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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 59 Related to ESBWR Design Certification Application – ESBWR Probabilistic Risk Assessment and Chapter 19 - RAI Numbers 19.5-3 through 19.5-14**

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

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

Sincerely,

Kathy Sedney for

David H. Hinds
Manager, ESBWR

D068

Reference:

1. MFN 06-329, Letter from U.S. Nuclear Regulatory Commission to David Hinds, *Request for Additional Information Letter No. 59 Related to ESBWR Design Certification Application,* September 13, 2006

Enclosure:

1. MFN 06-429 – Response to Portion of NRC Request for Additional Information Letter No. 59 Related to ESBWR Design Certification Application – ESBWR Probabilistic Risk Assessment and Chapter 19 - RAI Numbers 19.5-3 through 19.5-14

cc: AE Cubbage USNRC (with enclosures)
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eDRF 0059-0240

ENCLOSURE 1

MFN 06-429

Response to Portion of NRC Request for
Additional Information Letter No. 59
Related to ESBWR Design Certification Application
ESBWR Probabilistic Risk Assessment and Chapter 19
RAI Numbers 19.5-3 through 19.5-14

NRC RAI 19.5-3

DCD Tier 2, Section 19.2.2.4 provides a seismic margin analysis result of 0.6g for the High Confidence Low Probability of Failure (HCLPF). A seismic margins analysis to determine that the plant HCLPF for a certified design should be at least equal to 1.67 times the safe shutdown earthquake (SSE), based on criteria in SECY 93-087,"Policy, Technical and Licensing issues Pertaining to Evolutionary and Advances Light-Water Reactor (ALWRs) Designs," April 2, 1993. The seismic margins analysis addressing the criteria in SECY 93-087 should be located in this section of the DCD. The associated structural calculations and assumptions need to be presented in DCD Tier 2,Chapter 19, showing all relevant assessments of the critical elements necessary to maintain plant performance during and after the SSE. References applicable to HCLPF calculations should be presented in Chapter 19.

GE Response:

A summary of HCLPF margins is included in Table 19.2-4 of DCD Tier 2 Chapter 19 Rev. 1.

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

NRC RAI 19.5-4

All the certified design components important for the plant HCLPF analysis should be presented in a tabluar form in the DCD Tier 2,Chapter 19. Also, the table of HCLPF values in the ESBWR Probabilistic Risk Assessment (PRA) Report (NEDO-33201) should be incorporated into Tier 1 of the DCD as a part of an ITAAC item to ensure and verify that the as-built plant HCLPF is equal to or greater than the certified plant HCLPF value.

GE Response:

A summary of HCLPF margins is included in Table 19.2-4 of DCD Tier 2 Chapter 19 Rev 1. Such information will not be included as ITAAC items in Tier 1 since the existing ITAAC items for various SSCs will ensure that the plant has adequate seismic margin beyond the design basis SSE due to the various conservatism introduced in the normal design process.

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

NRC RAI 19.5-5

Provide the essential elements of a procurement specification and associated installation criteria that would ensure that Structures, Systems and Components (SSCs) are procured and installed to develop the necessary HCLPF capacities.

GE Response:

There is no plan to incorporate HCLPF requirements in procurement specifications. Detailed seismic fragility analysis can only be performed after the equipment is procured and designed when the explicit details of the equipment are known, particularly anchorages. The minimum HCLPF margin of 1.67 as required in SECY 93-087 will be met. It is GE's experience that including the HCLPF capacities as an element of the procurement specifications is not successful. After procurement, additional fixes can be made to the equipment in order to meet the committed DCD HCLPF values.

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

NRC RAI 19.5-6

In Section 15.3.3 of NEDO-33201, Rev. 1, it has been recognized that relative displacements limiting SSC operability frequently control their seismic capacity. The structural fragility assessment method in Reference 15-1, R.P. Kennedy, et al., "Assessment of Seismic Margin Calculation Methods", NUREG/CR-5270, Lawrence Livermore National Laboratory, March 1989, is somewhat dated, and is based on a PWR plant study. The ESBWR design is very different - it has a very tall reactor vessel and drywell functionality is very much dependent on proper functioning of all pressure suppression components. Simply because of the reactor vessel height, a small amount rotation at the pedestal would significantly scale up the displacement near the reactor vessel head and the top of the drywell. Please discuss individual elements of functionality limits for ensuring drywell and wetwell functionality and the integrity of components attached to the reactor vessel

GE Response:

NUREG/CR-5270 is used as a guide for processes and procedures applicable to any type of plant. Any unique ESBWR features are addressed through normal design process to ensure adequacy in withstanding the design basis earthquake, and their HCLPF's are in turn estimated from design basis information accordingly.

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

NRC RAI 19.5-7

Provide a description of the failure modes used to determine the HCLPF values for category I structures, particularly the containment structure. Provide a description of the extrapolation process supplemented by judgment.

GE Response

See response to RAI 19.2-67 for the containment structure and to RAI 19.2-66 for shear wall structures.

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

NRC RAI 19.5-8

Provide a description of how HCLPF values are determined for equipment and components qualified by testing, especially for the North Anna early site permit (ESP) site-specific ground motion spectrum.

GE Response

Generic HCLPF values assumed for equipment and components are considered achievable by testing. Equipment qualified for application in GE ESBWR plants have inherent seismic margins in high frequencies due to design consideration of high-frequency containment dynamic loads in combination with seismic loads. The inherent high-frequency capacities provide margins for North Anna ESP site-specific ground motion spectrum.

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

NRC RAI 19.5-9

Justify the use of both ductility (inelastic energy absorption factor) as well as damping (structural response factor) effects to determine the overall factor of safety.

GE Response

To avoid double counting of margins related to the inherent strength of material beyond yield without loss of function, some changes will be made in NEDO-33201 Section 15.3. The inelastic energy absorption (Fu) and its associated uncertainties are calculated according to the effective Riddell-Newmark method proposed in EPRI TR 103959s.

In addition, for damping factor calculation (Fa), the percentage of critical damping is "at or just below yield point" stress level. Consistent median centered values are used for median (Fu) and (Fa).

NEDO-33201 Section 15.3 will be revised in the next update.

NRC RAI 19.5-10

Section 15.3.1 of NEDO-33201, Rev. 1, states that generic fragilities were chosen based on a review of prior PRAs and fragility data and that they are considered achievable for the ESBWRs with an evolutionary improvement in the seismic capacities of the components designed to a 0.3g SSE minimum. Provide a list of the prior PRAs and the bases for using their fragility values. If multiple fragility values for similar components were available, please describe the bases for the chosen value. Please describe where and how these generic fragility data were used to establish 0.6g HCLPF value for the ESBWR. Elaborate on the meaning of the phrase "evolutionary improvement"and how this ensures that these fragilities are achievable.

GE Response

As stated in NEDO-33201 Rev 1, Section 15.3.5, generic fragilities and corresponding HCLPF values are the same as those considered in the ABWR SSAR and ALWR recommendations (EPRI ALWR Utility Requirements Document, Appendix A PRA Key Assumptions and Ground rules); furthermore, they were later confirmed for the Lungmen NPP Project in Taiwan, which has a 0.4g SSE.

It is expected that the HCLPF will be "reasonably achievable" and cover the ESBWR as it did for the high seismic site in Taiwan. Furthermore, if after purchasing the equipment the HCLPF values are not achieved, equipment changes could be made for individual equipment items.

By "evolutionary improvements" it is meant that equipment may become more robust in design as vendors improve upon their products.

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

NRC RAI 19.5-11

Section 15.3.1 of NEDO-33201, Rev. 1, states that the peak ground acceleration (PGA) of the design earthquakes is 0.3g for the SSE while the North Anna specific SSE has a PGA value of 0.49g. Please clarify which PGA value was used in your analyses to compute the capacity factors, particularly the strength factor (Fs). A certified design for the North Anna ESP response spectra would put the plant HCLPF value at 1.67x0.49g or about 0.82g, please explain how you meet the HCLPF.

GE Response:

The HCLPF values currently shown in NEDO-33201 Rev.1 are relative to 0.3g PGA of RG 1.60 spectral shape. In order to be consistent with the updated definition of SSE design ground motion to be a single envelope of 0.3g RG 1.60 and North Anna specific SSE, two sets of HCLPF values will be developed: one for rock sites and another for soil sites. The PGA associated with HCLPF is 0.5g for rock sites and 0.3g for soil sites.

NEDO-33201 Rev 1. Section 15.3 will be revised in the next update.

NRC RAI 19.5-12

Justify the use of Equation 15.3-11 in NEDO-33201, Rev. 1, to determine the ultimate shear strength for short reinforced concrete shear walls, typical of nuclear power plants. Provide the equation used to determine the ultimate shear strength for the containment wall.

GE Response

See response to RAI 19.2-66 for shear strength in shear walls and 19.2-67 for containment wall assessment.

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

NRC RAI 19.5-13

For the shape factor (Fsa), Section 15.3.3.1.2 of NEDO-33201, Rev. 1,states that for the purpose of seismic risk assessment, the median ground motion spectrum given in NUREG/CR-0098, "Development of Criteria for Seismic Review of Selected Nuclear Power Plants," is considered to be the realistic input ground motion definition. Considering the significant number of advancements in the field of seismic hazards since the development of this spectrum in the late 1970's, justify your consideration of the NUREG/CR-0098 spectrum as realistic input ground motion.

GE Response

The shape factor will be re-evaluated for two site conditions, rock and soil.

For rock sites, the North-Anna site SSE spectrum will be compared to the ESBWR single envelope design spectrum to determine the shape factor.

For soil sites, the bounding SSE spectrum of soil sites among the 28 sites (excluding Vogtle) included in the current EPRI study will be compared to the ESBWR single envelope design spectrum to determine the shape factor. See Figure 19.5-13 (1) for spectrum comparison.

NEDO-33201 Section 15.3 will be revised in the next update.

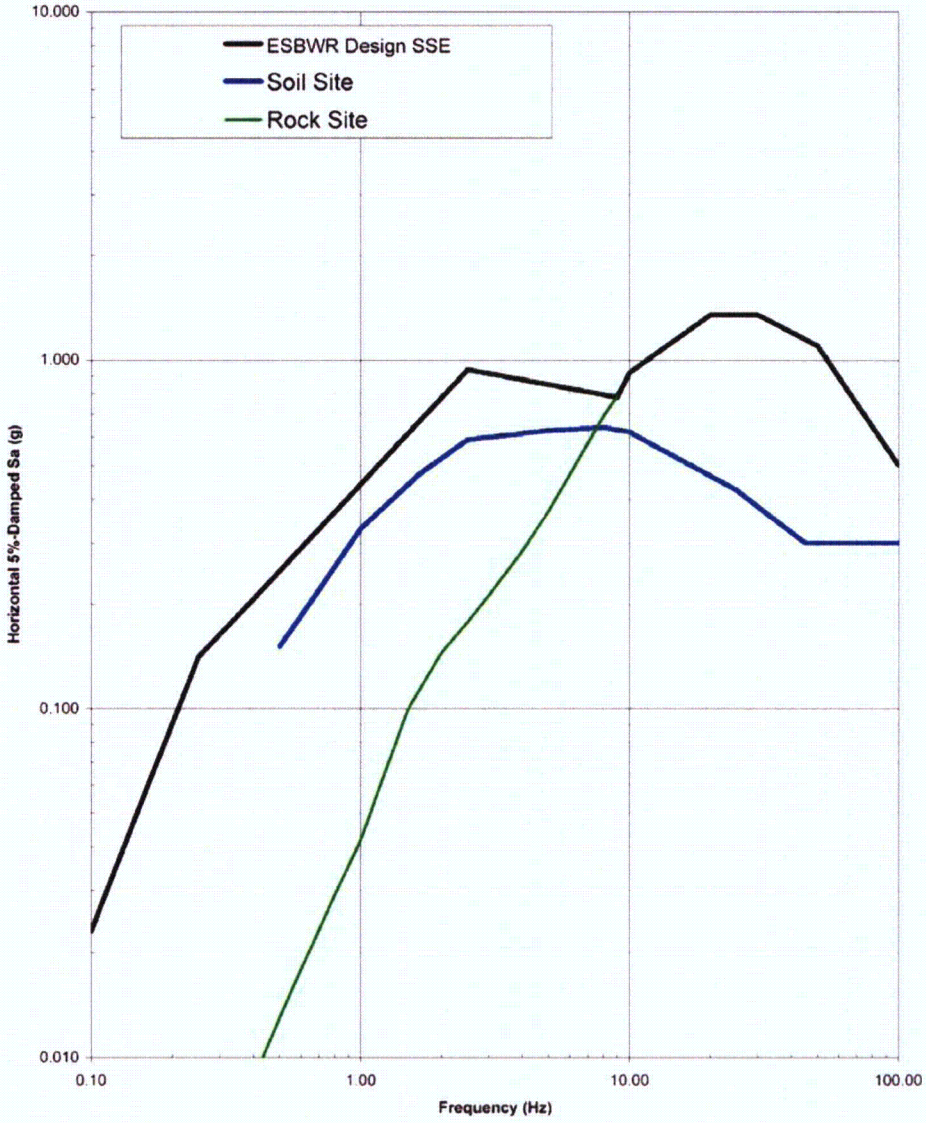

Figure 19.5-13 (1) Comparison of Design Ground Spectrum with Soil and Rock Spectra

NRC RAI 19.5-14

Provide a comparison showing ratios of the bounding (all site conditions) seismic responses of the containment structure at important locations to the critical functionality limits. Using the highest ratio determine the HCLPF value.

GE Response

See response to RAI 19.2-67 for the containment structure.

The HCLPF values will be revised based on the new spectra discussed in RAI 19.5-13. The lowest ratio (calculated-value divided by allowable-value) is used to determine the HCLPF in accordance with EPRI TR 103959s methodology.

NEDO-33201 Section 15.3 will be revised in the next update.