C. Kinsey
Project Manager, ESBWR Licensing

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NRO

Reference:

1. MFN 07-054, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application*, January 19, 2007

Enclosure:

1. MFN 07-310 - Response to Portion of NRC Request for Additional Information Letter No. 85 - Related to ESBWR Design Certification Application - Containment Systems and Emergency Core Cooling Systems - RAI Numbers 6.2-144, 6.2-145, 6.2-146, 6.2-147, and 6.3-66

cc:	AE Cubbage	USNRC (with enclosures)
	BE Brown	GE/Wilmington (with enclosures)
	GB Stramback	GE/San Jose (with enclosures)
	eDRF	0000-0065-0527 for RAI 6.2-144 0000-0064-5590 for RAIs 6.2-145, 6.2-146, 6.2-147, and 6.3-66

Enclosure 1

MFN 07-310

Response to Portion of NRC Request for
Additional Information Letter No. 85
Related to ESBWR Design Certification Application
Containment Systems and Emergency Core Cooling Systems
RAI Numbers 6.2-144, 6.2-145, 6.2-146, 6.2-147, and 6.3-66

NRC RAI 6.2-144:

DCD, Tier 2, Revision 2, Section 6.3 assumed the availability of the containment back pressure in determining the minimum water level in the reactor pressure vessel (RPV) following a LOCA. The depressurization of the RPV and thus the initiation of the Gravity Driven Cooling System (GDCS) is dependent on the assumptions used for determining the containment back pressure. However, the analyses are inconsistent with Standard Review Plan (SRP) Section 6.2.1.5, "Minimum Containment Pressure Analysis for Emergency Core Cooling System Performance Capability Studies," Revision 2, July 1981 and Branch Technical Position CSB 6-1, "Minimum Containment Pressure Model for PWR ECCS Performance Evaluation." Although, CSB 6-1 was developed to evaluate the performance of emergency core cooling system of a pressurized water reactor, most of its guidance is also applicable to ESBWR for determining the performance of the GDCS. Specifically, the input information for the model, active heat sinks (e.g., Fuel and Auxiliary Pools Cooling System operating on drywell spray mode), and passive heat sinks affect the containment back pressure. Please justify the containment back pressure used for determining the minimum RPV water level considering Branch Technical Position CSB 6-1.

GE Response:

The ESBWR analyses described in DCD Tier 2, Revision 2, Section 6.3, model the containment backpressure in the calculation of the minimum chimney collapsed level following a loss-of-coolant accident (LOCA). The input information for the model, active heat sinks, and passive heat sinks affect the containment backpressure as discussed in NUREG-0800, Standard Review Plan (SRP), Revision 2, Section 6.2.1.5, which could affect the emergency core cooling systems (ECCS) performance. However, the Gravity Driven Cooling System (GDCS), the drywell/wetwell, and the reactor pressure vessel (RPV) are interconnected in the ESBWR design. In addition, the GDCS performance depends mainly on the gravity head difference between the GDCS pool and the RPV, and not on the containment backpressure. Results of parametric cases, which conservatively model the additional passive and active heat sinks, show that the impacts on the containment backpressure are less than 20 kPa. The effects of this change in containment backpressure on the minimum chimney collapsed level are less than 0.1 m (6% of the level margin to the top of the active fuel). Results also show that the minimum chimney collapsed level is not sensitive for a wider range of change in the containment backpressure.

Parametric cases have been performed to assess the effect of containment backpressure on the minimum chimney collapsed level. For evaluation purpose, the GDCS line break with failure of one injection valve (DCD Tier 2, Revision 2, Table 6.3-5, nominal case) was selected as the base case. One case included conservative modeling of additional passive heat sinks (containment walls and internal structures), and another case included conservative modeling of both the additional passive heat sinks and active heat sink (1000 gpm drywell spray). Three additional parametric cases were performed to bound the impact of change in model input information on the containment backpressure. In these three cases, the wetwell and suppression pool volumes were artificially increased by a factor of 1.5, 2.0 and 3.0. Larger wetwell volume results in smaller drywell pressurization rate, and lower containment backpressure at the time of GDCS flow initiation. These three cases provide the bounding estimate of the containment backpressure, and the resulting bounding effect on the minimum chimney collapsed level.

For comparison purpose, the key parameters are the maximum wetwell pressure at around the time of GDCS flow initiation, the GDCS flow initiation timing, and the minimum chimney collapsed level. The results show that the maximum wetwell pressure decreases with the additional drywell steam condensing heat sinks such as the drywell spray and additional drywell heat structures, and decreases with larger wetwell volume. With the additional passive and active heat sinks, the maximum wetwell pressure decreases by 17 kPa from the base case value.

Figure 6.2-144-1 shows the effect of the maximum wetwell pressure on the GDCS injection timing. The initiation time for the GDCS flow increases linearly as the wetwell pressure reduces. With the additional passive and active heat sinks, the GDCS initiation time increases by 7 seconds from the base case value.

Figure 6.2-144-2 shows the effect of the maximum wetwell pressure on the minimum chimney collapsed level. This figure shows that the minimum chimney collapsed level is not sensitive to the change in the containment backpressure. With the additional passive and active heat sinks, the minimum chimney collapsed level reduces by less than 0.1 m from the base case value. This reduction in minimum chimney collapsed level corresponds to 6% of the level margin to the top of the active fuel.

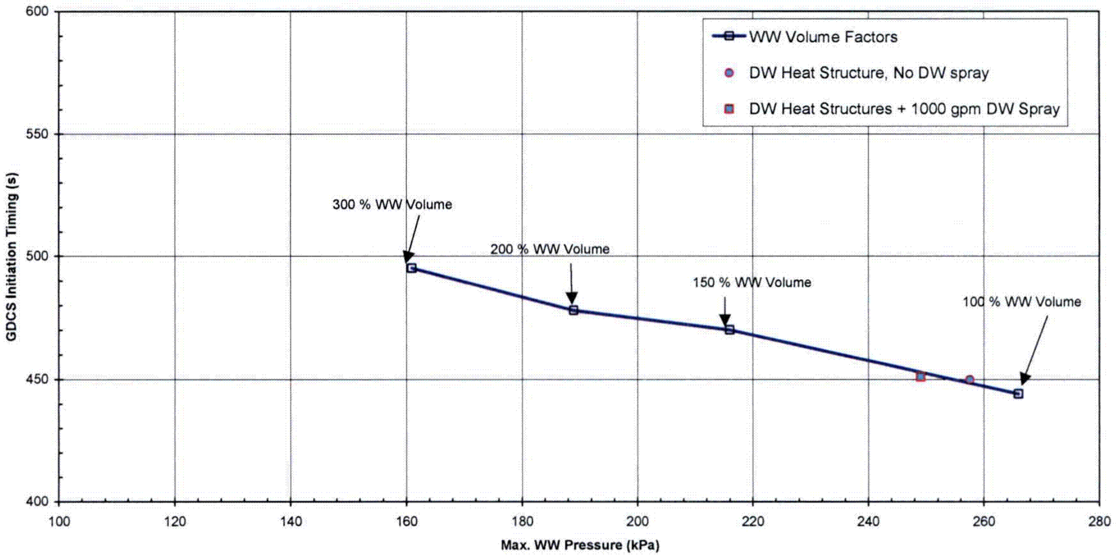

Figure 6.2-144-1: Effect of Wetwell Pressure on the GDCS Initiation Timing (GDCS Injection Line Break, 1 GDCS Injection Valve Failure)

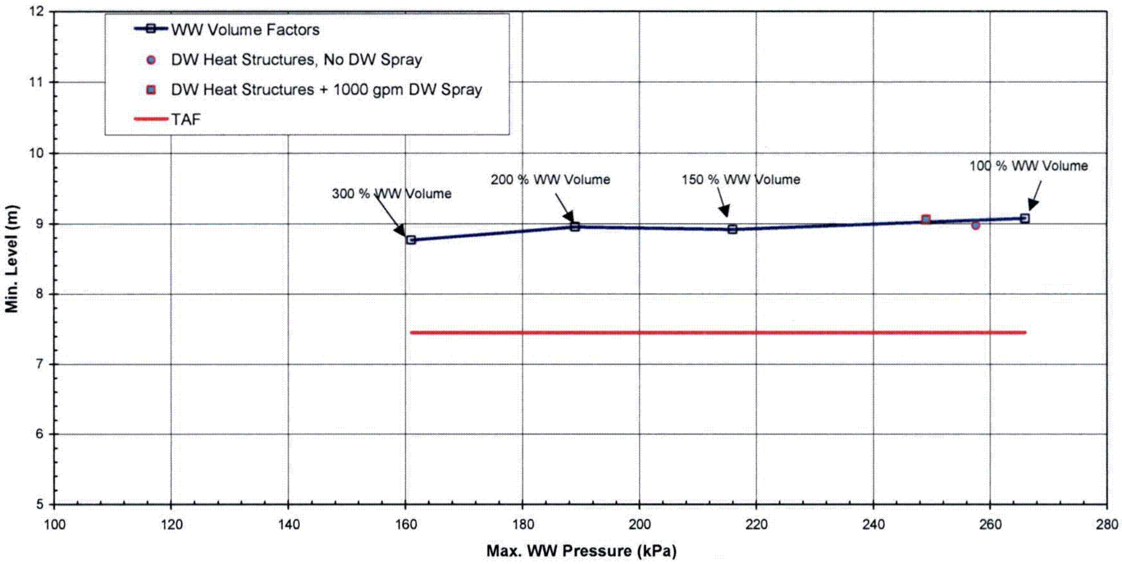

Figure 6.2-144-2: Effect of Wetwell Pressure on the Minimum Chimney Collapsed Level (GDCS Injection Line Break, 1 GDCS Injection Valve Failure)

DCD Impact:

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

NRC RAI 6.2-145:

DCD, Tier 2, Revision 2, Section 6.2.1.1.5.1 states that the bounding design basis calculation assumed a bypass leakage of 1 cm^2 (A/√K). This value is significantly lower than the design capacities of Mark I, II, and III containments: 18.6, 46.5, 929 cm^2 (A/√K), respectively (SRP Section 6.2.1.1.C, Revision 6, August 1984). DCD, Tier 2, Revision 2, Section 6.2.1.1.5.4.3 states that the acceptance criterion for the bypass leakage area for the leakage tests will be 10% of 1 cm^2 (A/√K) (i.e. 0.1 cm^2 (A/√K)). Please explain why you believe the plants will be able to meet and maintain the bypass leakage at such a low value.

GE Response:

DCD Tier 2, Revision 3, Subsection 6.2.1.1.5.1 contains additional information from the latest bounding design basis accident calculations that assume a bypass leakage size of 2 cm^2 (2.16E-03 ft^2) (A/√K). This bypass leakage supports containment pressures below the design pressure. Furthermore, a leakage size of 14 cm^2 (1.51E-02 ft^2) (A/√K) results in containment pressures below the ultimate capability of the drywell head pressure (1.204 MPag).

The acceptance criterion for the bypass leakage area was revised in DCD Tier 2, Revision 3, Subsection 6.2.1.1.5.4.3, to include alternate acceptance criterion for the ESBWR drywell/wetwell steam bypass testing based on NUREG-800, Standard Review Plan (SRP) 6.2.1.1.C, Draft Revision 7, April 1996, Appendix A, Steam Bypass for Mark I, II, and III Containments. The alternate acceptance criterion includes the above findings, and explains how the plants will meet and maintain the bypass leakage below the analytical limit of 2 cm^2 (2.16E-03 ft^2) (A/√K).

DCD Impact:

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

NRC RAI 6.2-146:

DCD, Tier 2, Revision 2, Section 6.2.1.1.5.4.3 states that the acceptance criterion for the bypass leakage area for the leakage tests will be 10% of $1\ cm^2\ (A/\sqrt{K})$ *i.e.* $0.1\ cm^2\ (A/\sqrt{K})$*). Surveillance Requirement 3.6.1.1.2 given in DCD, Tier 2, Revision 2, Chapter 16 is to "[v]erify drywell to wetwell bypass leakage is less than* $1\ cm^2\ (A/\sqrt{K})$*." Please correct this discrepancy.*

GE Response:

The acceptance criterion for the bypass leakage area was revised in DCD Tier 2, Revision 3, Subsection 6.2.1.1.5.4.3, "Acceptance Criteria for Leakage Tests," as discussed in the response to RAI 6.2-145. However, the acceptance criterion stated in Surveillance Requirement 3.6.1.1.3 (DCD Tier 2, Revision 3, Chapter 16) was not revised to reflect this change. Therefore, DCD Tier 2, Chapter 16, Surveillance Requirement 3.6.1.1.3, will be updated to reflect the acceptance criterion from DCD Tier 2, Revision 3, Subsection 6.2.1.1.5.4.3, in DCD Tier 2, Revision 4.

DCD Impact:

DCD Tier 2, Chapter 16, Surveillance Requirement 3.6.1.1.3, will be revised in DCD Tier 2, Revision 4, as shown in the attached markup.

3.6 CONTAINMENT SYSTEMS

3.6.1.1 Containment

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.6.1.1.3	Verify the combined leakage rate through all vacuum breaker lines is ≤ ~~{0.1~~2 cm^2 (~~1.0~~2.16 x 10-~~4~~3 ft^2) (A/√K)~~}~~ when tested at ≥ { kPaD (psid)}.	24 months

NRC RAI 6.2-147:

In response to NRC RAI 6.2-12, in letter MFN 06-159, dated June 5, 2006, GE stated that a sensitivity analysis showed that the peak drywell pressure of a feedwater line break accident would approach the design pressure of 45 psig at 72 hours after the pipe break if the leakage size were increased to $A/\sqrt{K} = 100\ cm^2$*. Please add this information to the DCD.*

GE Response:

The latest containment analysis results included in DCD Tier 2, Revision 3, Section 6.2, indicate that the bounding loss-of-coolant accident (LOCA) break is a Main Steam Line Break (MSLB) instead of a Feedwater Line Break (FWLB) as reported in DCD Tier 2, Revision 2, Section 6.2. Therefore, this issue is resolved by the additional containment analysis of a MSLB described in DCD Tier 2, Revision 3, Subsection 6.2.1.1.5.1, which states that the containment pressure remains below the ultimate design capability of the drywell head (1.204 MPag) with a bypass leakage area of 14 cm^2 (1.51E-02 ft^2) ($A/\sqrt{K}$). DCD Tier 2, Revision 3, Subsection 6.2.1.1.5.4.3 also discusses these findings and their relation to the acceptance criterion for the leakage test.

DCD Impact:

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

NRC RAI 6.3-66:

Revise DCD, Tier 2, Chapter 6.3 to include statements that the loss of coolant accident reactor pressure vessel level analyses takes credit for isolation condenser heat removal capacity and hydraulic control unit injection.

GE Response:

Based on a review of DCD Tier 2, Revision 3, Section 6.3, GE has determined that additional statements to indicate that the loss-of-coolant accident (LOCA) reactor pressure vessel (RPV) water level analysis takes credit for isolation condenser (IC) and hydraulic control unit (HCU) injection water inventory are not necessary in the text. This determination is based on the information provided in DCD Tier 2, Revision 3, Subsection 6.3.3.7.1, "LOCA Analysis Procedures and Input Variables," which provides the references for the significant input variables used for the LOCA RPV water level analysis and refers to DCD Tier 2, Subsection 6.2.1.1.3.1, for the TRACG nodalization discussion. DCD Tier 2, Subsection 6.2.1.1.3.1 cites Table 6.2-6a where credit for water added by the HCU injection during scram and credit for IC inventory are specifically listed. However, to provide clarity, statements crediting IC and HCU injection water inventory for the LOCA RPV water level analysis will be included in DCD Tier 2, Table 6.3-1. Additional review of DCD Tier 2, Revision 3, Tables 6.3-1, 6.3-6 (notes), 6.3-7, 6.3-8, 6.3-9 and 6.3-10 indicate credit for the IC heat removal capacity in the LOCA level analysis, therefore, no further discussion is included.

DCD Impact:

DCD Tier 2, Table 6.3-1, will be revised in DCD Tier 2, Revision 4, as shown in the attached markup.

Table 6.3-1

Significant Input Variables to the ECCS-LOCA Performance Analysis

B.3 Isolation Condenser System

Variable	**Units**	**Value**
Initiating Signal	—	Loss of Feedwater
Maximum Sensor Response Time	sec	2
Heat Removal Capacity per Unit	MW	33.75
Minimum Drainable Liquid Volume per System	m^3 [ft^3]	13.88 [490.1]
Isolation Condenser Water Inventory	—	Credited

B.6 Hydraulic Control Units

Variable	**Units**	**Value**
Water Added During Scram	—	Credited