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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 121 Related to ESBWR Design Certification Application, RAI Numbers 19.2-81, 19.2-82 and 19.2-84**

The purpose of this letter is to submit the GE Hitachi Nuclear Energy (GEH) response to the U.S. Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) sent by NRC letter dated December 5, 2007 (Reference 1). The GEH responses to RAI Numbers 19.2-81, 19.2-82 and 19.2-84 are in Enclosure 1.

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

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

D068
NRO

Reference:

1. MFN-07-658. Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request For Additional Information Letter No. 121 Related To ESBWR Design Certification Application.* December 5, 2007.

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 121 Related to ESBWR Design Certification Application, ESBWR Probabilistic Risk Assessment, RAI Numbers 19.2-81, 19.2-82 and 19.2-84

cc:	AE Cubbage	USNRC (with enclosure)	
	GB Stramback	GEH/San Jose (with enclosure)	
	RE Brown	GEH/Wilmington (with enclosure)	
	eDRFSection	0000-0078-6840	NRC RAI 19.2-81
		0000-0078-6057	NRC RAI 19.2-82
		0000-0078-6108	NRC RAI 19.2-84

Enclosure 1

MFN 08-046

Response to Portion of NRC Request for

Additional Information Letter No. 121

Related to ESBWR Design Certification Application

ESBWR Probabilistic Risk Assessment

RAI Numbers 19.2-81, 19.2-82 and 19.2-84

NRC RAI 19.2-81

The ROAAM analyses for DCH show short periods of potentially very high temperatures in the LDW atmosphere (up to 4000 K). Chapter 21 of the PRA states that "These, and the presence of potentially large quantities of melt in the LDW, indicate that the LDW liner could be subject to local failures, a condition that is noted in our HP CPET and is accounted for in Level-3 PRA." GEH has also stated that liner failure in the LDW space would not constitute containment failure because of the presence of structural "lips" that provide isolation of the gap space from that of the upper portions of the containment wall. Basically, it says that this release path would be negligible. No comment is made in PRA Revision 2 Section 8 about DCH LDW liner failure. Section 9.5 notes that local damage to the liner in the lower drywell will be studied as a sensitivity case in Section 11 and as such no DCH sequence is selected for the baseline case. Appendix 9A contains a "DCH" case which appears to be a basemat attack accident with overpressure failure due to noncondensables – not local LDW liner over-temperature failure. Several tables in Sections 10 and 11 note a DCH sensitivity set of results. This DCH has a frequency of 2.56x10-12 per reactor-year but no source for this frequency is quoted, and neither is the source of the release fractions given. Please provide the analysis that demonstrates that the DCH-induced LDW local liner failure is a negligible release path.

GEH Response

Liner failure is considered a negligible release path because there is still a 2 to 2.5 meter thick layer of reinforced concrete behind the liner if the stainless steel liner itself is breached by core debris. There are structural support ribs that attach the liner to the concrete; these ribs prevent communication between the LDW and UDW inter-wall-liner spaces as shown in DCD Figures 3G.1-48 and 3G.1-49. Thus, the structural design dictates that even if the liner experiences local failures, no release path is created.

However, to analyze the potential for a DCH-induced release path directly to the environment, a sensitivity study was developed. A split fraction of 1E-3 (as discussed in NEDO-33201 Section 21) was used to represent the probability of a DCH containment failure in the high-pressure containment event tree (CET). That is, the flag that set the point estimate to TRUE in the baseline model was removed from the flag file; this was the only necessary model change to get the frequency-based results for the DCH release category.

The DCH release fractions were developed using the same methodology as the other release categories as outlined in NEDO-33201 Section 8.3.2. Specifically, a leakage path from the LDW to the environment was simulated immediately following RPV failure. The leakage size was ten times the Tech Spec Leakage (TSL) area, which is why the MAAP results in Appendix 9A closely resemble a basemat attack accident with overpressure failure due to non-condensables. Because there are approximately 2.5 meters of reinforced concrete supporting the LDW liner, the liner failure was simulated as increased leakage, not gross containment failure.

The representative sequence selected to simulate the DCH case featured no injection, no depressurization, and no GDCS deluge function. Table 9-1, "Release Categories", is reproduced below and includes the DCH results (as Item 16) for comparison purposes. As shown, the release fractions of CsI and nobles gases are relatively high but are combined with a very low DCH release frequency; as a result, excluding DCH from the baseline Level 2 PRA does not negate significant offsite consequences.

Table 9-1

Release Categories

Source Term	Release Category	MAAP CASE	Total Release Frequency (per year)	Time of Plume Release (hr)	NG Release Fraction 24 hrs after onset of core damage	CsI Release Fraction 24 hrs after onse of core damage	NG Release Fraction 72 hrs after onset of core damage	CsI Release Fraction 72 hrs after onset of core damage
1	BOC	BOCsd_nIN_R1	1.47E-10	0.7	9.7E-01	7.0E-01	9.8E-01	7.0E-01
2		BOCdr_nIN_R1		0.6	2.4E-01	1.1E-01	2.6E-01	1.3E-01
3	BYP	T_nIN_BYP_R1	5.6E-11	0.7	9.5E-01	2.1E-01	9.7E-01	3.0E-01
4		T_nDP_nIN_BYP_R1		1.3	5.3E-01	3.3E-02	6.8E-01	3.5E-02
5	CCID	T_nIN_nD_CCID_R1	ε	25.8	0.0	0.0	9.1E-01	6.2E-02
6		T_nDP_nIN_nD_CCID_R1		16.0	9.1E-01	6.7E-02	9.6E-01	3.5E-01
7	CCIW	T_nIN_CCIW_R1	9.9E-11	25.6	0.0	0.0	8.9E-01	1.6E-05
8		T_nDP_nIN_CCIW_R1		18.4	6.4E-01	1.2E-04	8.3E-01	1.1E-02
9	EVE	T_nIN_nD_EVE_R1	6.10E-10	7.4	8.3E-01	2.8E-02	8.3E-01	1.5E-01
10	FR	T-AT_nIN_nCHR_FR_R1	ε	28.9	0.0E+0	0.0E+0	1.0E+00	6.1E-03
11	OPVB	T_nDP_nIN_VB_R1	6E-12	13.8	4.3E-01	1.33E-04	9.6E-01	4.1E-03
12		T_nIN_VB_R1		8.7	8.6E-01	5.0E-03	1.0E+00	1.5E-02
13	OPW1	T_nDP_nIN_nCHR_W1_R1	ε	34.2	0.0	0.0	1.0E+00	1.5E-02
14	OPW2	T_nDP_nIN_nCHR_W2_R1	ε	53.1	0.0E+0	0.0E+0	1.0E+00	1.5E-02
15	TSL	T_AT_nIN_TSL2x_R1	1.12E-08	0.5	2.7E-03	1.6E-04	2.7E-03	1.6E-04
16	**DCH**	**T_nDP_nIN_nD_DCH_R1**	**3E-12**	**5.6**	**9.0E-01**	**7.6E-02**	**9.6E-01**	**3.4E-01**

ε Less than 1E-12

DCD Impact

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

No changes to NEDO-33201 will be made in response to this RAI.

NRC RAI Number 19.2-82

The offsite consequence evaluation (Level 3 analysis) in Chapter 10 of NEDO 33201- ESBWR certification PRA indicates the use of both generic and ESBWR specific data. The analysis uses MACCS2 Version 1.13.1 computer code over a range of possible weather conditions and accident specific assumptions. The generic input parameters are from "Sample Problem A" of the MACCS2 volume 1, with the assumption of uniform population density based on the Sandia Siting Study (Ref. 1), a meteorology condition comparable with ALWR URD (Ref. 2), and an assumption of ground release with no evacuation, relocation, or sheltering during reactor release.

The ESBWR specific data are plant performance analyses from containment event tress (Chapter 8), source terms for select sequences (Chapter 9), and the projected core inventory at the time of accident. The analysis also includes a sensitivity analysis on the meteorology, and assumptions regarding release elevation and buoyancy. The analysis concludes that the selected parameters and assumptions would result in bounding consequences. Review of the methods and assumptions has identified a number of questions related to the details of the GEH analyses and conclusions that follow.

1. *As indicated in the analysis, the meteorology and the population density are site specific. Please elaborate the assumptions that the use of ALWR URD meteorology, and the Sandia Siting Study population density (1980's vintage data) would lead to bounding results. Note that the annual disturbances in meteorology could lead to variations in offsite consequences of the order of about ±20 percent.*

2. *Tables 10.4-1a, and10.4 -1b provide individual risk (0-1 mile), which is defined as the total number of early fatalities within one mile divided by the total population within one mile. The assumption of fully populated first segment (0-1 mile) would lead to an underestimation in the stated risk. Please provide additional information on early fatality and latent cancer estimates for the 0-1 and 0-10 miles. Note that, given the assumption of ground release, and no evacuation, relocation, or sheltering, the majority of doses would be to those residing within 10 miles of the plant. The estimated population doses in Tables 10.5-2a and 10.5-2b do not seem to correlate with the values given in Tables 10.4-1a and 10.4-1b.*

3. *Chapter 8 of NEDO 33201 provides information on containment performance. Table 8.2-2 provides CET release category frequencies which are similar, except for the OPVB and OPW1 release categories, to those used in Chapter 9, Table 9-1, and Chapter 10, Table 103-3b. The frequency values listed for the OPVB and OPW1 release categories in*

   Table 8.2-2 are 1.6 E-11, and 3.2 E-11 per reactor-year, respectively. On the other hand, in the Chapter 9 tables, the frequency values listed for the same release categories are 6E-12, and less than 1 E-15 per reactor year, respectively. Please explain.

GEH Response

1. The intent of the wording "bounding result" was to state that the results and insights, such as the Individual Risk and the Societal Risk, derived from the meteorological and population data are several orders of magnitude lower than the Risk Goals. A sensitivity study is described in Section 10.5 of NEDO-33201, which illustrates that the ESBWR radiological design goals are adequately bounding, that is, they maintain a very large margin.

2. The adoption of bounding population density is ultimately conservative for future evacuation planning, Emergency Response Organization (ERO) planning and risk management strategies.

   As shown in Table 10.4-2, with a fully populated density, the Individual Risk and Societal Risk are on the order of E-11 and E-12, compared to goals that are on the order of E-7 and E-6. The three goals presented in Section 10 of NEDO-33201 are applicable to 0-10 miles. The intent of Table 10.5-2a and 0.5-2b is to show that it makes little difference at 0-50 miles between ground and elevated release.

3. The release category frequencies for OPW1 and OPVB in Section 8, Table 8.2-2 include the contribution from Class II core damage sequences. The Class II contribution is removed from those release categories in the Section 9 and Section 10 tables, so the release frequencies are reduced. Both the OPVB and the OPW1 release categories have frequency contributions from core damage Class II sequences as well as from Class I, III, and IV. As discussed in Section 8A.1, the Class II sequences are binned according to which system failure(s) led to core damage, but because containment failure preceded core damage, these sequences are not analyzed in the Level 2 PRA. Further, because core damage does not occur until at least 72 hours post-initiating event (per Section 8.3.2.2.1), the contribution from Class II core damage sequences is not considered for the offsite consequences analysis.

DCD Impact

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

No changes to NEDO-33201 will be made in response to this RAI.

RC RAI Number 19.2-84

PRA R2 Section 10.5 (SENSITIVITY STUDY) states, "*Elevated release with and without buoyant plume energy rise is studied along with sensitivity on population density*". The results for varying population density are not apparent. Please clarify.

GEH Response

The Risk Goals measures (Individual Risk and Societal Risk) presented in Section 10 of NEDO-33210 are normalized to population density. As such, the population density variation is not presented in Section 10 of NEDO-33201.

The current wording of Section 10.5 will be revised in a future update for clarification. The markup copy of the future update is shown below.

DCD Impact

No DCD changes will be made in response to this RAI.
Editorial changes to NEDO-33201 Section 10 will be made in a future update.

Attachment

10.5 Sensitivity study

For this sensitivity study, two meteorological conditions are studied. The first is used for the ESBWR Level 3 base case study and is comparable with the of ALWR URD meteorological reference data.
The second, the sensitivity meteorological condition case, represents a narrower distribution condition. The narrower distribution can represent conservative radiological consequences in certain wind sectors and with certain stability classes. The goal of the sensitivity study is to reveal the radiological consequence insights with regard to the three risk goals.

Elevated release with and without buoyant plume energy rise is studied in this section~~along with sensitivity on population density~~.

The sensitivity study results show that the three risk goals stated in Subsection 10.4.1 are bounded with substantial margin. In addition, the design goals stated in Subsection 10.4.1, are set at one tenth of the NRC risk goals.
The sensitivity study results show that the baseline case is sufficiently bounding to allow the variation of inputs and assumptions while maintaining several orders of magnitude of design margin relative to the NRC risk goals Table 10.5-1 through Table 10.5-7b present the sensitivity study results.

Table 10.5-1 shows the sensitivity study results summary. As shown in Table 10.5-1, the three NRC risk goals and the conservative design risk goals are adequate to envelop the variations of MACCS2 input parameters and assumptions, with several orders of magnitude margin. The results also indicate that the variation of certain MACCS2 input parameters, such as the meteorological conditions, would result in minute changes in relation to the three risk goals measures. However, the magnitude of changes due to these input parameter variations are still well bounded by, or still several orders of magnitude lower than, the risk goals. Though the three risk goals are not applicable at 50 miles, to show the impact of elevated release, Table 10.5-2a and 10.5-2b show that the population dose at 50 miles do not vary much for ground vs. elevated release for 24 hour and 72 hour mission time. The risk insights obtained via ground release modeling at 50 miles does not change even with elevated release modeling.

Table 10.5-3a and 10.5-3b show the ground vs. elevated release at 0 to 10 miles for 24 hour and 72 hour mission time. Similar to Table 10.5-2a and 10.5-2b, at 0-10 miles, the risk goals measures are still within the same order of magnitude between ground and elevated releases. The importance here is the risk insights are maintained whether modeled as ground or elevated releases.
Table 10.5-4 shows the ground release results with hourly meteorological data sampling of 72 hour mission time. The intent of this case is to show that the risk insights obtained with different meteorological data sampling method (more conservative hourly sampling method vs. binning sampling method) does not change the risk goal measures results and conclusions.