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MFN 06-298
Supplement 4

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U.S. Nuclear Regulatory Commission
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Subject: **Response to Portion of NRC Request for Additional Information Letter No. 38 Related to ESBWR Design Certification Application – Structural Analysis – RAI Number 3.8-4 S02**

Enclosure 1 contains GEH's response to the subject NRC RAI transmitted via e-mail on May 24, 2007. GE's original responses were provided in the Reference 1 and 2 letters.

If you have any questions or require additional information regarding the information provided here, please contact me.

Sincerely,

Kathy Sedney for

James C. Kinsey
Vice President, ESBWR Licensing

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NRO

References:

1. MFN 06-298, Letter from David Hinds to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 38 Related to ESBWR Design Certification Application – Structural Analysis - RAI Numbers 3.8 1, 3.8 2, 3.8 4, 3.8 5, 3.8 7 through 3.8 12, 3.8 15, 3.8 16, 3.8 21, 3.8 22, 3.8 29 through 3.8 31, 3.8 39, 3.8 42, 3.8 43, 3.8 45, 3.8 50, 3.8 52 through 3.8 55, 3.8 57, 3.8 58, 3.8 60, 3.8 61, 3.8 66 through 3.8 68, 3.8 70 through 3.8 72, 3.8 74, 3.8 75, 3.8 78, and 3.8-98,* August 31, 2006
2. MFN 06-298, Supplement 1, Letter from James C. Kinsey to U.S. Nuclear Regulatory Commission, *Response to Portion of NRC Request for Additional Information Letter No. 38 Related to ESBWR Design Certification Application – Structural Analysis - RAI Numbers 3.8-1 S01, 3.8-2 S01, 3.8-4 S01, 3.8-5 S01, 3.8-7 S01, 3.8-9 S01, 3.8-10 S01, 3.8-12 S01, 3.8-15 S01, 3.8-29 S01, 3.8-30 S01, 3.8-31 S01, 3.8-42 S01, 3.8-52 S01, 3.8-53 S01, 3.8-54 S01, 3.8-58 S01, 3.8-60 S01, 3.8-61 S01, 3.8-67 S01, 3.8-70 S01, 3.8-71 S01, 3.8-72 S01, 3.8-74 S01 & 3.8-98 S01 - Supplement 1,* January 29, 2007

Enclosure:

1. MFN 06-298, Supplement 4 – Response to Portion of NRC Request for Additional Information Letter No. 38 Related to ESBWR Design Certification Application – Structural Analysis – RAI Number 3.8-4 S02

cc:		
	AE Cubbage	USNRC (with enclosures)
	DH Hinds	GEH (with enclosures)
	RE Brown	GEH (w/o enclosures)
	GB Stramback	GEH (w/o enclosures)
	eDRF	0000-0069-4237

ENCLOSURE 1

MFN 06-298, SUPPLEMENT 4

Response to Portion of NRC Request for

Additional Information Letter No. 38

Related to ESBWR Design Certification Application

Structural Analysis – RAI Number 3.8-4 S02 [1]

[1] Original Response and Supplement 1 previously submitted under MFNs 06-298 and 06-298S1 without DCD updates are included to provide historical continuity during review.

NRC RAI 3.8-4

Described how the jurisdictional boundaries defined in DCD Section 3.8.1.1.3 and Figure 3.8-1 meet the definition of jurisdictional boundaries as specified in the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME BPVC), Division 2, Subsection CC. Subsection CC of the Code states that "When a structural concrete support is constructed as an integral part of the containment, it shall be included within the jurisdiction of these criteria." There are a number of structural components in the reactor building (RB), such as the RB concrete floor slabs, that are integrally connected to the containment structure that restrain and provide support to the containment under various loads (e.g., internal containment pressure).

GE Response

ASME III, Division 2, Subsection CC, Section CC-1140, require that the Containment conform to the requirements of ASME III, NCA-3254.2. Furthermore, Section CC-1140 states that NCA-3254.2 is supplemented by the provision below:

"When a structural concrete support is constructed as an integral part of the containment, it shall be included within the jurisdiction of these criteria."

According to the ASME Code Section III, NCA-3254.2, "Definition of Division 2 Boundaries", the support structure that is constructed as an integral part of the concrete containment shall be included within the jurisdiction of Division 2. However, in Interpretation No. 12 (III-2-83-01) of ASME Code Section III, the code committee states that when the containment mat is integral with other building foundations, only the portion of the containment foundation mat directly beneath the containment vessel including any additional peripheral volume for anchoring of the containment shell reinforcement shall be considered within the code jurisdictional boundary and constructed in accordance with the rules of ASME Code Section III Division 2. The portion of the common mat subject to the rules of ASME Section III, Division 2, shall be proportioned for the forces and moments resulting from the consideration of the entire mat. The loads from the portion of the common mat outside the rules of ASME Section III, Division 2, shall be specified in the design specification and applied to the ASME Section III Division 2 mat in combination with those specified for Section III, Division 2 mat. The load combinations specified in CC-3000 and the Design Specification shall be applicable for all loads.

The ESBWR containment pressure boundary, as described in DCD Section 3.8.1 is limited to the cylindrical walls of the containment, the foundation mat directly beneath the containment, and the top slab. This boundary is shown in DCD Figure 3.8-1. The fuel pool girders, RB floor slabs, cylindrical wall supporting the containment wall and suppression pool slab, and the diaphragm floor slab, which are outside of the boundary defined in DCD Figure 3.8-1, participate in carrying loads which act on the containment structure. The fuel pool girders, which are integral with the containment top slab, provide additional strength to resist internal containment pressure acting on the top slab.

Similarly, the diaphragm floor slab and the RB floor slabs, which are integral with the containment wall, provide additional strength to resist internal containment pressure acting on the containment wall.

Analogous to the jurisdictional boundary definition per Interpretation No. 12, structural components (RB floor slabs, fuel pool girders etc.), which are integral with the containment are treated the same as the containment only as far as loads and loading combinations are concerned in the design. This is consistent with the USNRC's position shown in Regulatory Guide 1.142 (revision 2) on the design code (ANSI/ACI 349-97) and requirements for the diaphragm floor slab in the ABWR and Mark II design which is integral with the containment wall and participates in resisting a portion of the pressure load on the containment wall. See response to RAI 3.8-101 for additional information.

Interpretation No. 12 (III-2-83-01) of ASME Code Section III is below.

DCD Impact

No DCD change was made in response to this RAI.

Interpretation: III-2-83-01

Subject: Section III, Division 2, CC-3200, Load Criteria Used for Containment Vessel and Auxiliary Building

Date Issued: September 9, 1982

File: NI81-180

Question (1): When a common foundation is used for both the containment vessel and auxiliary building in a nuclear power plant, is it permissible for only the volume of the common foundation directly beneath the Class CC containment vessel, including any additional peripheral volume for anchorage of the containment shell reinforcing, to be subject to the rules of Section III, Division 2?

Reply (1): The specific boundaries of a Section III, Division 2, Class CC containment vessel shall be specified in the Design Specification as required by NCA-3254.2. The portion of the common foundation directly beneath the containment vessel, including any additional peripheral volume for anchoring of the containment shell reinforcing, shall be constructed in accordance with the rules of Section III, Division 2, when required by the Design Specification. The balance of the common foundation outside the jurisdictional boundary of the containment vessel, specified in the Design Specification, is not included in the scope of Section III, Division 2.

Question (2): If the balance of the common foundation is outside the scope of Section III, Division 2, what, if any, consideration should be given to the forces and moments of this portion of the foundation in the design of the Section III, Division 2 portion?

Reply (2): The portion of the common mat subject to the rules of Section III, Division 2, shall be proportioned for the forces and moments resulting from consideration of the entire mat. The loads from the portion of the common mat outside the rules of Section III, Division 2, shall be specified in the Design Specification and applied to the Section III, Division 2 mat in combination with those specified for the Section III, Division 2 mat. The load combinations specified in CC-3000 and the Design Specification shall be applicable for all loads.

NRC RAI 3.8-4, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

Further clarification and discussion needed with GE.

During the audit, GE explained that the loads and load combinations for the entire RB from the ACI 349 and ASME Section III, Division 2 are checked against the acceptance criteria in ASME Section III, Division 2 Code. GE indicated that they have confirmed that the acceptance criteria in the ASME, Section III, Division 2 Code are more conservative than the acceptance criteria in ACI 349. GE was requested to provide the technical basis for this conclusion. Therefore, in effect the entire RB is designed to both the ASME Section III, Division 2, Subsection CC and the ACI 349 Code. In this case, the current boundary shown in DCD Figure 3.8-1 for the ASME jurisdictional boundary for all aspects of design, construction, fabrication, and inspection is acceptable. GE will provide a supplemental response to this RAI and RAIs 3.8-67, 101, 102 and 103 to reflect the above.

GE Response

In the original response submitted under MFN 06-298, the suppression pool slab was inadvertently omitted. The first sentence of the third paragraph is corrected as follows:

The ESBWR concrete containment pressure boundary, as described in DCD Section 3.8.1, is limited to the cylindrical walls of the containment, the suppression pool slab, the foundation mat directly beneath the containment, and the top slab.

Further, the original response submitted under MFN 06-298 is supplemented as follows:

The entire RB is designed to both the ASME Section III, Division 2, Subsection CC code and the ACI 349-01 Code. The acceptance criteria in ASME 2004 Section III, Division 2 are more conservative than the acceptance criteria in ACI 349-01 as shown below. The current boundary shown in DCD Tier 2 Figure 3.8-1 for the ASME jurisdictional boundary for all aspects of design, construction, fabrication, and inspection is acceptable.

Comparison of Acceptance Criteria of ACI 349-01 Vs. ASME 2004 Section III Div. 2 Subsection CC:

Figure 3.8-4 (1) shows the comparison of M-N (bending moment-axial force) interactions that define the relationships between allowable bending moments and axial forces calculated in accordance with ACI 349-01 and ASME 2004 Section III, Division 2 codes (for factored primary and secondary loads).

As shown in Figure 3.8-4 (1), the ASME allowable values are smaller, except in the high axial force (compression) region in which the ASME limit is $0.75f_c'$ for primary plus secondary membrane and $0.60f_c'$ for primary membrane. For additional conservatism,

the $0.60 f_c'$ limit, which is lower than the ACI 349-01 allowable, is applied to the ESBWR design. Therefore, the use of the ASME acceptance criteria is a conservative design approach for the design of ESBWR concrete structures that are integrated with the containment.

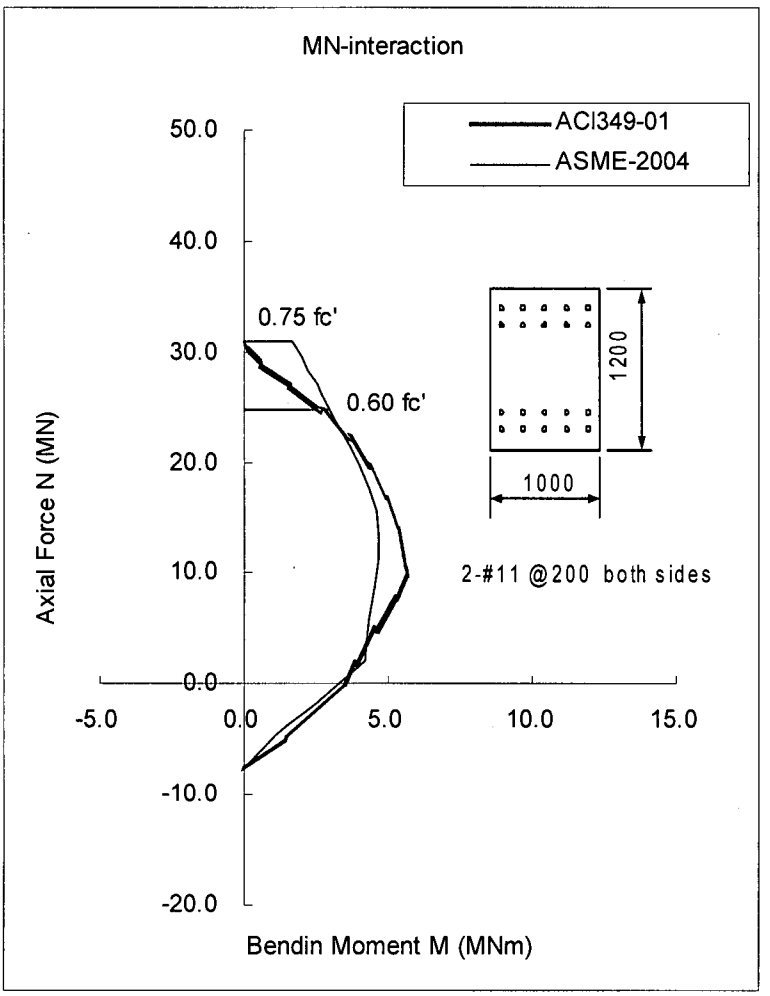

Figure 3.8-4 (1) Comparison in M-N interaction between ACI 349-01 and ASME 2004-Section III, Division 2

DCD Impact

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

NRC RAI 3.8-4, Supplement 2

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

The staff reviewed the latest supplemental response and finds that additional clarification is needed. The applicant stated that the entire Reactor Building is designed to both the ASME Section III, Division 2, Subsection CC code and the ACI 349-01 Code. Therefore, it is not clear to the staff why there is a need to demonstrate that the acceptance criteria in ASME, Section III, Division 2 are more conservative than the criteria in ACI 349. In addition, the RAI response does not appear to support that conclusion. The comparison between the codes is limited to the case of a member subjected to a combination of axial loading and bending. As indicated in the response, in the high axial force (compression) region the ASME allowable values are not more conservative. The limited comparison presented in the response does not constitute a technical basis for concluding that other acceptance criteria in the ASME Code are also more conservative than the ACI 349-01 Code. The staff requests the applicant to explain the purpose of the comparison, and clarify how ASME Section III, Division 2, Subsection CC and ACI 349-01 Code were used for the design of the RB.

GEH Response

The RB is integral to the Concrete Containment and is designed to the more limiting acceptance criteria of ASME Section III, Division 2, Subsection CC and ACI 349-01. For the design of RB elements integral with the Concrete Containment, the relevant acceptance criteria are load combinations, allowable compressive stress in concrete, allowable tensile and compressive stresses in reinforcing steel, and allowable transverse shear stress. The case of a member subjected to a combination of axial force and bending moment is demonstrated in the response to NRC RAI 3.8-4, Supplement 1 as an example to show that ASME Section III, Division 2, Subsection CC is governing and is applied in the RB design. The acceptance criteria for transverse shear are essentially the same between ASME Section III, Division 2, Subsection CC and ACI 349-01 as shown in the comparison between Tables 7 and 8 of the SSDP-2D validation report in Enclosure 2 to MFN 06-416 in response to NRC RAI 3.8-107. Therefore, the ACI 349-01 acceptance criteria for transverse shear are applied in the RB design. For the load combinations, an envelope of load combinations specified in ACI 349-01 and ASME 2004, Division 2, Subsection CC is used.

This design approach ensures that the RB, which is designed to ACI 349-01 acceptance criteria, also meets the ASME Section III, Division 2, Subsection CC acceptance criteria for the Concrete Containment.

DCD Impact

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