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MFN 08-304

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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application - Emergency Core Cooling Systems - RAI Number 6.3-64 S01**

Enclosure 1 contains the GE Hitachi Nuclear Energy (GEH) response to the subject NRC RAI originally transmitted via the Reference 1 letter and supplemented by an NRC request for clarification in Reference 2. DCD Markups related to this response are provided in Enclosure 2.

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

Sincerely,

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

References:

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
2. E-Mail from Shawn Williams, U.S. Nuclear Regulatory Commission, to George Wadkins, GE Hitachi Nuclear Energy, dated June 12, 2007 (ADAMS Accession Number ML071630437)

Enclosures:

1. MFN 08-304 - Response to Portion of NRC Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application - Emergency Core Cooling Systems - RAI Number 6.3-64 S01
2. MFN 08-304 - Response to Portion of NRC Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application - Emergency Core Cooling Systems - RAI Number 6.3-64 S01 - DCD Markups

cc:	AE Cubbage	USNRC (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	GB Stramback	GEH/San Jose (with enclosures)
	RE Brown	GEH/Wilmington (with enclosures)
	eDRF	0000-0076-7671

Enclosure 1

MFN 08-304

Response to Portion of NRC Request for Additional Information Letter No. 85 Related to ESBWR Design Certification Application

Emergency Core Cooling Systems

RAI Number 6.3-64 S01

NRC RAI 6.3-64 S01:

The original RAI 6.3-64 is repeated below for reference:

> *"Show plots of the core level demonstrating that the core remains covered for 72 hours for the limiting break. Justify that the input deck assumptions used for calculating long term core level are conservative."*

GE's response, MFN 07-269 dated 5/14/07, is repeated below (except for the figure) for reference:

> *"TRACG prediction of the collapsed level in chimney for Gravity Driven Cooling System (GDCS) line break with 1 depressurization valve (DPV) failure is shown in Figure 6.3-64-1. The predictions show that the core remains covered for 72 hours. The assumptions used to develop the core model of TRACG input for the 72 hour analysis are the same as the assumptions used for Emergency Core Cooling Systems (ECCS) performance analysis (nominal case) reported in DCD Tier 2, Revision 3, Section 6.3."*

Staff requested that the applicant demonstrate the core remains covered for 72 hours for the limiting break. GE's response infers (it was not directly stated) that TRACG predicted the most limiting break for long term cooling is a GDCS line break with 1 DPV failure.

DCD, Section 6.3.3.7.9, with results displayed in Table 6.3-5, states that "the GDCS injection line break with a GDCS injection valve failure results in the lowest minimum chimney static head above vessel zero." Thus, the Staff would have expected that the RAI response provided plots of this limiting break. GE provided no explanation in the RAI response.

A. *Explain how GE came to the conclusion that the GDCS injection line break with 1 DPV failure (nominal case) is the most limiting break given the information provided in Table 6.3-5. Staff is also unclear why GE provided a plot of the nominal conditions rather than the bounding conditions for the GDCS Line break with 1 DPV failure. Include the appropriate information in the DCD.*

B. *Concerning the input deck assumptions, where are the non-condensible gases during the life of the transient? Staff is not convinced TRACG can accurately calculate the movement of non-condensible gases (reference RAI 21.6-96). Therefore, explain, and include in the DCD additional information regarding the treatment of non-condensible gases. Demonstrate that the treatment of non-condensible gases are conservative for long-term PCCS operation. Provide plots that show PCCS power versus time and, on the same plots, decay heat versus time.*

C. *Provide a qualitative discussion and results of the ESBWR long-term core cooling system response similar to that submitted in MFN 05-105 (Reference 1) in the DCD. The collapsed chimney level response shown in Figure 6.3-64-1 in MFN 07-269 for the GDL line break is different from that shown in Figure 7 in MFN 05-105 (Reference 1). Provide a discussion of the differences.*

D. Concerning the input deck assumptions, there may be steam condensation on drywell surfaces that will cause steam to condense and not return to the vessel via the PCCS. Provide a discussion on how this is accounted for or, if not accounted for, justify that the calculation is still conservative without this consideration.

Reference:

1. Letter from D.H. Hinds (GE) to NRC, MFN 05-105, Letter from David H. Hinds to U.S. Nuclear Regulatory Commission, TRACG LOCA SER Confirmatory Items (TAC # MC868), Enclosure 2, Reactor Pressure Vessel (RPV) Level Response for the Long Term PCCS Period, Phenomena Identification and Ranking Table, and Major Design Changes from Pre-Application Review Design to DCD Design, October 6, 2005. (ADAMS Accession No. ML053140223)

Regulatory Justification:

10 CFR 50.46 states in part that the "emergency core cooling system (ECCS) ... must be designed so that its calculated cooling performance following postulated loss-of-coolant accidents conforms to the criteria set forth in paragraph (b) of this section." Paragraph (b)(5) states requirements for Long-term cooling. It states: "After any calculated successful initial operation of the ECCS, the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core."

Commission Paper SECY-94-084 "Policy and Technical Issues Associated with the Regulatory Treatment of Non-Safety Systems in Passive Plant Designs" states that "passive systems should be able to perform their safety functions, independent of operator action or offsite support, for 72 hours after an initiating event."

GEH Response:

A. The Gravity-Driven Cooling System (GDCS) injection line break with one depressurization valve (DPV) failure (nominal case) is not considered the most limiting break with regard to level. However, it is the most limiting GDCS injection line break with regard to containment pressure response. For this reason, a 72-hour case already exists because the particular single failure mode will mainly impact the short-term response, and does not have a significant effect on the long-term loss-of-coolant accident (LOCA) response as was described in the original response to this RAI. The TRACG prediction of the collapsed level in chimney for GDCS line break with one GDCS injection valve failure is shown in Figure 6.3-64 S01-1. The minimum level of 8.50 m occurs at 593 seconds.

B. The discussion of the treatment of non-condensable gases in the analysis coverage was originally contained in the response to RAI 21.6-96 (MFN 07-348, dated June 21, 2007), and will be further clarified in the pending response to RAI 21.6-96 S01. Meanwhile, Figure 6.3-64 S01-2 contains the plot of Passive Containment Cooling System (PCCS) power versus decay heat for 72 hours from the current analysis.

C. A discussion of the GDCS Bounding Case will be included in DCD Tier 2, Subsection 6.3.3.7.9.

D. A discussion of the effects of condensation on drywell wall surfaces is contained in the response to RAI 6.3-79 (MFN 07-377, dated August 24, 2007). As stated in that response, the "drywell wall condensation rate reduces as the transient progresses due to the heating of the wall surface. This process of steam production and condensation do not affect the equilibrium water level because there is no net loss of inventory." Therefore, the effect of condensation is ignored in the analysis used for calculating long term core level.

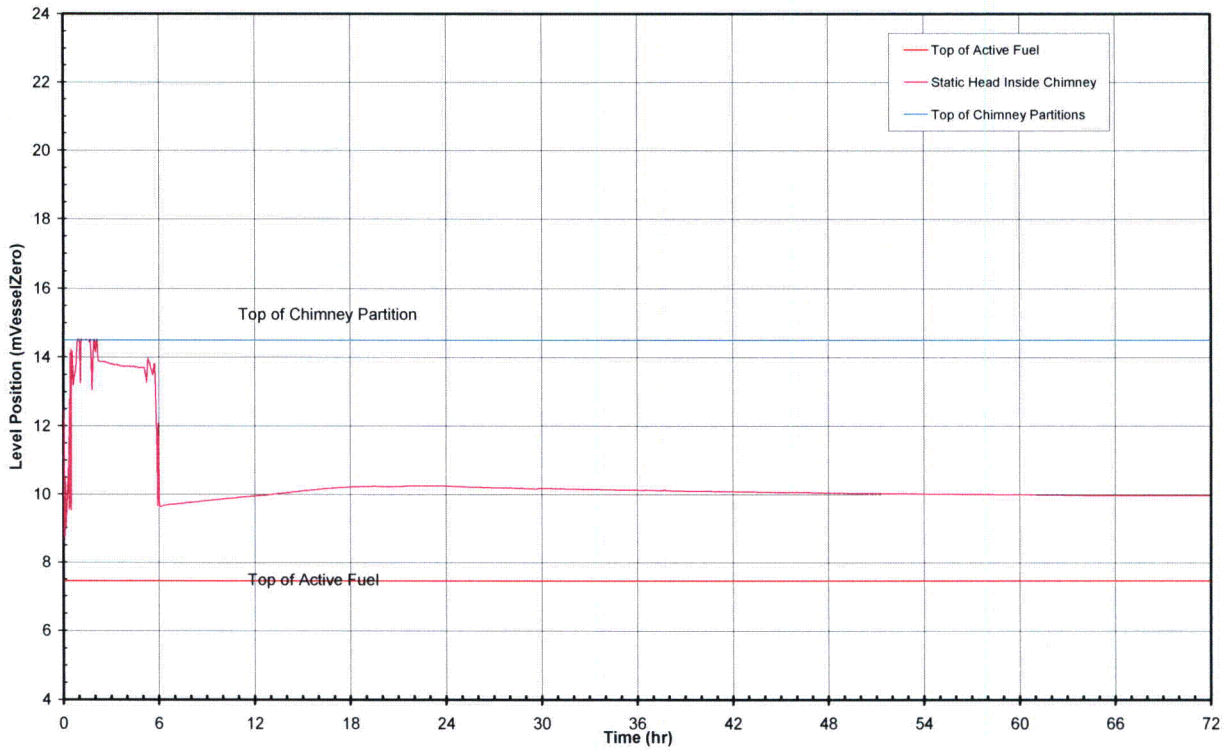

Figure 6.3-64 S01-1. GDCS Line Break (Bounding Case) – Chimney Collapsed Level (72 hours)

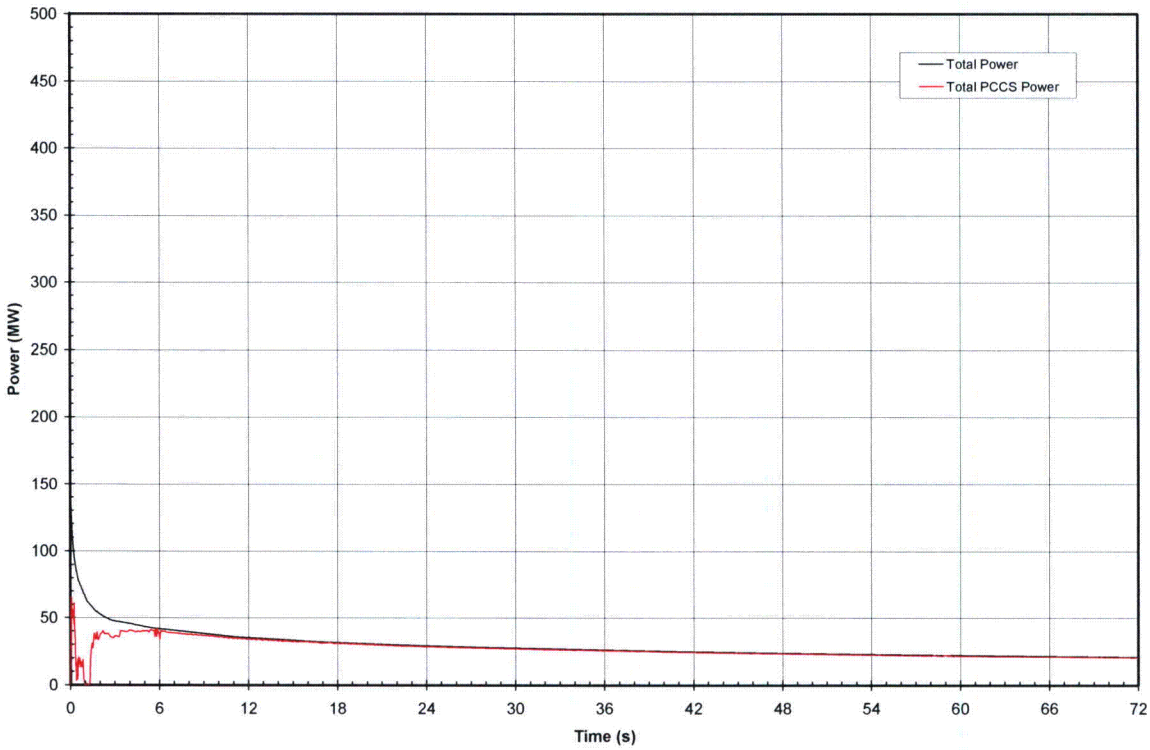

Figure 6.3-64 S01-2. GDCS Line Break (Bounding Case) – PCCS Heat Removal (72 hours)

DCD Impact:

DCD Tier 2, Subsection 6.3.3.7.9, will be revised as shown in the attached markup.

Enclosure 2

MFN 08-304

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Emergency Core Cooling Systems

RAI Number 6.3-64 S01

DCD Markups

injection to maintain the vessel water level. Thus the key LOCA result of minimum chimney static head above vessel zero is similar for all LOCA events (see Table 6.3-5). The results for maximum GDCS injection line break with 1 GDCS valve failure and maximum inside steam line break with 1 DPV failure are slightly more limiting than the other LOCA cases.

For each bundle design in a plant, comformance is reconfirmed by the limiting break.

6.3.3.7.9 Bounding LOCA Evaluations

Consistent with previous LOCA model application methodology, LOCA evaluations in the previous sections are compared to a bounding result. Table 6.3-11 presents the significant plant variables that were considered in the determination of the bounding LOCA result. Because the ESBWR LOCA results have large margins to the acceptance criteria, a conservative LOCA evaluation was performed which bounds the 95% probability LOCA results. This bounding LOCA result was calculated by varying all significant plant parameters in the conservative direction simultaneously. The maximum inside steam line break cases (refer to Subsection 6.3.3.7.8) and the GDCS injection line break (the most limiting break location, refer to Table 6.3-5) were evaluated. The results of these calculations are given in Table 6.3-5. The GDCS injection line break with a GDCS injection valve failure results in the lowest minimum chimney static head level above vessel zero. Because the ESBWR results have large margins to the 10 CFR 50.46 licensing acceptance criteria, the ESBWR licensing LOCA results can be based on this bounding LOCA case.

The GDCS line break with failure of 1 GDCS injection valve is the limiting case for level above the core and described here. The GDCS line break is located above the top of the core. However, the elevation is slightly below the location of the spillover holes. Thus, the water in the drywell can build up and communicate with the RPV through the break. During the first hour of the transient, the RPV fills almost to the elevation of the steam lines. Flow through the break discharges to the drywell and accumulates in the lower drywell. In a few hours, the GDCS pools have drained completely. At this point, the level in the downcomer starts dropping faster as inventory continues to be lost to break flow and steaming with reduced compensation from GDCS drain flow. Concurrently, the water accumulating in the lower drywell builds up to the elevation of the spillover holes. The levels inside the RPV and in the DW come together and reach an equilibrium position where the difference in the two levels is the head loss for the decay heat generated steam flow through the DPVs. This difference in levels is larger than for the BDL break, because the GDCS break is larger and the RPV and drywell levels come together earlier when the decay heat is higher. During the long term period, the steam generated by the decay heat is condensed in the PCCS and returned to the RPV via the GDCS pools. A small amount of steam condenses on the drywell surfaces and does not return to the RPV. This will not affect the RPV water level over 72 hours.

6.3.3.8 ECCS-LOCA Performance Analysis Conclusions

The ECCS-LOCA perforemance analyses are performed according to the key parameters listed in Table 6.3-11. Results of these analyses demonstrate the compliance with all the applicable acceptance criteria. It is concluded that the ECCS would perform its function in an acceptable manner.