GE Hitachi Nuclear Energy

Richard E. Kingston
Vice President, ESBWR Licensing

P.O. Box 780
3901 Castle Hayne Road, M/C A-65
Wilmington, NC 28402 USA

T 910.819.6192
F 910.362.6192
rick.kingston@ge.com

MFN 09-342

Docket No. 52-010

May 28, 2009

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Subject: **Response to Portion of NRC RAI Letter No. 336 Related to ESBWR Design Certification Application – DCD Tier 2 Section 3.8 – Seismic Category I Structures; RAI Numbers 3.8-79 S04 and 3.8-80 S04**

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 336 sent by NRC letter dated April 22, 2009 (Reference 1). RAI Numbers 3.8-79 S04 and 3.8-80 S04 are addressed in Enclosure 1. Enclosure 2 contains the DCD changes to Tier 1 and Tier 2 as a result of GEH's response to these RAIs. Verified DCD changes associated with these RAI responses 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

Richard E. Kingston
Vice President, ESBWR Licensing

Reference:

1. MFN 09-282 Letter from U.S. Nuclear Regulatory Commission to J. G. Head, GEH, *Request For Additional Information Letter No. 336 Related to ESBWR Design Certification* dated April 22, 2009

Enclosure:

1. Response to Portion of NRC RAI Letter No. 336 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.8 – Seismic Category I Structures; RAI Numbers 3.8-79 S04 and 3.8-80 S04
2. Response to Portion of NRC RAI Letter No. 336 Related to ESBWR Design Certification Application - DCD Markups for RAI Numbers 3.8-79 S04 and 3.8-80 S04

cc:	AE Cubbage	USNRC (with enclosures)
	JG Head	GEH/Wilmington (with enclosures)
	DH Hinds	GEH/Wilmington (with enclosures)
	eDRF Section	0000-0101-1564 (RAI 3.8-79 S04 and 3.8-80 S04)

ENCLOSURE 1

MFN 09-342

Response to Portion of NRC RAI Letter No. 336
Related to ESBWR Design Certification Application[1]

DCD Tier 2 Section 3.8 – Seismic Category I Structures

RAI Numbers 3.8-79 S04 and 3.8-80 S04

[1] **Original Response and Supplement 1 previously submitted under MFNs 06-407, 06-407 S1, 06-407 S4 and 06-407 S12 without DCD updates are included to provide historical continuity during review.**

NRC RAI 3.8-79

Confirm that the Turbine Building (TB), Service Building (SB), and Radwaste (RW) Building, which are in close proximity to Category I structures, are designed to Seismic Category II requirements. If not, explain why not.

Include this information in DCD Section 3.8.4.

GEH Response

The TB, SB and RW seismic category classifications are shown in DCD Tier 2 Table 3.2-1. The TB is classified as Seismic Category II, and the SB is classified as Non-seismic. Since SB is in close proximity to RB/FB, its classification will be changed to Seismic Category II in DCD Tier 2 Table 3.2-1. The RW is remotely located from C-I structures and is classified as Non-Seismic Category. It is, however, designed to the special prescriptive provisions of RG 1.143, Category RW-IIa.

DCD Impact

A markup of DCD Tier 2 Table 3.2-1 was provided in MFN 06-407.

NRC RAI 3.8-79, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

For the RW building, the term "remote" needs to be clarified. Does this building meet the criteria in SRP 3.7.2.8.a, which states that the collapse of any non-Category I structure will not cause the non-Category I structure to strike a seismic Category I structure or component? If so, provide a description of what was done to demonstrate this, since the RB/FB and RW buildings appear to be relatively close (see DCD Figure 1.1-1).

During the audit, GE indicated that they will document that the distance between the RW building and any SC I structure, system, and component is greater than the height of the RW above grade.

GEH Response

An exception to the requirement that any NS structure be located at least a distance of its height above grade from C-I or C-II structures was taken for the RW building in DCD Tier 2 Rev. 2 Subsection 3.5.3.3 as shown in the DCD Tier 2 excerpt below:

3.5.3.3 Impact of Failure of Nonsafety-Related Structures, Systems and Components

Non-safety related structures could be either Seismic Category II (C-II) or NS. C-II structures are designed not to collapse under tornado wind loads. Any NS structure (except the Radwaste Building) is located at least a distance of its height above grade from C-I or C-II structures. Per Section 3.5.2, Offgas Charcoal Bed Adsorbers are provided with missile protection.

The RW building has a height of 12 m above grade and is at least 10 m away from the RB (measured corner to corner). The RW building is designed to RG 1.143 (Category RW-IIa), which exceeds NS requirements for seismic design. Therefore, potential failure of the RW building under full SSE will have negligible impact on C-I or C-II structures.

DCD Impact

No DCD change was made in response to this RAI Supplement.

NRC RAI 3.8-79, Supplement 2

NRC Assessment from Chandu Patel E-mail Dated May 24, 2007

The applicant stated that the Radwaste Building (RW) has a height of 12 m above grade and is at least 10 m away from the RB (measured corner to corner). The RW building is designed to RG 1.143 (Category RW IIa), which exceeds NS requirements for seismic design. Therefore, potential failure of the RW building under full Safe Shutdown Earthquake will have negligible impact on C I or C II structures.

The staff determined that this exception was not identified in DCD Tier 2 Section 3.7, and has not been reviewed by the staff for acceptability. Given the possibility that the RB may be impacted by collapse of the RW building, the staff requires a detailed technical evaluation to support the conclusion that there would be no unacceptable damage to the RB. This information needs to be documented in the DCD.

GEH Response

The Radwaste (RW) building is primarily a reinforced concrete box type structure. The roof trusses are the only significant steel structures. Its design classification is RW-IIa (High Hazard). Per RG 1.143, the seismic loading for the RW-IIa classification is OBE (Operating Basis Earthquake) or ½ SSE (Safe Shutdown Earthquake). Therefore, for the ESBWR design, the seismic design load for RW building is taken as ½ SSE. The load factors and capacity criteria for reinforced concrete structures are per ACI 349-01 as modified by RG 1.142. The load factors per ACI 349-01 for the load combinations with OBE (i.e. 1/2 SSE) (i.e. loading combination 2 in Subsection 9.2.1) are as follows: 1.4 for dead loads (D), and 1.7 for live loads (L), soil pressure loads (H) and OBE loads (E_0). The load factors for the SSE load combinations (i.e. loading combination 4 in Subsection 9.2.1 of ACI 349-01) are all equal to 1.0 for loads D, L, H and SSE (E_{ss}). By comparison, the load effects of the OBE load combinations are at least 1.7/2.0 = 0.85 of those SSE load combinations assuming that there are no D, L and H loads and SSE response loads are two times the OBE loads. However, the SSE response loads will be less than two times the OBE loads, because the damping for the SSE loads is significantly higher than OBE loads. Furthermore, D, L and H loads are significant for the RW building design. Therefore, the load effects of OBE load combinations will be larger than 0.85 and closer to 1.0 of the SSE load combinations. Thus, a total collapse of the RW building with unacceptable damage to the RB located 10 m away will not occur.

DCD Tier 2 Subsection 3.7.2.8 was revised in Rev. 4 to identify that the RW building is an exception to the proximity criteria for locating NS buildings.

DCD Impact

No DCD change is required in response to this RAI supplement.

NRC RAI 3.8-79, Supplement 3

(1) The response, transmitted in GEH letter dated November 20, 2007, relies on the analysis and design of the radwaste building (RW), which will be performed in accordance with RG 1.143 in the future, as the basis for demonstrating that the RW building meets the interaction criteria of non-category I structures and seismic Category I structures. The information provided does not demonstrate that the RW building has been analyzed and designed to withstand an SSE.

GEH DCD Tier 2 Rev. 4, Section 3.7.2.8, provides three options for addressing the interaction of non-Category I structures and seismic Category I structures. For the RW building, it appears from GEH's response that Option (3) has been selected. Option (3) indicates that non-Category I structures are analyzed and designed to prevent their failure under SSE conditions in a manner such that the margin of safety of these structures is equivalent to that of seismic Category I structures. SSCs in this category are classified as C-II. According to DCD Section 3.7, the methods of seismic analysis and the design acceptance criteria for C-II SSCs are the same as C-I. The staff has approved Option (3) as a means of demonstrating the adequacy of potential interaction between non-category I and seismic Category I structures. The analysis and design to satisfy this option should be separate from the criteria in RG 1.143 which is intended to demonstrate the design adequacy of the RW building under the OBE or ½ SSE (not the SSE).

Based on the above discussion, the staff requests that GEH provide the analysis and design of the RW building in accordance with DCD Section 3.7.2.8, Option (3); which indicates that they are performed in accordance with the same criteria as seismic Category I structures. This should include the seismic SSI analysis, definition of SSE spectra used as input, site interface parameters, and design adequacy of critical sections as was performed for the other C-I structures.

(2) Since the service building (SB) is classified as a Seismic C-II structure, the same information requested above for the RW building is also needed for the SB to address the interaction of non-Category I structures and Seismic C-I structures.

(3) The GEH response to the original RAI indicated that the turbine building (TB) is classified as Seismic C-II structure. The staff notes that Table 3.2-1 in DCD Tier 2 Rev. 4 now indicates that the seismic classification of the TB is non-seismic (NS). Since the TB is also in close proximity to the reactor building/fuel building, what is the technical basis for this change in classification? If GEH has selected Option (2) of DCD Section 3.7.2.8 to address the interaction criteria, then provide a description of the calculations that were performed to demonstrate that the collapse of the TB does not impair the integrity of the seismic C-I structures. This description should be included in the DCD to demonstrate the integrity of the seismic C-I structures. If

Option (3) is selected, then the TB should be classified as seismic C-II, and the same information as described above for the SB and RW building is needed.

<u>GEH Response</u>

In compliance with SRP 3.7.2, the design and analysis criteria for the Radwaste Building and Seismic Category II Buildings will be added under DCD Tier 2 Subsection 3.7.2.8. The completed design analysis for these structures will be available as a part of the final design of the ESBWR. SRP 3.7.2 Section III.8 states "The design and analysis criteria for interaction of non-Category I structures with Category I SSCs are reviewed to ensure compliance with the acceptance criteria of subsection II.8 of this SRP section." ITAACs for the Radwaste Building and all the Seismic Category II Buildings will be created to ensure acceptable design and construction of the structures.

The following design and analysis criteria describes the seismic design requirements of the Radwaste Building and Seismic Category II Buildings to prevent interaction with Seismic Category I structures:

(1) The Radwaste Building seismic design follows RG 1.143 (Classification RW-IIa) except that the seismic loading is full SSE instead of ½ SSE. The seismic analysis of the Radwaste Building is the same as Seismic Category I structure, including the load combinations and acceptance criteria. This analysis and design method will preclude any adverse interaction with Seismic Category I structures. DCD Tier 2 Subsection 3.7.2.8.2 will be added to describe the seismic analysis method and acceptance criteria of the Radwaste Building.

(2) The Service Building is classified as Seismic Category II with the same margin of safety as a Seismic Category I structure as described in DCD Tier 2 Subsection 3.7.2.8 option (3), therefore, precludes any adverse interaction with Seismic Category I structures. DCD Tier 2 Subsection 3.7.2.8.3 will be added to describe the seismic analysis method and acceptance criteria of the Service Building.

(3) The Turbine Building is re-classified as Seismic Category II and designed to meet the requirements of DCD Tier 2 Subsections 3.7.2.8 option (3) and 3.7.2.8.1, therefore, precludes adverse interaction with Seismic Category I SSCs. DCD Tier 2 Table 3.2-1, Figures 3.2-1, 3.2-2, Subsections 1.2.2.16.8, 3.3.2.3, 3.7.2.8 and 19A.8.3 are revised to reflect the re-classification of the Turbine Building to Seismic Category II. DCD Tier 2 Subsection 3.7.2.8.1 will be added to describe the seismic analysis method and acceptance criteria of the Turbine Building.

DCD Impact

New DCD Tier 2 Subsections 3.7.2.8.1, 3.7.2.8.2, 3.7.2.8.3 and 3.7.2.8.4 will be added by the response to RAI 3.8-80 Supplement 3.

New ITAACs DCD Tier 1 Subsections 2.16.8, 2.16.9, 2.16.10 and 2.16.11, Tables 2.16.8-1, 2.16.9-1, 2.16.10-1 and 2.16.11-1 will be added by the response to RAI 3.8-80 Supplement 3.

DCD Tier 2 Table 3.2-1, Figures 3.2-1, 3.2-2, Subsections 1.2.2.16.8, 3.3.2.3, 3.7.2.8 and 19A.8.3 are revised in DCD Tier 2 Revision 6 by the response to RAI 3.2-66 S01 (MFN 08-206 S01 issued 12-12-2008).

NRC RAI 3.8-79, Supplement 4

As a result of the staff's review of the GEH response transmitted in GEH letter MFN 06-407, Supplement 12, dated February 3, 2009, GEH is requested to address the following items:

(1) In the mark-up of DCD Sections 3.7.2.8.1 and 3.7.2.8.3 for the Turbine Building and Service Building, respectively, GEH indicates that the minimum gap between these structures and the adjacent structures is 4 inches to prevent building interaction from seismic displacements. Since the seismic analyses of these seismic Category II structures and the Radwaste Building will not be performed until some time in the future, GEH needs to provide the technical basis to show that the 4 inch gaps will be sufficient. This should consider the potential for out-of-phase motion for all soil cases.

(2) Due to the close proximity (4 inch gaps) of the Turbine Building and Service Building to seismic Category I structures, the seismic interaction of these buildings with the seismic Category I structures may affect the seismic input motion and response of the structures. Explain whether structure-soil structure interaction evaluations between the seismic Category II structures and the adjacent seismic Category I structures have been considered or will be considered. The explanation should include a description of how the structure-soil-structure evaluations were or will be considered, and if not required, then provide the technical basis for not considering them.

(3) The proposed mark-ups for DCD Sections 3.7.2.8.1 through 3.7.2.8.4, for the seismic analysis of seismic Category II structures and the Radwaste Building, indicate that "The soil-structure interaction (SSI) analysis is performed using the soil spring/dashpot approach in accordance with Appendix 3A for generic uniform sites. Because the SSI responses of layered sites are mostly enveloped by the uniform sites as described in Subsection 3A.8.6, generic layered sites are not considered on the basis of the SSI analysis results of Seismic Category I structures." The technical basis for this approach is not presented and it is not evident to the staff. There are also a number of SSI issues that are still outstanding which relate to this subject of layered soil cases versus the uniform soil assumption in a soil spring/dashpot approach. Therefore, GEH is requested incorporate the resolution of the other SSI issues, including those associated with RAI 3.8-94 Supplement 3, into the criteria presented in DCD Section 3.7.2.8.

(4) Since the actual analysis and detailed design for the non-seismic Category I structures will be performed at a future date, ITAAC have been created to address the analysis and design of the seismic Category II structures and the Radwaste Building. Unlike the other ITAACs for seismic Category I structures, where the design of the critical sections have been completed already during the design certification phase, these additional new ITAACs must address the fact that the analysis and design of seismic Category II structures and the Radwaste Building have not been performed as yet. These new ITAACs for the seismic Category II structures and the Radwaste Building that will be performed in the future should ensure that the analysis and design have been properly

performed in accordance with the design criteria presented in DCD Tier 2, Sections 3.7 and 3.8.4. Therefore, the current set of ITAACs proposed in the mark-up for the Turbine Building, Radwaste Building, Service Building, and Ancillary Diesel Building need to be enhanced. Using the Turbine Building as an example, the proposed ITAAC states that "Report(s) exist and conclude that the TB design conforms to the structural design basis loads specified in the Design Description of Subsection 2.16.8 associated with: Natural phenomena - wind, floods, … and Normal plant operations - live loads and dead loads." It is insufficient for the report(s) to only exist and make the stated conclusion that the design conforms to the loads specified in DCD Subsection 2.16.8. The information within Subsection 2.16.8 does not contain all of the analysis and design criteria that are needed for these structures. Therefore, the applicant is requested to revise, for each structure, the ITAAC Acceptance Criteria in the DCD Tier 1 tables and the text in Subsection 2.16, that precede the ITAAC, to indicate that the Report(s) exist and demonstrate that the analysis and design of the structure is the same as a Seismic Category I structure, including the load combinations and the acceptance criteria. Otherwise, GEH needs to explain what mechanism exists to ensure that the analysis and design have been performed in accordance with the proposed mark-up for DCD Tier 2, Sections 3.7 and 3.8.4.

<u>GEH Response</u>

(1) The seismic gaps between the adjacent buildings will be no less than the calculated maximum relative displacement between the buildings during SSE event, considering out-of-phase motion. DCD Subsections 3.7.2.8.1 and 3.7.2.8.3, and 3.8.4 will be clarified accordingly.

(2) The effect of structure-soil-structure interaction between the RW, Seismic Category II structures and the adjacent seismic Category I structures will be considered. DCD Subsections 3.7.2.8 will be clarified accordingly.

(3) The generic uniform sites and layered sites as defined in DCD Tables 3A.3-1 and 3A.3-3 will be considered in the design of the RW and Seismic Category II structures. DCD Subsection 3.7.2.8 will be clarified accordingly.

(4) The Design Description and ITAAC for the TB, SB and ADB in DCD Tier 1 will be revised to state that the analysis and design is the same as a Seismic Category I structure, including the load combinations and acceptance criteria.

DCD Subsection 3.8.4.3.4 will be revised to clarify the loads and load combinations for the RW.

DCD Impact

DCD Tier 2 Subsections 3.7.2.8.1, 3.7.2.8.2, 3.7.2.8.3, 3.7.2.8.4, 3.8.4 and 3.8.4.3.4 will be revised in Revision 6 of the DCD as noted in the attached markups.

DCD Tier 1 Subsections 2.16.8, 2.16.10, 2.16.11, Tables 2.16.8-1, 2.16.10-1 and 2.16.11-1 will be revised in Revision 6 of the DCD as noted in the attached markups.

NRC RAI 3.8-80

What buildings other than the RB, FB and CB have been designed and evaluated to applicable acceptance criteria? What is the status of the EBAS and RW Building designs? What are the COL applicant responsibilities and what are the standard plant design restrictions/limitations/requirements for the design of buildings not covered in the DCD?

Include this information in the DCD.

GEH Response

The analytical design of the RB, CB and FB is done and documented in DCD Tier 2 Appendices 3A and 3G. The preliminary design of the EBAS is done. The RW design has not started.

The COL applicant responsibilities are addressed in DCD Tier 2 Section 3.8.6.

DCD Impact

No DCD change was made in response to this RAI.

NRC RAI 3.8-80, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

Will the design of the EBAS and RW be completed soon enough to allow the NRC staff to review it before issuing the SER? Otherwise, this will likely be an Open Item in the SER. Also, DCD Section 3.8.6 is not labeled "COL applicant responsibilities", but rather "COL Information." For COL applicant responsibilities, are there additional items specified somewhere else in the DCD that must be satisfied? Currently there is only one item in DCD Section 3.8.6; it refers to the structural integrity test (SIT) of the ESBWR containment.

During the audit, GE indicated that the status of the EBAS design is addressed in RAI 3.8-65. GE stated that since the RW building is a non safety-related and non SCI or SC II structure, it does not need to be designed as part of the design certification, nor will it be a COL Action Item. GE also provided a draft supplemental response to address the questions related to Section 3.8.6 - COL Information. During the meeting GE indicated that structural related COL Action Items will be included in Section 3.8.6.

GEH Response

See response to NRC RAI 3.8-65, Supplement 1 for EBAS status. The RW building is a non C-I structure.

The SIT information contained in DCD Tier 2 Subsection 3.8.6 has been moved to DCD Tier 1 Table 2.15.1-1, Item 5 per NRC RAI 14.3-101 as an ITAAC item. There will be no COL Action Items in DCD Tier 2 Section 3.8, Revision 3.

DCD Impact

Markups of DCD Tier 2 Subsections 3.8.1.7.3.12 and 3.8.6 were provided in MFN 06-407S1.

NRC RAI 3.8-80, Supplement 2

NRC Assessment from Chandu Patel E-mail Dated May 24, 2007

The DCD Section 3.8.4 introductory paragraph discusses the RW building as if it is part of the design certification scope. In its response to RAI 3.8-79, the applicant identified the RW building height above grade, its distance from the RB, and the potential for impact of the RB if the RW should collapse in a seismic event. However, during the December 2006 audit discussion, the applicant indicated that it does not need to be designed as part of the design certification nor identified as a COL action item. Consequently, the staff is unclear about the status of the RW building, with respect to design certification or COL applicant responsibility. The staff requests the applicant to clearly define the design responsibility for this essential building, in accordance with RG 1.143. This information needs to be documented in the DCD.

GEH Response

The RW is identified as being part of the ESBWR Standard Plant in DCD Tier 2 Subsection 1.1.2.1 and is therefore a part of the design certification scope.

Please also see the response to NRC RAI 3.8-79, Supplement 2.

DCD Impact

No DCD change is required in response to this RAI Supplement.

NRC RAI 3.8-80, Supplement 3

The response, transmitted in GEH letter dated November 20, 2007, explained that the radwaste building (RW) is identified as part of the ESBWR standard plant in DCD Tier 2 Subsection 1.1.2.1, and is therefore a part of the design certification scope. The staff accepts the response which indicates that the RW building is part of the design certification scope. However, the referenced Subsection 1.1.2.1 does not clearly state this; it indicates that "The following main buildings (see Figure 1.1-1) are within the scope for the ESBWR:" This should be revised to clearly indicate that the following buildings are within the design certification scope for the ESBWR.

The DCD indicates that the analysis and design of the RW building is in accordance with NRC RG 1.143, Rev. 2, 2001. This RG provides information and criteria that will provide reasonable assurance that SSCs used in the radioactive waste management and steam generator blowdown systems are designed, constructed, installed, and tested on a level commensurate with the need to protect the health and safety of the public and plant operating personnel. Since the RW building is within the design certification scope, the information needed to develop the reasonable assurance that the health and safety of the public and plant operating personnel is achieved, should be provided. Therefore, the staff requests that GEH provide in the DCD the description of the analysis and design as well as a summary of the results for the RW building, similar to Category I structures, which demonstrate compliance with RG 1.143.

GEH Response

DCD Tier 2 Subsection 1.1.2.1 will be revised to add two new Subsections. Subsection 1.1.2.1.1 will identify the Seismic Category I structures that are included in the design certification scope for the ESBWR, and Subsection 1.1.2.1.2 will identify the Seismic Category II and NS structures that are included in the ESBWR Standard Plant Scope. The design criteria for the structures listed in Subsection 1.1.2.1.2 (except the Electrical Building) will be added under DCD Tier 2 Subsection 3.7.2.8 in compliance with SRP 3.7.2.

New ITAACs for the Radwaste Building and all the Seismic Category II Buildings will be created to ensure acceptable design and construction of the structures.

The Radwaste Building design follows RG 1.143 (Classification RW-IIa) except that the seismic loading is full SSE instead of ½ SSE. The seismic analysis methodology of the RW is the same as a Seismic Category I structure, including the load combinations and acceptance criteria. As a result, there is no adverse interaction with Seismic Category I structures. DCD Tier 2 Subsection 3.7.2.8.2 will be added to describe the seismic analysis method of the Radwaste Building.

Note 1 of Tables 2.0-1 and 5.1-1 are deleted. The tornado wind load for the Radwaste Building is discussed in Subsection 3.3.2.3, and the seismic design is discussed in the new Subsection 3.7.2.8.2.

DCD Impact

DCD Tier 2 Subsections 1.1.2.1, 3.3.2.3, 3.8.4.1.5 and Table 3.8-9 will be revised in Revision 6 of the DCD as noted in the attached markups.

New DCD Tier 2 Subsections 1.1.2.1.1, 1.1.2.1.2, 3.7.2.8.1, 3.7.2.8.2, 3.7.2.8.3 and 3.7.2.8.4 will be added in Revision 6 of the DCD as noted in the attached markups.

New ITAACs DCD Tier 1 Subsections 2.16.8, 2.16.9, 2.16.10, 2.16.11, Tables 2.16.8-1, 2.16.9-1, 2.16.10-1 and 2.16.11-1 will be added in Revision 6 of the DCD as noted in the attached markups.

DCD Tier 1 Table 5.1-1 and DCD Tier 2 Table 2.0-1 will be revised in Revision 6 of the DCD as noted in the attached markups.

NRC RAI 3.8-80, Supplement 4

As a result of the staff's review of the GEH response transmitted in GEH letter MFN 06-407, Supplement 12, dated February 3, 2009, GEH is requested to address the remaining issue associated with the mark-up for the ITAAC for the design of the Radwaste Building in accordance with Regulatory Guide 1.143. The seismic interaction issue with the Radwaste Building and adjacent structures is addressed separately under RAI 3.8-79. As noted in RAI 3.8-79, Supplement 4, unlike the other ITAACs for seismic Category I structures, where the design of the critical sections have been completed already during the design certification phase, the proposed ITAAC for the Radwaste Building must address the fact that the analysis and detailed design of the Radwaste Building has not been performed as yet. The new ITAAC for the Radwaste Building should ensure that the analysis and design will be properly performed in accordance with the design criteria presented in the proposed mark-up for DCD Tier 2, Sections 3.7 and 3.8.4. Therefore, the current ITAACs proposed in the mark-up for the Radwaste Building need to be
enhanced. The applicant is requested to revise the ITAAC Acceptance Criteria in the DCD Tier 1 table and the text in Subsection 2.16, that precede the ITAAC, to indicate that the Report(s) exist and demonstrate that the method of analysis for the Radwaste Building is the same as a Seismic Category I structure, including the load combinations and acceptance criteria. For design purposes, the Radwaste building is designed in accordance with RG 1.143 Classification RW-IIa. The earthquake loading is the full SSE instead of ½ SSE as shown in RG 1.143. Otherwise, GEH needs to explain what mechanism exists to ensure that the analysis and design have been performed in accordance with the proposed mark-up for DCD Tier 2, Sections 3.7 and 3.8.4.

GEH Response

The Design Description and ITAAC for the RW will be revised to state that the RW method of analysis is the same as a Seismic Category I structure, including the load combinations and acceptance criteria. The RW is designed in accordance with RG 1.143 Classification RW-IIa. The earthquake loading is full SSE instead of ½ SSE as shown RG 1.143.

DCD Impact

DCD Tier 1 Subsections 2.16.9 and Table 2.16.9-1 will be revised in Revision 6 of the DCD as noted in the attached markups.

Enclosure 2

MFN 09-342

Response to Portion of NRC Request for

Additional Information Letter No. 336

Related to ESBWR Design Certification Application

DCD Markups for RAI Numbers:

3.8-79 S04 and 3.8-80 S04

2.16.8 Turbine Building

Design Description

The Turbine Building (TB) encloses the turbine generator, main condenser, condensate and feedwater systems, condensate purification system, offgas system, turbine-generator support systems and bridge crane. The TB is designed as a Seismic Category II structure.

The key characteristics of the TB are as follows:

(1) The TB analysis and design is the same as a Seismic Category I structure, including the load combinations and the acceptance critera, for loads associated with:

- Natural phenomenon –wind, floods, tornadoes (excluding tornado missiles), earthquakes, rain and snow. In addition, the TB is designed for hurricane wind to protect RTNSS systems.
- Normal plant operation – live loads and dead loads.

(2) The RTNSS systems in the TB are surrounded by barriers to protect them from hurricane wind and missiles.

(3) The internal flooding analysis of the TB is performed using ANSI/ANS 56.11-1988 guidelines to ensure protection of RTNSS equipment.

(4) RTNSS equipment in the TB is located above the maximum flood level for that location or is qualified for flood conditions.

(5) The TB external flooding features are:

- Water seals at pipe penetrations installed in external walls below flood and groundwater levels.
- Water stops provided in expansion and construction joints below flood and groundwater levels.

(6) The TB is constructed in accordance with the design documents, with any deviations from the design documents reconciled to demonstrate the as-built TB structural integrity.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.16.8-1 provides a definition of the inspections, tests and/or analyses, together with associated acceptance criteria for the TB.

~~No ITAAC are required for this system~~.

Table 2.16.8-1

ITAAC For The Turbine Building

Design Commitment	Inspection, Tests, Analyses	Acceptance Criteria
1. The TB analysis and design is the same as a Seismic Category I structure, including the load combinations and the acceptance criteria, for loads associated with: • Natural phenomenon –wind, floods, tornadoes (excluding tornado missiles), earthquakes, rain and snow. In addition, the TB is designed for hurricane wind to protect RTNSS systems. • Normal plant operation—live loads and dead loads.	Analyses of the TB will be conducted.	Report(s) exist and conclude that the TB analysis and design is the same as a Seismic Category I structure including the load combinations and the acceptance criteria, for loads associated with: • Natural phenomena – wind, floods, tornadoes (excluding tornado missiles), earthquakes, rain, snow and hurricane wind (for RTNSS protection). • Normal plant operations – live loads and dead loads.
2. The RTNSS systems in the TB are surrounded by barriers to protect them from hurricane wind and missiles.	Inspection of the as-built RTNSS systems in the TB will be conducted.	Report(s) exist and conclude the as-built RTNSS systems in the TB are surrounded by barriers to protect them from hurricane wind and missiles.
3. The internal flooding analysis of the TB is performed using ANSI/ANS 56.11-1988 guidelines to ensure protection of RTNSS equipment.	Internal flooding analysis of the TB will be performed.	Report(s) exist and conclude that internal flooding analysis of the TB has been performed using ANSI/ANS 56.11-1988 guidelines to ensure protection of RTNSS equipment.

2.16.9 Radwaste Building

Design Description

The Radwaste Building (RW) is a box-shaped reinforced concrete structure housing tanks and equipment including processing systems for radioactive liquid and solid waste processing. The RW is designed in accordance with RG 1.143 Classification RW-IIa except: Tornado Wind Speed, Radius, Pressure drop, and Rate of Pressure Drop. The RW structure is designed for full Safe Shutdown Earthquake (SSE) instead of ½ SSE.

The key characteristics of the RW are as follows:

(1) The RW method of analysis is the same as a Seismic Category I structure, including the load combinations and the acceptance criteria. The RW is designed in accordance with RG 1.143 Classification RW-IIa. The earthquake loading is the full SSE instead of ½ SSE as shown in RG 1.143. The RW loads are those associated with:

- The RW loads are those associated with:
- Natural phenomenon – wind, floods, tornadoes, tornado missiles, earthquakes, rain and snow.
- Internal events - floods
- Normal plant operation – live loads and dead loads.

(2) The RW external flooding features are:

- Water seals at pipe penetrations installed in external walls below flood and groundwater levels.
- Water stops provided in expansion and construction joints below flood and groundwater levels.

(3) The RW is constructed in accordance with the design documents, with any deviations from the design documents reconciled to demonstrate the as-built RW structural integrity.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.16.9-1 provides a definition of the inspections, test and/or analyses, together with associated acceptance criteria for the RW.

~~No ITAAC are required for this system.~~

Table 2.16.9-1

ITAAC For The Radwaste Building

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The RW method of analysis is the same as a Seismic Category I structure, including the load combinations and the acceptance criteria. The RW is designed in accordance with RG 1.143 Classification RW-IIa. The earthquake loading is the full SSE instead of ½ SSE as shown in RG 1.143. The RW loads are those associated with: • Natural phenomena—wind, floods, tornadoes, tornado missiles, earthquakes, rain and snow. • Internal events - floods • Normal plant operation—live loads and dead loads.	Analyses of the RW will be conducted.	Report(s) exist and conclude that the RW method of analysis is the same as a Seismic Category I structure, including the load combinations and the acceptance criteria. The RW is designed in accordance with RG 1.143 Classification RW-IIa. The earthquake loading is the full SSE instead of ½ SSE as shown in RG 1.143. The RW loads are those associated with: • Natural phenomena – wind, floods, tornadoes, tornado missiles, earthquakes, rain and snow. • Internal events – floods. • Normal plant operation – live loads and dead loads.
2. The RW is protected against external flooding. The following protection features are: • Water seals at pipe penetrations are installed in external walls below flood and groundwater levels. • Water stops are in expansion and construction joints below flood	Inspection of the as-built RW flood control features will be conducted.	Inspection report(s) exist and conclude that the following as-built RW flood protection features exist: • Water seals at pipe penetrations are installed in external walls below flood and groundwater levels. • Water stops are provided in expansion and construction joints below flood and groundwater

2.16.10 ~~Other Buildings and Structures~~Service Building

Design Description

~~No ITAAC are required for this system.~~ The Service Building (SB) houses the equipment and control facilities associated with personnel entry into the RB and TB, eating areas, radiation protection, changing rooms, shops and offices. The SB is designed as a Seismic Category II structure.

The key characteristics of the SB are as follows:

(1) The SB analysis and design is the same as a Seismic Category I structure, including the load combinations and the acceptance criteria, for loads associated with:

- Natural phenomenon – wind, floods, tornadoes (excluding tornado missiles), earthquakes, rain and snow.
- Normal plant operation – live loads and dead loads.

(2) The SB external flooding features are:

- Water seals at pipe penetrations installed in external walls below flood and groundwater levels.
- Water stops provided in expansion and construction joints below flood and groundwater levels.

(3) The SB is constructed in accordance with the design documents, with any deviations from the design documents reconciled to demonstrate the as-built SB structural integrity.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.16.10-1 provides a definition of the inspections, tests and/or analyses, together with associated acceptance criteria for the SB.

Table 2.16.10-1

ITAAC For The Service Building

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The Service Building (SB) analysis and design is the same as a Seismic Category I structure, including the load combinations and the acceptance criteria, for loads associated with: • Natural phenomena—wind, floods, tornadoes (excluding tornado missiles), earthquakes, rain and snow. • Normal plant operation—live loads and dead loads.	Analyses of the SB will be conducted.	Report(s) exist and conclude that the SB analysis and design is the same as a Seismic Category I structure, including the load combinations and the acceptance criteria, for loads associated with: • Natural phenomena – wind, floods, tornadoes (excluding tornado missiles), earthquakes, rain and snow. • Normal plant operation – live loads and dead loads.
2. The SB is protected against external flooding. The following protection features are: • Water seals at pipe penetrations are installed in external walls below flood and groundwater levels. • Water stops are in expansion and construction joints below flood and groundwater levels.	Inspection of the as-built SB flood control features will be conducted	Inspection report(s) exist and conclude that the following as-built SB flood protection features exist: • Water seals at pipe penetrations are installed in external walls below flood and groundwater levels. • Water stops are provided in expansion and construction joints below flood and groundwater levels.

2.16.11 Ancillary Diesel Building

Design Description

The Ancillary Diesel Building (ADB) houses the Ancillary Diesel Generators and all associated supporting systems and equipment. The ADB is designed as a Seismic Category II structure.

The key characteristics of the ADB are as follows:

(1) The ADB analysis and design is the same as a Seismic Category I structure, including the load combinations and the acceptance criteria, for loads associated with:

- Natural phenomenon –wind, floods, tornadoes (excluding tornado missiles), earthquakes, rain and snow. In addition, the ADB is designed for hurricane wind to protect RTNSS systems.
- Normal plant operation – live loads and dead loads.

(2) The RTNSS systems in the ADB are surrounded by barriers to protect them from hurricane wind and missiles.

(3) Internal flooding analysis of the ADB is performed using ANSI/ANS 56.11-1988 guidelines to ensure protection of RTNSS equipment.

(4) RTNSS equipment in the ADB is located above the maximum flood level for that location or is qualified for flood conditions.

(5) The ADB external flooding features are:

- Water seals at pipe penetrations installed in external walls below flood and groundwater levels
- Water stops provided in expansion and construction joints below flood and groundwater levels.

(6) The ADB is constructed in accordance with the design documents, with any deviations from the design documents reconciled to demonstrate the as-built ADB structural integrity.

Inspections, Tests, Analyses and Acceptance Criteria

Table 2.16.11-1 provides a definition of the inspections, tests and/or analyses, together with associated acceptance criteria for the ADB.

Table 2.16.11-1

ITAAC For The Ancillary Diesel Building

Design Commitment	Inspection, Tests, Analyses	Acceptance Criteria
1. The Ancillary Diesel Building (ADB) analysis and design is the same as a Seismic Category I structure, including the load combinations and the acceptance criteria, for loads associated with: • Natural phenomena—wind, floods, tornadoes (excluding tornado missiles), earthquakes, rain and snow. In addition, the ADB is designed for hurricane wind to protect RTNSS systems. • Normal plant operation—live loads and dead loads.	Analyses of the ADB will be conducted.	Report(s) exist and conclude that the ADB analysis and design is the same as a Seismic Category I structure, including the load combinations and the acceptance criteria, for loads associated with: • Natural phenomena – wind, floods, tornadoes (excluding tornado missiles), earthquakes, rain, snow and hurricane wind (for RTNSS protection). • Normal plant operation – live loads and dead loads.
2. The RTNSS systems in the ADB are surrounded by barriers to protect them from hurricane wind and missiles.	Inspection of the as-built RTNSS systems in the ADB will be conducted.	Report(s) exist and conclude that as-built RTNSS systems in the ADB are surrounded by barriers to protect them from hurricane wind and missiles
3. Internal flooding analysis of the ADB is performed using ANSI/ANS 56.11-1988 guidelines to ensure protection of RTNSS equipment.	Internal flooding analysis of the ADB will be performed.	Report(s) exist and conclude that the internal flooding analysis of the ADB has been performed using ANSI/ANS 56.11-1988 guidelines to ensure protection of RTNSS equipment.

3.7.2.8 Interaction of Non-Category I Structures with Seismic Category I Structures

The interfaces between Seismic Category I and non-Seismic Category I SSCs are designed for the dynamic loads and displacements produced by both the Category I and non-Category I SSCs. All non-Category I SSCs meet at least one of the following requirements:

(1) The collapse of any non-Category I structure, system or component does not cause the non-Category I structure, system or component to strike a Seismic Category I structure, system or component. SSCs in this category are classified as non-seismic. Any non-seismic structure postulated to fail under SSE is located at least a distance of its height above grade from Seismic Category I structures.

(2) The collapse of any non-Category I structure, system or component does not impair the integrity of Seismic Category I structures, systems or components. This is demonstrated by showing that the impact loads on the Category I structure, system or component resulting from collapse of an adjacent non-Category I structure, because of its size and mass, are either negligible or smaller than those considered in the design (e.g., loads associated with tornado, including missiles). SSCs in this category are classified as non-seismic.

(3) The non-Category I structures, systems or components are analyzed and designed to prevent their failure under SSE conditions in a manner such that the margin of safety of these structures, systems or components is equivalent to that of Seismic Category I structures, systems or components. SSCs in this category are classified as Seismic Category II, except the Radwaste Building ~~and the Turbine Building (TB)~~.

~~The TB is a non-seismic structure that is designed using the IBC-2003 to maintain structural integrity with a margin of safety that is equivalent to a Seismic Category I structure under SSE conditions. The TB is seismically designed using the dynamic analysis method with the SSE ground input motion equal to two-thirds of the Certified Seismic Design Spectra taken from Figures 2.0-1 and 2.0-2 adjusted as required to their bases. Occupancy Importance Factor of 1.5, Response Modification Factor of 2 and Seismic Design Category D/Seismic Use Group III apply to the TB. The TB is designed such that the maximum combined seismic displacement of the TB and an adjacent Seismic Category I structure is less than their separation distance.~~

The following subsections describe the seismic analysis methodology and design acceptance criteria for the Radwaste Building and Seismic Category II Buildings to preclude any adverse interaction with Seismic Category I structures.

3.7.2.8.1 Turbine Building

The Turbine Building is a Seismic Category II structure that is adjacent to the Reactor Building. The method of analysis of the Turbine Building is the same as a Seismic Category I structure including the loading cases and acceptance criteria as shown in Tables 3.8-15 and 3.8-16. The mathematical model of the structural systems for seismic analysis is either a stick model or a finite element model using the procedures in accordance with Subsection 3.7.2.3. The soil-structure interaction (SSI) analysis is performed using the soil spring/dashpot approach or the finite element approach in accordance with Appendix 3A. The generic uniform site properties are shown in Table 3A.3-1 and the layered site properties are shown in Table 3A.3-3. The effect of structure-soil-structure interaction with adjacent Seismic Category I structure is performed in the same manner as described in Subsection 3A.8.1.1. Seismic input motions are based on the single envelop design response spectra as defined in Table 3.7-2 with the applicable scale factor, applied at the foundation level, bottom of the base slab.

The Turbine Building location is shown in Figure 1.1-1. The building height is shown in Figure 1.2-19. The seismic gaps between the Turbine Building and the Reactor Building are no less than the calculated maximum relative displacements between the two buildings during SSE event, considering out-of-phase motion.

3.7.2.8.2 Radwaste Building

The Radwaste Building is designed in accordance with RG 1.143 Classification RW-IIa. The earthquake loading for the RW is full SSE instead of 1/2 SSE as shown in RG 1.143. Systems, structures and components classified as RW-IIa that are housed within the Radwaste Building are designed to 1/2 SSE.

The method of analysis for the Radwaste Building is performed in the same manner as a Seismic Category I structure including the loading cases and acceptance criteria as shown in Tables 3.8-15 and 3.8-16. The mathematical model of the structural systems for seismic analysis is either a stick model or a finite element model using the procedures in accordance with Subsection 3.7.2.3. The SSI analysis is performed using the soil spring/dashpot approach or the finite element approach in accordance with Appendix 3A. The generic uniform site properties are shown in Table 3A.3-1 and the layered site properties are shown in Table 3A.3-3. The effect of structure-soil-structure interaction with adjacent Seismic Category I structure is performed in the same manner as described in Subsection 3A.8.1.1. Seismic input motions are based on the single envelop design response spectra as defined in Table 3.7-2 with the applicable scale factor, applied at the foundation level, bottom of the base slab.

The Radwaste Building location is shown in Figure 1.1-1. It is located at least 10 meters from the Reactor Building. The building height is shown in Figure 1.2-25.

3.7.2.8.3 Service Building

The Service Building is a Seismic Category II structure that is adjacent to the Reactor Building and the Fuel Building. The method of analysis of the Service Building is the same as a Seismic Category I structure including the loading cases and acceptance criteria as shown in Tables 3.8-15 and 3.8-16. The mathematical model of the structural systems for seismic analysis is either a stick model or a finite element model using the procedures in accordance with Subsection 3.7.2.3. The SSI analysis is performed using the soil spring/dashpot approach or the finite element approach in accordance with Appendix 3A. The generic uniform site properties are shown in Table 3A.3-1 and the layered site properties are shown in Table 3A.3-3. The effect of structure-soil-structure interaction with adjacent Seismic Category I structure is performed in the same manner as described in Subsection 3A.8.11. Seismic input motions are based on the single envelop design response spectra as defined in Table 3.7-2 with the applicable scale factor, applied at the foundation level, bottom of the base slab.

The Service Building location is shown in Figure 1.1-1. The seismic gaps between the Service Building and the Reactor/Fuel Building are no less than the calculated maximum relative displacements between the two buildings during SSE event, considering out-of-phase motion.

3.7.2.8.4 Ancillary Diesel Building

The Ancillary Diesel Building is a Seismic Category II structure. It houses the Ancillary Diesel Generators that are classified as Criterion B under the Regulatory Treatment of non-Safety Systems. The method of analysis of the Ancillary Diesel Building is the same as a Seismic Category I structure including the loading cases and acceptance criteria as shown in Tables 3.8-15 and 3.8-16. The mathematical model of the structural systems for seismic analysis is either a stick model or a finite element model using the procedures in accordance with Subsection 3.7.2.3. The soil-structure interaction (SSI) analysis is performed using the soil spring/dashpot approach or the finite element approach in accordance with Appendix 3A. The generic uniform site properties are shown in Table 3A.3-1 and the layered site properties are shown in Table 3A.3-3. The effect of structure-soil-structure interaction with adjacent Seismic Category I structure is performed in the same manner as described in Subsection 3A.8.11. Seismic input motions are based on the single envelop design response spectra as defined in Table 3.7-2 with the applicable scale factor, applied at the foundation level, bottom of the base slab.

The Ancillary Diesel Building location is shown in Figure 1.1-1. It is located at least 15.2 meters from the Fuel Building.

3.7.2.9 Effects of Parameter Variations on Floor Response Spectra

Floor response spectra calculated according to the procedures described in Subsection 3.7.2.5 are peak broadened by ±15% to account for uncertainties in the structural frequencies owing to uncertainties in the material properties of the structure and soil and to approximations in the modeling techniques used in the analysis.

When, in lieu of response spectrum analysis, the calculated floor acceleration time history is used to perform a time history analysis of piping and equipment, uncertainties are accounted for by expanding and shrinking the floor acceleration time history within 1/(1±0.15) so as to change the frequency content of the time history by ±15%. In this case, multiple time history analyses are performed. Alternatively, a single synthetic time history, which matches the broadened floor response spectra, may be used.

The methods described above to account for the effect of parameter variation are applicable to seismic and other building dynamic loads.

3.7.2.10 Use of Equivalent Vertical Static Factors

Equivalent vertical static factors are used when the requirements for the static coefficient method in Subsection 3.7.2.1.3 are satisfied. All Seismic Category I structures are dynamically analyzed in the vertical direction. No constant static factors are utilized.

3.7.2.11 Methods Used to Account for Torsional Effects

One method of treating the torsional effects in the dynamic analysis is to carry out a dynamic analysis that incorporates the torsional degrees of freedom. For structures having negligible coupling of lateral and torsional motions, a two-dimensional model without the torsional degrees of freedom can be used for the dynamic analysis and the torsional effects are accounted for in the following manner. The locations of the center of mass are calculated for each floor. The center

3.8.4 Other Seismic Category I Structures

Other Seismic Category I structures which are not inside the containment and which constitute the ESBWR Standard Plant are RB, CB, FB and FWSC. Figure 1.1-1 shows the spatial relationship of these buildings. Although the Radwaste Building (RW) that houses non safety-related facilities is not a Seismic Category I structure, it is designed to meet requirements as defined in RG 1.143 under Safety Class RW-IIa. The seismic design of the Radwaste Building is full SSE instead of 1/2 SSE as shown in Table 2 of RG 1.143. The RB and FB are built on a common foundation mat and structurally integrated into one building. The FWSC consists of Firewater Storage Tank (FWS) and Fire Pump Enclosure (FPE) structures that share a common basemat. The other structures in close proximity to these structures are the Turbine Building (TB) and Service Building. The Ancillary Diesel Building is located at least 15.2 meters from the Fuel Building. They are structurally separated from the other ESBWR Standard Plant buildings. Seismic gaps ~~capable of a minimum 100 mm (3-15/16 in) free movement~~ are provided with no less than the calculated maximum relative displacement during SSE event, considering out-of-phase motion between independent Nuclear Island buildings to eliminate seismic interaction.

Among the Seismic Category I structures within the ESBWR Standard Plant, other than the containment structure, only the RB contains certain rooms that have high-energy pipes, and therefore these rooms are more structurally demanding. The main steam tunnel walls protect the RB from potential impact by rupture of the high-energy main steam pipes that extend to the TB. Thus the RB walls of the main steam tunnel are designed to accommodate the pipe support forces and the environmental conditions during and after the postulated high-energy pipe break. Longitudinal pipe breaks required by BTP ~~EMEB~~ 3-~~1~~4 of SRP 3.6.2 are postulated inside the main steam tunnel and cause a slight pressurization that is used for environmental qualification. See Subsection 6.2.3.2 for the main steam tunnel functional design.

The ESBWR Standard Plant does not contain underground Seismic Category I pipelines or masonry wall construction.

Removable shield blocks consisting of metallic forms filled with grout or concrete designed to Seismic Category II requirements are used. The shield blocks are provided with removable structural steel frame also designed to Seismic Category II requirements to prevent the shielding blocks from sliding or tipping under seismic events.

3.8.4.1 Description of the Structures

3.8.4.1.1 Reactor Building Structure

Key dimensions of the RB are summarized in Table 3.8-8.

The RB encloses the concrete containment and its internal systems, structures, and components. Located above the concrete containment in the RB are the IC/PCCS pools (including expansion pools), the buffer pool, which is also used to store the dryer, and the equipment storage pool, which is also used to store the chimney partitions and the separator. Main Steam and Feedwater lines are routed to the TB through the Main Steam Tunnel in the RB as described in Subsection 3.8.4. The RB is a Seismic Category I structure.

accordance with the load combinations and acceptance criteria defined in Table 3.8-15. Table 3.8-15 is also applicable to steel liners except that the load factors in load combinations are 1.0 and acceptance criteria are in accordance with ASME Section III Division 2 CC-3700.

3.8.4.3.4 Radwaste Building

Loads and load combinations for the RW are described in Subsection 3.7.2.8.2~~listed in Table 3.8-9 Item 32, Safety Class RW-IIa is used for the design of the RW~~.

3.8.4.3.5 Firewater Service Complex

Refer to the loads, notations, and combinations established in Subsection 3.8.4.3.1, except that fluid pressure F, accident pressure P_a, accident thermal T_a, accident pipe reactions R_a and pipe break loads Y_r, Y_j, Y_m do not exist. In addition, because the FWSC is structurally separated from the concrete containment, the load combinations for the concrete containment do not apply to the FWSC design. The live loads and temperature loads are as follows:

- All concrete floors (except FWS areas) - 4.8 kPa (100 psf)
- Concrete roof - 2.9 kPa (60 psf)
- Construction live load on floor framing in addition to dead weight of floor - 2.4 kPa (50 psf)

The temperatures during normal operating conditions are shown in Table 3.8-18.

3.8.4.4 Design and Analysis Procedures

3.8.4.4.1 Reactor Building, Control Building and Fuel Building

The RB, CB and FB are analyzed using the linear elastic finite element computer program NASTRAN described in Appendix 3C.

As described in Subsection 3.8.4.1.3, the RB and FB is integrated into one building. Therefore, the Reactor Building/Fuel Building (RB/FB) structure is analyzed using a common FEA model, which includes the RB and FB and also the concrete containment. The model is described in Appendix 3G Subsection 3G.1.4.1.

The FEA model of the CB includes the entire structure. The details of the FEA model of the CB are described in Appendix 3G Subsection 3G.2.4.1.

The foundation soil is simulated by a set of horizontal and vertical springs in each model. The soil spring constraints are calculated based on the properties of the soil spring used in the SSI analysis model, which is described in Appendix 3A. The constraints by soil surrounding the buildings are conservatively neglected in the FEA models.

3.8.4.4.2 Radwaste Building

The RW is described in Subsection 3.8.4.1.5. The design is in accordance with the criteria in Table 3.8-9 Item 32 for Safety Class RW-IIa.