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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 132 Related to ESBWR Design Certification Application, RAI Numbers 19.2-87, 19.2-88 and 19.2-89**

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 January 15, 2008 (Reference 1). The GEH responses to RAI Numbers 19.2-87, 19.2-88 and 19.2-89 are addressed 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 08-040, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request For Additional Information Letter No. 132 Related To ESBWR Design Certification Application*, dated January 15, 2008.

Enclosure:

1. Response to Portion of NRC RAI Letter No. 132 Related to ESBWR Design Certification Application, ESBWR Probabilistic Risk Assessment, DCD Tier 2 Section 19.2 - PRA Results and Insights, RAI Numbers 19.2-87, 19.2-88 and 19.2-89

   Attachment to Enclosure 1: DCD Tier 2 Revision 5 Markup Table 19.2-4 ESBWR Systems and Structures in Seismic Margins Analysis with Plant Level HCLPF not less than 1.67*SSE

cc:	AE Cubbage	USNRC (with enclosure)
	GB Stramback	GEH/San Jose (with enclosure)
	RE Brown	GEH/Wilmington (with enclosure)
	DH Hinds	GEH/Wilmington (with enclosure)
	eDRF	0000-0080-9911

ENCLOSURE 1

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Response to Portion of NRC RAI Letter No. 132
Related to ESBWR Design Certification Application
ESBWR Probabilistic Risk Assessment
DCD Tier 2 Section 19.2 - PRA Results and Insights
RAI Numbers 19.2-87, 19.2-88 and 19.2-89

NRC RAI 19.2-87

NEDO-33201, Revision 2, Chapter 15, Table 15-2 thru 15-6 provided various factor of safety and associated uncertainty estimates for seismic fragility calculations, which included SSI effect and ground motion incoherency effect. Since no discussion was made with respect to the site conditions (soil vs. rock), the staff could not determine how and why the SSI and incoherency effects are included in the analysis (SSI effect only pertains to soil site). Please provide a justification of including the safety factor for SSI and incoherency effects in absence of any discussion regarding the site conditions.

GEH Response

The site conditions considered in the estimate of the safety factor for SSI and incoherency for the reactor building shear walls are discussed in NEDO-33201, Revision 2, Subsection 15.3.3.1.2 under the paragraph heading "Soil-Structure Interaction Factor (F_{ssi})" on pages 15.3-9 and 15.3-10. The ESBWR SSE design seismic response analyses considered different site conditions (See DCD Tier 2 Appendix 3A). The generic medium uniform half-space site was identified to yield the highest SSE seismic response, and as such the seismic fragility evaluations were performed for this site condition. The predominant SSI system frequency for the controlling medium soil site is 2.6 Hz at which the effect of ground motion incoherence is insignificant; hence, the incoherence factor is taken as unity. The factor of safety associated with SSI is taken to be the average responses of medium soil and soft soil conditions to account for soil degradation from medium to soft as ground motion increases. The effect of site conditions on ground motion incoherence and SSI response are considered in a similar manner for other structures.

DCD/NEDO-33201 Impact

No change to the DCD or NEDO-33201 is required in response to this RAI.

NRC RAI 19.2-88

*In NEDO-33201, Revision 2, Section 15.3.3, the structural fragility analysis assumed that the mode of failure due to differential building displacement has a capacity no less than the required margin of 1.67*SSE. Since this statement was made in the context of ESBWR certified design, the staff requests that the DCD be revised to clarify that SSE means CSDRS.*

GEH Response

As stated in the response to NRC RAI 19.2-85 (MFN 08-159, dated February 22, 2008), the Performance-Based Seismic Design Spectrum anchored to the SSE of the Certified Seismic Design Response Spectrum (CSDRS) is used to estimate conservatism in the CSDRS of the ESBWR. The plant level HCLPF capacity reported in Chapter 15 of NEDO-33201 is at least 1.67 times the SSE, where SSE is the 0.5g PGA of the CSDRS, to demonstrate meeting the requirement of SECY-93-087. This definition is consistent with the PRA-based seismic margin analysis in which seismic fragility is first estimated from a median or mean ground motion spectrum anchored to the design SSE PGA; HCLPF is then calculated from the fragility value expressed in terms of PGA.

DCD/NEDO-33201 Impact

DCD Tier 2 Table 19.2-4 will be revised as shown on the attached markup.

No change to NEDO-33201 is required in response to this RAI.

NRC RAI 19.2-89

NEDO-33201, Revision 2, Section 15.3.3.2 describes the HCLPF calculation for RCCV and RPV Pedestal, using Appendix N of EPRI NP-6041-SL. It is unclear how the non-seismic loads were considered in the calculation. Further, given the tall structure of RCCV, discuss how the seismic induced local bending was considered in the HCLPF calculation for RPV pedestal.

GEH Response

The non-seismic loads considered in the HCLPF calculations for the RCCV consist of dead weight and normal operating pressure. The resulting vertical and hoop membrane stresses calculated from the design basis stress analysis were used to compute the $\rho\sigma_y$ term in NEDO-33201, Revision 2, Equation 15.3-19 as follows:

$$\rho\sigma_y = \frac{\rho_h + \rho_m}{2} f_{y_m} - \frac{\sigma_{h_NOL} + \sigma_{m_NOL}}{2}$$

where,

ρ_h, ρ_m : Reinforcing steel ratio in the hoop and meridional directions, respectively.

f_{y_m} : Median strength of reinforcing steel.

σ_{h_NOL}, σ_{m_NOL}: Normal load stresses in the hoop and meridional directions, respectively.

The median shear strength of the RPV pedestal was computed using the Bader and Krawinkler formula (NEDO-33201, Revision 2, Section 15.8, Reference 15-16) for thick-walled reinforced concrete cylinders. The hoop membrane stress due to normal operating pressure was deducted from the hoop rebar yielding capacity to determine remaining reinforcing steel capacity for seismic load, similar to the adjustment discussed above for the RCCV. Dead weight tends to produce compressive stress and was conservatively neglected.

The only location where the RPV pedestal is subject to seismic induced local bending is at the joint with the support brackets for the RPV. The seismic load transfer from the RPV to the RPV pedestal is accounted for in the RBFB complex seismic model in DCD Tier 2 Appendix 3A. The resulting seismic loads were applied to the detailed finite element model for stress analysis of various structures, including the RPV pedestal and RPV support brackets, as described in DCD Tier 2 Appendix 3G. The HCLPF calculations for the RPV pedestal were estimated from the SSE design analysis results, thus the local bending effect from the RPV support brackets is included. A separate fragility calculation was performed for the RPV support brackets and the median seismic capacity and the associated variability are reported in NEDO-33201, Revision 2, Table 15-5.

DCD/NEDO-33201 Impact

No DCD or NEDO-33201 change is required in response to this RAI.

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Attachment to Enclosure 1:

DCD Tier 2 Revision 5 Markup
Table 19.2-4
ESBWR Systems and Structures in Seismic Margins Analysis with Plant Level HCLPF not less than 1.67*SSE

Table 19.2-4
ESBWR Systems and Structures in Seismic Margins Analysis with Plant Level HCLPF not less than 1.67*SSE[1]

PLANT STRUCTURES
- Reactor Building
- Containment
- RPV Pedestal
- Control Building
- Reactor Pressure Vessel Support

DC POWER
- Batteries
- Cable trays
- Motor control centers

REACTIVITY CONTROL SYSTEM
- Fuel assembly
- CRD Guide tubes
- Shroud support
- CRD Housing
- Hydraulic control unit

SRV
- SRV

STANDBY LIQUID CONTROL
- Accumulator Tank
- Check valve
- Squib valve
- Piping
- Valve (motor operated)

Table 19.2-4
ESBWR Systems and Structures in Seismic Margins Analysis with Plant Level HCLPF not less than 1.67*SSE[1]

ISOLATION CONDENSER
- Piping
- Heat exchanger
- Valve (motor operated)
- Valve (nitrogen operated)
DPV
- DPV
GRAVITY-DRIVEN COOLING
- Check valve
- Squib valve
- Piping
VACUUM BREAKERS
- Vacuum breaker valve
PASSIVE CONTAINMENT COOLING
- Heat Exchanger
- Piping
IC/PCC POOL INTERCONNECTION
- Valve (motor operated)
FIRE PROTECTION WATER SYSTEM
- Pump (diesel driven)

Note:

1. A minimum HCLPF value of 1.67*SSE will be met for the equipment shown. SSE is the 0.5g peak ground acceleration (PGA) of the ESBWR Certified Seismic Design Response Spectrum (CSDRS).