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Subject: **Response to NRC Request for Additional Information Letter No. 3 for the ESBWR Design Certification Application – PRA – RAI Numbers 19.0.0-2, 19.0.0-3, 19.1.0-3 (Partial Response)**

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

Since it is not practical to respond to RAI 19.1.0-2d in two parts, one complete response will be submitted in accordance with the schedule for part 2 in the Reference 2 letter.

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

Sincerely,

David H. Hinds
Manager, ESBWR

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References:

1. MFN 05-156, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 3 for the ESBWR Design Certification Application,* December 8, 2005
2. MFN 06-015, Letter from David H. Hinds to U.S. Nuclear Regulatory Commission, *Submittal Schedule for Documents Related to ESBWR Probabilistic Risk Assessment*, January 16, 2006

Enclosure:

1. MFN 06-059 – GE Response to NRC Request for Additional Information Letter No. 3 for the ESBWR Design Certification Application – PRA – RAI Numbers 19.0.0-2, 19.0.0-3, 19.1.0-3 (Partial Response)

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ENCLOSURE 1

MFN 06-059

GE Response to NRC Request for Additional Information Letter No. 3 for the ESBWR Design Certification Application - PRA – RAI Numbers 19.0.0-2, 19.0.0-3, 19.1.0-3 (Partial Response)

RAI #19.0.0-2 Include the contribution from all accident classes

In determining the large release frequency (LRF), conditional containment failure probability (CCFP), and total population dose for the ESBWR, GE neglected the contribution of Class II, IV, and V sequences. Class II sequences, which contribute about 8 percent of the core damage frequency (CDF), were neglected because these sequences do not result in core damage until after 72 hours and are recoverable with manual actions. The other sequence classes were neglected based on their small contribution to CDF. Although releases for Class II sequences would not generally be considered "early," they could still result in substantial consequences and impact the risk metrics (e.g., inclusion of all accident sequence classes could increase the CCFP from about 3 percent to 12 percent). Accordingly, the contribution from all accident classes needs to be included when characterizing the overall containment performance and risk for severe accidents.

GE Response
In the original issue of the ESBWR PRA (NEDC-33201P revision 0), Class II sequences were qualitatively analyzed for the effect on the containment performance results. The statement that manual actions could be justified to recover the events, along with the time frame of 72 hours for that recovery, implies that the Class II frequency could be reduced by a factor of approximately 0.001 (Section 6, Table 6.2-3). The result of this reduction factor was that Class II sequences would present a negligible contribution to LRF. Because of this, Class II sequences were not explicitly included in the presentation of the results.

Class IV sequences were included in the Section 8.2 analysis. As the Section 8.2 analysis shows, the failure to insert negative reactivity does not significantly affect the performance of the containment. Therefore Class IV sequences can be mapped into either the Class I or Class III groups, whichever is the most appropriate.

Further, Section 8.3.3 of Rev 0 to NEDC-33201P states that Accident Class IV involves sequences with failure to insert negative reactivity. As with Classes I and III, these sequences could be further classed in terms of the pressure at which RPV failure occurs. However, results of the severe accident progression analysis described in Section 8.2 indicate that the containment challenges and source terms associated with these sequences do not differ significantly from those of Classes I and III. Further, as indicated in Table 8.3-1, such sequences represent a very small contribution to the CDF. Thus, unique containment event trees were not developed for Class IV. Instead, the Class IV frequency is incorporated into the Class I and III release category frequencies.

Revision 0 of Section 8 did not explicitly show how the Class IV sequence frequencies were mapped into the Class I and Class III LRF analyses. Revision 1 will provide this explicit mapping.

Table 7.2-4 (in both revisions 0 and 1) provides a basis for the mapping for the ATWS sequences that are among the top 10. In these particular cases, depressurization of the RPV is available, so these should be grouped with Class I. Adding these in to the final LRF results would not be a significant change (i.e. from 3% to 3.03%).

Class V sequences are containment bypass sequences, and should be grouped as such. Because the calculated frequency was "negligible", as reported in Section 8.2, the LRF results are valid with respect to this accident class.

In revision 1 of the ESBWR PRA (NEDO-33201), the mission time of the PRA was corrected to be 24 hours in all cases, rather than a mixture of 24 hours in some places and 72 hours in others. This causes the frequency of Class II sequences to become negligible. The effects of long term cooling are addressed using sensitivity analyses in revision 1 of Section 9 (for LRF) and revision 1 of Section 11 (CDF). For the Class IV sequences, they are explicitly mapped into the appropriate Class I or Class III groups. Class V sequences remain negligible, however they should continue to be considered as containment bypass events.

RAI #19.0.0-3 Address lower drywell flooding issues

Flooding of the lower drywell (LDW) prior to reactor vessel breach is a key determinant of the probability of containment failure due to ex-vessel steam explosions. No description is provided of the flow paths into the LDW, and the basis for GE's estimated probabilities of various pre-existing water levels in the LDW. Also, inconsistent sets of probability values are provided for the LDW water heights (i.e., PRA p. 21.4-5 indicates the likelihood of a high, medium, and low water level is 5 percent, 59 percent, and 36 percent, respectively, whereas PRA p. 8.3-4 indicates values of 0.9 percent, 0.1 percent, and 99 percent). This calls into question GE's quality assurance of the document, and could substantially impact PRA results. Please address these LDW flooding issues.

GE Response
In revision 1 of the ESBWR PRA (NEDO-33201), Section 7.2.5 was added to address this question. The following is a reproduction of that section along with the relevant table:

--- Begin excerpt from NEDO-33201 revision 1 ---

7.2.5 Accident Subclasses Based on Lower Drywell Water Level

In order to fully describe the containment state for the Level 2 analysis, Class I events must be broken down further into subclasses based on the height of the water pool in the lower drywell at the time of vessel breach.

Section 21 shows that the challenge to the containment structure and systems due to steam explosions is highly dependent upon any pre-existing water pool in the lower drywell at the time the core is deposited into the containment. If the water pool is less than 0.7 m deep, the challenge to the containment structure and to the ex-vessel cooling system (BiMAC) is negligible. If the water pool is more than 1.5 m deep and is sub-cooled, there is a possibility that the containment structure will be over-stressed due to a steam explosion shortly after vessel breach. If the water pool is in the intermediate range, there is a challenge to the containment, but it is well within the containment capacity (see Section 21).

The design of the ESBWR containment reflects this unique challenge. Liquid LOCAs provide the only means for depositing a large amount of water in the lower drywell. The rules presented in Table 7.2-4 are used to bin the Class I sequences into these subclasses.

Table 7.2-5 contains the results of the water level analysis for each of the Class I sequences. This was done by reviewing the cutsets for each of the sequences with a contribution of more than 0.025% of Class I using the rules presented in Table 7.2-4. The conditional probability for each subclass, given a Class I core damage, is as follows:

- Low LDW Water 0.991
- Medium LDW Water 0.001
- High LDW Water 0.008

None of the sequences showed any significant contribution to the medium category, so 0.001 was taken from the low level and conservatively assigned to the medium category.

Table 7.2-4
LDW Water Level Subclass Rules

Break Location	Break Size	Injection Status	Lower Drywell Water Level
No Break			Low
Steam Line			Low
Drain Line			High
Feedwater Line			High
Outside Containment			Low
Other	Small		Medium
	Medium	No Injection	Medium
		Any Injection	High
	Large	No Injection	Medium
		Any Injection	High

--- End excerpt from NEDO-33201 revision 1 ---

In Table 7.2-4, a blank entry means that the information is not relevant to determining the water level. The break location refers to the initiating events defined in Section 2 of NEDO-33201 revision 1. The line breaks inside the containment are relevant for determining lower drywell water level.

The overarching principle is that steam line breaks in the drywell or ADS actuations do not result in a significant amount of water in the lower drywell. In these scenarios, the only transport mechanism is condensation of the steam on the liner of the upper drywell. The bulk of the steam is actually condensed in the PCCS heat exchanger and is discharged to the GDCS pools. Condensation on the walls is a very small fraction of the total steam condensed. Therefore, the only scenarios that can result in a medium or high LDW water level involve Liquid LOCAs.

Additionally, Section 21, revision 1 states:

"In treating the EVE threat we need only consider Class I accidents. They amount to ~90% of the CDF, and of these the proportions with High (H>1.5 m), Medium (0.7<H<1.5), and Low (H<0.7) water pool depths (on the LDW floor, at the time of vessel breach) are 0.9%, 0.1%, and 99% respectively. Adjusting these proportions for the 0.6% of the Class IV accidents that revert to Class I with Low water pool levels is not significant. This in combination with the extremely low CDF, satisfies the Integrated ROAAM criteria for ignoring scenarios that are remote and speculative."

These sections are now consistent; and the only differences can be attributed to rounding of the values.

RAI #19.1.0-3 Provide additional cutsets and a discussion on the use of uncertainty, sensitivity and importance analyses

The documentation of CDF quantification results (in Section 7.0) provides only the top ten cutsets contributing to the internal events CDF for review. Provide cutsets contributing to 90 percent of CDF or top 200 cutsets, whichever is smaller, as the initial information for the staff's review. In addition, provide a discussion on how the uncertainty, sensitivity and importance analyses are being used to provide insights and identify requirements for structures, systems, and components as well as for human actions.

GE Partial Response

This response only addresses this question as it relates to the number of cutsets presented in the ESBWR PRA report. The remainder of the question will be resolved in accordance with the schedule provided in MFN 06-015.

Revision 1 of the ESBWR PRA report (NEDO-33201) presents the Level 1 cutsets in Section 7. In this revision, the top 200 cutsets for CDF are provided. This represents approximately 60% of the internal events CDF. In addition, the highest 25 cutsets are provided for each of the top 10 sequences.

NEDO-33201 revision 1, section 7 was provided as an attachment to MFN 06-058.