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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 396 Related to ESBWR Design Certification Application – Fuel Racks – RAI Number 9.1-147**

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) 9.1-147 sent by NRC Letter No. 396, Reference 1.

GEH response to RAI 9.1-147 is addressed in Enclosure 1.

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

Sincerely,

Richard E. Kingston

Richard E. Kingston
Vice President, ESBWR Licensing

Reference:

1. MFN 09-745, Letter from U.S. Nuclear Regulatory Commission to Jerald G. Head, *Request for Additional Information Letter No. 396 Related to ESBWR Design Certification Application*, November 24, 2009

Enclosure:

1. Response to Portion of NRC Request for Additional Information Letter No. 396 Related to ESBWR Design Certification Application – Fuel Racks – RAI Number 9.1-147

cc:	AE Cubbage	USNRC (with enclosure)
	JG Head	GEH/Wilmington (with enclosure)
	DH Hinds	GEH/Wilmington (with enclosure)
	TL Enfinger	GEH/Wilmington (with enclosure)
	eDRF Section	0000-0110-5413

Enclosure 1

MFN 09-765

Response to Portion of NRC Request for Additional Information Letter No. 396 Related to ESBWR Design Certification Application

Fuel Racks

RAI Number 9.1-147

NRC RAI 9.1-147

To determine the global stresses for the free-standing racks, a ratio coefficient was used to scale the fixed-based response spectrum stress results. Since the global stresses in plates and welds are controlled by the maximum global bending moments acting at the level of the base plate, the ratio coefficient was determined as the ratio of the maximum bending moment of free-standing model to the maximum bending moment of the fixed-base response spectrum model. However, the staff noticed that the maximum bending moment of free-standing model was determined by the safe shutdown earthquake (SSE) motion while the maximum bending moment of the fixed-base response spectrum model was calculated based on SSE plus loss-of-coolant accident (LOCA) plus safety and relief valve discharge (SRVD), resulting in smaller ratio coefficient than that if calculation was done based on the SSE for both models. Given some stresses provided in NEDE-33373P, Table 1-19 are very close to the ASME stress limit, the staff requests that the applicant demonstrate the ASME stress limit will not be exceeded if the ratio coefficient is calculated using SSE for both models.

The staff notes that RAIs 9.1-144, 9.1-145, 9.1-146 an 9.1-147 are based on the review of NEDE-33373P Section 1, Dynamic Load Analysis for Spent Fuel Racks in the Spent Fuel Pool. GEH should evaluate if comparable approaches were used in Section 2, Dynamic Load Analysis for Spent Fuel Racks in the Buffer Pool, Section 3, Dynamic Load Analysis for New Fuel Racks in the Buffer Pool, and Section 4, Load-Drop (Impact) Analysis and address the RAIs for those sections also, as applicable.

GEH Response

In reviewing the methods for calculating the spent fuel rack stresses, it was found that although a different combination of dynamic response spectra was used in the fixed model as compared to the free-standing model, the calculation of stress for the free-standing model is unaffected by this difference. The reason is that stresses are calculated for the free-standing model by multiplying the calculated stresses from the fixed-based model by the ratio coefficient. If the ratio coefficient were calculated based on an analysis of the fixed-base model with only SSE loads, the ratio coefficient would indeed be higher; however, the calculated stresses for the fixed-base model would be lower in the same proportion since the input loads are lower. When the higher ratio coefficient is multiplied by the lower fixed-base model stress, the resulting free-standing model stress is the same. The following equations analytically explain this idea.

From NEDE-33373P Section 1.8,

$$\text{Stress(freestanding FSR)} = f_M \cdot \text{Stress(fixed FSR)}$$

And

$f_M = \max[(M_{Xtable1\text{-}17}/M_{Xtable1\text{-}14}), (M_{Ytable1\text{-}17}/M_{Ytable1\text{-}14})] = \max(1645/2505;$ $2176/2354) = 0.925$

To simply and clearly define the terms of the equations the following is provided:

$M_1 = M_{table1\text{-}17}$ = Moment from Free-Standing Model using SSE only

$M_2 = M_{table1\text{-}14}$ = Moment from Fixed Model using SSE + LOCA + SRV

M_3 = Moment from Fixed Model using SSE only

S_1 = Stress(freestanding FSR) = Stress from Free-Standing Model using SSE only

S_2 = Stress(fixed FSR) = Stress from Fixed Model using SSE + LOCA +SRV

S_3 = Stress from Fixed Model using SSE only

Converting the above equations:

$S_1 = f_M * S_2$

$f_M = M_1/ M_2$

Since Stress and Moment are proportional,

$S_2/S_3 = M_2/M_3$

And

$S_3 = (M_3/M_2) * S_2$ (1)

If the fixed FSR model is used to calculate M_3 and S_3 then:

$f_M = M_1/ M_3$, and $S_1 = f_M * S_3$

Substituting using the proportional equation (1) yields:

$S_1 = f_M * S_3 = (M_1/ M_3) * (M_3/M_2) * S_2 = M_1/M_2 * S_2$

As shown the S_1 remains the same regardless of whether S_2 or S_3 data is used.

Also, using the fixed model with all the dynamic loads provides assurance that the maximum loads have been calculated; whereas, using SSE only for the fixed model would leave doubt as to whether the maximum stress is calculated.

Also, in comparing the fixed versus free-standing models, the fixed model should logically result in the largest moment at the base of the model since it is constrained at the base. The fact that the f_M factor used in the analysis is high is an indication that the combination of other loads (LOCA and SRV) is not very significant which is primarily due to the fact that the largest amplitudes occur at high frequencies which are out of phase with the dominant SSE response spectrum. In reviewing Table 1-19 and assuming an f_M factor of 1.0, the resulting stresses are still less than the allowable stress limits. Therefore, it is concluded that the analysis as presented in NEDE-33373P is acceptable as-is.

Note that Sections 2, 3 and 4 of NEDE-33373P do not use a ratio coefficient to calculate stresses; therefore, the issue raised in this RAI is not applicable to those sections. The applicability of RAIs 9.1-144, 9.1-145 and 9.1-146 to Sections 2, 3 and 4 of NEDE-33373P will be addressed in those RAI responses.

DCD/LTR Impact

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

No changes to the subject LTR will be made in response to this RAI.