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Subject: **Response to Portion of NRC RAI Letter No. 240 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.7 – Seismic Design; RAI Numbers 3.7-66 through 3.7-68**

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) letter number 240 sent by NRC letter dated August 8, 2008 (Reference 1). RAI Numbers 3.7-66 through 3.7-68 are addressed in Enclosure 1. Verified DCD changes associated with this RAI response are identified in the enclosed DCD 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
Vice President, ESBWR Licensing

Reference:

1. MFN 08-632, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, GEH, *Request For Additional Information Letter No. 240 Related to ESBWR Design Certification Application*, dated August 8, 2008

Enclosure:

1. Response to Portion of NRC RAI Letter No. 240 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.7 – Seismic Design; RAI Numbers 3.7-66 through 3.7-68

cc:	AE Cabbage	USNRC (with enclosure)
	RE Brown	GEH/Wilmington (with enclosure)
	DH Hinds	GEH/Wilmington (with enclosure)
	eDRF Sections	0000-0098-0208 (RAI 3.7-66)
		0000-0098-0215 (RAI 3.7-67a)
		0000-0098-0220 (RAI 3.7-67b)
		0000-0098-0212 (RAI 3.7-68)

Enclosure 1

MFN 09-155

**Response to Portion of NRC Request for
Additional Information Letter No. 240
Related to ESBWR Design Certification Application
DCD Tier 2, Section 3.7 - Seismic Design
RAI Numbers 3.7-66 through 3.7-68**

NRC RAI 3.7-66

Question Summary:

Clarify and make consistent the proposed damping value used for seismic analysis of conduit and cable trays.

Full Text:

Items 19 through 22 in the Tier 2 Section 3.7 Revision 4 to Revision 5 Change List require clarification. RAI 3.7-13 S02 is identified in the Change List as the basis for the changes. There are inconsistencies in the damping values identified for cable trays and conduit, between DCD Table 3.7-1 and DCD Section 3.7.1.2. The staff requests GEH to clarify and make consistent in the DCD the proposed damping values to be used for seismic analysis of conduit and cable trays. If the proposed values are not consistent with RG 1.61, Revision 1, provide the technical basis for the proposed damping values.

GEH Response

Damping values for cable trays and conduit are consistent with Table 4 of RG 1.61 Revision 1. DCD Tier 2 Tables 1.9-21 and 1.9-21a, DCD Tier 2 Subsection 3.7.1.2, DCD Tier 2 Reference 3.7-5 and DCD Tier 2 Table 3.7-1 will be revised in Revision 6 for consistency.

DCD Impact

DCD Tier 2 Tables 1.9-21 and 1.9-21a, DCD Tier 2 Subsection 3.7.1.2, DCD Tier 2 Reference 3.7-5 and DCD Tier 2 Table 3.7-1 will be revised in Revision 6 as noted in the attached markups.

NRC RAI 3.7-67

Question Summary: Identify the resolution status of Section 3.7 changes.

Full Text:

The staff noted that the change list identified several changes in DCD Section 3.7 that are linked to RAIs other than 3.7 RAIs. The staff requests GEH to identify the resolution status of the following 3.7 changes:

- a) Items 7 and 8 in the Tier 2 Section 3.7 5 Change List shows that changes to Section 3.7.2.8 are linked to RAI 3.2-66. They relate to seismic classification/seismic analysis methods for the Turbine and Radwaste Buildings.*
- b) Items 12, 13, and 15 in the Tier 2 Section 3.7 Change List shows that changes to Sections 3.7.3.9, 3.7.3.12, and 3.7.3.17 are linked to RAIs 3.12-3 S03, 3.12-27 S01, 3.12-15 S03. They relate to (1) ISM piping analysis and (2) piping de-coupling criteria.*

GEH Response

- a) The changes in DCD Tier 2 Revision 5 Subsection 3.7.2.8, as described by Items 7 and 8 of the DCD Revision 5 Change List, will be updated by the response to NRC RAI 3.2-66 S01 (Resolved - MFN 08-206 S01, dated December 12, 2008) and NRC RAIs 3.8-79 S03 and 3.8-80 S03 (Submitted - MFN 06-407 S12, dated February 3, 2009) to clarify the seismic design and classification of the Turbine Building (TB) and the Radwaste Building (RW).

The TB will be re-classified as a Seismic Category II structure by the response to NRC RAI 3.2-66 S01, and DCD Tier 2 Subsection 3.7.2.8 will be revised in Revision 6 to reflect this change. The seismic analysis methodology and design acceptance criteria for the TB and RW will be included in DCD Tier 2 Revision 6 Subsections 3.7.2.8.1 and 3.7.2.8.2 respectively by the response to NRC RAIs 3.8-79 S03 and 3.8-80 S03.

- b) The resolution status of the RAIs listed in part (b) above are as follows:

RAI 3.12-3 S03: Response has been submitted by GEH (Response MFN # 06-119 S05 dated 02/20/08) and considered resolved by the NRC.

RAI 3.12-27 S01: Response has been submitted by GEH to NRC (Response MFN # 06-119 S08 dated 05/20/2008).

RAI 3.12-15 S03: Response has been submitted by GEH (Response MFN # 06-119 S05 dated 02/20/08) and considered resolved by the NRC

DCD Impact

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

NRC RAI 3.7-68

Question Summary:

Describe the effects of Case RU-5a on the enveloped seismic loads.

Full Text:

There are 21 changes identified in the Tier 2 Appendix 3A Revision 4 to Revision 5 Change List. The staff noted that 17 of the 21 changes identified are linked to RAI 3.8-41 S05. This RAI deals with the treatment of in-fill concrete in steel/concrete sandwich structures (e.g., diaphragm floor). GEH has incorporated the results of Case RU-5a, for 100 percent infill concrete stiffness of VW and D/F, in Sections 3A.8 and 3A.9. The staff requests GEH to specifically describe the effects of Case RU-5a on the enveloped seismic loads and the enveloped design FRS presented in Section 3A.9, and also to describe any structural re-analysis/re-design conducted, to address the results of Case RU-5a.

GEH Response

The effects of Case RU-5a on the enveloped seismic loads are most significant for the vent wall (VW), where the shear, moment and torsion at the base are increased by approximately 38%, 30% and 71%, respectively, as described in GEH's response to NRC RAI 3.8-41 S05 (Ref. MFN 06-191 S09, submitted 11/6/08). The effects of Case RU-5a on the enveloped design FRS are more pronounced at the reactor shield wall (RSW) as shown in Figures 3.8-41(43) and 3.8-41(49) in GEH's response to NRC RAI 3.8-41 S05.

The structural evaluation for the increased seismic forces of Case RU-5a was performed for the VW. The evaluation results, as documented in GEH's response to NRC RAI 3.8-41 S05 and associated markups for Revision 6 of DCD Tier 2 Subsection 3G.1.5.2.1.13, indicate that the higher seismic loads have no impact on the VW design.

DCD Impact

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

Table 1.9-21
NRC Regulatory Guides Applicability to ESBWR

RG No.	Regulatory Guide Title	Appl. Rev.	Issued Date	ESBWR Appli-cable?	Comments
1.56	Maintenance of Water Purity in Boiling Water Reactors	1	07/1978	Yes	
1.57	Design Limits and Loading Combinations for Metal Primary Reactor Containment System Components	1	03/2007	Yes	
1.58	Qualification of Nuclear Power Plant Inspection, Examination, and Testing Personnel		Super-ceded		See Table 1.9-21b. Withdrawn 07/31/1991
1.59	Design Basis Floods for Nuclear Power Plants	2	08/1977	Yes	Errata published 07/30/1980
1.60	Design Response Spectra for Seismic Design of Nuclear Power Plants	1	12/1973	Yes	
1.61	Damping Values for Seismic Design of Nuclear Power Plants	10	10/1973 3/2007	Yes	URD optimization—see Table 1.9-21a
1.62	Manual Initiation of Protective Actions	0	10/1973	Yes	
1.63	Electric Penetration Assemblies in Containment Structures for Nuclear Power Plants	3	02/1987	Yes	
1.64	Quality Assurance Requirements for the Design of Nuclear Power Plants		Super-ceded		See Table 1.9-21b. Withdrawn 07/31/1991
1.65	Materials and Inspections for Reactor Vessel Closure Studs	0	10/1973	Yes	
1.68	Initial Test Programs for Water-Cooled Reactor Power Plants	2	08/1978	Yes	

Table 1.9-21a
EPRI Intent and Optimization Topics

Reg. Guide	Topic Type	URD* Section	Comment
1.6	Intent	4.12	Passive safety systems use DC-derived power systems that are designed with the required independence.
1.7	Optim	2.5.2	Use a passive plant-specific physically-based source term.
1.9	Intent	4.13	Passive safety systems do not require diesel generators.
1.13	Intent	4.14	ESBWR complies with spent fuel storage facility requirements by keeping spent fuel covered with a loss of AC power for 72 hours.
1.26	Optim	2.3.1.2 (4)	The Main Steamline downstream of the seismic interface restraint is to be considered Seismic Category II and Quality Group B.
1.27	Intent	4.15.3	Passive decay heat removal systems provide the ultimate heat sink function so a separate reservoir is not required.
1.29	Optim	2.3.1.2 (4)	The Main Steamline downstream of the seismic interface restraint is to be considered Seismic Category II and Quality Group B.
1.30	Intent	4.16	AC power systems quality assurance requirements are consistent with design requirements in 10 CFR 50 Appendix B.
1.32	Intent	4.17	Safety-related DC power sources are provided to support passive core cooling and containment integrity safety functions. No offsite or diesel-generator-derived AC power is required for 72 hours.
1.41	Intent	4.18	Safety-related DC-derived power load groups will be tested. Minimal safety-related (inverter-derived) AC power testing is required.
1.52	Optim	2.5.2	Use of a Passive plant-specific physically-based source term eliminates the need for additional systems.
1.61	Optim	2.1.1.2 (4)	ASME Code case N-411 for SSE uses a higher damping value (more realistic)(Deleted)
1.70	Intent	4.19.3	Safety analysis reports will be provided that describe the design in a similar scope.

3.7.1.2 Percentage of Critical Damping Values

Damping values of various structures and components are shown in Table 3.7-1 for use in SSE dynamic analysis. These damping values are consistent with RG 1.61 [Revision 1](#) SSE damping ~~except for the damping value of cable trays and conduits.~~

~~The damping values shown in Table 3.7-1 for cable trays and conduits are based on the results of over 2000 individual dynamic tests conducted by Bechtel/ANCO for a variety of raceway configurations (Reference 3.7-5). The damping value of conduit systems (including supports) is 7% constant. For Heating, Ventilation and Air Conditioning (HVAC) ducts and supports the damping value is 7% for companion angle construction, 10% for pocket lock construction and 4% for welded construction.~~

For ASME Section III, Division 1 Class 1, 2, and 3, and ASME B31.1 piping systems, the damping values of Table 3.7-1 or alternative damping values specified in Figure 3.7-37 are used. The damping values shown in Table 3.7-1 are applicable to all modes of a structure or component constructed of the same material. Damping values for systems composed of subsystems with different damping properties are obtained using the procedures described in Subsection 3.7.2.13.

3.7.1.3 Supporting Media for Category I Structures

The Seismic Category I structures have concrete mat foundations supported on soil, rock or compacted backfill. The embedment depth, dimensions of the structural foundation, and total structural height for each structure are given in Subsection 3.8.5.1. The soil conditions considered for soil-structural interaction analysis are described in Appendix 3A.

3.7.2 Seismic System Analysis

This section applies to building structures that constitute primary structural systems (RB, FB, CB, and FWSC). The reactor pressure vessel (RPV) is not a primary structural component but, due to its dynamic interaction with the supporting structure, it is considered as another part of the primary system of the RB for the purpose of dynamic analysis. Table 3.7-3 provides a summary of methods of seismic analysis for primary building structures.

3.7.2.1 Seismic Analysis Methods

Analysis can be performed using any of the following methods:

- time history method;
- response spectrum method;
 - singly- or multi-supported system with Uniform Support Motion (USM); or
 - multi-supported system with independent support motion (ISM); or
- static coefficient method.

the actual event records to assure their long-term reliability in accordance with Reference 3.7-10 guidelines, as permitted by RG 1.167.

3.7.4.5 *In-Service Surveillance*

The seismic instrumentation operates during all modes of plant operation including periods of plant shutdown. The maintenance and repair procedures keep the maximum number of instruments in service during plant operation and shutdown. The walkdown inspection following a felt earthquake ensures the safety condition of the plant.

Each of the seismic instruments is demonstrated operable by the performance of the channel check, channel calibration, and channel functional test operations. The channel checks are performed every two weeks for the first three months of service after startup. After the initial three-month period and three consecutive successful checks, the channel checks are performed on a monthly basis. The channel calibration are performed during each refueling. The channel functional test is performed every 6 months.

3.7.5 Site-Specific Information

- (1) See Table 2.0-1 for seismology requirements of site-specific SSE ground response spectra.
- (2) See Table 2.0-1 for soil properties requirements of site-specific foundation bearing capacities, minimum shear wave velocity and liquefaction potential. For sites not meeting the soil ~~properties~~[property](#) requirements, a site-specific analysis is required to demonstrate ~~that site-specific conditions are enveloped by the standardized design~~[the adequacy of the standard plant design](#).

3.7.6 References

- 3.7-1 (Deleted)
- 3.7-2 Dominion Nuclear North Anna, LLC, "North Anna Early Site Permit Application," Revision 4, May 2005.
- 3.7-3 Exelon Generation Company, LLC, "Clinton Early Site Permit Application," Revision 0, September 2003.
- 3.7-4 System Energy Resources, INC, "Grand Gulf Early Site Permit Application," Revision 0, October 2003.
- 3.7-5 ~~P. Koss, "Seismic Testing of Electrical Cable Support Systems, Structural Engineers of California Conference," San Diego, September 1979. (Deleted)~~
- 3.7-6 L. K. Liu, "Seismic Analysis of the Boiling Water Reactor, symposium on seismic analysis of pressure vessel and piping components, First National Congress on Pressure Vessel and Piping," San Francisco, California, May 1971.
- 3.7-7 M. P. Singh, "Seismic Design Input for Secondary Systems, ASCE Mini-Conference on Civil Engineering and Nuclear Power," Vol. II, Boston, April 1979.
- 3.7-8 ASCE 4-98, "Seismic Analysis of Safety-Related Nuclear Structures and Commentary."
- 3.7-9 R. W. Clough et al., "Dynamics of Structure," McGraw-Hill, 1975.

Table 3.7-1
Damping Values for SSE Dynamic Analysis

Components	Percent of Critical Damping
Reinforced concrete structures	7.0
Welded and friction bolted steel assemblies/structures	4.0
Bearing bolted steel assemblies/structures	7.0
Equipment	3.0
Piping systems ¹	4.0
RPV, skirt, shroud, chimney, and separators	4.0
Control rod guide tubes and CRD housings	2.0
Fuel assemblies	6.0
Cable Trays system ²	7.0
- <u>maximum cable loading</u>	<u>10.0</u>
- <u>empty</u>	<u>7.0</u>
- <u>sprayed-on fire retardant or other cable-restraining mechanism</u>	<u>7.0</u>
Conduits systems ²	5.0
- <u>maximum cable fill</u>	<u>7.0</u>
- <u>empty</u>	<u>5.0</u>
HVAC ductwork	
- companion angle	7.0
- pocket lock	10.0
- welded	4.0

¹See Figure 3.7-37 for alternative damping values for response spectra analysis of ASME Section III, Division 1, Class 1, 2, and 3, and ASME B31.1 piping systems.

²Notes to Table 4 of RG 1.61 Revision 1 apply.