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MFN 07-359
Supplement 1

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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 124 Related to ESBWR Design Certification Application - DCD Tier 2 Section 3.8 - Seismic Design - RAI Number 3.8-110 S01**

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) transmitted via the Reference 1 letter. The NRC's original request was transmitted via Reference 3, and GEH's response to the original request was transmitted via Reference 2.

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

Sincerely,

James C. Kinsey

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 08-029, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 124 Related to ESBWR Design Certification Application*, January 14, 2008

2. MFN 07-359, Letter from James C. Kinsey, GEH to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 97 Related to ESBWR Design Certification Application – Seismic Category I Structures, RAI Number 3.8-110,* June 29, 2007

3. MFN 07-292, Letter from U.S. Nuclear Regulatory Commission to Robert E. Brown, *Request for Additional Information Letter No. 97 Related to ESBWR Design Certification Application,* May 21, 2007

Enclosure:

1. MFN 07-359, Supplement 1, *Partial Response to NRC RAI Letter No. 124 Related to ESBWR Design Certification Application, DCD Tier 2 Section 3.8 – Seismic Category I Structures, RAI Number 3.8-110 S01*

cc:	AE Cubbage	USNRC
	DH Hinds	GEH/Wilmington
	GB Stramback	GEH/San Jose
	RE Brown	GEH/Wilmington
	eDRF Section	0000-0079-9383

ENCLOSURE 1

MFN 07-359, SUPPLEMENT 1

Partial Response to NRC RAI Letter No. 124 Related to ESBWR Design Certification Application[1]

DCD Tier 2 Section 3.8 – Seismic Category I Structures

RAI Number 3.8-110 S01

[1] Original Response previously submitted under MFN 07-359 is included to provide historical continuity during review.

For historical purposes, the original text of RAI 3.8-110 and the GEH response are included. The attachments (if any) are not included from the original response to avoid confusion.

NRC RAI 3.8-110

The applicant has referenced the 2004 edition of ASME Code Section III, Subsection NE. The staff notes that Regulatory Guide (RG) 1.57, Revision 1, entitled "Design Limits and Loading Combinations for Metal Primary Reactor Containment System Components," was officially issued in March 2007. This regulatory guide endorses the 2001 Edition of the ASME Code, Section III, Division 1, through the 2003 addenda, subject to the exceptions cited in Section C, Regulatory Position, of the RG. Since the staff has officially accepted the code, through the 2003 addenda, the applicant needs to identify any relaxations between the 2004 Code referenced for the ESBWR design and RG 1.57, Rev. 1, including the regulatory positions. Any deviation from the staff positions identified will require a technical justification. As an alternative, the applicant may choose to reference RG 1.57, Rev. 1 directly.

GE Response

As stated in DCD Tier 2 Table 1.9-21, the ESBWR design certification is based on Regulatory Guide 1.57, Revision 0, which is the version in effect six months prior to the design certification application. Revision 0 of RG 1.57 does not cite any specific version of ASME Code, Section III (other than a reference in a note to "that part of the Summer 1973 Addenda that pertains to Class MC components"). Consequently, RG 1.57, Revision 0, allows use of the version of ASME Code, Section III that is currently endorsed by 10 CFR 50.55a.

In the April 5, 2007 Federal Register (Volume 72, No. 65, Pages 16731 through 16741), the NRC published notice of its intention to amend 10 CFR 50.55a to endorse the 2004 Edition of ASME Code, Section III, Division 1. This Federal Register notice demonstrates that the NRC has officially accepted ASME Code, Section III, Division 1, through the 2004 version, subject to any exceptions cited in the Federal Register notice.

Therefore, GE's position on the use of the 2004 Edition of the ASME Code, Section III, Division 1, for ESBWR is consistent with published NRC endorsements.

Please also note that the ASME Code, Section III comparisons presented in the response to NRC RAI 3.8-5 include the differences between the 2004 Edition of the ASME Code, Section III and the 2001 Edition of the ASME Code, Section III through the 2003 addenda. None of the changes in the 2004 Edition reduce the levels of previous conservatisms in the Code since the 1989 Edition as stated in the response to NRC RAI 3.8-5S1.

DCD Impact

No DCD change was made in response to this RAI.

NRC RAI 3.8-110, Supplement 1

In the response dated June 29, 2007, GEH stated that the ESBWR design certification is based on RG 1.57, Revision 0, which is the version in effect six months prior to the design certification application. In addition, GEH referred to the ASME Code Section III comparisons presented in the response to RAI 3.8-5 which included the differences between the 2004 Edition of the ASME Code, Section III and the 2001 Edition of the ASME Code, Section III through the 2003 Addenda. RG 1.57, Revision 1 endorses the 2001 Edition of the ASME Code through the 2003 Addenda.

The staff reviewed the comparisons presented in the original and the Supplement 1 responses to RAI 3.8-5, which included the differences between the 2004 Edition of the ASME Code, Section III and the 2001 Edition of the ASME Code, Section III through the 2003 edition. The staff agrees with GEH that the revisions identified in the 2004 Edition of the ASME Code, Section III, Subsection NE for the applicable steel portions of the containment are acceptable. However, since GEH utilized the recent 2004 Edition of the ASME Code, Section III, Division 1, Subsection NE, based on a comparison to the Code through the 2003 Addenda, GEH needs to confirm that the regulatory positions in the current RG 1.57, Revision 1, which endorses the Code through the 2003 Addenda, are also met.

GEH Response

GEH confirms that the ESBWR design certification meets the regulatory positions stated in Regulatory Guide 1.57, Revision 1, which endorses the ASME Section III, Division 1, Subsection NE, 2001 Edition through the 2003 Addenda.

DCD Tier 2 Table 1.9-21 and Subsection 3.8.2.2 will be revised to show Regulatory Guide 1.57, Revision 1 as being applicable to the ESBWR design certification.

DCD Tier 2 Table 3.8-4 will be revised to agree with the load combinations in Regulatory Guide 1.57, Revision 1.

The materials listed in DCD Tier 2 Subsection 3.8.2.6 have been made consistent with the materials listed in ASME Section III, Division 1, Subsection NE, Article NE-2121. Any materials listed in DCD Tier 2 Subsection 3.8.2.6 that are applicable to ASME Section III, Division 1, Subsection NF, ASME Section III, Division 2, Subsection CC or any materials not shown on DCD Tier 2 Appendix 3G drawings of the steel components of the RCCV have been removed.

DCD Impact

DCD Tier 2 Subsections 3.8.2.2, 3.8.2.6 and Tables 1.9-21 and 3.8-4 will be revised in the next update as noted in the attached markups.

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~~0~~	03/2007~~0~~ ~~6/1973~~	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	0	10/1973	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	

distance from the RCCV wall to minimize conductive heat transfer to the RCCV wall. With regard to the local areas of concrete around high energy penetrations, thermal analyses have been carried out to demonstrate that concrete temperature limits in ASME Section III, Division 2, CC-3440 are satisfied. In all cases the concrete temperature is lower than 93°C (200°F) for normal operation, and lower than 177°C (350°F) for accident condition. The sleeve length for hot penetrations is designed to meet these temperature requirements.

Figures 3.8-6, 3.8-7, 3.8-8, 3.8-9, 3.8-10 and 3.8-11 show the typical details for the containment mechanical and electrical penetrations.

3.8.2.1.4 Drywell Head

A 10,400 mm (34 ft. 1-7/16 in.) diameter opening in the RCCV upper drywell top slab over the RPV is covered with a removable steel torispherical drywell head, which is part of the pressure boundary. This structure is shown in Appendix 3G Figure 3G.1-51. The drywell head is designed for removal during reactor refueling and for replacement prior to reactor operation using the Reactor Building crane. One pair of mating flanges is anchored in the drywell top slab and the other is welded integrally with the drywell head. Provisions are made for testing the flange seals without pressurizing the drywell.

There is water in the reactor well above the drywell head during normal operation. The height of water is 6.7 m (21 ft. 11-3/4 in.). The stainless steel clad thickness for the drywell head is 2.5 mm (98 mils) and is determined in accordance with NB-3122.3 requirements so that it results in negligible change to the stress in the base metal.

There are six (6) support brackets attached to the inner surface of the drywell head circumferentially to support the head on the operating floor during refueling. These support brackets have no stiffening effect and do not resist loads when the head is in the installed configuration.

To provide a leak resistant refueling seal, a structural seal plate with an attached compressible-bellows sealing mechanism between the Reactor Vessel and Upper Drywell opening is utilized. The Refueling Seal is a continuous gusseted radial plate that is anchored to the Drywell opening in the Top floor slab. The radial plate surrounds the RPV with a radial gap opening to allow for thermal radial expansion of the RPV. A circumferential radial bracket from the RPV connects to a circumferential bellows that is also connected to the underside of the Drywell opening plate, thus providing a refueling seal, and allowing for axial thermal expansion of the RPV.

3.8.2.1.5 PCCS Condenser

There are six (6) PCCS Condensers located in the PCC subcompartment pools. The condensers form an integral part of the containment boundary while the pool structure and pool water are outside containment. The PCCS Condensers are described in Subsection 6.2.2.

3.8.2.2 Applicable Codes, Standards, ~~and~~ Specifications and Regulatory Guides

3.8.2.2.1 Codes, ~~and~~ Standards and Regulatory Guides

In addition to the documents~~codes and standards~~ specified in Subsection 3.8.1.2.2, the following ~~codes and standards~~code, standard and regulatory guide apply:

(1) American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III, Division 1, Nuclear Power Plant Components, Subsection NE, Class MC and Code Case N-284.

(2) ANSI/AISC N690-1994s2 (2004) Specification for the Design, Fabrication and Erection of Steel Safety-Related Structures for Nuclear Facilities.

(3) Regulatory Guide 1.57, Design Limits and Loading Combinations for Metal Primary Reactor Containment Components.

3.8.2.2.2 Code Classification

The steel components of the RCCV are classified as Class MC in accordance with Subarticle NCA-2130, ASME Code Section III.

3.8.2.2.3 Code Compliance

The steel components within the boundaries defined in Subsection 3.8.2.1.2, are designed, fabricated, erected, inspected, examined, and tested in accordance with Subsection NE, Class MC Components and Articles NCA-4000 and NCA-5000 of ASME Code Section III. Structural steel attachments beyond the boundaries established for the steel components of the RCCV are designed, fabricated, and constructed according to the AISC Manual for Steel Construction.

3.8.2.3 Loads and Load Combinations

The applicable loads are described in Subsection 3.8.1.3 and load combinations are shown in Table 3.8-4.

3.8.2.4 Design and Analysis Procedures

The steel components of the RCCV are designed in accordance with the General Design Rules of Subarticles NE-3100 (General Design), NE-3200 (Design by Analysis), and NE-3300 (Design by Formula) of ASME Code Section III. For the configurations and loadings that are not explicitly treated in Subarticle NE-3130, the design is in accordance with the applicable Subarticles designated in paragraphs (b) and (d) of Subarticle NE-3130 of ASME Code Section III.

The design of nonpressure-resisting parts is performed in accordance with the general practices of the AISC N690 Manual of Steel Construction.

3.8.2.4.1 Description

Following are individual descriptions of the design and analysis procedures required to verify the structural integrity of critical areas present within the steel components of the RCCV.

3.8.2.4.1.1 Personnel Air Locks

The personnel air lock consists of four main sections: doors, bulkheads, main barrel, and reinforcing barrel with collar. The personnel air locks are supported entirely by the RCCV wall. The lock barrel is welded directly to the containment liner penetration through the RCCV wall. The personnel lock and penetration through the RCCV wall is analyzed using a finite element computer program and/or manual calculation based on handbook formulas and tables. The containing the feed line, return line and drain lines penetrate the RCCV Top Slab. The lines connected to the condenser and the sleeves are part of the containment boundary. Figure 3.8-7 shows the typical configuration for these passages through the RCCV Top Slab and Table 3.8-17 lists each of these passages and their function.

The PCCS condenser is anchored to the RCCV Top Slab and is laterally supported by the IC/PCC pool walls.

The PCCS condenser is subjected to various combinations of piping reactions, mechanical, thermal and seismic loads including sloshing. The resulting forces due to various load combinations are combined with the effects of differential pressures.

The PCCS condenser parts conform to the design requirements of Subarticles NE-3200 and NE-3300 of ASME Code, Section III, Subsection NE (Class MC). The PCCS condenser support is evaluated in accordance with the ASME Code, Section III, Subsection NF.

3.8.2.5 Structural Acceptance Criteria

The structural acceptance criteria for the steel components of the RCCV (i.e., the basis for establishing allowable stress values, the deformation limits, and the factors of safety) are established by and in accordance with ASME Code Section III, Subsection NE.

In addition to the structural acceptance criteria, the RCCV is designed to meet minimum leakage rate requirements discussed in Section 6.2. Those leakage requirements also apply to the steel components of the RCCV.

The combined loadings designated under "Normal", "Construction", "Severe Environmental", "Extreme Environmental", "Abnormal", "Abnormal/Severe Environmental" and "Abnormal/Extreme Environmental" in Table 3.8-2 are categorized according to Level A, B, C and D service limits as defined in NE-3113. The resulting primary and local membrane, bending, and secondary stress intensities, including compressive stresses, are calculated and their corresponding allowable limit is in accordance with Subarticle NE-3220 of ASME Code Section III.

In addition, the stress intensity limits for testing, design and Level A, B, C and D conditions are summarized in Table 3.8-4.

Stability against compression buckling is assured by an adequate factor of safety.

The allowable stress limits used in the design and analysis of non-pressure-resisting components are in accordance with Subsection 3.8.2.2.1 (2).

3.8.2.6 Materials, Quality Control, and Special Construction Techniques

The steel pressure retaining components of the RCCV meet the requirements of Article NE-2120 of ASME Section III. The principal materials for the RCCV locks, hatches, penetrations, drywell head, and PCCS condensers are ~~fabricated from the following materials~~as follows:

- Plate (~~SA-516 grade 70,~~ SA-240 type 304L, SA-516 grade 60 or 70~~ purchased to SA-264~~)
- Pipe (seamless SA-333 grade 1 or 6; or SA-106 grade B or SA-312 type 304L or Welded SA-671 Gr CC70)

- Forgings (~~SA-350 grade LFl or LF2 or~~ SA-182F 304L/~~316L~~)
- Tubes (SA-213 grade TP304L)
- Bolting (~~SA-320-L43 or SA-193-B7 or~~ SA-193-B8 or ~~SA-540 Gr. B24 Class 3 bolts with SA-194-7 or A325 or A490 or SA-479 Type 304 nuts~~SA-437 Gr B4B bolts. Nuts shall conform to SA-194 or to the requirements for nuts in the specification for the bolting material to be used.)

~~Castings (SA-216, grade WCB or SA-352, grade LCB, A27, or 7036)~~

~~Cold finished steel (A108 grade 1018 to 1050)~~

~~Bar and machine steel (A576, carbon content not less than 0.3%)~~

- Clad (SA-240 type 304L)

~~The structural steel materials located beyond the containment vessel boundaries are as follows:~~

~~Carbon steel (A-36 or SA-36)~~

~~Stainless steel extruded shapes (SA-479)~~

3.8.2.7 Testing and In-service Inspection Requirements

Testing and In-service Inspection Requirements of the containment vessel, including the steel components, is described in Subsection 3.8.1.7.

3.8.2.7.1 Welding Methods and Acceptance Criteria

Welding activities conform to requirements of Section III of the ASME Code. The required nondestructive examination and acceptance criteria are provided in Table 3.8-5.

3.8.2.7.2 Shop Testing Requirements

The shop tests of the personnel air locks include operational testing and an overpressure test. After completion of the personnel air locks tests (including all latching mechanisms and interlocks), each lock is given an operational test consisting of repeated operating of each door and mechanism to determine whether all parts are operating smoothly without binding or other defects. All defects encountered are corrected and retested. The process of testing, correcting defects, and retesting is continued until no defects are detectable.

For the operational test, the personnel air locks are pressurized with air to the maximum permissible code test pressure. All welds and seals are observed for visual signs of distress or noticeable leakage. The lock pressure is then reduced to design pressure and a thick bubble solution is applied to all welds and seals and observed for bubbles or dry flaking as indications of leaks. All leaks and questionable areas are clearly marked for identification and subsequent repair.

During the overpressure testing, the inner door is blocked with holddown devices to prevent unseating of the seals. The internal pressure of the lock is reduced to atmospheric pressure and all leaks are repaired. Afterward, the lock is again pressurized to the design pressure with air and all areas suspected or known to have leaked during the previous test are retested by the bubble technique. This procedure is repeated until no leaks are discernible.

Table 3.8-4

Load Combination, Load Factors and Acceptance Criteria for Steel Containment Components of the RCCV (1), (2), (3)

Service Level	No	Load Combination (1)																Acceptance Criteria			
		D	L	P_t	P_o	P_a	T_t	T_o	T_a	E'	W	W'	R_o	R_a	Y (4)	SRV (12)	LOCA (5)(12)	P_m	P_L	P_L+P_b (8)	P_L+P_b+Q
Test Condition	1	1.0	1.0	1.0			1.0											0.75 S_y	1.15Sy	1.15Sy (11)	N/A (10)
Design Condition	2	1.0	1.0			1.0			1.0					1.0				1.0 S_{mc}	1.5 S_{mc}	1.5 S_{mc}	N/A
Level A, B (9)	3	1.0	1.0		1.0			1.0					1.0					1.0 S_{mc}	1.5 S_{mc}	1.5 S_{mc}	3.0 S_{ml}
	4	1.0	1.0		1.0			1.0								1.0					
	5	1.0	1.0			1.0			1.0					1.0			1.0				
	6	1.0	1.0			1.0			1.0					1.0		1.0	1.0				
Level C (6)	7	1.0	1.0		1.0			1.0		1.0			1.0					1.2 S_{mc} or* 1.0 S_y	1.8 S_{mc} or* 1.5S_y	1.8 S_{mc} or* 1.5S_y	N/A
	8	1.0	1.0			1.0			1.0	1.0				1.0		1.0	1.0				
	9	1.0	1.0			1.0			1.0	1.0		~~1.0~~	~~1.0~~	1.0	~~1.0~~	~~1.0~~	1.0				
Level D (7)	10	1.0	1.0			1.0			1.0	1.0				1.0	1.0	1.0	1.0	S_f	1.5S_f	1.5S_f	N/A
	11	1.0	1.0			1.0			1.0	1.0				1.0	1.0		1.0				

Notes:

(1) The loads are described in Subsection 3.8.1.3.

(2) For any load combination, if the effects of any load component (other than D) reduces the combined load, then the load component is deleted from the load combination.

(3) P_a, T_a, SRV and LOCA are time-dependent loads. The sequence of occurrence is given in Appendix 3B.

(4) Y includes Y_j, Y_m and Y_r.

(5) LOCA loads include CO, CHUG and PS. They are time-dependent loads. The sequence of occurrence is given in Appendix 3B. LOCA loads include hydrostatic pressure (with a load factor of 1.0) due to containment flooding.

(6) Limits identified by (*) indicate a choice of the larger of the two.

(7) S_f is 85% of the general primary membrane allowable permitted in Appendix F, ASME B&PV Code, Section III. In the application of Appendix F, S_{ml}, if applicable, is as specified in Section II, Part D, Subpart 1, Tables 2A and 2B of ASME B&PV Code, which is the same as S_m.

(8) Values shown are for a rectangular section. See NE-3221.3(d) for other than a solid rectangular section.

(9) The allowable stress intensity S_{ml} is the S_m listed in Section II, Part D, Subpart 1, Tables 2A and 2B of the ASME B&PV Code. The allowable stress intensity S_{mc} is 1.1 times the S_m listed in Section II, Part D, Subpart 1, Tables 1A and 1B of the ASME B&PV Code, except that S_{mc} does not exceed 90% of the material's yield strength at temperature shown in Section II, Part D, Subpart 1, Tables Y-1 of the ASME B&PV Code.

(10) N/A = No evaluation required.

(11) Bending and General Membrane P_m+P_b.

(12) The peak responses of dynamic loads do not occur at the same instant. SRSS method to combine peak dynamic responses is acceptable for steel structures.