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Subject: **Submittal of Response to NRC Request for Additional Information Letter No. 395 Related to ESBWR Design Certification - RAI Number 18.7-16.**

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 No. 395, dated November 17, 2009 (Reference 1).

Enclosure 1 provides the GEH response to the subject RAI as requested in Reference 1. Enclosure 2 contains the associated document markups as a result of GEH's response to this RAI. Verified DCD and LTR changes associated with this RAI response are identified in the enclosed markups by enclosing the text within a black box.

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

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

References:

1. MFN 09-741 - Letter from U.S. Nuclear Regulatory Commission to Jerald G. Head, *Request For Additional Information Letter No. 395 Related To ESBWR Design Certification Application*, dated November 17, 2009

Enclosures:

1. MFN 09-753 – Response to Portion of NRC Request for Additional Information Letter No. 395 Related to ESBWR Design Certification - RAI Number 18.7-16
2. MFN 09-753 – Markups for Response to Portion of NRC Request for Additional Information Letter No. 395 Related to ESBWR Design Certification - RAI Number 18.7-16

cc:	AE Cubbage	USNRC (with enclosures)
	JG Head	GEH/Wilmington (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	DF Taylor	GEH/Wilmington (with enclosures)
	eDRF Section	0000-0110-3945 (RAI 18.7-16)

Enclosure 1

MFN 09-753

Response to NRC Request for

Additional Information Letter No. 395

Related to ESBWR Design Certification Application

RAI Numbers 18.7-16

NRC RAI 18.7-16

DCD Section 18.7, Human Reliability Analysis (HRA) describes how the risk-important human actions (HAs) are addressed in the various aspects of the human factors engineering (HFE) program. DCD Section 18.7 refers to the HRA Implementation Plan (IP) for how the risk-important HAs are determined. The HRA IP, Section 3.2 (and subsections), describe the Fussell-Vesely (FV) and Risk Achievement Worth (RAW) thresholds for determining the risk-important HAs and the potentially risk-significant human interaction events. The HRA IP also refers to the ESBWR PRA for tables of the human actions/interactions. Between the HRA IP and the PRA there are two sets of thresholds and it is not completely clear which are the thresholds and human actions that will be used for input into the HFE program. In addition, the Design Reliability Assurance Program (D-RAP), described in DCD Section 17.4, uses similar thresholds to those in the PRA to determine risk-significant structures, systems, and components (SSCs). Clarify and document clearly the thresholds and the risk-important human actions that will be used as input to the various elements of the HFE program as described in DCD Section 18.7. Provide the rationale for using different thresholds for risk-important human actions in the PRA. HFE program, and D-RAP if such differences are retained.

GEH Response

The basis for the PRA threshold values for risk-importance is described in Section 17.1 of the PRA, NEDO-33201 Rev 4. As noted in the RAI question, GEH has established a different threshold for risk-importance within the HRA Implementation Plan, NEDO-33267. This difference is a point of confusion, and GEH will now revise the HRA definition of risk-importance to be consistent with the PRA. NEDO-33267 and DCD Section 19.2.2.1 will be revised as shown in the attached markups to clarify this change in threshold value. A correction to the PRA threshold (the addition of the text "or equal to" after "greater than" as shown in the attached markups) in both of these documents is also made to provide consistency of the threshold value with Section 17.1 of the PRA, NEDO-33201.

The revised HRA threshold values will now be the same as the PRA and consistent with those defined for the D-RAP program described in DCD Section 17.4.

Additionally, NEDO-33267 will be revised to update the references to the PRA NEDO-33201. The tables in Section 17.7 of NEDO-33201 provides the list of human actions and their risk-importance values for the PRA and the table column titled "Threshold" will now indicate those human actions considered important to risk for the PRA, HRA and D-RAP.

The HRA program will continue to include all of the human interactions listed in the tables in Section 17.7 of NEDO-33201 as inputs to the HFE program. A statement to clarify this input scope will be added to NEDO-33267.

Threshold values used in NEDO-33267 will be revised as shown in the attached markups to reflect the new HRA definition of risk-importance.

DCD Impact

DCD Tier 2, Section 19.2.2.1 will be revised as noted in the attached markups.

LTR NEDO-33267, Rev 4 will be revised as noted in the attached markups.

Enclosure 2

MFN 09-753

Markups for Response to NRC Request for

Additional Information Letter No. 395

Related to ESBWR Design Certification Application

RAI Number 18.7-16

19.2.2 Uses of PRA

19.2.2.1 Design Phase

The PRA supports the design through assessing risks using key parameters such as core damage frequency (CDF), large release frequency, and importance measures such as Fussell-Vesely and risk achievement worth (RAW) for major component functions. In particular, the ESBWR design certification PRA shows that the design meets the objectives stated in Section 19.1.

The ESBWR PRA defines potentially risk-significant SSC and operator errors~~human interaction events and information~~ that contribute to CDF and LRF using thresholds ~~such as~~of Fussell-Vesely greater than or equal to 0.01, and ~~a~~ RAW greater than or equal to 5.0 for individual basic events and a RAW greater than or equal to 50.0 for common cause failure events. The objective of the human reliability analysis and human factors engineering operational analysis in Chapter 18 is to ensure that the means are provided in the plant design to keep the quantitative risk importance of all potentially risk-important human interactions modeled in the PRA as low as practical. For the purpose of human reliability analysis, a human interaction with a Fussell-Vesely value greater than or equal to 0.01 or a RAW value greater than or equal to ~~2~~5.0 is considered~~ for evaluation~~ important to risk. This classification of risk-significance is consistent with the PRA. The human reliability analysis ensures that information for identifying, planning and implementing the needed action within the time permitted is provided in the design or is provided by automated support to carry out the needed action. For example, the operator can identify the need for manual actions through procedures and training and implement with tools as needed.

19.2.2.1.1 Use of PRA in Support of Design

In the design phase, various aspects of probabilistic analyses are employed to enhance the ESBWR and reduce the overall risk profile. At the conceptual design phase, qualitative risk analyses are used to ensure that vulnerabilities of existing boiling water reactors (BWRs) have been addressed in the ESBWR design. Table 19.2-1 contains a comparison of ESBWR design features versus design issues in BWRs.

The diversity and redundancy level of certain systems has been established, in part, by qualitative risk insights. Consistent with other conceptual design methods, the risk insights applied at the conceptual design phase are not explicitly documented in the PRA. Table 19.2-2 lists design features that have been applied to the conceptual design of the ESBWR to reduce risk. Extensive use of operating experience in the design phase has led to significant improvements, over conventional BWRs, in the plant's ability to respond to severe accidents. Significant design improvements include:

(1) The ESBWR front-line safety functions are passive and, therefore, have significantly less reliance on the performance of supporting systems or operator actions. In fact, ESBWR does not require operator actions for successful event mitigation until 72 hours after the onset of an accident.

(2) The ESBWR design reduces the reliance on alternating current (AC) power by using 72-hour batteries for several components. Diesel-powered pumping has been added as a diverse makeup system. The core can be kept covered without any AC sources for the first

the same risk criteria as equipment when evaluating their risk importance and taking actions to manage the risk.

3.2.1.1 Quantitative Goal and Use of Importance Measure

The ESBWR PRA defines potentially risk-significant structures, systems, and components (SSC) and ~~HI events and information~~ operator errors that contribute to CDF and LRF using ~~conservative~~ thresholds~~, such as~~ of FV greater than or equal to 0.01, and ~~a~~ RAW greater than or equal to 5.0 for individual basic events and a RAW greater than or equal to 50.0 for common cause failure events ~~(~~[~~NEDO-33201 REV 2~~Reference 2.1.1(4), ~~Chapter~~Section 17~~)~~]. These risk importance threshold values are established to meet PRA goals and support the identification of potentially risk important human interactions.

For the purpose of human reliability analysis and human factors engineering, HIs with a FV value greater than or equal to 0.01 or a RAW value greater than or equal to 5.0 are classified as important to risk. This classification of risk-significance is consistent with the PRA.

The risk important HIs from analysis of PRA results are provided in NEDO-33201 Section 17 [Reference 2.1.1(4)]. The tables in Section 17.7 of Reference 2.1.1(4) provide the list of operator actions along with the FV and RAW values for use in identifying those important to risk~~REV 2 in Table 17.1-3 and additionally in Table 17.2-5 post-initiator actions~~. Th~~e~~ose human actions in these tables that exceed the PRA risk significance threshold are considered to be risk-important human actions~~ for evaluation in the HFE task analysis~~. The list of operator errors and probabilities~~Potentially risk important HIs~~ that are used ~~as inputs to~~ in the PRA are provided in Table 6.3-3 of Reference 2.1.1(4)~~NEDO-33201R2. The risk important HIs, used in the HFE evaluation of risk important human actions, are also provided in the HRA results summary report~~.

The goal of the HRA and HFE operational analysis in DCD Chapter 18 is to verify that the means are provided in the plant design to keep the quantitative risk importance of all potentially risk-~~-~~important human interactions modeled in the PRA as low as practical. For th~~e~~is purpose, all of the operator actions listed within the tables of Section 17.7 in Reference 2.1.1(4) will be included as inputs to HFE program. ~~of human reliability analysis and human factors engineering, HIs with a FV value greater than 0.1 or a RAW value greater than 2.0 are classified as important to risk.~~ The risk-important HIs, the final risk-important human actions, and the results of the HRA process are provided in the HRA results summary report.

GEH commits to using each individual PRA model for CDF and LRF to evaluate HI importance. The importance of each modeled HI is measured using the RAW and FV risk importance ranking at each stage of PRA development. Each importance measure is individually applied to the top event of all ESBWR PRA submodels. These models include the CDF for level 1 internal events, LRF for level 2, all of the external events such as fire and flooding, and the shutdown PRA.

The individual PRA application models are used to compare each HI event with the top event total to ensure that all potentially important HIs are ranked by their risk importance measures.

3.2.1.2 Application Process

The application process for evaluating potentially risk important HIs involves three main steps: identifying the HIs, evaluating the HIs against qualitative and quantitative criteria, and verifying that the quantified HIs are classified as risk important or are below the threshold importance measures.

Potentially risk sensitive actions that support ESBWR safety are identified through the top down HFE operational analysis and in the PRA for beyond design basis events. Sensitivity analyses using the FV and RAW importance measures described above on the basic events related to HIs are used to populate a list of relative risk contributors. This listing is generated from the PRA models and is compared with the top down operational analysis to identify gaps in the identification of potentially risk important actions and support requantification of the PRA HIs.

The risk impact of potentially risk important HIs is evaluated using both feasibility criteria and the relative risk listing.

The HIs from the PRA are evaluated for feasibility using the qualitative criteria in Section 4.1. On a relative scale, the risk important HIs identified in the PRA with a FV greater than or equal to ~~0.1~~0.01 or RAW greater than or equal to ~~2.0~~5.0 for CDF and LRF are subjected to the greatest detail in the HFE operational assessment and HSI design to ensure that their risk impact is reduced to as low as practical.

The goal of keeping the risk importance measure as low as practical is met by ensuring that information for identifying, planning, and implementing the needed human action within the time permitted is provided in the design or by providing automated support to carry out the needed action. For example, the design ensures that the operator can identify the need for manual actions through the HSI, plan through procedures and training, and implement with tools as needed.

If the human interaction can't be automated or partly automated to reduce the importance value below the threshold (e.g., either RAW or FV continues to exceed the risk importance threshold criteria for human interactions of FV equals 0.01 or RAW equals ~~2~~5.0), then the action is classified as a risk important human action. Risk important human actions receive individual HFE emphasis during task analysis to define special needs for training, priority in procedures, and during HSI design for clarity of cues and information feedback, and ease of implementation to increase the likelihood of success.

In the case of the ESBWR the passive features and automation virtually eliminate the need for the safety-related human actions required for design basis events (e.g., manually start a safety system). These design features reduce the CDF to a mean value much lower than the predecessor plants used as the basis for the NRC risk regions in RG 1.174. As a result, the baseline risk boundaries for the ESBWR are far below the boundaries for regions I and II following the risk mapping process described in NUREG-1764. Hence, the ESBWR basic events representing potentially risk important HIs do not become important contributors to plant risk on an absolute basis.

The HFE program addresses the verification that the potentially risk important HIs can be carried out using the HSI indications, procedures, the implementation interface, and other features