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MFN 06-298
Supplement 1

Docket No. 52-010

January 29, 2007

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

Subject: **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**

Enclosure 1 contains supplemental responses to the subject NRC RAIs resulting from the December 2006 Seismic Follow-up audit. The original responses to these RAIs were submitted in Reference 1.

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

Sincerely,

Kathy Sedney for

James C. Kinsey
Project Manager, ESBWR Licensing

D068

Enclosure:

1. MFN 06-298, Supplement 1 - 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

Reference:

1. MFN 06-298, Letter from David H. 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

cc:		
	AE Cubbage	USNRC (with enclosures)
	GB Stramback	GE/San Jose (with enclosures)
	eDRF	0000-0062-7978

ENCLOSURE 1

MFN 06-298, SUPPLEMENT 1

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

Original Response previously submitted under MFN 06-298 without DCD updates is included to provide historical continuity during review.

NRC RAI 3.8-1

Revision 1 of the Tier 2 DCD, Section 3.8.1.7.3, provides information about inservice inspections of the containment components. It is understandable that the COL applicants will develop plans for preservice and inservice inspections. However, (1) the DCD should provide additional pre-operational inspection requirements (per IWE-2000) specifically pertinent to the ESBWR containment, and (2) the IWE-1220 exclusions cited in Section 3.8.1.7.3.2 of the DCD should be revisited to minimize the inaccessible areas in the containment. Also, because of the high radiation areas in the containment, the remote means of monitoring certain structures and components inside the containments should be part of the DCD.

GE Response

(1) The requirements for performing the preservice inspection (PSI) per IWE-2000 are addressed in DCD Section 3.8.1.7.3.3, including pre-operational instruction to ensure PSI is performed after application of any required protective coating.

(2) The reference in DCD Section 3.8.1.7.3.2 to IWE-1220 discusses exclusions in general; the commitment to design to perform the required inspections per Subsection IWE is in the scope found in DCD Section 3.8.1.7.3.1. Provisions for access to specific areas for inspection are addressed in the detailed design, and discussion of remote tooling would only be included if for some design reason, the required inspections could not be carried out otherwise.

No DCD change was made in response to this RAI.

NRC RAI 3.8-1, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

During the audit, GE indicated they will revise the DCD to explain that during the detailed design phase, the number of inaccessible areas will be minimized in order to reduce the number of permissible exclusions cited in Section 3.8.1.7.3.2 of the DCD. Also, the first sentence in the second paragraph in DCD Section 3.8.1.7.3.1, will be revised to read "The design to perform preservice inspection is in compliance with the requirements of the ASME ..." GE will state in the DCD that the use of remote tooling for inspections will be done in high radiation areas where feasible.

GE Response

GE agrees to revise DCD Tier 2 as indicated above.

DCD Impact

DCD Tier 2 Subections 3.8.1.7.3.1 and 3.8.1.7.3.2 will be revised in the next update as noted in the attached markups.

NRC RAI 3.8-2

Provide a basis for the seismic categorization of the following structures and servicing systems: (1) upper and lower drywell servicing hoists and cranes [Component U31 2 in Table 3.2-1], (2) Reactor Building Heating, Ventilation and Air Conditioning (HVAC) [Component U40], (3) Fuel building Structure [Component U97] and HVAC [Component U98], and (4) Control Building Structure [Component U73], I/II categorization. Also, discuss the basis for categorizing Intake Structure and Discharge Structures [Component W12] as "Not in Scope".

GE Response

(1) The seismic classification for the upper and lower drywell servicing hoists and cranes will be changed to seismic category I. DCD Table 3.2-1 will be revised in the next update as noted in the attached markup.

(2) Consistent with DCD Subsection 9.4.6.1, the Reactor Building HVAC (U40) portion of DCD Table 3.2-1 will be updated as shown in the attached markup to indicate that the isolation dampers and ducting penetrating the Reactor Building Boundary and associated controls that provide the isolation signal are safety-related and seismic category I. The remainder of the Reactor Building HVAC system is classified as seismic category II because it is required to maintain its structural integrity following a safe shutdown earthquake (SSE).

(3) The Fuel Building Structure (U97) is primarily classified as seismic category I to ensure it retains the capability to keep the spent fuel covered after an SSE. The HVAC penthouse, stair towers and elevator shafts are classified as seismic category II to ensure they remain intact following an SSE and thus won't jeopardize the safety-related function of the building. Thus, no change to DCD Table 3.2-1 is required for System U97.

Consistent with DCD Subsection 9.4.2.1, the Fuel Building HVAC (U98) portion of DCD Table 3.2-1 will be updated as shown in the attached markup to indicate that the isolation dampers and ducting penetrating the Fuel Building Boundary are safety-related and seismic category I. The remainder of the Fuel Building HVAC system is classified as seismic category II because it is required to maintain its structural integrity following a safe shutdown earthquake.

(4) The main control room and all safety-related control equipment are located below grade in the seismic category I portion of the Control Building Structure (U73). The above grade levels of the Control Building only contain nonsafety-related control equipment that is not required to function following an SSE. Consequently, it is acceptable for the above grade portion of the Control Building to be classified as seismic category II. Thus, no change to DCD Table 3.2-1 is required for System U73.

The Intake Structure and Discharge Structures [Component W12] were listed as "Not in Scope" for the ESBWR Standard Plant because they are nonsafety-related structures that will vary in configuration on a site-specific basis. Nevertheless it is possible to define their classifications on a generic basis. The safety-related ultimate heat sink for ESBWR is the atmosphere, which receives heat via boiling of water in the IC/PCC and spent fuel pools. DCD Tier 2 Table 3.2 1 will be revised to provide classification information for these structures as well as for other systems that were listed as "Not in Scope".

Markup of DCD Table 3.2-1 was provided under MFN 06-298.

NRC RAI 3.8-2, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

During the audit, the following were discussed corresponding to item nos. in GE responses:

(1) Acceptable because DCD Rev. 2 reflects the change to seismic Category I.

(2) Acceptable because DCD Rev. 2 reflects the change to seismic Category I/II.

(3) GE indicated that they will revise Table 3.2-1 for the U97 - Fuel Bldg. Structure into two parts: 1 - for the main portion of the fuel bldg. categorized as SC I, and 2 - for the HVAC penthouse, stair towers and elevator shafts categorized as SC II

(4) Acceptable because DCD Rev. 2 reflects the change to seismic Category I. GE indicated, and as shown on DCD Figure 3G.2-3, the CB at floor slab elev. 4650 mm and below is classified as SC I and the CB structure above this floor slab is SC II.

With regard to the intake structure and discharge structures, GE indicated that they are classified as non-safety related, which is acceptable.

GE will incorporate the above agreements in the response.

GE Response

(1) Acceptable as shown in DCD Tier 2, Rev. 2.

(2) Acceptable as shown in DCD Tier 2, Rev. 2.

(3) DCD Tier 2 Table 3.2-1 for U97 – Fuel Building Structure will be revised as noted above.

(4) Acceptable as shown in DCD Tier 2, Rev. 2.

Intake and Discharge structures are classified as non-safety related in DCD Tier 2, Rev. 2 and are acceptable.

DCD Impact

DCD Tier 2 Table 3.2-1 will be revised in the next update as noted in the attached markup.

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.

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.

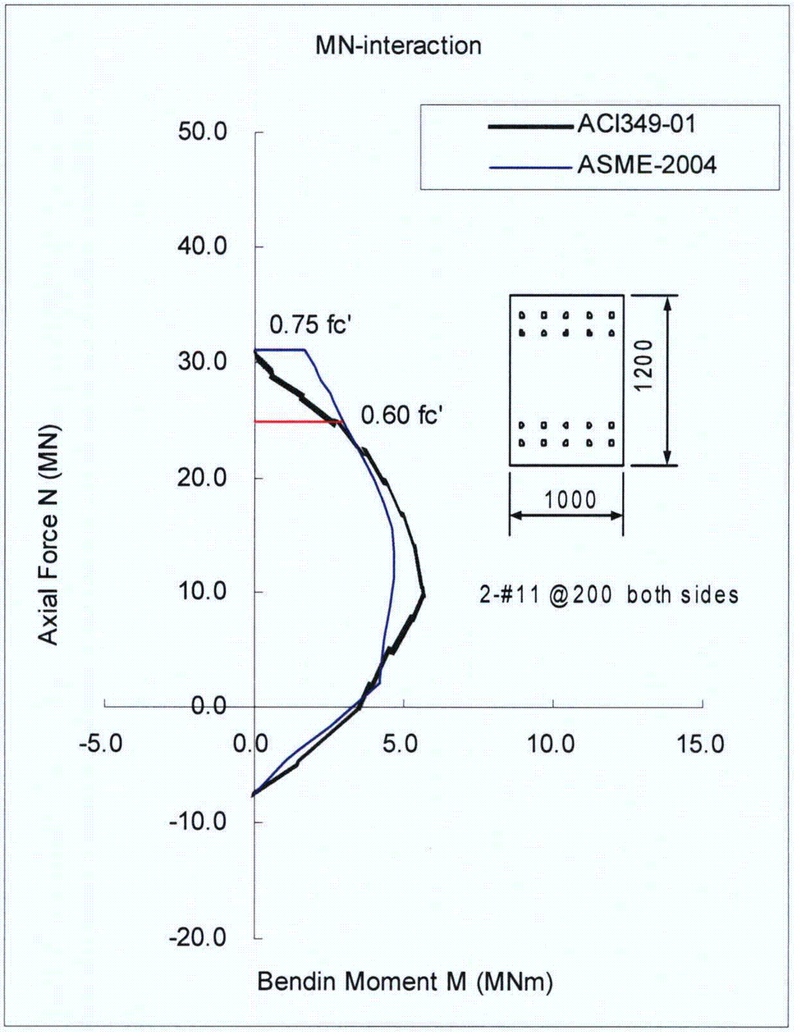


Figure 3.8-4 (1) Comparison in M-N interaction between ACI 349-01 and ASME 2004-Section III, Division 2

DCD Impact

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

NRC RAI 3.8-5

a) *DCD Section 3.8.1.2.2 and Table 3.8-9 indicate that ASME BPVC – 2004 is used for the design, fabrication, construction, testing, and in-service inspection of the concrete containment. The 2004 edition of the Code has not as yet been endorsed by the NRC; however, the 1989 edition was reviewed and accepted during the advanced boiling water reactor (ABWR) review process. Please provide a description of the differences between these two editions of the Code that are applicable to the design of the ESBWR containment (e.g., Subsections CC, NCA, and NE).*

b) *Assuming that the staff accepts the implementation of ASME Code 2004 edition for design of the ESBWR containment, the staff considers any deviation from the ASME Code 2004 edition for the design and construction of the containment would require NRC review and approval prior to implementation. This needs to be stated in Sections 3.8.1 and 3.8.2.*

c) *Since DCD Section 3.8.1.2.3 does not reference Regulatory Guide (RG) 1.94 (item 29 in Table 3.8-9), provide a discussion of how the provision of ANSI N45.2.5 and RG 1.94 are incorporated in the referenced codes and standards.*

GE Response

a) The differences between 1989 edition and 2004 edition (including the addenda after 1989 edition) of the ASME Section III Code for Subsections CC, NCA, and NE are summarized in two tables. One table presents the reduction in requirements due to the change from 1989 edition to the editions after 1989, while the other table presents the increase in requirements due to the change. When the requirements are reduced, a column called "Comments" at the end of the table summarizes those changes accepted by the USNRC and those that have not been endorsed. When the requirements are increased, the design is more conservative and meets 1989 edition requirements.

The changes found in the table of reduction in requirements not endorsed by the USNRC, which are applicable to the ESBWR design, need NRC review and approval. They are:

(1) Item III-1-A97 (96-250), Table NE-4622.7(b)-1, Exemption from PWHT

(2) Item III-1-A95 (94-316), NE-3221.1(c)(1), Stress Intensity Values

(3) Item III-2-A04, III-2 (BC03-472), CC-4331.2(b)(6) etc. (See Table), Cold Rolled Parallel Threaded Splices

(4) Item III-2-A02 (BC01-698), CC-4542.1 and CC-4542.2, Back-up Bars

(5) Item III-2-A01 (2001 Edition, BC00-182), CC-4333.2.3 Splicing of Reinforcing Bars-Performance Tests

(6) Item III-2-A01 (2001 Edition, BC00-183), Table CC-4552-2 Postweld Heat Treatment Exemptions

(7) III-2-A01 (2001 Edition, BC00-357), CC-5531.2, Extent of Examination

(8) III-2-A95 (94-306), CC-4331.2(b)(5) etc. (See Table), Splicing of Reinforcing Bars

(9) III-2-A91 (91-212), CC-3421.4.1(c) etc. (See Table), Evaluation of Membrane Stress

(10) III-2-A91 (91-222), CC-4321.1(c), CC-4321.2, CC-4322(a), Bending of Reinforcing Bar

(11) III-2-A91, Table I-2.2, Material for Concrete Containment Vessel Liner -Remove limitations on the use of SA-738, Grade B

(12) III-2-A90 (89-332), CC-4321.2, Bending of Reinforcing Bar

(13) III-2-A90 (90-174), CC-4240(c), CC-4240(d), CC-4260, Cold Weather Concrete Placement

No DCD change was made in response to this item.

b) There are no deviations from ASME Code 2004 edition for the design and construction of the ESBWR containment; therefore, no revisions to the DCD were necessary in response to this item.

c) Markup of DCD Subsection 3.8.1.2.3 to include item 29 as well as 31 and 33 of DCD Table 3.8-9 was provided under MFN 06-298.

Table 3.8-5(1) Reductions in Requirements from 1989 Edition to 2004 Edition

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
III-1-A99 (BC98-563) (2/99)	NCA-1140(a)(2) Code Edition and Addenda Permitted for Construction	This revision permits the use of the latest Edition and Addenda endorsed by the regulatory authority having jurisdiction at the plant site at the time the construction permit application is docketed. This change incorporates the provisions of Case N-608, "Applicable Code Edition and Addenda, NCA-1140(a)(2), Section III, Division 1."	These provisions have been accepted by the USNRC, in its endorsement of the 1999 Addenda of Section III, Subsections NB, NC, and ND.
III-1-A97 (97-200)	NCA-8320, NCA-8321, NCA-8322 Use of N-Symbol Stamp at Field Locations	This revision rewrites the paragraph to clarify the provisions by placing the requirements in two paragraphs. NCA-8322 addresses the application of the Stamp in the field without requiring extension of the Certificate of Authorization to the site, when only a pressure test is involved. The change also addresses subcontracting the pressure test.	These provisions have been accepted by the USNRC, in its endorsement of the 1999 Addenda of Section III, Subsections NB, NC, and ND.
III-1-A04 (BC03-765)	NE-3352.2(b), NE-5280(b) Examination of Category B Butt Welds in Electrical Penetrations	This revision provides for the use of liquid penetrant examination or magnetic particle examination of root pass and the surface of the completed weld as an alternative to the radiographic examination requirements for Category B butt welds in electrical penetration assemblies. It also adds an allowable stress reduction factor and limits the base materials that can be used to P-No. 1 materials. The revision incorporates the provisions of Case N-505, "Alternative Rules for the Examination of Butt Welds Used as Closure Welds for Electrical Penetration Assemblies in Containment Structures, Section III, Division 1."	These provisions have been accepted by the USNRC, in Case N-505, in Regulatory Guide 1.84, Rev. 33.
III-1-A02 (BC00-771)	NE-2331, NE-2431, NE-4335 Impact Testing of Heat Affected Zone (HAZ)	Changes in steel making technology have enabled materials to be supplied with much better impact toughness properties than in the past. One problem associated with this is that it does not take much heat input to reduce the toughness of the HAZ to levels below the unaffected base material. This results in the need for more testing and test coupons. This revision allows three methods of qualifying the HAZ. 1) An upward adjustment of RT_{NDT}, which was the original basic method. 2) Downward adjustment in test temperature, which is currently permitted, but	These provisions have been accepted by the USNRC, in its endorsement of the 2002 Addenda of Section III, Subsections NB, NC, and ND

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
		requires many tests for the development of the transition curves. This is difficult when using existing materials, without enough coupons. 3) Evaluation of actual material impact toughness test data with an adjustment upward of the toughness acceptance criteria to compensate for the loss of toughness shown on the Welding Procedure Specification (WPS). This can be used with existing material or new material. These changes include a 15F penalty without further test data. This alternative is based on many years of testing. An exemption is also provided for gas tungsten arc welding (GTAW) weld metal with a maximum of two layers for the HAZ.	
III-1-A02 (BC01-613)	Table NE-2121(a)-1 Addition of SA-738 Material	This revision permits the use of SA-738, Grade B material for construction of containment vessels. This material is a P-1, Group 3 ferritic material. The change incorporates the provisions of Case N-655, "Use of SA-738, Grade B for Metal Containment Vessels, Class MC, Section III, Division 1."	These provisions have been accepted by the USNRC, in its endorsement of the 2002 Addenda of Section III, Subsections NB, NC, and ND.
III-1-A00	NE-4000 Standard Weld Procedure Specifications (SWPS)	Standard Weld Procedures Specifications were added to Section IX in the A00 Addenda. These SWPSs are acceptable for use in Section III by reference to Section IX. Highlights of the Section IX (QW-500) requirements are: 1) Not all AWS SWPSs are permitted. 2) A demonstration test coupon must be welded and tested; QW-520 lists specific information that must be recorded as part of the demonstration. 3) SWPSs must be used exactly as they are written; there are no "nonessential variables" when using SWPS. 4) The applicable fabrication document (i.e., construction code, customer specification, etc.) and the demonstration test number must be shown on the SPWS, and it must be signed and dated by the manufacturer or contractor.	These provisions have been accepted by the USNRC, in its endorsement of the 2000 Addenda of Section III, Subsections NB, NC, and ND.

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
III-1-A99 (BC98-414) (12/98)	NE-3226, NE-6221 Test Limits	The purpose of this revision is to remove inconsistencies in the rules for testing. The change provides that a stress analysis for the test condition is not required unless the test pressure at some point in the vessel exceeds the required test pressure by more than six percent. For Class 1 components, the change reduces the pneumatic test pressure from 1.2 to 1.1 times the design pressure. The change also reduces the hydrostatic test pressure for Class 2 and 3 components from 1.5 to 1.25 times the design pressure, and the pneumatic test pressure from 1.25 to 1.1 times the design pressure. For Class MC containment vessels, the hydrostatic test pressure was reduced from 1.35 to 1.2 times the design pressure. These changes compensate for the reduction in design factor from 4 to 3.5 that was made to increase allowable stresses in Section II, Part D, Table 1A and Table 1B for Class 2 and 3 components. The pneumatic test pressure for containment vessels was not changed.	These provisions have been accepted by the USNRC, in its endorsement of the 1999 Addenda of Section III, Subsections NB, NC, and ND.
III-1-A99 (BC98-571) (2/99)	NE-5279, NE-5280 Special Exemptions to Radiography	Previously these paragraphs provided rules for special exemptions to radiographic examination when weld joint details did not permit a meaningful examination. This revision changes the requirements to be consistent for all subsections. The effect of the change is to allow exceptions to radiography whenever radiographic examination is not practical.	These provisions have been accepted by the USNRC, in its endorsement of the 1999 Addenda of Section III, Subsections NB, NC, and ND.
II-D-A99 (BC98-165)	TABLE 1A, TABLE 1B STRESS TABLES Reduced Design Factor	This revision significantly increased all allowable stress values in these tables by reducing the design factor on tensile strength from 4 to 3.5. There was no change in the factor on yield strength, so not all allowable stresses are changed. The increase in allowable stress decreases as the design temperature increases. The increase in allowable stress is not dependent on any change in design formulas, nondestructive examination, or material properties. The main reason for the change is to be more consistent with the allowable stresses used in Europe and other parts of the world. The change will make the use of the ASME Code more competitive in the international market on an economical basis.	These provisions have been accepted by the USNRC, in its endorsement of the 1999 Addenda of Section III, Subsections NC and ND.

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
		This change incorporates the provisions of Case 2278, "Alternative Method for Calculating Maximum Allowable Stresses Based on a Factor of 3.5 on Tensile Strength, Section II and Section VIII, Division 1," Case 2290, "Alternative Maximum Allowable Stresses Based on the Factor of 3.5 on Tensile Strength, Section II, Part D, and Section VIII, Division 1," and Case 2284, "Alternative Maximum Allowable Stresses for Section I Construction Based on a Factor of 3.5 on Tensile Strength, Section I." To make this change, all of the Stress Tables were reviewed, and many changes were made to correct chemistry designations, product forms, external pressure chart references, heat treatments, and Notes. Also, many stress lines were merged. Changes to the Stress Tables, not directly associated with the change in the design factor used to determine allowable stresses, are identified with separate comments. In a number of places, the Summary of Changes printed with the Addenda identified materials as being deleted that were not. It only appeared that way because the stress lines were merged. The National Board of Boiler and Pressure Vessel Inspectors permits the use of the new allowable stresses for rerating pressure retaining equipment now in service that was produced to ASME Codes as far back as the 1968 Edition of the ASME Code. Provisions for doing this are given in National Board Interpretation 98-14. ERROR: Appendix 1, 1-100(a)(1), 1-100(a)(2), and Table 1-100 should have been revised to show the change in the design factors. Corrected by Special Notice.	
III-1-A97 (96-250)	Table NE-4622.7(b)-1 Exemptions to Mandatory Postweld	This change allows an exemption from postweld heat treatment for welds attaching nozzles and penetrations up to and including NPS 12.	The exemption is limited to P-No. 1 material; the shell and nozzle thickness do not exceed 1-1/2 in.; the preheat and carbon

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
	Heat Treatment		content limits are identical to the limits for exemption of other welds in P-No. 1 materials; and nozzle diameter is irrelevant to the need for PWHT.
III-1-A95 (94-305)	NE-7726 Proration of Valve Capacity	This revision provides for proration of valve capacities to pressures greater than the pressure to which the valve capacity was certified.	These provisions have been accepted by the USNRC, in its endorsement of the 1995 Addenda of Section III, Subsections NB, NC, and ND.
III-1-A95 (94-316)	NE-3221.1(c)(1) Stress Intensity Values	This change allows, under limited conditions, an increase in the primary membrane stress for Service Level D Limits, up to the maximum value permitted for Service Level C Limits.	This is a small increase in allowable stress and is limited to no more than the allowable stress for Service Level C Limits, which are otherwise generally lower than the allowable stress for Service Level D Limits.
III-1-A93	NE-2545.3(b), NE-2545.3(b)(3), NE-2545.3(b)(4), NE-2546.3(b), NE-2546.3(b)(3), NE-2546.3(b)(4) Acceptance Standards	This change clarifies the NDE acceptance criteria and provides consistency with NB-2576(c), NB-2677(c), NC-2576(c), NC-2677(c), ND-2576(c), ND-2677(c), NE-2576(c), NE-2677(c), NG-2576(c), and NG-2677(c). The significant change is to refer to only "relevant" indications.	These provisions have been accepted by the USNRC, in its endorsement of the 1987 Addenda of Section III, Subsections NB, NC, and ND.

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
III-1-A92	NE-5112 Nondestructive Examination Procedures	This revision provides for the digitization of radiographic film and radioscopic images in accordance with the provisions of Section V, Article 2, Appendix III.	These provisions have been accepted by the USNRC, in its endorsement of the 1992 Addenda of Section III, Subsections NB, NC, and ND.
II-D-1992 Edition	TABLE 1A SECTION III-1, Class MC	Corrected Stress Values for SA-516 - 55 (K01800) from 15.1 ksi to 15.2 ksi.	The prior values were incorrect.
III-1-A91 (91-208)	NE-7512, NE-7721.3, NE-7724.2(a) Tolerances on Pressure Relief Valves	This revision increases the set pressure tolerances for pressure relief valves.	These provisions have been accepted by the USNRC, in its endorsement of the 1991 Addenda of Section III, Subsections NB, NC, and ND.
III-1-A90	NE-2510 Attachment Material	This revision deletes the requirement for examining the attached material in the same manner as the pressure retaining material to which it is welded. (TECHNICAL ERRATA to A87)	These provisions have been accepted by the USNRC, in its endorsement of the 1990 Addenda of Section III, Subsections NC and ND.
III-1-A90	Table NE-3132-1 Dimensional Standards	- Updated: ANSI B1.20.3-76 (R82) ANSI B16.5 to 88 This change extended nickel alloy ratings to higher temperatures, clarified flat face flange requirements, updated the referenced standards, and made other minor editorial revisions. Metric equivalents were deleted.	These provisions have been accepted by the USNRC, in its endorsement of the 1990 Addenda of Section III, Subsections NB, NC, and ND.

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
		ANSI B16.9 to 86 ANSI B16.11 to 80 ANSI B16.25 to 86 ANSI B16.28 to 86 ANSI B18.2.2 to 87 ANSI B18.3 to 86 ANSI B36.10 to 85 ANSI B36.19 to 85 ANSI B16.34 to 88 The scope of the standard was increased by the addition of socket welded end and threaded end valves. The listings for nickel alloy and other alloy valve materials were expanded. Also, rules for threaded body joints were added and wafer-type valve body rules were revised. MSS SP-43 to 82 (R86) MSS SP-44 to 85	
III-1-A90	Table I-10.1 Stress Tables for Class MC Ferritic Steels	- Added: SA-738 - C (to 2-1/2 in.) (TS/YS = 80/60) (2-1/2 in. to 4 in.) (TS/YS = 75/55) (4 to 6 in.) (TS/YS = 70/46) - Changed designation for: SA-738 - ... to SA-738 - A (K12447)	SA-738 Grade C has been accepted by the USNRC, in its endorsement of the 1990 Addenda of Section III, Subsections NC and ND (see Table I-7.1 for permitted materials for Class 2 and 3 applications).
III-2-A04, III-2 (BC03-472)	CC-4331.2(b)(6), CC-4333.2.3(a), CC-4333.2.3(b),	This revision adds cold rolled formed parallel threaded splices as an acceptable form of splice. Cold roll formed parallel threaded splices are being widely used in the construction industry. Cold rolled formed parallel threaded splices have a	This revision adds a new type of mechanical splice called a "cold-roll-formed parallel-threaded

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
	CC-4333.2.4(e)(3), CC-4333.2.4(g), CC-4333.3(b)(6), CC-4333.3(c)(4), CC-4333.3(d)(5), CC-4333.3(f), CC-4333.5.3(b) Cold Rolled Parallel Threaded Splices	special thread and locknut to lock the coupler. This mechanical splice is limited to cold formed parallel threaded splices to prevent any single threaded rebar from being included, which would not possess the extra cold rolling process. Requirements for locknuts, which need to be used on both ends of the device to prevent loosening and to improve slip performance, are included. A testing requirement for cold rolled parallel threaded splices at 20F is also required.	splice." This splice for reinforcing bars is widely used in the construction industry. The new coupler meets the current requirements for the "taper-threaded splices" to have threads, and the requirements of the "thread-deformed reinforcing bars," which require locknuts to lock the coupler. The new mechanical splice is limited to "cold-formed parallel-threaded splices," to prevent any single threaded re-bar from being included that would not possess the extra cold rolling process.
III-2-A02 (BC01-698)	CC-4542.1, CC-4542.2 Back-up Bars	This revision deletes the prohibition against the use of back-up bars in Category A and B welded joints.	For more than 70 years, Section VIII, Division 1 has permitted use of back-up bars for butt welds in the vessel shell. During this time, there has been no evidence of leakage caused by the back-up bars, even though they are subjected to the same stress as the pressure vessel shell. In Section III, Division 2, the containment liner plate is assumed to have no structural strength. It is logical to permit

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
			the same weld details in containment liners as permitted for pressure shells.
III-2-A01 (2001 Edition) (BC00-182)	CC-4333.2.3 Splicing of Reinforcing Bars-Performance Tests	This revision incorporates the provisions of Case N-363-1, "Splicing of Reinforcing Bars-Performance Tests, Section III, Division 2." The change permits acceptance of performance test results for reinforcing bar mechanical splices when the load extension does not achieve 2% strain. The alternative test results must meet the lesser of 2% strain or 125% of the specified minimum yield strength of the reinforcing bar.	The alternative test is more than adequate to assure the structural capability of the splices. (The USNRC has not endorsed Case N-363-1.)
III-2-A01 (2001 Edition) (BC00-183)	Table CC-4552-2 Postweld Heat Treatment Exemptions	This revision changes the Table to permit containment liners the same PWHT exemptions that were allowed for concrete reactor vessel liners. The change incorporates the provisions of Case N-536, "Alternative to Table CC-4552-2 Exemptions to Mandatory PWHT Concrete Containment Liner, Section III, Division 2."	There is no reduction in requirements when the alternative rules for containment liners are the same as for reactor liners. (The USNRC has not endorsed Case N-536.)
III-2-A01 (2001 Edition) (BC00-357)	CC-5531.2 Extent of Examination	This revision removes the requirement to increase number of radiographs of double-sided welds, when a portion of the liner uses backup bars and single-sided welding. This was an arbitrary requirement intended to discourage the use of single-sided welds with backup bars. The change also clarifies that the welds made using back-up bars shall be examined by UT or MT for the full length of the backed-up weld.	The number of radiographs has no effect on assuring acceptable weld quality.
III-2-A00 (BC00-005)	CC-2231.4 Specified Concrete Properties	This revision provides conditions under which the required creep testing of CC-2231.4, may be delayed. The change incorporates the provisions of Case N-529 "Creep Testing, Section III, Division 2."	It takes about 28 days for concrete to set. However, early in that time frame, it is possible to accurately evaluate the creep of the concrete based on early tests. This is common industry

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
			practice. Not applicable to the ESBWR RCCV. (The USNRC has not endorsed Case N-529.)
III-2-A00 (BC00-006)	CC-3543(a) Tendon Anchor Reinforcement	CC-3543(a) requires that reinforcement "be located starting not more than 2 inches from the bearing plate and not extending more than twice the minimum bearing plate width." This revision provides conditions under which that requirement can be waived. The change incorporates the provisions of Case N-488, "Design of Tendon and Anchorage Reinforcement, Section III, Division 2."	Not applicable to ESBWR.
III-2-A00 (BC00-007)	CC-4432.5 Twisting and Coiling Prestressing Tendons	This revision provides an alternative to the provisions of CC-4432.5 regarding intentional twisting for all horizontal circumferential tendons comprised of multiple elements. The change incorporates the provisions of Case N-487, "Twisting of Horizontal Prestressing Tendons, Section III, Division 2."	Not applicable to ESBWR
III-2-A96 (96-55)	CC-3740, CC-3750 Penetration Assemblies, Brackets and Attachments	Previously, Division 2 limited attachment loads in the through-thickness direction of plate. This revision eliminates that restriction and allows the full strength of the plate to be used in the through-thickness direction. This is a continuation of the similar change started in the 1995 Addenda.	Similar provisions in Section III, Division 1, Subsection NF have been permitted for Class 1, 2, and 3 supports by USNRC endorsement on the Winter 1982 Addenda.
III-2-A95 (94-309)	CC-3750(b), CC-4543.6, Fig. CC-4543.6-1, Fig. CC-4543.6-2 Through-Thickness Loads	The Code restricted allowable stresses in liners to one-half of the allowable stress for tensile loads normal to the liner, because of lamellar tearing, laminations, and through-thickness strength. Because of improved steel melting practices and examination techniques, the one-half factor has been eliminated. This revision provides new requirements that must be met when liner materials one inch and greater in thickness are loaded in the through-thickness direction. When loaded in this direction, the materials must meet the acceptance standards of SA-770, "Through-Thickness Tension Testing of Steel Plates for Special Applications." Special welding procedure qualifications are required, and must use either inlays or	Similar provisions in Section III, Division 1, Subsection NF have been permitted for Class 1, 2, and 3 supports by USNRC endorsement on the Winter 1982 Addenda.

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
		overlays, or special weld deposition techniques. After completion of welding, the base metal underneath the attachment weld must be ultrasonically examined. Special examination methods and acceptance standards are provided. This revision is similar to changes made to Section III, Division 1, Subsection NF in the Winter 1978 and Winter 1982 Addenda.	
III-2-A95 (94-306)	CC-4331.2(b)(5), CC-4333.2.3(a), CC-4333.2.4(f), CC-4333.3(e), CC-4333.4, CC-4333.5.3(a) Splicing of Reinforcing Bars	This revision adds provisions for a new mechanical reinforcing bar splice. The new splice is identified as a "sleeve with cementitious grout splice." The splice has been evaluated for use by building officials organizations and found to meet the requirements of ACI-318.	This splice has been in use for more than ten years and meets the requirements of ACI-318, which has served as the basis for the Section III, Division2 Concrete Code.
III-2-A93	CC-4532.2.1 Group Identification of Welders to Weld Joints	The revision allows multiple welds to have group identification for the purposes of verifying that all welders and welding operators were properly qualified. Previously, this group identification was only allowed for structural attachment welds. This revision incorporates the provisions of Case N-507, "Identification of Welders, Section III, Division 2."	The USNRC previously approved these provisions through endorsement of Case N-507 in RG 1.84, Rev. 32.
III-2-A92	Table CC-2160-1, Note (2), Codes, Standards, and Specifications Referenced in Text Dimensional Standards	This revision updates the listed standards and moves the dates to "Codes, Standards, and Specifications Referenced in Text." Pipes and Tubes - Updated: ASME B36.10 to M85 ASME B36.19 to M85	These provisions have been accepted by the USNRC, in its endorsement of various early-1990's Editions and Addenda of Section III, Subsections NB, NC, and ND. Most of the changes are editorial.

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
		Fittings, Flanges and Gaskets - Deleted: ANSI B70.1 Refrigeration Flare Type Fittings - Updated: ASME B16.5 to 88 Comments on the changes to this standard can be found in the RA-search data base Rev_B31. ASME B16.9 to 86 ASME B16.11 to 80 ASME B16.21 to 78 ASME B16.25 to 86 ASME B16.28 to 86 - Titles for Standards were changed to: ASME B16.5 Pipe Flanges and Flanged Fittings ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges AWWA C207 Standard for Steel Pipe Flanges for Waterworks Services Bolting - Titles for Standards were changed to: ASME B18.2.1 Square and Hex Bolts and Screws (Inch Series) Including Hex Cap Screws, and Lag Screws ASME B18.2.2 Square and Hex Nuts (Inch Series) ASME B18.3 Socket Cap, Shoulder, and Set Screws (Inch Series) - Updated: ASME B18.2.2 to 87 ASME B18.3 to 86 Threads - Updated: ASME B1.1a to 84	

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
		- Changed Standard Numbers from: ANSI B2.1 to ASME B1.20.1-83 Pipe Threads, General Purpose (Inch) ANSI B2.2 to ASME B1.20.5-78 (R80) Gaging for Dryseal Pipe Threads (In.) Valves - Updated: ASME B16.34 to 88 Comments on the changes to this standard can be found in the RA-search data base Rev_B31. - Titles for Standards were changed to: ASME B16.34 Valves - Flanged, Threaded, and Welded End This revision corrects the title of the dimensional standards to ASME because they are no longer subject to approval by ANSI. This revision also deletes the revision year from Table CB-2160 and CC-2160 because the revision dates are now given in, "Codes, Standards, and Specifications Referenced in Text," located at the end of the book.	
III-2-A92	Codes, Standards, and Specifications Referenced in Text	- Deleted: ANSI B2.1 Pipe Threads (Except Dryseal) ANSI B2.2 Dryseal Pipe Threads ANSI B70.1-60 Refrigeration Flare Type Fittings - Added: ANSI B1.20.1-83 Pipe Threads (Except Dryseal) ANSI B1.20.5-78 (R80) Gaging for Dryseal Pipe Threads - Updated: ANSI B1.1 to ASME B1.1a-84	These provisions have been accepted by the USNRC, in its endorsement of various early-1990's Editions and Addenda of Section III, Subsections NB, NC, and ND. Most of the changes are editorial.

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
		ANSI B16.5 to ASME B16.5-88 Comments on the changes to this standard can be found in the RA-search data base Rev_B31, and are available upon request. ANSI B16.9 to ASME B16.9-86 ANSI B16.11 to ASME B16.11-80 ANSI B16.20 to ASME B16.20 ANSI B16.21 to ASME B16.21 ANSI B16.25 to ASME B16.25-86 ANSI B16.28 to ASME B16.28-86 ANSI B16.34 to ASME B16.34-88 Comments on the changes to this standard can be found in the RA-search data base Rev_B31, and are available upon request. ANSI B18.2.1 to ASME B18.2.1 ANSI B18.2.2 to ASME B18.2.2-87 ANSI B18.3 to ASME B18.3-86 ANSI B36.10 to ASME B36.10M-85 ANSI B36.19 to ASME B36.19M-85	
III-2-A91 (91-212)	CC-3421.4.1(c), CC-3421.4.2, CC-3421.4.2(h) Evaluation of Membrane Stress	This revision modifies the definition of membrane stress to be at the centroid of the concrete section where the shear load is applied. Previously the definition described the stress at the extreme fiber of the section.	Use of the centroid of the section is a more accurate approach to determination of stress.
III-2-A91 (91-222)	CC-4321.1(c), CC-4321.2, CC-4322(a) Bending of Reinforcing Bar	This revision changes the rules for bending reinforcing bar to conform to the provisions of ACI 318-89. The change provides that the minimum diameter of the bend in the bar and the extension length are dependent on the diameter of the reinforcing bar being bent. This revision removes the change made in the 1990 Addenda.	This change is consistent with the provisions of ACI-318.

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
III-2-A91	CC-5536.2 Leak Chase System	This revision allows leak chase channels to be tested by air using the "maintenance of pressure" method. The change incorporates the provisions of Case N-231, "Alternate Methods for Leak Detection in the Attachment Weld to Leak Chase Channels for Section III, Division 2, Class CC Construction."	The USNRC previously approved these provisions through endorsement of Case N-231 in RG 1.84, Rev. 32.
III-2-A91	Table I-2.2 Material for Concrete Containment Vessel Liners	- Added: SA-210 - C (K03501) SA-738 - B (K12447) and C - Deleted: SA-234 - WPA SA-376 - 316L (S31603) - Changed: SA-181 - ... to 60 (K03502) & 70 (K03502) SA-210 - ... to A-1 (K02707) SA-738 - ... to A (K12447)	SA-210 is not applicable to ESBWR. SA-738 Grade B has been accepted by the NRC with limitations, in their endorsement of Case N-655 in RG 1.84 Rev. 33. The limitations require compliance with SA-738 Supplementary Requirements S17 and S20. SA-738 Grade C has been accepted by the USNRC, in its endorsement of the 1990 Addenda of Section III, Subsections NC and ND (see Table I-7.1 for permitted materials for Class 2 and 3 applications).
III-2-A90	CC-2242.5, CC-2242.6 Use of Prepackaged	This change incorporates the provisions of Case N-384-1, "Use of Prepackaged General Purpose Cement Grouts, Epoxy Grouts, and Epoxy Bonding Materials, Section III, Division 2, Class CC." The Case permitted the use of prepackaged grouts and bonding materials in lieu of materials mixed at site.	The USNRC previously approved these provisions through endorsement of Case N-384-1 in RG 1.84, Rev. 32.

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels	Comments
	General Purpose Cement Grouts		
III-2-A90 (90-174)	CC-4240(c), CC-4240(d), CC-4260 Cold Weather Concrete Placement	This revision provides a definition for cold weather concrete placement and clarifies the requirements for these conditions. The revision changes the period of temperature control at the surface of the concrete from seven days to three days.	The only effect of this change is to allow slower curing of the concrete, if the temperature falls below 32F. The concrete will cure sufficiently in three days to prevent damage due to freezing.
III-2-A90 (89-332)	CC-4321.2 Bending of Reinforcing Bar	This revision adds a standard industry tolerance for bending reinforcing bars. The specified tolerance is one bar diameter.	This change is consistent with the provisions of ACI-318. Furthermore, this change was removed by the revision in the 1991 Addenda.

Table 3.8-5(2) Increases in Requirements from 1989 Edition to 2004 Edition

Affecting Addenda after 1989 Ed.	Affected chapters	INCREASES IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels
III-1-1995 Edition (94-229)	NCA-4134.10 Reporting Independence of Inspectors	This paragraph references NQA-1, Supplement 10S-1, for inspection. Paragraph 2.1 of the Supplement provides that inspection personnel shall not report directly to the immediate supervisors who are responsible for performing the work being inspected. This revision deletes the provisions of Paragraph 2.1, Personnel, for Section III work because such restrictions were felt unnecessary with the other controls already in NQA-1. (ERROR: The revision also deleted the provisions of Paragraph 2.2, Qualification. However, the provisions of Paragraph 2.2 are intended to be applicable to qualification of inspection personnel. Corrected A96.) (ERROR: The A94 Addenda now refers to the 1992 Addenda to NQA-1, which renumbered Paragraph 2.1, Personnel, as paragraph 3.1. Therefore this change should refer to the deletion of Paragraph 3.1 of NQA-1. Corrected A96.)
III-1-A94 (93-380)	NCA-3800, NCA-3810, NCA-3820, NCA-3830, NCA-3840, NCA-3841, NCA-3842, NCA-3850, NCA-3851, NCA-3852, NCA-3853, NCA-3855, NCA-3856, NCA-3857, NCA-3858, NCA-3859, NCA-3860, NCA-3861, NCA-3862	This revision modifies the quality assurance requirements for organizations providing metallic material. The terms "Material Manufacturer" and "Material Supplier" have been changed to "Material Organization." The purpose of the change is allow any material organization to perform the work activities detailed in their Quality Assurance Program rather than to limit work activities based on whether the organization is considered a material manufacturer or a material supplier. This change is significant because it will require most organizations furnishing material under the provisions of NCA-3800 to extensively modify their QA Manual prior to their next ASME Survey. The revision adds or revises definitions for approved supplier, material, performance assessment, Quality System Program, source material, supplier, and unqualified source material. NCA-3842.2(h)(3) was added to permit annual performance assessments of qualified Material Organizations in lieu of annual audits. The performance assessments are to include evaluation of sample testing of furnished material to assure conformance with the material specification, along with evaluation of nonconformances and corrective actions. The old paragraph NCA-3867.4(e), which identified the rules for upgrading material, has been renumbered NCA-3855.5(a). "Stock material" is now identified as "unqualified source material." NCA-3855.5(a)(1) clarifies that the restriction, "no welding," on an unqualified source material means no

Affecting Addenda after 1989 Ed.	Affected chapters	INCREASES IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels
	Material Quality System Programs	welding with filler material added. Autogenous welding is exempt from this restriction. This revision deleted the exemption that allowed allows bars with a cross-sectional area of one square inch and less to be furnished with a Certificate of Compliance in lieu of a Certified Material Test Report. (ERROR: Not corrected.)
III-1-A93	NCA-3220(d), NCA-3220(n), NCA-3220(s), NCA-3270, NCA-3271, NCA-3272, NCA-3273, NCA-3280, NCA-3290 Overpressure Protection Report	This revision adds new provisions regarding the Owner's responsibilities for providing, certifying, and filing Class 1, 2, 3, and MC Overpressure Protection Reports. Other than the changes to the NCA-3270 paragraphs, the revision corrects references and renumbers paragraphs.
III-1-A92	NCA-5121(a) Authorized Inspection Agency	This revision requires that Authorized Inspection Agencies are to be accredited by ASME, not States nor Provinces.
III-1-A91	NCA-4110(b) Quality Assurance Program Requirements	This revision updates the reference to NQA-1 to the 1989 Edition, including the NQA-1a-1989 Addenda. The change also includes NQA-1a-1986 Addenda, NQA-1b-1987 Addenda, and NQA-1c-1988 Addenda. The following changes were included in the NQA-1a-1989 Addenda: 3S-1 - 5 Design Control Change Control *- Adds additional provisions for incorporating design changes into the appropriate design documents.*

Affecting Addenda after 1989 Ed.	Affected chapters	INCREASES IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels
		3A-1 Design Control - Rewritten for clarity. - Expanded provisions on interfaces. *- Added provisions regarding load path requirements for installation, removal, repair and replacement of equipment.* - Added provisions regarding the design process. - Added provisions regarding design interface control. - Deleted Figs. 3A-1.1, 3A-1.2, and 3A-1.3 regarding design responsibilities and drawing checklists. The following changes were included in the NQA-1c-1988 Addenda: Technical Inquiries - Revised guidelines for preparation of technical inquiries. II - 11 Test Control - Modified item to address computer program tests. S-1 - 2 Definitions - Added definition of computer program. - Revised definition of design output to include computer programs, and added footnotes 2 and 3. 3S-1 - 4, 4.1 Design Verification - Modified to address computer programs. 11S-2 Computer Program Testing - Added Supplementary Requirements for Computer Program Testing. 17S-1 - 4.4.2, 4.4.3 QA Records - Clarified provisions regarding storage facilities and updated NFPA documents to the 1986 Edition. This change incorporates the provisions of NQA-1 Case 1, "Records Storage Facility - Use of NFPA 232. ANSI/ASME NQA-1-1979 with the 1c-1981 Addenda, and Later Editions and Addenda through the 1c-1987 Addenda, Supplement 17S-1, Paragraph 4.4.2." 17A-1 - 3.1 Design Records - Modified item to address computer programs.

Affecting Addenda after 1989 Ed.	Affected chapters	INCREASES IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels
		The following changes were included in the NQA-1b-1987 Addenda: S-1 - 2 Terms and Definitions - Revised definition [paragraph (a)] for "Commercial Grade Item," and added Footnote 1 regarding nuclear facilities as they relate to commercial grade items. 17A-1 - 1.3 Records - Added provision for using records stored on magnetic or optical media. The following changes were included in the NQA-1a-1986 Addenda: 17S-1 - 4.4.2 Alternate Single Facilities *- Corrected address for NFPA.* 4A-1 - 3.2(a) Document Control - Added guidelines regarding radioactive products and by products.
III-1-A90	NCA-3820(a) Quality System Certificate	This revision restricts the qualification of Material Manufacturers to organizations with a Quality System Certificate (QSC) from ASME or to Certificate Holders who use the material. This change will have a profound effect on many material suppliers who do not have a QSC.
III-1-A90	NCA-3851, NCA-3852(c), NCA-3852(d), NCA-9000 Material Manufacturers and Material Suppliers	This revision clarifies the definitions of organizations which are considered by ASME to be "Material Manufacturers." The revision provides that an organization which machines stock material from one product form to another must be qualified as a Material Manufacturer in order to issue a Certificate for the new product form. A "Material Supplier" who is not qualified as a Material Manufacturer cannot issue Certificates of Compliance or CMTR's with the materials as provided in NCA-3867.4(b).
III-1-A02 (BC01-613)	NE-2211 Exemption from Postweld Heat Treatment for Ferritic Material Test Coupons	This change eliminates the exemption from PWHT for test coupons for P-1, Group 3 ferritic material.

Affecting Addenda after 1989 Ed.	Affected chapters	INCREASES IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels
III-1-A97 (96-160)	NE-5521(a), NE-5521(a)(1)(a), NE-5521(a)(1)(b), NE-5521(a)(3), NE-5521(a)(4) & Footnotes 1 & 2, NE-5521(a)(6), NE-5530 ASNT SNT-TC-1A	This revision updates the nondestructive examination qualification requirements to the 1992 Edition of SNC-TC-1A. The change requires that personnel performing visual examination be qualified to SNT-TC-1A.
III-1-A95 (94-397)	NE-3338.2(d)(3), XIII-2124(c) Stress Indices for Nozzles	This revision modifies the thickness and diameter dimensional ratios to be consistent with the provisions in Section VIII, Division 2. It restricts the outside nozzle radius on cylindrical shells.
III-1-A95 (94-302)	NE-3112.4 Allowable Stress Intensity and Stress Values	This change identifies the criteria for establishing the allowable stress intensity and allowable stress values for Class MC containments. The allowable stress intensity is now limited to 90% of the yield strength of the material, based on the values given in Table Y-1 of Section II, Part D. This is a new stress limit for containment vessels. The original design philosophy was to allow stresses at 1.1 times the Section VIII allowable stresses, regardless of the yield strength.
III-1-A94 (94-79)	NE-4212, NE-4213 Forming and Bending	This revision adds references for qualifying forming and bending material processes when impact testing is required. The change also revises and clarifies the requirements for confirming minimum wall thickness after forming and bending pipe and tube. The actual thickness may be measured or the forming procedure must show that the required thickness will be maintained.
III-1-A92 (92-174)	NE-4435 Removal of Temporary Attachments	This revision clarifies the fabrication requirements for nonstructural and temporary attachments. The change also reinstates requirements for the examination of the area when temporary attachments are removed. NB-4435(b), NC-4435(b), ND-4435(b), and NE-4435(b) were deleted by mistake in the 1987 Addenda. (TECHNICAL ERRATA to 1987 Addenda.)

Affecting Addenda after 1989 Ed.	Affected chapters	INCREASES IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels
III-1-A91 (91-226)	NE-7111(b), NE-7727, NE-7734.2(a), NE-7734.3, NE-7735 Laboratory Acceptance of Pressure Relieving Capacity Tests	This revision updates the reference to PCT 25.3 to the 1988 Edition. The change also adds a limit for the coefficient of design.
III-1-A91 (90-340)	NE-7723, NE-7724.2(b), NE-7733, NE-7734.2(b) Pressure Relief Valve Capacity Certification	This revision standardizes the procedure for replacing unacceptable valves, with more restrictive limits, and standardizes and clarifies the types of test failures that are to be used as a basis for ASME refusing certification of a particular valve design.
III-1-A90	Table I-10.2 Stress Tables for Class MC	Austenitic Steels and High Nickel Alloys - Deleted: SA-376 - TP304 (S30400) (NPS 8 & >) (< Sch 140) (ERROR: Corrected 1995 Edition.) (< NPS 8) (Sch 140 & >) *(ERROR: Corrected 1995 Edition.)* TP304H (S30409) (NPS 8 & >) (< Sch 140) (ERROR: Corrected A92 Add.) (< NPS 8) (Sch 140 & >) (ERROR: Corrected A92 Add.) (ERROR: Should have deleted SA-813 - TP309 (S30900) & TP310 (S31000) which were deleted from Section II. Table deleted A91 Add.) (ERROR: Should have deleted SA-814 - TP309 (S30900) & TP310 (S31000) which were deleted from Section II. Table deleted A91 Add.)

Affecting Addenda after 1989 Ed.	Affected chapters	INCREASES IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels
		- Reduced TS/YS for: SA-376 - TP321 (S32100) (> 3/8 in.) from 75/30 to 70/25 and reduced stress values TP321H (S32109) (> 3/8 in.) from 75/30 to 70/25 and reduced stress values *- Reduced TS/YS for:* (ERROR: Should have reduced TS/YS for: SA-312 - TP321 (S32100) (Sml) (> 3/8 in.) from 75/30 to 70/25) TP321H (S32109) (Sml) (> 3/8 in.) from 75/30 to 70/25) Table deleted A91 Add.) *- Reduced YS from 75 to 70 for:* SA-376 - TP304 (S30400) (NPS 8 & >) (Sch. 140 & >) and reduced stress values (TECHNICAL ERRATA to S72) TP304H (S30409) (NPS 8 & >) (Sch. 140 & >) and reduced stress values (ERROR: This reduction does not apply to TP304H (S30409). Corrected A92 Add.) - Revised stress values for: SA-182 - F321 (S32100), F321H (S32109) SA-213 - TP321 (S32100), TP321H (S32109) SA-240 - 321 (S32100) SA-249 - TP321 (S32100), TP321H (S32109) SA-312 - TP321 (S32100), TP321H (S32109) SA-336 - F321 (S32100), F321H (S32109) SA-376 - TP304 (S30400) (NPS 8 & >) (Sch. 140 & >) TP321 (S32100), TP321H (S32109) SA-403 - 321 (S32100), 321H (S32109) SA-479 - 321 (S32100) SA-813 - TP321 (S32100), TP321H (S32109) SA-814 - TP321 (S32100), TP321H (S32109) - Added notes (15), (16), (17), (18) regarding thickness and pipe sizes.

Affecting Addenda after 1989 Ed.	Affected chapters	INCREASES IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels
III-1-A90	Table I-10.3 Stress Tables for Class MC	Bolting Materials - Reduced stress values for: SA-193 - B8C (S34700), B8M (S31600)
III-2-A95 (94-307)	CC-3570, CC-3571, CC-3572, CC-3573, CC-3574, CC-3575 Containment External Anchors	This revision adds requirements for anchorage of structural members, supports, and embedments affixed to the external surface of the containment structure.
III-2-A93	CC-3530, CC-3531, CC-3532, CC-3533, CC-3534 Reinforcing Steel Requirements	This revision adds the requirement that mechanical devices for the end anchorages are to be capable of developing at least 125 percent of the specified minimum yield strength of the bar. The change also provides that no reinforcement should be terminated in a tension zone except under certain identified conditions.
III-2-A92 (92-177)	VII-3211 Level I Technician Qualifications	This revision increases the education and experience requirements and clarifies the training and evaluation requirements for Level I Concrete Inspection and Testing Technicians.
III-2-A92 (92-178)	VII-3212 Level II Technician Qualifications	This revision increases the education and experience requirements and clarifies the training and evaluation requirements for Level II Concrete Inspector qualifications.
III-2-A91 (91-210)	CC-3421.8,	This revision revises the design rules for brackets and corbels to be consistent with the provisions in ACI-

Affecting Addenda after 1989 Ed.	Affected chapters	INCREASES IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels
	CC-3424, CC-3431.3(a), CC-3431.3(c) Brackets and Corbels	318-83. The new rules are much more detailed and modify the formula for determining acceptable shear stress.
III-2-A91 (91-215)	CC-3531, CC-3532, CC-3532(c), CC-3532.1.2(a), CC-3532.1.2(c), CC-3532.1.2(e), CC-3532.1.2(g), CC-3532.1.2(h)(1), CC-3532.1.2(h)(2), CC-3532.1.2(i)(4), CC-3532.1.3, CC-3532.1.5, CC-3532.2.3(b), CC-3533.1(a)(3), CC-3533.1(c), CC-3533.2, CC-3534 Reinforcing Steel	This revision clarifies the requirements regarding design of reinforcing steel. New provisions are added for mechanical devices used for end anchorages.
III-2-A91 (91-217)	CC-3730(c), CC-3740(f), CC-3750(c) Anchorage Design	These new paragraphs provide guidance regarding the design of reinforcing steel for anchorage forces.
III-2-A90	CC-2131.3, CC-2224	This change adds new provisions for mineral admixtures, chemical admixtures and special grouting admixtures as well as adding a new ASTM specification C 1017, "Chemical Admixtures for Use in

Affecting Addenda after 1989 Ed.	Affected chapters	INCREASES IN REQUIREMENTS: differences in ASME Section III 2004 Edition from 1989 Edition, for steel and concrete containment vessels
	Admixtures	Producing Flowing Concrete."
III-2-A90	CC-2131.3.1 & Footnote 10 Laboratory Accreditation for Testing Concrete Constituents	This revision provides that laboratories testing concrete constituents must meet the provisions of ASTM C 1077-87, "Standard Practice for Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation." The purpose of the change is to assure the use of properly qualified laboratories and personnel.
III-2-A90	CC-2232, CC-2233, Table CC-2233.1.2-1, Table CC-2233.2.2-1 Selection of Concrete Mix Proportions	This revision was made to make the provisions concerning concrete mix proportions consistent with the existing ACI-318 Building Code requirements. The change also addresses concerns raised by the American Concrete Institute in a report titled "Special Awareness Concerning Structural Mass Concrete."
III-2-A90	CC-5211, Footnote 4 Laboratory Qualification	This revision provides that tests which are required by CC-5200 are to be performed by an accredited laboratory that complies with ASTM C 1077, "Standard Practice for Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation."
III-2-A90	CC-2231.3 Alkali Content	This revision adds provisions for a program to control alkali content when known reactive materials are present in the aggregate.

NRC RAI 3.8-5, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

GE identified 13 items in their comparison table where the criteria in the 2004 edition of the Code is considered to be a relaxation of the 1989 Code. For each reduction in requirements tabulated in the table, GE needs to submit its technical basis for concluding that an equivalent level of safety will be achieved. Parts a), b) and c) are Acceptable.

During the audit, GE provided an update to the Table which provides the explanation for these items. Some of the 13 items do not apply to ESBWR which is acceptable. GE indicated that for the remaining items, they will provide additional technical information to justify these items.

GE Response

The comparison table provided in the original response under MFN 06-298 where the criteria in the 2004 edition of the ASME Section III Code is considered to be a relaxation of the 1989 edition is updated as follows in Table 3.8-5 (1) R1. Please note that none of the changes reduce the levels of previous conservatisms in the ASME Section III 1989 edition.

DCD Impact

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

Table 3.8-5 (1) R1 Reductions in Requirements from 1989 Edition to 2004 Edition

Affecting Addenda after 1989 Ed.	**Affected chapters**	**REDUCTIONS IN REQUIREMENTS:** ***differences with ASME 1989 Edition, and Technical Basis for concluding that an equivalent level of safety will be achieved***	**Explanation/Justification** ***None of the changes reduce the levels of previous conservatism in the Code***
III-1-A99 (BC98-563) (2/99)	NCA-1140(a)(2) Code Edition and Addenda Permitted for Construction	This revision permits the use of the latest Edition and Addenda endorsed by the regulatory authority having jurisdiction at the plant site at the time the construction permit application is docketed. This change incorporates the provisions of Case N-608, "Applicable Code Edition and Addenda, NCA-1140(a)(2), Section III, Division 1."	These provisions have been accepted by the USNRC, in its endorsement of the 1999 Addenda of Section III, Subsections NB, NC, and ND.
III-1-A97 (97-200)	NCA-8320, NCA-8321, NCA-8322 Use of N-Symbol Stamp at Field Locations	This revision rewrites the paragraph to clarify the provisions by placing the requirements in two paragraphs. NCA-8322 addresses the application of the Stamp in the field without requiring extension of the Certificate of Authorization to the site, when only a pressure test is involved. The change also addresses subcontracting the pressure test.	These provisions have been accepted by the USNRC, in its endorsement of the 1999 Addenda of Section III, Subsections NB, NC, and ND.
III-1-A04 (BC03-765)	NE-3352.2(b), NE-5280(b) Examination of Category B Butt Welds in Electrical Penetrations	This revision provides for the use of liquid penetrant examination or magnetic particle examination of root pass and the surface of the completed weld as an alternative to the radiographic examination requirements for Category B butt welds in electrical penetration assemblies. It also adds an allowable stress reduction factor and limits the base materials that can be used to P-No. 1 materials. The revision incorporates the provisions of Case N-505, "Alternative Rules for the Examination of Butt Welds Used as Closure Welds for Electrical Penetration Assemblies in Containment Structures, Section III, Division 1."	These provisions have been accepted by the USNRC, in Case N-505, in Regulatory Guide 1.84, Rev. 33.
III-1-A02 (BC00-771)	NE-2331, NE-2431, NE-4335 Impact Testing of Heat Affected Zone (HAZ)	Changes in steel making technology have enabled materials to be supplied with much better impact toughness properties than in the past. One problem associated with this is that it does not take much heat input to reduce the toughness of the HAZ to levels below the unaffected base material. This results in the need for more testing and test coupons. This revision allows three methods of qualifying the HAZ. 4) An upward adjustment of RT_{NDT}, which was the original basic method. 5) Downward adjustment in test temperature, which is currently permitted, but	These provisions have been accepted by the USNRC, in its endorsement of the 2002 Addenda of Section III, Subsections NB, NC, and ND

Affecting Addenda after 1989 Ed.	**Affected chapters**	**REDUCTIONS IN REQUIREMENTS:** ***differences with ASME 1989 Edition, and Technical Basis for concluding that an equivalent level of safety will be achieved***	**Explanation/Justification** ***None of the changes reduce the levels of previous conservatism in the Code***
		requires many tests for the development of the transition curves. This is difficult when using existing materials, without enough coupons. 6) Evaluation of actual material impact toughness test data with an adjustment upward of the toughness acceptance criteria to compensate for the loss of toughness shown on the Welding Procedure Specification (WPS). This can be used with existing material or new material. These changes include a 15F penalty without further test data. This alternative is based on many years of testing. An exemption is also provided for gas tungsten arc welding (GTAW) weld metal with a maximum of two layers for the HAZ.	
III-1-A02 (BC01-613)	Table NE-2121(a)-1 Addition of SA-738 Material	This revision permits the use of SA-738, Grade B material for construction of containment vessels. This material is a P-1, Group 3 ferritic material. The change incorporates the provisions of Case N-655, "Use of SA-738, Grade B for Metal Containment Vessels, Class MC, Section III, Division 1."	These provisions have been accepted by the USNRC, in its endorsement of the 2002 Addenda of Section III, Subsections NB, NC, and ND.
III-1-A00	NE-4000 Standard Weld Procedure Specifications (SWPS)	Standard Weld Procedures Specifications were added to Section IX in the A00 Addenda. These SWPSs are acceptable for use in Section III by reference to Section IX. Highlights of the Section IX (QW-500) requirements are: 5) Not all AWS SWPSs are permitted. 6) A demonstration test coupon must be welded and tested; QW-520 lists specific information that must be recorded as part of the demonstration. 7) SWPSs must be used exactly as they are written; there are no "nonessential variables" when using SWPS. 8) The applicable fabrication document (i.e., construction code, customer specification, etc.) and the demonstration test number must be shown on the SPWS, and it must be signed and dated by the manufacturer or contractor.	These provisions have been accepted by the USNRC, in its endorsement of the 2000 Addenda of Section III, Subsections NB, NC, and ND.

Affecting Addenda after 1989 Ed.	**Affected chapters**	**REDUCTIONS IN REQUIREMENTS:** ***differences with ASME 1989 Edition, and Technical Basis for concluding that an equivalent level of safety will be achieved***	**Explanation/Justification** ***None of the changes reduce the levels of previous conservatism in the Code***
III-1-A99 (BC98-414) (12/98)	NE-3226, NE-6221 Test Limits	The purpose of this revision is to remove inconsistencies in the rules for testing. The change provides that a stress analysis for the test condition is not required unless the test pressure at some point in the vessel exceeds the required test pressure by more than six percent. For Class 1 components, the change reduces the pneumatic test pressure from 1.2 to 1.1 times the design pressure. The change also reduces the hydrostatic test pressure for Class 2 and 3 components from 1.5 to 1.25 times the design pressure, and the pneumatic test pressure from 1.25 to 1.1 times the design pressure. For Class MC containment vessels, the hydrostatic test pressure was reduced from 1.35 to 1.2 times the design pressure. These changes compensate for the reduction in design factor from 4 to 3.5 that was made to increase allowable stresses in Section II, Part D, Table 1A and Table 1B for Class 2 and 3 components. The pneumatic test pressure for containment vessels was not changed.	These provisions have been accepted by the USNRC, in its endorsement of the 1999 Addenda of Section III, Subsections NB, NC, and ND.
III-1-A99 (BC98-571) (2/99)	NE-5279, NE-5280 Special Exemptions to Radiography	Previously these paragraphs provided rules for special exemptions to radiographic examination when weld joint details did not permit a meaningful examination. This revision changes the requirements to be consistent for all subsections. The effect of the change is to allow exceptions to radiography whenever radiographic examination is not practical.	These provisions have been accepted by the USNRC, in its endorsement of the 1999 Addenda of Section III, Subsections NB, NC, and ND.
II-D-A99 (BC98-165)	TABLE 1A, TABLE 1B STRESS TABLES Reduced Design Factor	This revision significantly increased all allowable stress values in these tables by reducing the design factor on tensile strength from 4 to 3.5. There was no change in the factor on yield strength, so not all allowable stresses are changed. The increase in allowable stress decreases as the design temperature increases. The increase in allowable stress is not dependent on any change in design formulas, nondestructive examination, or material properties. The main reason for the change is to be more consistent with the allowable stresses used in Europe and other parts of the world. The change will make the use of the ASME Code more competitive in the	These provisions have been accepted by the USNRC, in its endorsement of the 1999 Addenda of Section III, Subsections NC and ND.

Affecting Addenda after 1989 Ed.	Affected chapters	**REDUCTIONS IN REQUIREMENTS:** ***differences with ASME 1989 Edition, and Technical Basis for concluding that an equivalent level of safety will be achieved***	**Explanation/Justification** ***None of the changes reduce the levels of previous conservatism in the Code***
		international market on an economical basis. This change incorporates the provisions of Case 2278, "Alternative Method for Calculating Maximum Allowable Stresses Based on a Factor of 3.5 on Tensile Strength, Section II and Section VIII, Division 1," Case 2290, "Alternative Maximum Allowable Stresses Based on the Factor of 3.5 on Tensile Strength, Section II, Part D, and Section VIII, Division 1," and Case 2284, "Alternative Maximum Allowable Stresses for Section I Construction Based on a Factor of 3.5 on Tensile Strength, Section I." To make this change, all of the Stress Tables were reviewed, and many changes were made to correct chemistry designations, product forms, external pressure chart references, heat treatments, and Notes. Also, many stress lines were merged. Changes to the Stress Tables, not directly associated with the change in the design factor used to determine allowable stresses, are identified with separate comments. In a number of places, the Summary of Changes printed with the Addenda identified materials as being deleted that were not. It only appeared that way because the stress lines were merged. The National Board of Boiler and Pressure Vessel Inspectors permits the use of the new allowable stresses for rerating pressure retaining equipment now in service that was produced to ASME Codes as far back as the 1968 Edition of the ASME Code. Provisions for doing this are given in National Board Interpretation 98-14. ERROR: Appendix 1, 1-100(a)(1), 1-100(a)(2), and Table 1-100 should have been revised to show the change in the design factors. Corrected by Special Notice.	
III-1-A97 (96-250)	Table NE-4622.7(b)-1	This change allows an exemption from postweld heat treatment for welds attaching nozzles and penetrations up to and including NPS 12.	The exemption is limited to P-No. 1 material; the shell and

Affecting Addenda after 1989 Ed.	Affected chapters	**REDUCTIONS IN REQUIREMENTS:** ***differences with ASME 1989 Edition, and Technical Basis for concluding that an equivalent level of safety will be achieved***	**Explanation/Justification** ***None of the changes reduce the levels of previous conservatism in the Code***
	Exemptions to Mandatory Postweld Heat Treatment		nozzle thickness do not exceed 1-1/2 in.; the preheat and carbon content limits are identical to the limits for exemption of other welds in P-No. 1 materials; and nozzle diameter is irrelevant to the need for PWHT.
III-1-A95 (94-305)	NE-7726 Proration of Valve Capacity	This revision provides for proration of valve capacities to pressures greater than the pressure to which the valve capacity was certified.	These provisions have been accepted by the USNRC, in its endorsement of the 1995 Addenda of Section III, Subsections NB, NC, and ND.
III-1-A95 (94-316)	NE-3221.1(c)(1) Stress Intensity Values	This change allows, under limited conditions, an increase in the primary membrane stress for Service Level D Limits, up to the maximum value permitted for Service Level C Limits.	This is a small increase in allowable stress and is limited to no more than the allowable stress for Service Level C Limits, which are otherwise generally lower than the allowable stress for Service Level D Limits.
III-1-A93	NE-2545.3(b), NE-2545.3(b)(3), NE-2545.3(b)(4), NE-2546.3(b), NE-2546.3(b)(3),	This change clarifies the NDE acceptance criteria and provides consistency with NB-2576(c), NB-2677(c), NC-2576(c), NC-2677(c), ND-2576(c), ND-2677(c), NE-2576(c), NE-2677(c), NG-2576(c), and NG-2677(c). The significant change is to refer to only "relevant" indications.	These provisions have been accepted by the USNRC, in its endorsement of the 1987 Addenda of Section III, Subsections NB, NC, and ND.

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: *differences with ASME 1989 Edition, and Technical Basis for concluding that an equivalent level of safety will be achieved*	Explanation/Justification *None of the changes reduce the levels of previous conservatism in the Code*
	NE-2546.3(b)(4) Acceptance Standards		
III-1-A92	NE-5112 Nondestructive Examination Procedures	This revision provides for the digitization of radiographic film and radioscopic images in accordance with the provisions of Section V, Article 2, Appendix III.	These provisions have been accepted by the USNRC, in its endorsement of the 1992 Addenda of Section III, Subsections NB, NC, and ND.
II-D-1992 Edition	TABLE 1A SECTION III-1, Class MC	Corrected Stress Values for SA-516 - 55 (K01800) from 15.1 ksi to 15.2 ksi.	The prior values were incorrect.
III-1-A91 (91-208)	NE-7512, NE-7721.3, NE-7724.2(a) Tolerances on Pressure Relief Valves	This revision increases the set pressure tolerances for pressure relief valves.	These provisions have been accepted by the USNRC, in its endorsement of the 1991 Addenda of Section III, Subsections NB, NC, and ND.
III-1-A90	NE-2510 Attachment Material	This revision deletes the requirement for examining the attached material in the same manner as the pressure retaining material to which it is welded. (TECHNICAL ERRATA to A87)	These provisions have been accepted by the USNRC, in its endorsement of the 1990 Addenda of Section III, Subsections NC and ND.
III-1-A90	Table NE-3132-1 Dimensional Standards	- Updated: ANSI B1.20.3-76 (R82) ANSI B16.5 to 88 This change extended nickel alloy ratings to higher temperatures,	These provisions have been accepted by the USNRC, in its endorsement of the 1990 Addenda of Section III,

Affecting Addenda after 1989 Ed.	**Affected chapters**	**REDUCTIONS IN REQUIREMENTS:** ***differences with ASME 1989 Edition, and Technical Basis for concluding that an equivalent level of safety will be achieved***	**Explanation/Justification** ***None of the changes reduce the levels of previous conservatism in the Code***
		clarified flat face flange requirements, updated the referenced standards, and made other minor editorial revisions. Metric equivalents were deleted. ANSI B16.9 to 86 ANSI B16.11 to 80 ANSI B16.25 to 86 ANSI B16.28 to 86 ANSI B18.2.2 to 87 ANSI B18.3 to 86 ANSI B36.10 to 85 ANSI B36.19 to 85 ANSI B16.34 to 88 The scope of the standard was increased by the addition of socket welded end and threaded end valves. The listings for nickel alloy and other alloy valve materials were expanded. Also, rules for threaded body joints were added and wafer-type valve body rules were revised. MSS SP-43 to 82 (R86) MSS SP-44 to 85	Subsections NB, NC, and ND.
III-1-A90	Table I-10.1 Stress Tables for Class MC Ferritic Steels	- Added: SA-738 - C (to 2-1/2 in.) (TS/YS = 80/60) (2-1/2 in. to 4 in.) (TS/YS = 75/55) (4 to 6 in.) (TS/YS = 70/46) - Changed designation for: SA-738 - ... to SA-738 - A (K12447)	SA-738 Grade C has been accepted by the USNRC, in its endorsement of the 1990 Addenda of Section III, Subsections NC and ND (see Table I-7.1 for permitted materials for Class 2 and 3 applications).

Affecting Addenda after 1989 Ed.	Affected chapters	**REDUCTIONS IN REQUIREMENTS:** ***differences with ASME 1989 Edition, and Technical Basis for concluding that an equivalent level of safety will be achieved***	**Explanation/Justification** ***None of the changes reduce the levels of previous conservatism in the Code***
III-2-A04, III-2 (BC03-472)	CC-4331.2(b)(6), CC-4333.2.3(a), CC-4333.2.3(b), CC-4333.2.4(e)(3), CC-4333.2.4(g), CC-4333.3(b)(6), CC-4333.3(c)(4), CC-4333.3(d)(5), CC-4333.3(f), CC-4333.5.3(b) Cold Rolled Parallel Threaded Splices	This revision adds cold rolled formed parallel threaded splices as an acceptable form of splice. Cold roll formed parallel threaded splices are being widely used in the construction industry. Cold rolled formed parallel threaded splices have a special thread and locknut to lock the coupler. This mechanical splice is limited to cold formed parallel threaded splices to prevent any single threaded rebar from being included, which would not possess the extra cold rolling process. Requirements for locknuts, which need to be used on both ends of the device to prevent loosening and to improve slip performance, are included. A testing requirement for cold rolled parallel threaded splices at 20F is also required.	This revision adds a new type of mechanical splice called a "cold-roll-formed parallel-threaded splice."
III-2-A02 (BC01-698)	CC-4542.1, CC-4542.2 Back-up Bars	This revision deletes the prohibition against the use of back-up bars in Category A and B welded joints.	This is a logical extension of existing requirements in Section VIII Div. 1 to permit the same weld details in containment liners as permitted for pressure shells.
III-2-A01 (2001 Edition) (BC00-182)	CC-4333.2.3 Splicing of Reinforcing Bars-Performance Tests	This revision incorporates the provisions of Case N-363-1, "Splicing of Reinforcing Bars-Performance Tests, Section III, Division 2." The change permits acceptance of performance test results for reinforcing bar mechanical splices when the load extension does not achieve 2% strain. The alternative test results must meet the lesser of 2% strain or 125% of the specified minimum yield strength of the reinforcing bar.	The alternative test provides an alternative way to assure the structural capability of the splices.
III-2-A01 (2001 Edition)	Table CC-4552-2 Postweld Heat	This revision changes the Table to permit containment liners the same PWHT exemptions that were allowed for concrete reactor vessel liners. The change incorporates the provisions of Case N-536, "Alternative to Table CC-4552-2	There is no reduction in requirements when the alternative rules for containment

Affecting Addenda after 1989 Ed.	Affected chapters	**REDUCTIONS IN REQUIREMENTS:** ***differences with ASME 1989 Edition, and Technical Basis for concluding that an equivalent level of safety will be achieved***	**Explanation/Justification** ***None of the changes reduce the levels of previous conservatism in the Code***
(BC00-183)	Treatment Exemptions	Exemptions to Mandatory PWHT Concrete Containment Liner, Section III, Division 2."	liners are the same as for reactor liners. (The USNRC has not endorsed Case N-536.)
III-2-A01 (2001 Edition) (BC00-357)	CC-5531.2 Extent of Examination	This revision removes the requirement to increase number of radiographs of double-sided welds, when a portion of the liner uses backup bars and single-sided welding. This was an arbitrary requirement intended to discourage the use of single-sided welds with backup bars. The change also clarifies that the welds made using back-up bars shall be examined by UT or MT for the full length of the backed-up weld.	The number of radiographs has no effect on assuring acceptable weld quality.
III-2-A00 (BC00-005)	CC-2231.4 Specified Concrete Properties	This revision provides conditions under which the required creep testing of CC-2231.4, may be delayed. The change incorporates the provisions of Case N-529 "Creep Testing, Section III, Division 2."	It takes about 28 days for concrete to set. However, early in that time frame, it is possible to accurately evaluate the creep of the concrete based on early tests. This is common industry practice. Not applicable to the ESBWR RCCV. (The USNRC has not endorsed Case N-529.)
III-2-A00 (BC00-006)	CC-3543(a) Tendon Anchor Reinforcement	CC-3543(a) requires that reinforcement "be located starting not more than 2 inches from the bearing plate and not extending more than twice the minimum bearing plate width." This revision provides conditions under which that requirement can be waived. The change incorporates the provisions of Case N-488, "Design of Tendon and Anchorage Reinforcement, Section III, Division 2."	Not applicable to ESBWR.
III-2-A00 (BC00-007)	CC-4432.5 Twisting and Coiling Prestressing Tendons	This revision provides an alternative to the provisions of CC-4432.5 regarding intentional twisting for all horizontal circumferential tendons comprised of multiple elements. The change incorporates the provisions of Case N-487, "Twisting of Horizontal Prestressing Tendons, Section III, Division 2."	Not applicable to ESBWR

Affecting Addenda after 1989 Ed.	**Affected chapters**	**REDUCTIONS IN REQUIREMENTS:** ***differences with ASME 1989 Edition, and Technical Basis for concluding that an equivalent level of safety will be achieved***	**Explanation/Justification** ***None of the changes reduce the levels of previous conservatism in the Code***
III-2-A96 (96-55)	CC-3740, CC-3750 Penetration Assemblies, Brackets and Attachments	Previously, Division 2 limited attachment loads in the through-thickness direction of plate. This revision eliminates that restriction and allows the full strength of the plate to be used in the through-thickness direction. This is a continuation of the similar change started in the 1995 Addenda.	Similar provisions in Section III, Division 1, Subsection NF have been permitted for Class 1, 2, and 3 supports by USNRC endorsement on the Winter 1982 Addenda.
III-2-A95 (94-309)	CC-3750(b), CC-4543.6, Fig. CC-4543.6-1, Fig. CC-4543.6-2 Through-Thickness Loads	The Code restricted allowable stresses in liners to one-half of the allowable stress for tensile loads normal to the liner, because of lamellar tearing, laminations, and through-thickness strength. Because of improved steel melting practices and examination techniques, the one-half factor has been eliminated. This revision provides new requirements that must be met when liner materials one inch and greater in thickness are loaded in the through-thickness direction. When loaded in this direction, the materials must meet the acceptance standards of SA-770, "Through-Thickness Tension Testing of Steel Plates for Special Applications." Special welding procedure qualifications are required, and must use either inlays or overlays, or special weld deposition techniques. After completion of welding, the base metal underneath the attachment weld must be ultrasonically examined. Special examination methods and acceptance standards are provided. This revision is similar to changes made to Section III, Division 1, Subsection NF in the Winter 1978 and Winter 1982 Addenda.	Similar provisions in Section III, Division 1, Subsection NF have been permitted for Class 1, 2, and 3 supports by USNRC endorsement on the Winter 1982 Addenda.
III-2-A95 (94-306)	CC-4331.2(b)(5), CC-4333.2.3(a), CC-4333.2.4(f), CC-4333.3(e), CC-4333.4, CC-4333.5.3(a)	This revision adds provisions for a new mechanical reinforcing bar splice. The new splice is identified as a "sleeve with cementitious grout splice." The splice has been evaluated for use by building officials organizations and found to meet the requirements of ACI-318.	This splice has been in use for more than ten years and meets the requirements of ACI-318, which has served as the basis for the Section III, Division2 Concrete Code.

Affecting Addenda after 1989 Ed.	Affected chapters	REDUCTIONS IN REQUIREMENTS: *differences with ASME 1989 Edition, and Technical Basis for concluding that an equivalent level of safety will be achieved*	Explanation/Justification *None of the changes reduce the levels of previous conservatism in the Code*
	Splicing of Reinforcing Bars		
III-2-A93	CC-4532.2.1 Group Identification of Welders to Weld Joints	The revision allows multiple welds to have group identification for the purposes of verifying that all welders and welding operators were properly qualified. Previously, this group identification was only allowed for structural attachment welds. This revision incorporates the provisions of Case N-507, "Identification of Welders, Section III, Division 2."	The USNRC previously approved these provisions through endorsement of Case N-507 in RG 1.84, Rev. 32.
III-2-A92	Table CC-2160-1, Note (2), Codes, Standards, and Specifications Referenced in Text Dimensional Standards	This revision updates the listed standards and moves the dates to "Codes, Standards, and Specifications Referenced in Text." Pipes and Tubes - Updated: ASME B36.10 to M85 ASME B36.19 to M85 Fittings, Flanges and Gaskets - Deleted: ANSI B70.1 Refrigeration Flare Type Fittings - Updated: ASME B16.5 to 88 Comments on the changes to this standard can be found in the RA-search data base Rev_B31. ASME B16.9 to 86 ASME B16.11 to 80 ASME B16.21 to 78 ASME B16.25 to 86 ASME B16.28 to 86	These provisions have been accepted by the USNRC, in its endorsement of various early-1990's Editions and Addenda of Section III, Subsections NB, NC, and ND. Most of the changes are editorial.

Affecting Addenda after 1989 Ed.	Affected chapters	**REDUCTIONS IN REQUIREMENTS:** ***differences with ASME 1989 Edition, and Technical Basis for concluding that an equivalent level of safety will be achieved***	**Explanation/Justification** ***None of the changes reduce the levels of previous conservatism in the Code***
		- Titles for Standards were changed to: ASME B16.5 Pipe Flanges and Flanged Fittings ASME B16.21 Nonmetallic Flat Gaskets for Pipe Flanges AWWA C207 Standard for Steel Pipe Flanges for Waterworks Services Bolting - Titles for Standards were changed to: ASME B18.2.1 Square and Hex Bolts and Screws (Inch Series) Including Hex Cap Screws, and Lag Screws ASME B18.2.2 Square and Hex Nuts (Inch Series) ASME B18.3 Socket Cap, Shoulder, and Set Screws (Inch Series) - Updated: ASME B18.2.2 to 87 ASME B18.3 to 86 Threads - Updated: ASME B1.1a to 84 - Changed Standard Numbers from: ANSI B2.1 to ASME B1.20.1-83 Pipe Threads, General Purpose (Inch) ANSI B2.2 to ASME B1.20.5-78 (R80) Gaging for Dryseal Pipe Threads (In.) Valves - Updated: ASME B16.34 to 88 Comments on the changes to this standard can be found in the RA-search data base Rev_B31. - Titles for Standards were changed to:	

Affecting Addenda after 1989 Ed.	**Affected chapters**	**REDUCTIONS IN REQUIREMENTS:** ***differences with ASME 1989 Edition, and Technical Basis for concluding that an equivalent level of safety will be achieved***	**Explanation/Justification** ***None of the changes reduce the levels of previous conservatism in the Code***
		ASME B16.34 Valves - Flanged, Threaded, and Welded End This revision corrects the title of the dimensional standards to ASME because they are no longer subject to approval by ANSI. This revision also deletes the revision year from Table CB-2160 and CC-2160 because the revision dates are now given in, "Codes, Standards, and Specifications Referenced in Text," located at the end of the book.	
III-2-A92	Codes, Standards, and Specifications Referenced in Text	- Deleted: ANSI B2.1 Pipe Threads (Except Dryseal) ANSI B2.2 Dryseal Pipe Threads ANSI B70.1-60 Refrigeration Flare Type Fittings - Added: ANSI B1.20.1-83 Pipe Threads (Except Dryseal) ANSI B1.20.5-78 (R80) Gaging for Dryseal Pipe Threads - Updated: ANSI B1.1 to ASME B1.1a-84 ANSI B16.5 to ASME B16.5-88 Comments on the changes to this standard can be found in the RA-search data base Rev_B31, and are available upon request. ANSI B16.9 to ASME B16.9-86 ANSI B16.11 to ASME B16.11-80 ANSI B16.20 to ASME B16.20 ANSI B16.21 to ASME B16.21 ANSI B16.25 to ASME B16.25-86 ANSI B16.28 to ASME B16.28-86 ANSI B16.34 to ASME B16.34-88 Comments on the changes to this standard can be found in the RA-search data base Rev_B31, and are available upon request.	These provisions have been accepted by the USNRC, in its endorsement of various early-1990's Editions and Addenda of Section III, Subsections NB, NC, and ND. Most of the changes are editorial.

Affecting Addenda after 1989 Ed.	**Affected chapters**	**REDUCTIONS IN REQUIREMENTS:** ***differences with ASME 1989 Edition, and Technical Basis for concluding that an equivalent level of safety will be achieved***	**Explanation/Justification** ***None of the changes reduce the levels of previous conservatism in the Code***
		ANSI B18.2.1 to ASME B18.2.1 ANSI B18.2.2 to ASME B18.2.2-87 ANSI B18.3 to ASME B18.3-86 ANSI B36.10 to ASME B36.10M-85 ANSI B36.19 to ASME B36.19M-85	
III-2-A91 (91-222)	CC-4321.1(c), CC-4321.2, CC-4322(a) Bending of Reinforcing Bar	This revision changes the rules for bending reinforcing bar to conform to the provisions of ACI 318-89. The change provides that the minimum diameter of the bend in the bar and the extension length are dependent on the diameter of the reinforcing bar being bent. This revision removes the change made in the 1990 Addenda.	This change is consistent with the provisions of ACI-318.
III-2-A91	CC-5536.2 Leak Chase System	This revision allows leak chase channels to be tested by air using the "maintenance of pressure" method. The change incorporates the provisions of Case N-231, "Alternate Methods for Leak Detection in the Attachment Weld to Leak Chase Channels for Section III, Division 2, Class CC Construction."	The USNRC previously approved these provisions through endorsement of Case N-231 in RG 1.84, Rev. 32.
III-2-A90	CC-2242.5, CC-2242.6 Use of Prepackaged General Purpose Cement Grouts	This change incorporates the provisions of Case N-384-1, "Use of Prepackaged General Purpose Cement Grouts, Epoxy Grouts, and Epoxy Bonding Materials, Section III, Division 2, Class CC." The Case permitted the use of prepackaged grouts and bonding materials in lieu of materials mixed at site.	The USNRC previously approved these provisions through endorsement of Case N-384-1 in RG 1.84, Rev. 32.
III-2-A90 (90-174)	CC-4240(c), CC-4240(d), CC-4260 Cold Weather Concrete Placement	This revision provides a definition for cold weather concrete placement and clarifies the requirements for these conditions. The revision changes the period of temperature control at the surface of the concrete from seven days to three days.	This change allows slower curing of the concrete, if the temperature falls below 32F.

NRC RAI 3.8-7

Explain where leak rate test loads are included in the load definitions presented in DCD Section 3.8.1.3. ASME BPVC, Subsection CC-3320, places this load as part of the load P_t *and* T_t*, however, these loads do not appear in the definition of the preoperational loads* P_t *and* T_t *described in DCD Section 3.8.1.3.2.*

GE Response

The leak rate test (LRT) loads are included in the pre-operational testing loads. Because the magnitude of the LRT pressure is less than that of the structural integrity test (SIT), the LRT loads are not explicitly included in the analysis. The LRT and SIT pressures can be readily compared in DCD Section 6.2.6.1, DCD Table 1.3-3 and DCD Table 3G.1-7.

No DCD change was made in response to this RAI.

NRC RAI 3.8-7, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

Discuss with GE. The LRT pressures could not be identified in DCD Section 6.2.6.1, DCD Table 1.3-3 and DCD Table 3G.1-7 for comparison with the SIT. Even if the LRT loads are less than the SIT loads, the definition of Pt and Tt in DCD Section 3.8.1.3.2 should define these test loads as SIT and LRT. In the DCD load combinations and load definitions, no other loads are eliminated because they might be less than some other load.

During the audit, GE provided a draft supplement to this RAI which indicates that the DCD will be revised to include the subject LRT pressure loads.

GE Response

DCD Tier 2 will be revised to include the subject SIT and LRT pressure loads as committed above.

DCD Impact

DCD Tier 2 Subsection 3.8.1.3.2 will be revised in the next update as noted in the attached markup.

NRC RAI 3.8-9

Provide a description of the different subcategories for SRV discharge (e.g., single valve, two valve, automatic depressurization system (ADS), and all valves) and for LOCA (large, intermediate, and small) if applicable, and how they are treated in the load combinations described in DCD Section 3.8.1.3. Also, provide a description and the basis for the method used to combine all of the dynamic loads.

In addition, (1) identify the applicable detailed report/calculation (number, title, revision and date, and brief description of content) that will be available for audit by the staff, and (2) reference this report/calculation in the DCD.

GE Response

LOCA (large, intermediate, and small break) and SRV discharges (single valve first actuation, single valve subsequent actuation, and multiple valves) are discussed the in Containment Load Definition (CLD) - NEDE-33261P. The bounding pressure and temperature values are used respectively as accident pressure P_a and LOCA temperature T_a in load combinations for design. The bounding pressure values are used as SRV loads for design. The SRV pressure values for these three limiting conditions (single valve first actuation, single valve subsequent actuation, and multiple valves) are furnished in Table 6 of NEDE-33261P. The multiple valve case bounds ADS. The SRV pressure values for these three limiting conditions cover the different subcategories of SRV discharge (e.g., single valve, two valve, ADS, and all valves). The bounding values of these three limiting conditions are shown in DCD Figure 3B-1 and are considered as SRV loads in DCD Subsections 3.8.1.3 and in the load combination DCD Tables 3.8-2, 3.8-4 and 3.8-7. Depending on the distribution of SRV loads in the suppression pool, they are further classified as axisymmetrical loads, or non-axisymmetrical loads. The SRV pressure loads are applied throughout the entire suppression pool as axisymmetrical SRV (DCD Subsection 3.8.1.4.1.1.2), which represents all of the (or multiple) valve cases. The SRV pressure loads are applied on half of the entire suppression pool as non-axisymmetrical SRV (DCD Subsection 3.8.1.4.1.1.1), which represents the single valve or two-valve case. Because the total load for the axisymmetrical SRV load case is greater than those for the non-axisymmetrical cases, only the former is considered in the RCCV and vent wall design. The design evaluation of the affected structures for SRV loads is performed using equivalent static pressure input equal to a dynamic load factor (DLF) of 2 times the peak dynamic pressure (i.e., the bounding values). The resulting forces or stresses were combined with those due to other loads in the most conservative manner by systematically varying the signs associated with dynamic (including seismic) loads. (See also response to RAI 3.8-48).

The SRV pressure time history and other related information is presented in DCD Appendix 3B. The SRV forcing function as defined in DCD Appendix 3B and the CLD (NEDE-33261P) has a range between 5 to 15 Hz. To perform dynamic analyses to generate response spectra, a finite number of cases using various forcing function frequencies are selected to match with the natural frequencies of the structure to maximize the responses and is described in DCD Appendix 3F as follows:

Axisymmetrical SRV (all) response analysis is covered by n=0 harmonic. Non-axisymmetrical of SRV actuation is covered by n=1 harmonic that corresponds to the effect of the overturning moment.

Frequency range of SRV Loads: $f_1 \leq f \leq f_2$ ($f_1 = 5$ Hz, $f_2 = 12$ Hz)

For vertical structural frequencies $(fs)_v$ (n=0):

a. If $(fs)_v > f_2$ then use f_2
b. If $f_1 < (fs)_v < f_2$ then use $(fs)_v$
c. If $f_1 > (fs)_v$ then use f_1

For horizontal structural frequencies $(fs)_h$ (n=1):

a. If $(fs)_h > f_2$ then use f_2
b. If $f_1 < (fs)_h < f_2$ then use $(fs)_h$
c. If $f_1 > (fs)_h$ then use f_1

In an axisymmetrical load case, three vertical frequencies of 5 Hz, 6.06 Hz and 12 Hz are selected. In a non-axisymmetrical load case, 3 horizontal frequencies of 5 Hz, 8.83 Hz and 12 Hz, of the structure satisfying the above selection are adopted as SRV forcing function frequencies.

The bounding response spectra of these cases are documented in DCD Appendix 3F. They are to be used with the response spectra due to seismic and other hydrodynamic loads for the design of safety-related structures, systems, and components inside of containment using the SRSS method of combination.

(1) The applicable detailed report/calculation that will be available for the NRC audit is:

    NEDE-33261P, *Containment Load Definition, Revision 1*, May 2006, containing the description of the hydrodynamic loads.

(2) Since this information exists as part of GE's internal tracking system, it is not necessary to add it to the DCD submittal to the NRC.

Markup of DCD Section 3.7 was provided under MFN 06-298.

NRC RAI 3.8-9, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

a) *If NEDE-33261P indicates that SRV has a range of 5 to 15 Hz, why does the analysis only consider a range of 5 to 12 Hz.*

b) *Are the values 6.06 and 8.83 the fundamental natural frequencies of the structure in the vertical and horizontal direction respectively?*

c) *Provide a comparable description for selecting the appropriate forcing functions for the different LOCA loads (chugging, CO, pool swell, AP, vent clearing, etc.)*

d) *Since this is done for generation of floor response spectra throughout the building (not just local containment response), aren't there other structural natural frequencies that should be considered?*

e) *GE provided a markup to 3.7 (first paragraph) where it states that the method for combining seismic and RBV loads for reinforced concrete structures varies the sign (+ or -), equivalent to ABS. This is acceptable for reinforced concrete structures. However, it also states that the method used (presumably for all other SSCs) is the SRSS in accordance with NUREG-0484., Rev. 1. This is acceptable for seismic plus LOCA; however, the criteria for combining other dynamic loads (e.g., SRV and individual LOCA loads (AP, PS, CO, CH, LCO, HVL, etc) are not clearly defined. According to NUREG-0484, the use of SRSS for the other loads would require demonstrating a non-exceedance probability (NEP) of 84 percent or higher is achieved. Some of this information may be implied and buried within various scattered sections of the DCD (e.g., response spectra for some of the loads in App. 3F; however, the criteria should be clearly specified in one location. e) If time permits during the audit, the referenced NEDE report should be looked at, not for development of the loads (not within BNL's scope) but for proper application of the defined loads to the plant structures. Note: This is also identified as an RAI (RAI-3.12-17) during the piping review of DCD Section 3.9.*

During the audit, GE provided a draft supplemental response to this RAI. The staff needs to review this information. The response for items a, b, c, and d are acceptable. For item e, GE needs to provide documentation which describes the use of the SRSS method based on demonstrating that the NEP criteria was met.

GE Response

a) Frequency range of 5 to 15 Hz, as stated in the original response, was a typographical error. NEDE-33261P, page 6-5 specifies the bubble frequency range to be 5 to 12 Hz.

b) Yes, 6.06 and 8.83 Hz are the fundamental frequencies of the structure in the vertical and horizontal directions respectively.

c) Sixteen chugging and five CO cases, as described in DCD Tier 2 Subsection 3F.2.3 (4), cover the entire range of forcing functions, and there is no need to select specific structural frequencies.

d) The dynamic analysis model includes all structures in the reactor building. The resulting natural frequencies of 6.06 and 8.83 Hz are the only structural frequencies within the SRV forcing frequency range of 5 to 12 Hz.

e) ESBWR hydrodynamic loads are the same as the ABWR. The ABWR loads satisfy the 84-percentile non-exceedance (NEP) requirement of NUREG-0484, Rev. 1 as shown in the following memorandum that documents the applicability of the SRSS method for hydrodynamic loads.

Confirmation of Hydrodynamic Loads

Reference:
1. Letter, GE-1997-0731, U.C. Saxena to Ai-Shen Liu, Confirmation of Hydrodynamic Loads, dated 12/19/97
2. Response of Structures Due to Containment Loads, 299X700-001, Rev. 2
3. Containment Load, 299X701-030, Rev. 1
4. FOAKE Containment Accident Response Calculations Report, 24156-1A10-1820, Rev. 0

As a follow-up to my letter (Reference 1), additional analyses were performed to determine and confirm applicability of hydrodynamic loads for Lungmen application. Conclusion results from these analyses are summarized in this letter.

1. **SRSS in Combining Dynamic Loads**

NUREG-0484, Rev. 1 allows SRSS combination of dynamic loads, if these loads meet the Condition B (i). This condition requires that the loads must have an 84% non-exceedance probability or have a load magnitude which is 1.15 times the median, whichever is greater.

Results from the additional analyses confirm that SRV/CO/Chugging loads described in Reference 3 and used in Reference 2, meet the Condition B (i) of NUREG-0484, Rev. 1.

This letter, we hope, addresses your project needs. If you have any questions, please let us know. Evidence of verification is contained in DRF U71-00024/18.

DCD Impact

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

NRC RAI 3.8-10

Please confirm that application of the 100/40/40 method for combining directional responses discussed in DCD Section 3.8.1.3.6 is consistent with the staff-accepted method, as delineated in draft regulatory guide DG-1127 issued for public comment February 2005. If not, provide the technical basis for the differences.

GE Response

Refer to RAI 3.7-41 for the same question. The 100/40/40 method used is consistent with DG-1127 requirements.

No DCD change was required in response to this RAI.

NRC RAI 3.8-10, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

Unresolved. GE's implementation of 100/40/40 method is NOT consistent with DG-1127 (RG 1.92). Recently identified and discussed with GE via teleconference on 11/21/06.

This will be discussed under RAI 3.8-107.

GE Response

Please see response to NRC RAI 3.8-107, Supplement 1.

DCD Impact

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

NRC RAI 3.8-12

For the various computer programs described in DCD Appendix 3C, applicable to Seismic Category I structures:

a) *Identify which codes have already been reviewed by the NRC on prior plant license applications. Include the name, version, and prior plant license application. This will minimize the review effort needed during the audit.*

b) *Confirm that the following information is available for each computer program, for staff review during the audit: the author, source, and dated version; a description, and the extent and limitation of the program application; a description of how the computer program has been validated; and the user manuals. For those programs that are not widely recognized and in the public domain, more detailed information (including a summary comparison) is expected, in order to demonstrate that the computer program solutions to a series of applicable test problems are similar to solutions obtained by alternative means such as hand calculations, analytical results published in the literature, other similar computer programs, etc.*

GE Response

a) Among all computer programs described in DCD Appendix 3C, NASTRAN, ABAQUS and ANSYS are commercially available programs. GE has no knowledge as to whether or not they have already been reviewed by the NRC during prior plant license applications.

   The ANACAP-U software, which is a concrete and steel constitutive model for ABAQUS, is written and maintained by ANATECH Corp., San Diego, CA. To the best of our knowledge, ANACAP-U has never been reviewed by the NRC as part of a plant license application. However, the ABAQUS/ANACAP-U software combination has been used in many structural investigations and research projects on nuclear structures, including sponsorship by the NRC, DOE, and EPRI. It has also been used in evaluation of other critical infrastructure projects for the U. S. Army Corps of Engineers and State Departments of Transportation. A list of references for this pedigree of the ANACAP-U software is provided as part of the additional information for verification and validation in Part b of the question below.

b) Validation packages for SSDP-2D, DAC3N and TEMCOM2 were provided in response to RAI 3.7-55. The SSDP-2D validation package will be revised in response to RAI 3.8-107, which is a new RAI identified after the NRC staff audit of DCD Section 3.8.

   For ABAQUS and ANACAP-U, the following information will be made available for staff review during the audit: 1) the authors, versions, and general descriptions of ABAQUS and ANACAP-U, 2) the User's Manuals for the versions of both programs used, 3) general theory basis of the programs for determining extent and limitations of applicability, 4) the Verification Manual for ABAQUS, and 5) the Verification and Validation documentation for the ANACAP-U software.

In addition, copies of the following references will be available for review. These references document application of the ABAQUS/ANACAP-U combination software for projects where comparisons between the analyses (usually blind predictions) and experimental data from structural specimen tests are provided or where third party peer reviews of the work were conducted. These are listed in chronological order:

1. NUREG/CR-5341, *Round-Robin Analysis of the Behavior of a 1:6-Scale Reinforced Concrete Containment Model Pressurized to Failure*, Sandia National Laboratories for U. S. Nuclear Regulatory Commission, 1989. This report documents pre-test analysis predictions using the ANACAP-U software against measured results from the scale model tests.
2. Marlow, R. S., *Analytical Simulation of the 241-A-105 Scale-Model Test*, CSA:RSM:ggb:93/2, Westinghouse Hanford Company, Richland WA, 1993. This document describes use, review, and acceptance of the ABAQUS/ANACAP-U software in simulating a test for loading to collapse of a scale model of a reinforced concrete storage tank. This benchmark of the software was done in qualifying the software for use by the U. S. Department of Energy in structural integrity evaluations of the underground nuclear waste storage tanks at the Hanford Reserve, which included thermal stress considerations at elevated temperatures.
3. Bonnard & Gardel, *Bench Mark on Numerical Analysis of Concrete Structures*, HTR Project – Phase 2, Switzerland, 1994. This document provides comparisons from several concrete analysis software packages for blind analysis predictions against specimen tests.
4. ETL 1110-2-365, *Nonlinear, Incremental Structural Analysis of Massive Concrete Structures*, U. S. Army Corps of Engineers, Washington, D. C., August 1994. This document provides specifications and procedures for performing NISA analysis involving thermal-stress analyses and creep, shrinkage, and aging of concrete for the U. S. Army Corps of Engineers. Based on extensive peer review and testing of the ANACAP-U software, this document specifically identifies the ABAQUS/ANACAP-U software in the requirements for conducting these analyses.
5. EPRI TR-108760, *Validation of EPRI Methodology of Analysis of Spent-Fuel Cask Drop and Tipover Events*, Electric Power Research Institute, Palo Alto, CA, August 1997. This report compares measured g-loads from full scale cask drop tests onto R/C slabs against calculated values using the ANACAP-U software.

6. HVD-MDA-D8110-97-4, *Nonlinear Dynamic Structural Analysis of Hoover Dam Including Modeling of Contraction Joints and Concrete Cracking*, U. S. Department of the Interior, Bureau of Reclamation, Denver, CO, September 1997. HVD-MDA-D8110-97-1, "Executive Summary of the Static and Dynamic Stability Studies of Hoover Dam," U. S. Department of the Interior, Bureau of Reclamation, Denver, CO, May 1998. These reports document the use, review, and acceptance of the ANACAP-U software by the Bureau of Reclamation and an external technical review board in evaluating the seismic stability of the Hoover Dam.

7. NUREG/CR-5671, *Pretest Prediction Analysis and Posttest Correlation of the Sizewell-B 1:10 Scale Prestressed Concrete Model Test*, ANATECH Research Corp for U. S. Nuclear Regulatory Commission, 1998. This report compares analyses using the ANACAP-U software with test data for over-pressurization tests of a prestressed concrete containment vessel (PCCV) model.

8. NUREG/CR-6639, *Seismic Analysis of a Prestressed Concrete Containment Vessel Model*, Sandia National Laboratories for U. S. Nuclear Regulatory Commission, 1999. This report documents the comparisons between ANACAP-U analyses and test results for a series of increasing seismic demands until failure of a prestressed concrete containment vessel (PCCV) model.

9. NUREG/CR-6707, *Seismic Analysis of a Reinforced Concrete Containment Vessel Model*, Sandia National Laboratories for U. S. Nuclear Regulatory Commission, 2000. This report documents the comparisons between ANACAP-U analyses and test results for a series of increasing seismic demands until failure of a reinforced concrete containment vessel (RCCV) model.

10. NUREG/CR-6809, *Posttest Analysis of the NUPEC/NRC 1:4 Scale Prestressed Concrete Containment Vessel Model*, Sandia National Laboratories for U. S. Nuclear Regulatory Commission, 2003. This document provides correlations between ANACAP-U analyses and test data for overpressure failure of a prestressed concrete containment vessel (PCCV) model.

11. *Resistance of Nuclear Power Plant Structures Housing Nuclear Fuel to Aircraft Crash Impact*, EPRI Report (not for public disclosure), Palo Alto, CA, Feb 2003. *Aircraft Crash Impacts at Nuclear Power Plants – Validation of Analysis Methodology*, ANATECH Report ANA-03-0637 to EPRI, 2003. *Aircraft Impacts at Nuclear Power Plants – Analyses for Impacts into BWR Spent Fuel Support Structures*, ANATECH Report ANA-05-0683 to EPRI, 2005. These reports document results of peer-reviewed work using the ANACAP-U software for studies on structural damage to nuclear power plant facilities from aircraft crash impacts.

These reports are not available for review without consent from EPRI. However, the next 2 references in the public domain document some of the validation work performed for the ANACAP-U software used in the studies.

12. James, R. J., Zhang, L., Rashid, Y. R., *Impact of High Velocity Objects into Concrete Structures – Methodology and Application*, Proceedings of 2003 ASME International Mechanical Engineering Congress, Washington, D. C., November 16-21, 2003. This paper provides benchmark comparisons for ANACAP-U analyses with test data for rigid missile impacts on reinforced concrete slabs.

13. James, R. J. and Rashid, Y. R., *Severe Impact Dynamics of Reinforced Concrete Structures*. Proceedings of the 6th European Conference on Structural Dynamics, Paris, France, September 4-7, 2005. This paper provides benchmark comparisons of test data to analytical simulations using the ANACAP-U software for crushable missile impacts on reinforced concrete slabs causing extensive structural damage.

No DCD change was made in response to this RAI.

NRC RAI 3.8-12, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

For all computer programs, identify version (and revision nos. if applicable). NASTRAN and ANSYS are widely used, commercially available, and utilized in prior NPP designs. ABAQUS/ANACAP-U has been applied to a significant number of concrete nonlinear problems both in and outside the US nuclear power industry. (The SSDP-2D validation package has been revised in response to RAI 3.8-107, which is a new RAI identified after the first NRC staff audit of DCD Section 3.8. GE's response to RAI 3.8-107 was submitted on 11/07/06. Staff to review the response prior to next audit.)

The remaining question on SSDP will be discussed under RAI 3.8-107.

GE Response

Please see response to NRC RAI 3.8-107, Supplement 1.

DCD Impact

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

NRC RAI 3.8-15

Describe how all of the pressure loads acting on the containment and internal structures are calculated and applied to the containment. (DCD Section 3.8.1.4.1.1, Appendix 3G.1.5.2.1.7, and Appendix 3B) This should include how axisymmetric and nonaxisymmetric loads are applied and how variations in pressure definition parameters (phasing of maximum pressure on different pool boundary locations, dynamic load factor (DLF), variation in loading function frequencies, etc.) are considered. The description should include pressures due to normal operating, accident pressures, and SRV actuations. Explain if negative pressure loads (i.e., net positive external pressure) acting on the containment can occur and will upward pressure loading on the diaphragm floor develop under any conditions. Appendix 3B – Hydrodynamic Load Definitions needs to be expanded to include this information. Some information is presented in App. 3B, however it appears that much of the description is applicable to response spectra generation using a different model than the NASTRAN finite element model.

In addition, (1) identify the applicable detailed report/calculation (number, title, revision and date, and brief description of content) that will be available for audit by the staff, and (2) reference this report/calculation in the DCD.

GE Response

Figures 3.8-15(1), 3.8-15(2) and 3.8-15(3) show the transient pressure envelopes at DBA, the areas subject to differential pressure between the Reactor Building and Containment, and areas subject to differential pressure between Drywell and Wetwell. Table 3.8-15(1) shows the load combination for design pressure loads. This table shows four load phases considered critical cases for design. Two of these two cases (e.g., 6 min. and 72 hours after LOCA) are presented in the DCD. The DLF is not considered for the pressure loads.

The information for Hydrodynamic loads presented in DCD Figures 3G.1-21 through 23, and DLF=2 is used for SRV, CO and CHUG to cover the variation in loading function frequencies. The use of DLF of 2 is believed to be conservative which will be confirmed by dynamic analysis in the detailed design phase. Only the axisymmetric loads (both positive and negative cases) are considered since they are more severe than nonaxisymmetric loads. The method of load application to the FEM model is shown in Figure 3.8-15(4).

A differential pressure of –20.7 kPad (–3.0 psid) is generated in the RCCV as a result of steam quenching after a break caused by drywell spray actuation. The diaphragm floor (DF) and vent structure are subject to this differential pressure acting from the Wetwell to the Drywell. It is combined with CHUG in the load combination. As presented in the Containment Load Definition (NEDE-33261P), the DF is only subjected to downward pressure differential loading during the pool swell phase.

As for internal structures, the pressure loads acting on them are the same as for the RCCV. In addition, AP loads including pressure on the inner surface of the RSW, nozzle jet, impingement jet and pipe whip restraint loads are applied as nonaxisymmetric loads. The application of AP load is described in DE-OG-0077, *AP Load Evaluation for RSW Model Input Data, Revision 0,* July 2006, which contains how the dynamic response of RSW to AP loads are calculated.

The diaphragm floor (DF) slab is designed to the downward pressure of 35 psid. The DF slab is also subjected to an upward pressure of 3 psid as shown in Figure 3.8-15(3). It is not controlling.

Regarding the vent wall structure, the pressure loads acting on its outer surface are the same as Wetwell portion of the RCCV, and those acting on the inner surface of it are the same as the Drywell portion of the RCCV.

(1) The applicable detailed reports/calculations that will be available for the NRC audit are:

  a. 26A6651, *Reactor Building Structural Design Report, Revision 1*, October 2005, containing the structural analysis and design of Reactor Building structure including RCCV

  b. NEDE-33261P, *Containment Load Definition, Revision 1*, May 2006, containing description of hydrodynamic loads.

  c. DE-OG-0077, *AP Load Evaluation for RSW Model Input Data, Revision 0*, July 2006, which contains how the dynamic response of RSW to AP loads are calculated.

(2) This information exists as part of GE's internal tracking system.

No DCD change was made in response to this RAI.

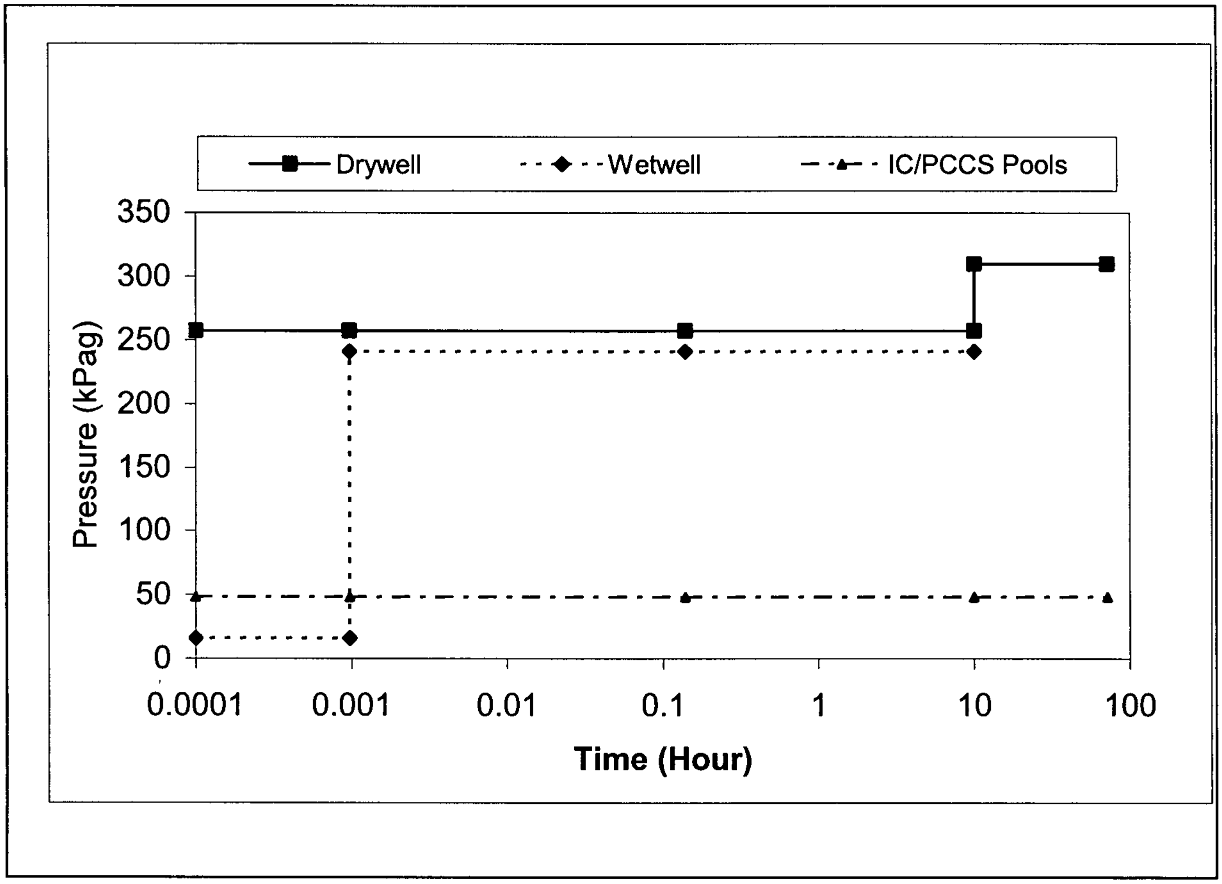
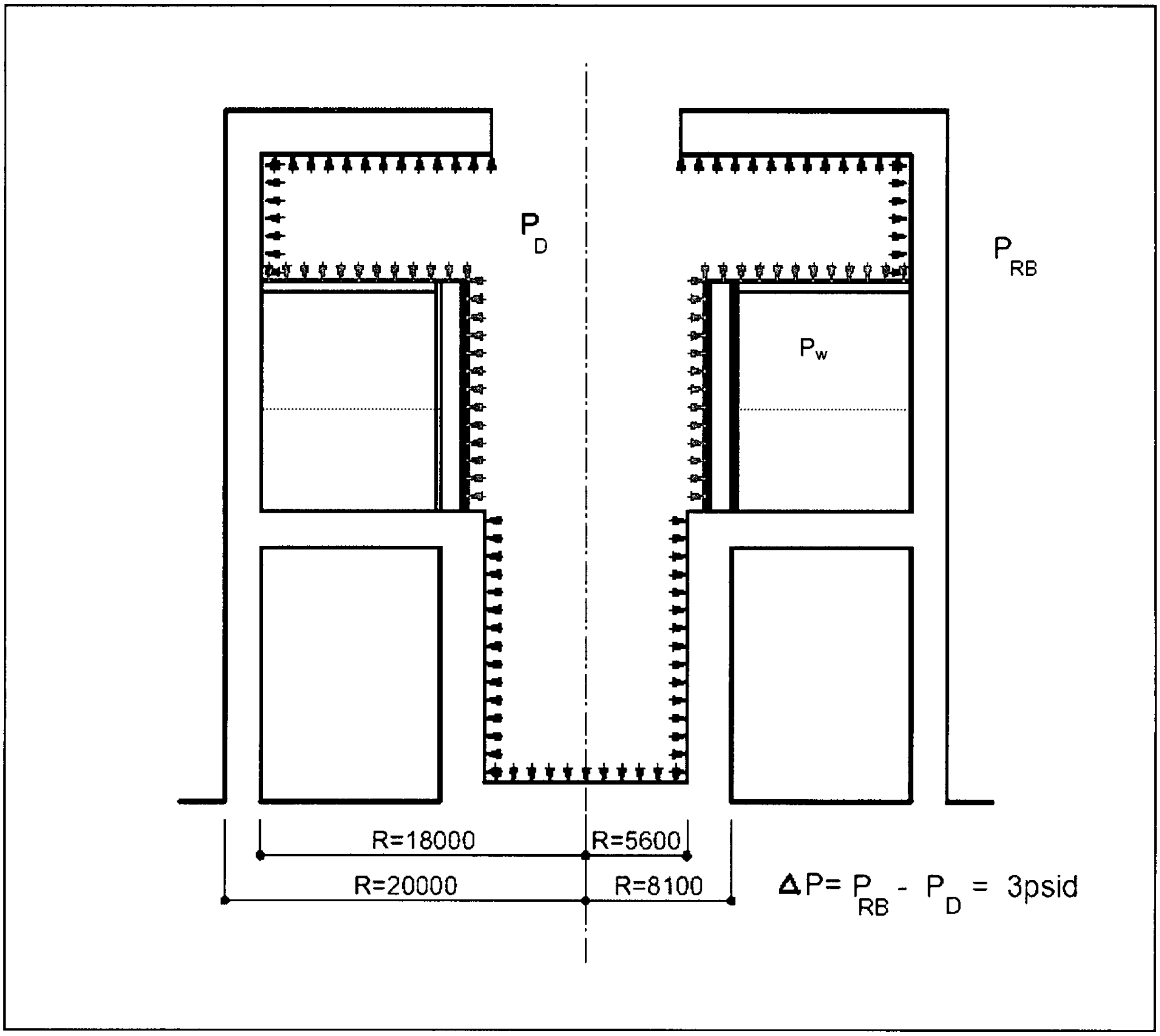


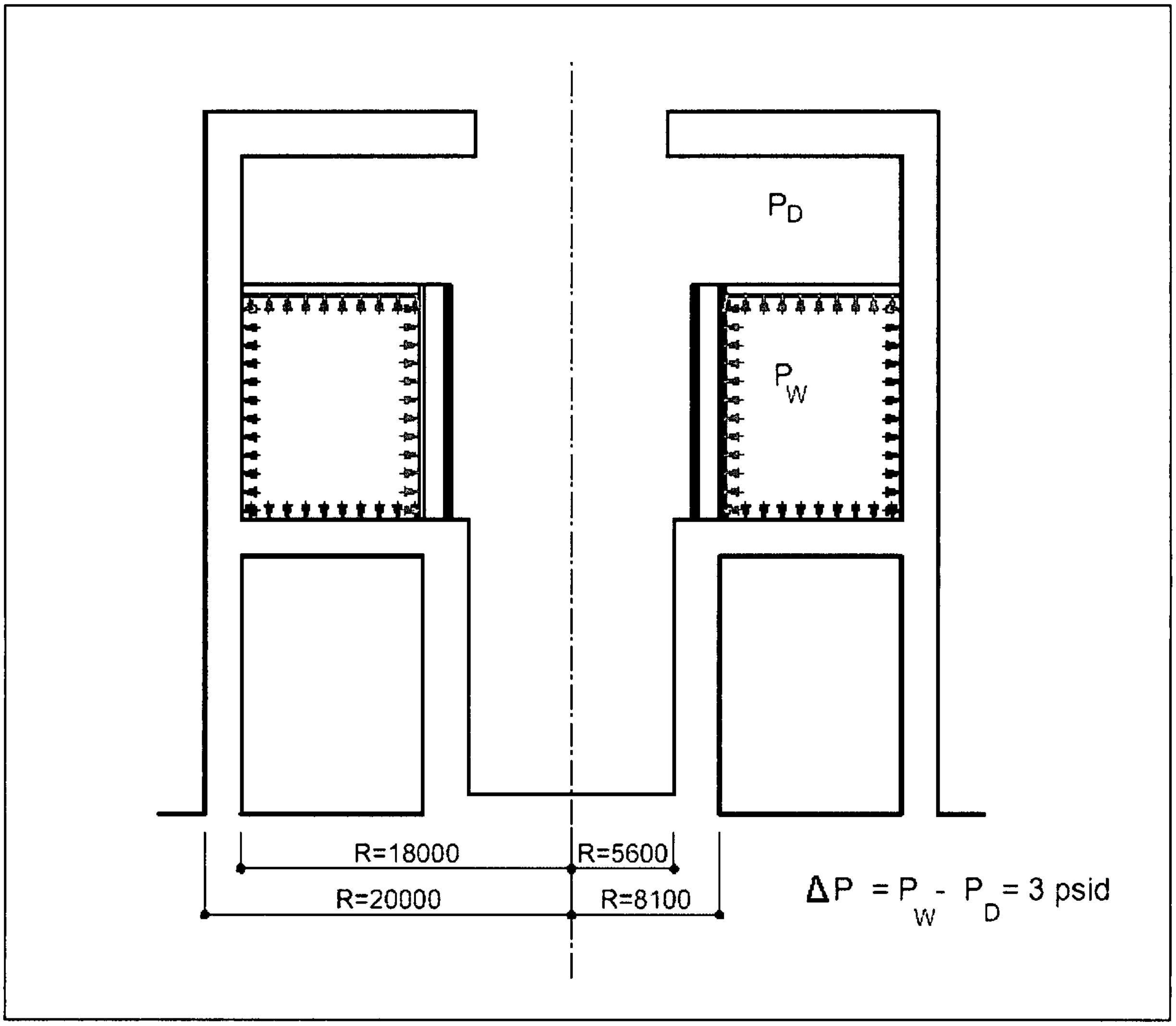
Figure 3.8-15(1) Envelopes of Transient Pressure Curves at DBA



Note: (i) $\Delta P = P_{RB} - P_D$ or $P_{RB} - P_W$

(ii) Higher Pressure in RB than in Drywell or Wetwell

Figure 3.8-15 (2) - Differential Pressure (ΔP) Between Reactor Building (RB) and Containment



Note: Higher Pressure in Wetwell

Figure 3.8-15 (3) Differential Pressure Between Drywell and Wetwell

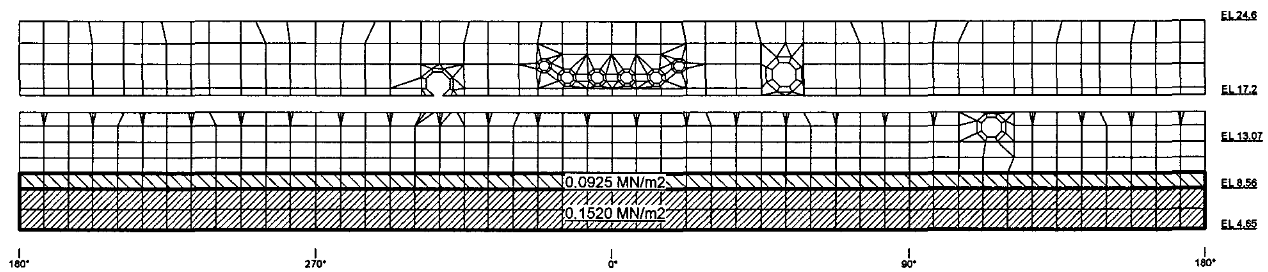


Figure 3.8-15 (4) Application of Hydrodynamic Load on the RCCV Liner (SRV Positive)

Table 3.8-15(1) Load Combinations for Design Pressure Loads

			Drywell*1	Wetwell*1	IC/PCCS*1	Main Steam Tunnel*1	Note
		Label	PDW	PSC	PIC	PMS	
TEST	Max.	PTL1	0.3568	0.3568			
	Diff.	PTL2	0.3100	0.0325			Max. Differential Pressure 277.5kPa
Normal Operation		POL	0.0052	0.0052	0.0345		
LOCA	After 5 seconds	PL1	0.0000*2	0.0000*2	0.0483		Period-I
	After 6 minutes	PL2	0.2570	0.2410	0.0483		Period-II
	After 10 hours	PL3	0.3100	0.3100	0.0483		Period-IV
	After 72 hours	PL4	0.3100	0.3100	0.0483		Period-IV
HELB		PLMS				0.0760	HELB in MS Tunnel

Note: *1: Unit pressure load, 1.0 MPa, is applied to each space in stress analyses.

*2: The pressure loads at 5 seconds are considered in the Pool Swell Pressure Load.

NRC RAI 3.8-15, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

In Fig. 3.8-15(1), should the curve for WW stop or continue until 100 Hrs? Explanation should be included how the determination was made that the axisymmetric loads are more severe than the nonaxisymmetric loads, and that the nonaxisymmetric loads did not need to be considered. Where in the DCD is the requirement for the COL Action item to confirm, in the detailed design phase, that the DLF of 2.0 is adequate to account for variation in loading function frequencies and dynamic amplification?

During the audit, GE provided a draft supplemental response to address the first and third items discussed above. Clarification is needed for the first item since the supplemental response does not agree with information provided in discussions during the meeting. The second item will be discussed under RAI 3.8-46.

GE Response

In Fig. 3.8-15 (1), the curve for the WW coincides with the curve for the DW between 10 hours and 72 hours.

For the discussion about non-axisymmetric loads, please see the response to NRC RAI 3.8-46, Supplement 1.

The DLF of 2 is the ESBWR structural design basis for hydrodynamic loads. It has been confirmed to be adequate by comparing static and dynamic results. Therefore, it is not necessary to provide a COL Action item in the DCD as suggested.

DCD Impact

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

NRC RAI 3.8-29

DCD Table 3G.1-36 identifies that the Service Level A, B primary + secondary stress condition in the drywell head exceeds the basic code allowable stress by 75% (PL+Pb+Q is 794 MPa calculated vs. 456 MPa allowable). Describe in detail and pictorially the geometry/location of all overstress conditions. Explain why Q is 11 times greater than PL+Pb. Identify the loading condition(s) that created this overstress condition (pressure loads, thermal loads, or a combination). Provide the technical basis for relying on the NE-3228.3 analysis to show acceptability, rather than implementing a design modification to alleviate the high secondary stress. Provide the details of the NE-3228.3 analysis. Include this information in DCD Section 3.8.2 and/or Appendix 3G.

In addition, (1) identify the applicable detailed report/calculation (number, title, revision and date, and brief description of content) that will be available for audit by the staff, and (2) reference this report/calculation in the DCD.

GE Response

The high stress value is due to thermal loads from the LOCA condition. Since the DW head is fixed at the cylindrical part to the concrete slab, high discontinuity stresses are present at the joint. This is secondary stress and cannot be alleviated by design modification. The portion where the high stress occurs is shown in Figure 3.8-29(1). P_L+P_b is the primary membrane stress so it does not include thermal stress, and the stress value is at the center of the plate thickness, while P_L+P_b+Q is the primary plus secondary stress including thermal stress, and the stress value is at the surface of the plate. Therefore, P_L+P_b+Q is much higher than P_L+P_b. Under this type of secondary stress, the ASME permits a simplified elasto-plastic analysis in NE-3228.3. The details of the NE-3228.3 analysis will be included in DCD Section 3G.1.5.4.1.4 in the next DCD revision as noted in the attached markup.

(1) The applicable detailed report/calculation that will be available for the NRC audit is DC-OG-0052, *Structural Design Report for Containment Metal Components, Revision 1*, September 2005, containing the evaluation method and results for structural integrity of the containment liner and drywell head.

(2) Since this information exists as part of GE's internal tracking system, it is not necessary to add it to the DCD submittal to the NRC.

Markup of DCD Section 3G.1.5.4.1.4 was provided under MFN 06-298.

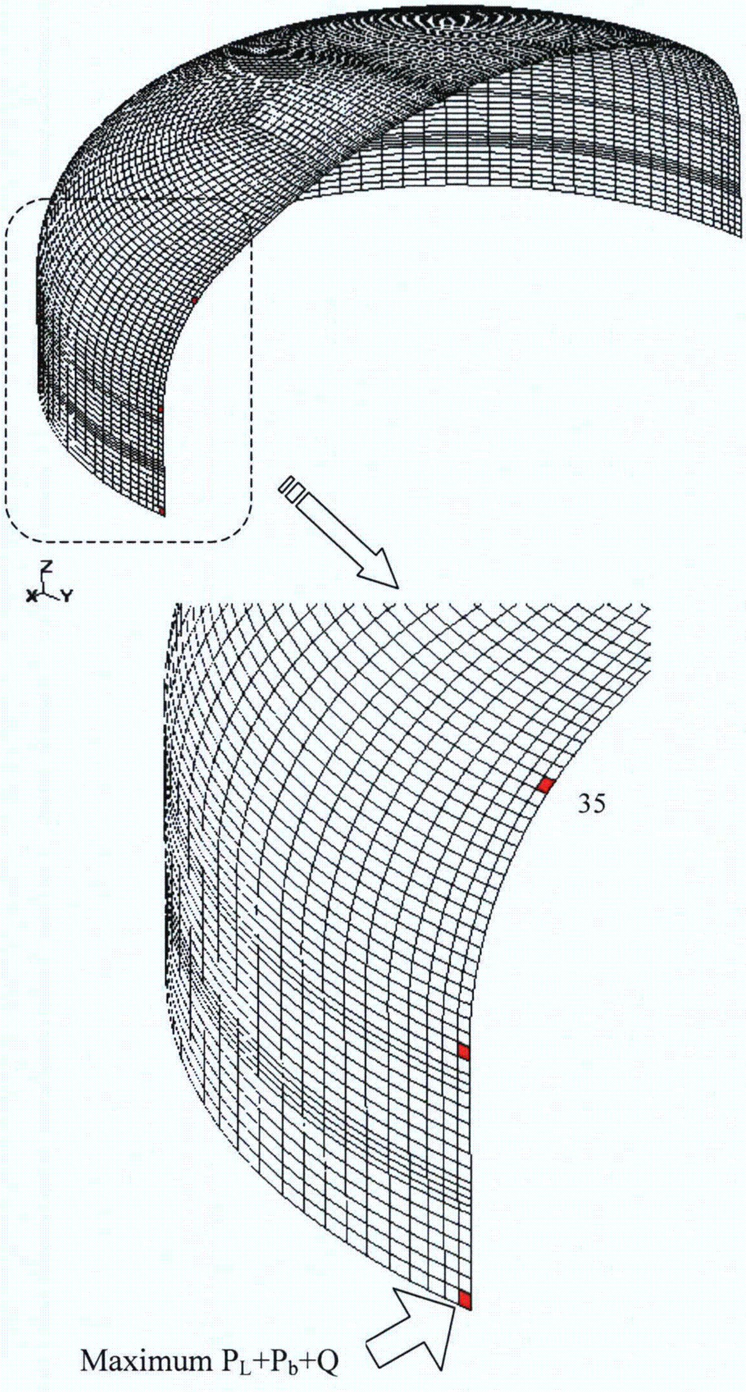


Figure 3.8-29 (1) High Secondary Stress Portion due to T_a = 171°C

NRC RAI 3.8-29, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

Insufficient information provided. Need to know Pm, Pl, Pb and Q at critical location. Also need the comparison to allowable stress limits for Pm, Pl+Pb, and Pl+Pb+Q. Provide hand calculation of fully restrained thermal stress for deltaT from construction ambient temperature to 171 degrees C. Compare to computer results for the thermal condition.

GE Response

P_L, P_L+Pb and P_L+Pb+Q for each service level are shown in Tables 3.8-29 (1) through (5). The evaluated points are shown in Figure 3.8-29 (2). Pm is not evaluated because the high stress portion is a structurally discontinuous part, and the stress is categorized as P_L. However, if the allowable stress limit for Pm is applied, P_L satisfies it.

The following shows a comparison of the computer analysis result with a hand calculation for thermal stress:

(1) Thermal Load

Maximum accident temperature: Ta=171°C

Stress free temperature: T_0=15.5°C

Temperature difference: $\Delta T = Ta - T_0 = 171 - 15.5 = 155.5$°C

(2) Material Properties

The following material properties at 171°C are used based on ASME Section II, Part D.

Modulus of elasticity: $E = 1.94 \times 10^5$ MPa

Thermal expansion ratio: $\alpha = 12.56 \times 10^{-6}$ mm/mm/°C

(3) Calculation of Thermal Stress

The hoop membrane stress σt is calculated as follows;

$$\sigma_t = -E \cdot \alpha \cdot \Delta T = -1.94 \times 10^5 \times 12.56 \times 10^{-6} \times 155.5 = -379\text{MPa}$$

(4) Comparison with NASTRAN Analysis result

NASTRAN analysis results of thermal stress for the above condition are shown in Table 5-47 of DC-OG-0052. These values are as follows:

$$\sigma_{t,\text{surface 1}} = -194.0\text{MPa}$$

$$\sigma_{t,\text{surface 2}} = -540.2\text{MPa}$$

$$\sigma_{t,\text{membrane}} = \frac{\sigma_{t,\text{surface 1}} + \sigma_{t,\text{surface 2}}}{2} = \frac{-194 - 540.2}{2} = -367\text{MPa}$$

The NASTRAN analysis result is 97% of the hand calculation result; therefore, it can be concluded that the NASTRAN analysis result has sufficient accuracy.

Table 3.8-29 (1) Drywell Head Load Combination Results Test Condition

(MPa)

Elem No	Stress				
	PL	PL+Pb		PL+Pb+Q	
		Surface1	Surface2	Surface1	Surface2
1	16	16	16	-	-
33	74	74	74	-	-
35	76	76	76	-	-
36	76	76	76	-	-
37	73	73	73	-	-
Allowable for PL or PL+Pb	262	262	262	-	-
Allowable for Pm	171	171	171	-	-

Table 3.8-29 (2) Drywell Head Load Combination Results Design Condition

(MPa)

Elem No	Stress				
	PL	PL+Pb		PL+Pb+Q	
		Surface1	Surface2	Surface1	Surface2
1	14	14	14	-	-
33	63	63	63	-	-
35	65	65	65	-	-
36	65	65	65	-	-
37	63	63	63	-	-
Allowable for PL or PL+Pb	227	227	227	-	-
Allowable for Pm	151	151	151	-	-

Table 3.8-29 (3) Drywell Head Load Combination Results A, B

(MPa)

Elem No	Stress				
	PL	PL+Pb		PL+Pb+Q	
		Surface1	Surface2	Surface1	Surface2
1	19	19	19	798	584
33	79	79	79	92	65
35	81	81	81	105	61
36	80	80	80	108	60
37	77	77	77	109	57
Allowable for PL, PL+Pb or PL+Pb+Q	227	227	227	456-	456-
Allowable for Pm	151	151	151	-	-

Table 3.8-29 (4) Drywell Head Load Combination Results C

(MPa)

Elem No	Stress				
	PL	PL+Pb		PL+Pb+Q	
		Surface1	Surface2	Surface1	Surface2
1	28	28	28	-	-
33	106	106	106	-	-
35	108	108	108	-	-
36	106	106	106	-	-
37	103	103	103	-	-
Allowable for PL or PL+Pb	342	342	342	-	-
Allowable for Pm	228	228	228	-	-

Table 3.8-29 (5) Drywell Head Load Combination Results D

(MPa)

Elem No	Stress				
	PL	PL+Pb		PL+Pb+Q	
		Surface1	Surface2	Surface1	Surface2
1	28	28	28	-	-
33	106	106	106	-	-
35	108	108	108	-	-
36	106	106	106	-	-
37	103	103	103	-	-
Allowable for PL or PL+Pb	430	430	430	-	-
Allowable for Pm	287	287	287	-	-

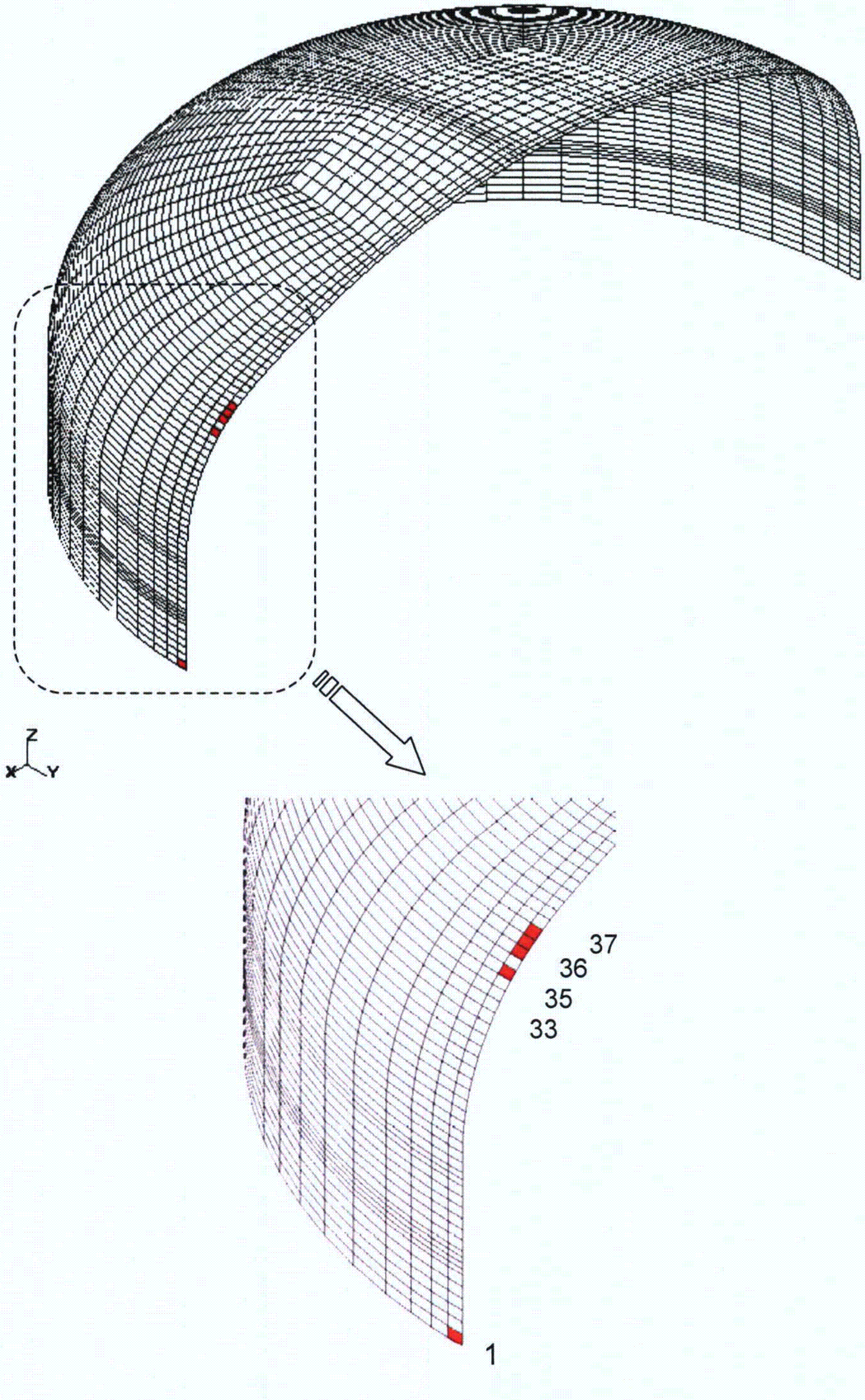


Figure 3.8-29 (2) Evaluated Points of Drywell Head

DCD Impact

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

NRC RAI 3.8-30

DCD Figure 3G.1-51 indicates there is stainless steel (SS) cladding on the exterior surface of the drywell head. Describe the purpose for the SS cladding. If there is water in the space above the drywell head during normal operation, what is the height of water in this space? What is the cladding thickness? How was the SS cladding modeled in the Service Level A and B pressure and thermal analyses of the drywell head? Was the mismatch in thermal expansion coefficients between carbon steel and SS considered in the thermal analyses? Include this information in DCD Section3.8.2 and/or Appendix 3G.

In addition, (1) identify the applicable detailed report/calculation (number, title, revision and date, and brief description of content) that will be available for audit by the staff, and (2) reference this report/calculation in the DCD.

GE Response

There is water in the reactor well above the drywell head during normal operation. The height of water is 6.7 m. The purpose of the SS cladding is to provide corrosion protection of the carbon steel base plate. Cladding is not considered in the analysis model, because the strength of cladding is not considered for primary stress based on ASME NE-3122.1. Since the stress of cladding is classified as peak stress in ASME Table NE-3217-1, only fatigue analysis is required for the cladding. Fatigue analysis will be performed to address RAI 3.8-32. In the provision of NE-3122, there is no requirement for cladding thickness; however, NB-3122.3 stipulates that the presence of the cladding may be neglected if the cladding is 10% or less of the total thickness of the component. Therefore the cladding thickness will be determined in the detailed design in accordance with NB-3122.3 requirements, so it results in negligible stress in the base metal.

(1) The applicable detailed report/calculation that will be available for the NRC audit is 26A6558, *General Civil Design Criteria, Revision 1*, November 2005, which contains the depth of water in the reactor cavity pool.

(2) Since this information exists as part of GE's internal tracking system, it is not necessary to add it to the DCD submittal to the NRC.

Markup of DCD Section 3.8.2.1.4 was submitted under MFN 06-298.

NRC RAI 3.8-30, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

Need additional information. When is the detailed design to be conducted? Apparently, the clad thickness has not been specified yet. Open, until detailed design is completed and assessment to ASME Code requirements is documented, and subsequently reviewed by the staff.

GE Response

Cladding is not considered in the analysis model, because the strength of the cladding is not considered for primary stress based on ASME Section III, Div. 1, Subsection NE-3122.1. Since the stress in cladding can be treated as peak stress per Subsection NE-3213.11 and Table NE-3217-1, only fatigue analysis is required for the cladding. Fatigue analysis was performed to address NRC RAI 3.8-32. Per Subsection NE-3122, there is no requirement for cladding thickness; however, Subsection NB-3122.3 stipulates that the presence of the cladding may be neglected if the cladding is 10% or less of the total thickness of the component. The stainless clad thickness for the drywell head is determined as 2.5mm in accordance with Subsection NB-3122.3 requirements so that it results in a negligible change to the stress in the base metal.

DCD Impact

DCD Tier 2 Subsection 3.8.2.1.4 and Figure 3G.1-51 will be revised in the next update as noted in the attached mark up.

NRC RAI 3.8-31

Figure 3G.1-51, Detail C, shows six (6) drywell head support brackets. Please explain their function. How were the brackets modeled in the Service Level A and B pressure and thermal analyses of the drywell head? Were local discontinuity stresses and peak stresses calculated and considered in the Code evaluation? If yes, describe the results. If not, explain why not. Include this information in DCD Section 3.8.2 and/or Appendix 3G.

In addition, (1) identify the applicable detailed report/calculation (number, title, revision and date, and brief description of content) that will be available for audit by the staff, and (2) reference this report/calculation in the DCD.

GE Response

These support brackets are attached to the inner surface of the DW 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 (stiffening effect is local and active only during refueling when the head is in its stored position). They are not considered in the design analysis model of the drywell head.

(1), (2) No detailed report exists since the effects of these supports are not evaluated.

Markup of DCD Section 3.8.2.1.4 was submitted under MFN 06-298.

NRC RAI 3.8-31, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

Need more information. Purpose of brackets is explained and acceptable. However, effects on local stresses in the drywell head when subjected to accident pressure and temperature is not adequately addressed. GE did not analyze this detail.

GE Response

The drywell head support brackets are only used during refueling to support the drywell head. During accident pressure and temperature conditions, there is no effect on the shell response since the bracket is not constrained.

The following analysis shows that effects of the support brackets on local stresses in the drywell head, when subjected to accident pressure and temperature, are small and negligible:

> The support brackets will be attached to the inner surface of the cylindrical portion of the drywell head by fillet welding. The simple analysis model shown in Figure 3.8-31 (1) is developed to confirm the effect due to pressure load. To simulate pressure load, both ends of the model of the cylindrical portion of the drywell head are pulled, and the stress distribution change is evaluated.
>
> Regarding thermal load, the support brackets expand equally with the drywell head because the temperature difference between them does not occur. (Surface heat transfer coefficients of steel structures are infinite during a LOCA condition; therefore, the temperature of steel structures becomes the same as the ambient one instantaneously.)
>
> Figure 3.8-31 (2) shows the stress (component stress σx) distribution in the cylindrical shell thickness direction. Line 1 represents the vicinity of the support bracket attached part and Line 2 represents the general part of the cylindrical shell. Both distributions are very similar, and no significant stress increment is found.
>
> Figure 3.8-31 (3) shows the membrane stress distribution along the hoop direction (Line 3), which is important for structural integrity. There is no significant stress increment noted.

Therefore it can be concluded that the support brackets do not affect the local stresses in the drywell head due to pressure load.

DCD Impact

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

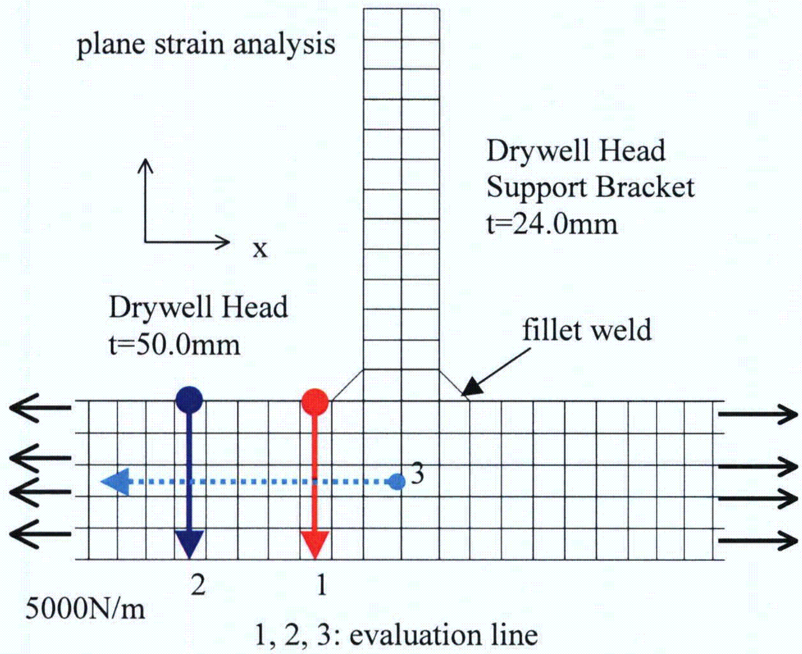


Figure 3.8-31 (1) Analysis Model for Support Bracket Attached Part of Drywell Head

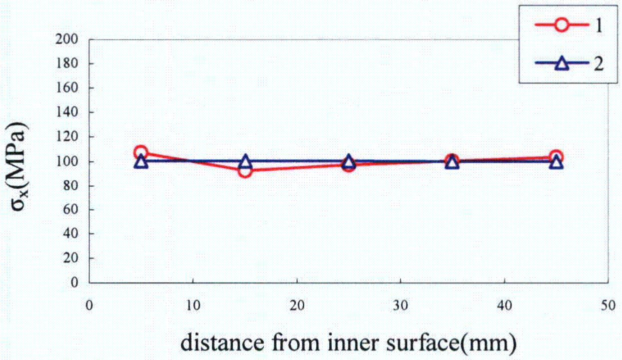
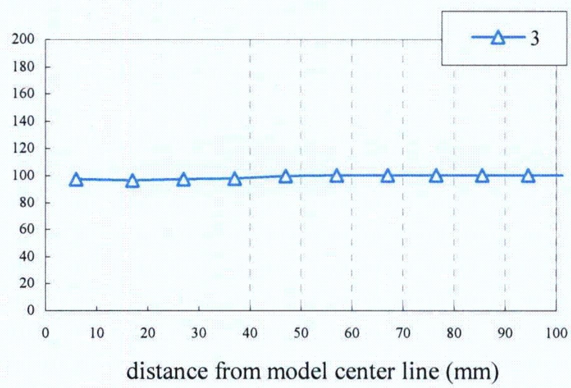


Figure 3.8-31 (2) Stress Distribution in Thickness Direction



NRC RAI 3.8-42

DCD Section 3.8.3.1.6 discusses platforms that are classified as Seismic Category I (C-I) and Seismic Category II (C-II). However, no description is provided regarding how they are analyzed or designed. Some information is presented in DCD Section 3.7, which states that Seismic Category II structures, systems, and components (SSCs) are "designed and/or so physically arranged that the SSE [safe shutdown earthquake] would not cause unacceptable structural interaction or failure." It also states that the methods of seismic analysis and design acceptance criteria for C-II SSCs are the same as C-I; however, the procurement, fabrication, and construction requirements for C-II SSCs are in accordance with industry practices. Based on the above:

a) *Explain what is meant by the statement "designed and/or so physically arranged that the SSE would not cause unacceptable structural interaction or failure." Provide sufficient information for the staff to confirm that the approach satisfies the three criteria presented in SRP 3.7.2 II,8 for all C-I SSCs.*

b) *Describe any other SSCs that are Seismic Category II inside containment.*

Include this information in DCD Section 3.8.3.1.6.

GE Response

a) DCD Section 3.7 will be revised to delete the words "physically arranged". The methods of seismic analysis and design acceptance criteria for Seismic Category II (C-II) SSCs are the same as C-I SSCs. C-II SSCs meet the SRP 3.7.2.II.8 criteria and are designed to prevent their collapse under an SSE.

b) SSCs inside containment are classified as Seismic Category II if they do not perform or support safety-related functions.

Markups of DCD Sections 3.7 and 3.8.3.1.6 were submitted under MFN 06-298.

NRC RAI 3.8-42, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

a) The markup for DCD Section 3.7 is not quite consistent with SRP 3.7.2.II.8. The DCD states that SC II are designed such that the SSE would not cause unacceptable structural interaction or failure, Whereas, SRP 3.7.2.II.8 states that the non-Category I structures will be analyzed and designed to prevent their failure under SSE in a manner such that the margin of safety of these structures is equivalent to that of the Category I structure. If the GE response stated above is true, "The methods of seismic analysis and design acceptance criteria for Seismic Category II (C-II) SSCs are the same as C-I SSCs," then this should be stated in the DCD.

During the audit, GE indicated that they will delete the inconsistency by deleting the first criteria and leaving the second criteria which states that "The methods of seismic analysis and design acceptance criteria for Seismic Category II (C-II) SSCs are the same as C-I SSCs.".

GE Response

The inconsistency between the criteria will be corrected as stated in the NRC assessment.

DCD Impact

DCD Tier 2 Section 3.7, Fourth paragraph will be revised in the next update as noted in the attached markup.

NRC RAI 3.8-52

DCD Section 3.9.2 presents the criteria, testing procedures, and dynamic analyses used to ensure the structural and functional integrity of piping systems, mechanical equipment, reactor internals, and their supports (including supports for conduits, cable trays, and ventilation ducts) under vibratory loadings. DCD Section 3.10.3.2 describes the design approach for cable tray, and conduit supports. Although some limited information is provided in DCD Sections 3.9.2 and 3.10.3 about the design of supports for conduits, cable trays, and ventilation ducts, no information could be located that covers design criteria for conduits, cable trays, and ventilation ducts. Containment internal structures have attached conduits, cable trays, and ventilation ducts. However, DCD Section 3.8.3 does not describe the design criteria used for cable trays, conduits, and ventilation ducts. Therefore, please provide a description of the analysis and design criteria (i.e., description; applicable codes, standards, and specifications; loads and load combinations; acceptance criteria; and analysis and design procedures) used for cable trays, conduits, and ventilation ducts inside containment.

Include this information in the DCD. In addition, (1) identify the applicable detailed report/calculation (number, title, revision and date, and brief description of content) that will be available for audit by the staff, and (2) reference this report/calculation in the DCD.

GE Response

The type and spacing of supports for Seismic Category I commodities such as cable trays, conduits, and ventilation ducts are governed by rigidity and stress. These commodities are designed to the loads, loading combinations, and allowable stresses in accordance with applicable codes, standards, and regulations consistent with C-I steel structures as shown in DCD Tables 3.8-6 and 3.8-9.

(1), (2) At this stage of the design process, detailed reports/calculations for the design of the commodities are not available.

Markups of DCD Sections 3.8.4.1.6 and 3.8.4.1.7 were submitted under MFN 06-298.

NRC RAI 3.8-52, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

References cited do not provide analysis criteria; therefore, describe in the DCD whether the analysis methods will follow those presented in 3.7 and 3.8. If cold-formed sections are used, then N690 does not apply. Are there other standards that should be referenced (e.g., SMACNA and IEEE)?

During the audit, GE indicated that Section 3.8.3 will be revised to provide criteria similar to, or reference the criteria in, Section 3.8.4.1.6 and 3.8.4.1.7 for cable trays, conduits, HVAC ducts, and their supports. In addition, the additional codes and standards provided in the draft supplemental response will be added to Tables 3.8-6 and 3.8-9.

GE Response

The following codes and standards will be included in DCD Tier 2 Tables 3.8-6 and 3.8-9:

a) ASME N509-2002, Nuclear Plants Air-Cleaning Units and Components
b) ASME/ANSI AG-1-2003, Code on Nuclear Air and Gas Treatment
c) AISI-2001 and 2004 Supplement, AISI Specification for the Design of Cold Formed Steel Structural Members.
d) SMACNA 1481, Third Edition, 2005, HVAC Duct Construction Standards-Metal and Flexible.

Analysis methods for cable trays, conduits, HVAC ducts and their supports will follow the methods presented in Sections 3.7 and 3.8.

DCD Impact

DCD Tier 2 Subsections 3.8.4.1.6 & 3.8.4.1.7 and Tables 3.8-6 & 3.8-9 will be revised and Subsection 3.8.3.1.7 will be added in the next update as noted in the attached markup.

NRC RAI 3.8-53

From the information provided in Section 3.8.3 and Appendix 3G, it is not clear whether there are any other pipe rupture loads acting on containment internal structures other than the FW and RWCU breaks which induce annulus pressurization loads on the reactor shield wall. Explain whether there are any other pipe break loads acting on containment internal structures and describe the loads, models, analysis, and design approach for these loads.

Include this information in DCD Section 3.8.3 and/or Appendix 3G. In addition, (1) identify the applicable detailed report/calculation (number, title, revision and date, and brief description of content) that will be available for audit by the staff, and (2) reference this report/calculation in the DCD.

GE Response

Pipe rupture loads contain not only annulus pressurization (AP) pressure acting on the reactor shield wall (RSW) but also the nozzle jet, jet impingement and pipe whip restraint loads as stated in DCD 3G.1.5.2.12. The AP pressure time histories were generated for the FW and RWCU breaks in the annulus between the RPV and the RSW. A steam line (SL) break being outside of the annulus does not induce AP pressure. The time histories of the nozzle jet, impingement jet and pipe whip restraint loads induced by SL, FW and RWCU breaks were calculated. They are considered not only for the reactor shield wall (RSW), but also for the RPV support bracket, diaphragm floor (DF) and vent wall (VW) structure.

Building dynamic spectral loads and displacements generated by the AP loads are considered in the design. Dynamic analyses and the results are documented in DCD Appendix 3F. Response Spectra and displacements generated by AP loads are to be used for the analysis and design of structures, systems and components (SSCs) located inside of RCCV.

(1) The applicable detailed reports/calculations that will be available for NRC audit are:

   a. 26A6558, *General Civil Design Criteria, Revision 1*, November 2005, containing pressure time histories of pressure due to FW and RWCU breaks, nozzle jet, impingement jet and pipe whip restraint loads.

   b. DC-OG-0053, *Structural Design Report for Containment Internal Structures, Revision 2*, October 2005, containing evaluation method and results for structural integrity of containment internal structures.

   c. 092-134-F-C-00008, *SRVD, LOCA & AP Dynamic Responses in RPV and RSW, Issue 1*, June 8, 2006, containing analysis and results for the response of the RPV, and the RSW to CO, CH, HVL, LCO and SRV in the SP, as well as AP in the RSW and the RPV, and the associated nozzle jet, jet impingement and pipe whip restraint loads.

(2) Since this information exists as part of GE's internal tracking system, it is not necessary to add it to the DCD submittal to the NRC.

No DCD change was made in response to this RAI.

NRC RAI 3.8-53, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

Original RAI not fully answered. As noted in the RAI, describe the loads, models, analysis, and design approach for assessment of containment internal structures due to the other pipe breaks (other than AP).

During the audit, the resolution of this RAI was addressed under the first part of RAI 3.8-51.

GE Response

Please see response to NRC RAI 3.8-51, Supplement 1.

DCD Impact

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

NRC RAI 3.8-54

DCD Section 3.8.3.5.1 through 3.8.3.5.6 state that the structural acceptance criteria for each of the containment internal structures are in accordance with ANSI/AISC-690. Explain why these statements do not specify that the structural acceptance criteria for each of the containment internal structures are in accordance with Table 3.8-7, where (as noted in footnote 5 of DCD Table 3.8-7) the allowable elastic working stress (S) is the allowable stress limit specified in Part 1 of ANSI/AISC-690.

GE Response

Invoking the structural acceptance criteria for each of the containment internal structures to be in accordance with ANSI/AISC N690 means the same as in DCD Table 3.8-7.

Markups of DCD Subsections 3.8.3.4 and 3.8.3.5 was submitted under MFN 06-298.

NRC RAI 3.8-54, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

Markup of DCD 3.8.3.4 sends you to Table 3.8-7 (internal structures to containment), which in a footnote sends you to DCD 3.8.4.5.1 (other structures - not internal structures to containment) for acceptance criteria, which sends you to Table 3.8-16 which is applicable to other structures (not internal structures to containment). This path for acceptance criteria of internal structures should not end up in Table 3.8-16.

During the audit, GE provided a draft supplemental response which indicates that DCD Table 3.8-7 will be revised to reference DCD Sections 3.8.3.3 and 3.8.3.5 for the loads/load combinations and the acceptance criteria, respectively.

GE Response

Footnote 1 to DCD Tier 2 Table 3.8-7 will be revised to read, "The loads are described in Subsection 3.8.3.3 and acceptance criteria in Subsection 3.8.3.5."

DCD Impact

DCD Tier 2 Table 3.8-7 will be revised in the next update as noted in the attached markup.

NRC RAI 3.8-58

DCD Section 3.8.3.7 states that a formal program of testing and in-service inspection is not planned for the internal structures except for the diaphragm floor and vent wall. DCD Section 3.8.3.7 also states that the other internal structures are not directly related to the functioning of the containment system; therefore, no testing or inspection is performed. For the other structures, confirm that Regulatory Guide 1.160 and 10 CFR 50.65 "Maintenance Rule" requirements for structures monitoring and maintenance are applicable to the ESBWR design. If this is not the case, provide the technical basis.

Include this information in DCD Section 3.8.3.7.

GE Response

DCD Section 3.8.3.7 will be revised to read: "A formal program of testing and in-service inspection is not planned for the internal structures except the diaphragm floor, and vent wall. The other internal structures are not directly related to the functioning of the containment system; therefore, no testing or inspection is performed. However, during the operating life of the plant the condition of these structures should be monitored by the COL holder to provide reasonable confidence that the structures are capable of fulfilling their intended functions."

Markup of DCD Section 3.8.3.7 was submitted under MFN 06-298.

NRC RAI 3.8-58, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

Response to the last part of the RAI was not provided: For the other structures, confirm that Regulatory Guide 1.160 and 10 CFR 50.65 "Maintenance Rule" requirements for structures monitoring and maintenance are applicable to the ESBWR design. If this is not the case, provide the technical basis. Include this information in DCD Section 3.8.3.7.

During the audit, GE provided a draft supplemental response to show that other structures are monitored per 10 CFR 50.65 as clarified by RG 1.160. This will be included in a revision to the DCD.

GE Response

DCD Tier 2 Subsection 3.8.3.7 second and third paragraphs will be revised as follows:

"However, during the operating life of the plant, the condition of these other internal structures is monitored per 10CFR50.65 as clarified in RG 1.160, in accordance with Section 1.5 of RG 1.160.

Testing and in-service inspection of the diaphragm floor and vent wall are directly related to the functioning of the containment system and are discussed in Subsection 3.8.1.7."

See NRC RAI 3.8-59, Supplement 1 that also adds a paragraph to DCD Tier 2 Subsection 3.8.3.7.

DCD Impact

DCD Tier 2 Subsection 3.8.3.7 will be revised in the next update as noted in the attached markup.

NRC RAI 3.8-60

DCD Section 3.8.4 (pg 3.8-28) states that: "The main steam tunnel walls protect the RB from potential impact by rupture of the high-energy main steam pipes that extend to the Turbine Building. Thus the RB walls of the main steam tunnel are designed to accommodate the guard pipe support forces." Clarify that all high energy lines in the main steam tunnel are protected by guard pipes. If not, explain why the tunnels are only designed for "guard pipe support forces." Also, the staff notes that Section 3.6.2.4 states that the ESBWR does not require guard pipes. Clarify this discrepancy and explain where the criteria for the design of any guard pipes used in the ESBWR design is discussed in the DCD.

Include this information in DCD Section 3.8.4. In addition, (1) identify the applicable detailed report/calculation (number, title, revision and date, and brief description of content) that will be available for audit by the staff, and (2) reference this report/calculation in the DCD.

GE Response

No guard pipes are provided in the ESBWR because the main steam and feedwater piping inside the Main Steam Tunnel from the RCCV penetrations to the seismic restraints located close to the Turbine Building comply with the break exclusion stress and fatigue limits as per BTP EMEB 3-1 of SRP 3.6.2. Therefore, the RB walls of the main steam tunnel are designed to accommodate the penetrations and pipe support forces as well as the postulated pipe break pressure loads. The postulated pipe break locations and configuration general criteria are discussed in DCD Subsection 3.6.2.1. Please see attached Figure 3.8-60(1) for further clarification on Main Steam Tunnel design.

Markup of DCD Subsection 3.8.4 was submitted under MFN 06-298.

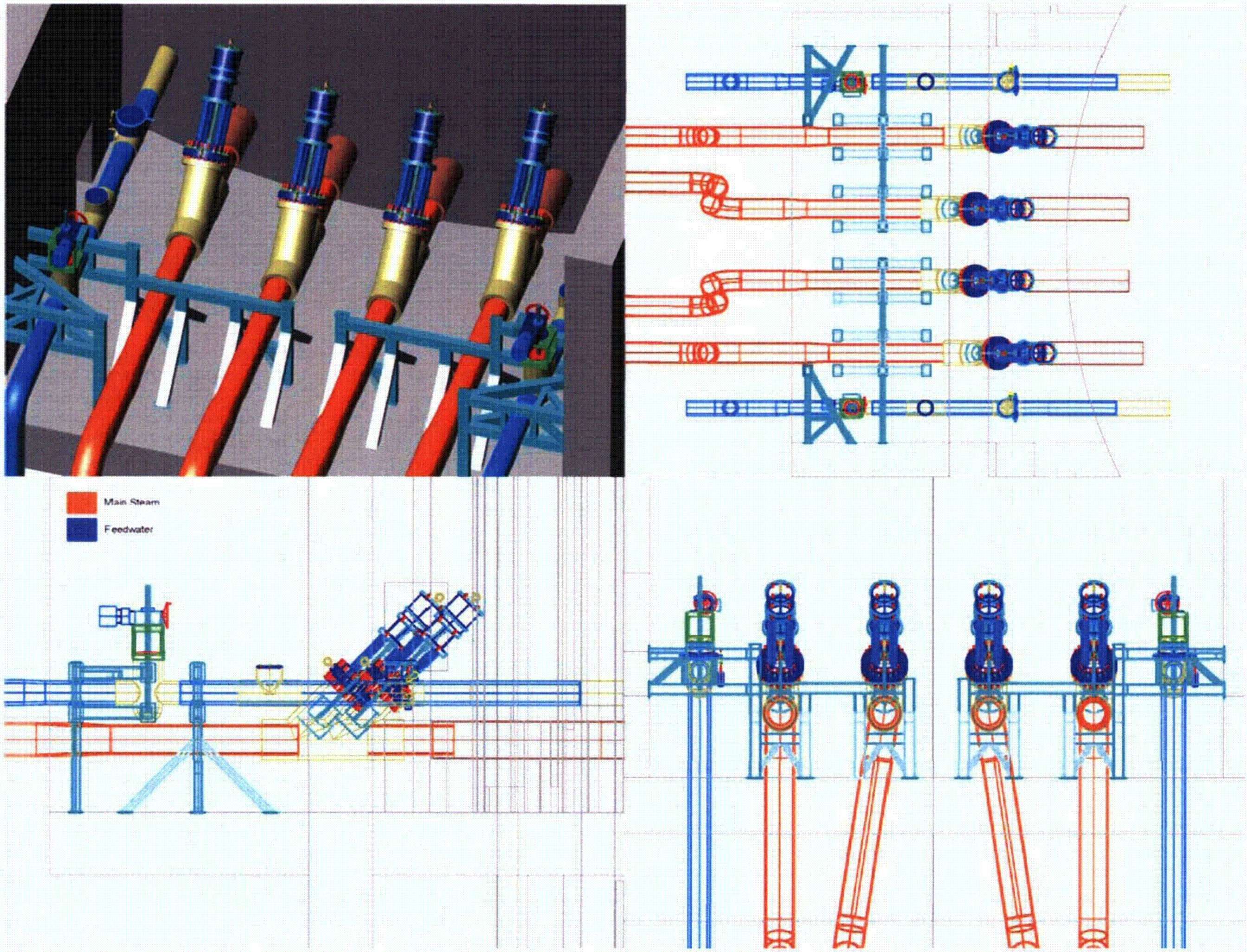


Figure 3.8-60(1) Main Steam Tunnel Overview

NRC RAI 3.8-60, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

GE needs to explain what information Figure 3.8-60(1) is trying to convey. Also the DCD revision states: "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." GE needs to clarify the "environmental conditions" that the tunnels are being designed to. Are they saying that "the break exclusion stress and fatigue limits as per BTP EMEB 3-1 of SRP 3.6.2" eliminate postulated breaks in the tunnel area, but the tunnel still experiences environmental conditions due to pressure and temperature from pipe breaks outside the area? GE needs to explain the source of these environmental effects.

During the audit, GE provided a draft supplemental response that clarifies the above question. GE also needs to revise the DCD to be consistent with the response.

GE Response

Figure 3.8-60 (1) is for information purposes only to show that no guard pipes are used in the Main Steam Tunnel.

According to SRP 3.6.2, longitudinal breaks (of at least 1 square foot) have to be postulated inside the steam tunnel, even though BTP EMEB 3-1 is met and circumferential breaks can be excluded. This is required to evaluate the effects of jet impingement and to determine environmental conditions for qualification of safety-related equipment. Outside of the steam tunnel, a circumferential break is postulated due to noncompliance with BTP EMEB 3-1. Therefore, the tunnel must be able to resist pressurization due to:

- Longitudinal break inside the tunnel (min. one square foot)
- Circumferential break outside the tunnel

The steam tunnel is an open space that connects directly (without any flow restrictions) to the Turbine Building. Therefore, the effects of pressurization in the tunnel are small and do not govern its design.

The Main Steam Tunnel design conditions are discussed in DCD Tier 2 Subsections 6.2.3.2 and 3G.1.5.2.1.10.

DCD Impact

DCD Tier 2 Subsections 3.8.4, 3G.1.5.2.1.10, and 6.2.3.2 will be revised in the next update as noted in the attached markup.

<u>NRC RAI 3.8-61</u>

DCD Section 3.8.4 (pg 3.8-28) states that Seismic Category I masonry walls are not used in the design. Explain if there are any non-safety related masonry walls used in the ESBWR design. If so, provide the criteria used to design such walls to assure that their failure does not affect any safety related structures, systems or components.

<u>GE Response</u>

Masonry wall construction is not used in the ESBWR design. Removable shield blocks designed to Seismic Category II acceptance criteria that provide equivalent shielding are used.

Markup of DCD Section 3.8.4 was submitted under MFN 06-298.

DCD Figures 1.2-1 and 1.2-3 were updated to revise "Concrete Block" to "Shield Block" in DCD Tier 2 Revision 2.

NRC RAI 3.8-61, Supplement 1

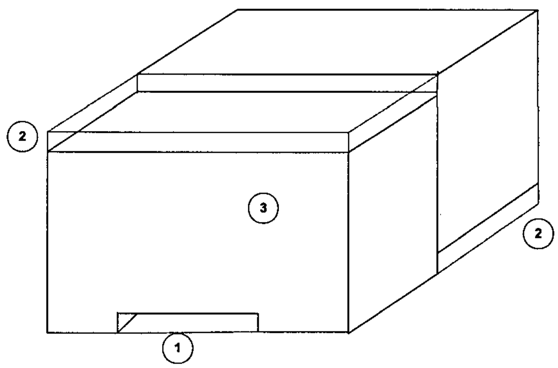
NRC Assessment Following the December 14, 2006 Audit

GE needs to explain the seismic design criteria for the removable shield blocks to assure that their failure does not affect any safety related structures, systems or components.

During the audit, GE provided a draft supplemental response to address this issue. A steel frame retainer structure will be designed to SC II requirements to prevent sliding or overturning under the SSE event.

GE Response

Removable shield blocks typically consist of metallic forms filled with grout or concrete. They will be designed as Seismic Category II components as stated in the original NRC RAI 3.8-61 response. They will be provided with a removable structural steel frame, also designed to Seismic Category II requirements, to prevent the shielding blocks from sliding or tipping under seismic events. See sketch below for typical details.



TYPICAL SHIELDING BLOCK

1 - Slot for fork lift arm
2 – Recess to lock adjacent blocks
3 – Metallic box construction

DCD Impact

DCD Tier 2 Subsection 3.8.4 will be revised in the next update as noted in the attached markup.

NRC RAI 3.8-67

DCD Section 3.8.4.2.1 states that the applicable documents for the RB design are shown in Table 3.8-9, except items 4, 11, 30 and 32. With regard to the exceptions listed:

(1) Explain why there is no exception to item 3 (ASME Subsection CC) while there is an exception to item 4 (ASME Subsection NE) and item 30 (RG 1.136 for Concrete containments),

(2) Explain the exception to item 11 (2005 AISC Specification for Structural Steel Building).

GE Response

(1) As stated in DCD Section 3.8.1.1.3, structural components which are integral with the containment structure are treated the same as far as loads and loading combinations are concerned in the design. Since item 3 (ASME Subsection CC) specifies the load combinations for the containment design, it is applicable to the design of other seismic category I structures that share a common basemat with the containment structure. Items 4 and 30 have no relation to other seismic category I structures.

(2) Item 11 is excluded because the design of safety-related steel structures is performed conforming to item 2 (ANSI/AISC-N690).

No DCD change was made in response to this RAI.

NRC RAI 3.8-67, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

Items 3 and 30 (of the DCD Table) relate to another question on the jurisdictional boundary of the use of Subsection CC. Staff needs to review this further. Response regarding item 11 is acceptable.

During the audit, it was agreed to address this item under the review of RAI 3.8-4. GE will provide a supplemental response.

GE Response

Please refer to NRC RAI 3.8-4, Supplement 1.

DCD Impact

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

NRC RAI 3.8-70

DCD Section 3.8.4.2.5 discusses the welding and subsequent inspections of pool liners during construction. Clarify that these procedures apply to all pool liners, including the spent fuel pool liner. For the spent fuel pool liner, explain whether the liner welds will include leak chase channels to monitor any spent fuel pool leakage during operation. If so, describe the design of the system and what is expected of the COL applicant. If not, describe how the potential for spent fuel pool leakage will be monitored during operation.

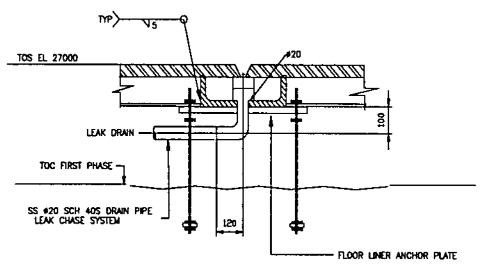
Include this information in DCD Section3.8.4.2.5.

GE Response

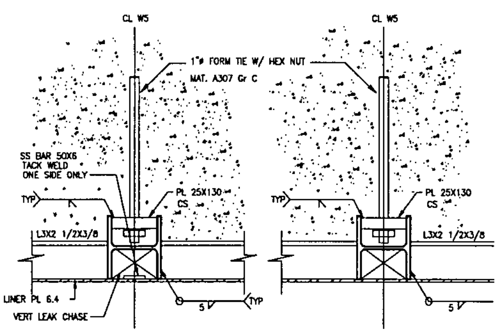
Liner welds of spent fuel pools are backed by leak chase channels. The leak chase channels are grouped according to the different pool areas and direct any leakage to area drains. This allows both leak detection and determination of where leaks originate. The functioning of the leak chase channels are checked prior to completion of the pool liner installation. Construction details of the location of drains and pipes that collect this leakage are not available at this time. The COL holder will determine the need for developing procedures for monitoring any potential pool leakage.

Generic examples of the leak chase channel are provided in Figure 3.8-70(1)

No DCD change was made in response to this RAI.



LINER FLOOR AND LEAK CHASE CHANNEL
NTS



LINER WALL WELD AND LEAK
CHASE CHANNELS DETAILS
NTS

Figure 3.8-70(1) Leak Chase Channel

NRC RAI 3.8-70, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

DCD Section 3.8.4.2.5 discusses the welding and subsequent inspections of pool liners during construction. GE needs to state in the DCD that these procedures apply to all pool liners, including the spent fuel pool liner. The remainder of the response is acceptable, but should be documented in the DCD.

During the audit, GE agreed to document in the DCD, the response given to the RAI. In addition, GE agreed to state in the DCD that the welding and the subsequent inspections of pool liners apply to all pool liners, including the spent fuel pool liner.

GE Response

Potential spent fuel pool or other pool leakage is collected by leak chase channels. The leak chase channels are grouped by different areas of a pool and direct any leakage to area drains. This allows both leak detection and the determination of where the leaks originate. Downstream of the drains, the leakage is directed to sightglasses, or tanks with level switches or to a leak detection control panel. Thus, the design of the leak collection system permits monitoring of leakage of any pool during operation. No COL action is needed.

DCD Impact

DCD Tier 2 Subsection 3.8.4.2.5 will be revised in the next update as noted in the attached mark up.

NRC RAI 3.8-71

DCD Section 3.8.4.3.1.1 identifies the loads for the Reactor Building. Pa is defined as the accident pressure at the main steam tunnel due to a high energy line break. Ta is defined as the thermal effects (including To which may occur during a design accident). It is noted that the Reactor Building is structurally connected to the Containment walls at all floor elevations. The Containment structure is also supported on the same foundation as the Reactor Building. Therefore, explain why the Reactor Building is not designed for the effects of Ra, Ta, Pa, CO, CHUG, VLC and PS as defined in Section 3.8.1.3.5 for the Containment, as well as SRV loads, as defined in Section 3.8.1.3.1. Some of these loads may not have a direct effect on the Reactor Building, but since the Reactor Building supports the Containment, the loads are transmitted to the Reactor Building floors and walls. Also explain why the dynamic effects of the above loads are not considered in the design of the entire Reactor Building.

Include this information in DCD Section 3.8.4 and/or Appendix 3G. In addition, (1) identify the applicable detailed report/calculation (number, title, revision and date, and brief description of content) that will be available for audit by the staff, and (2) reference this report/calculation in the DCD.

GE Response

DCD Section 3.8.4.3.1.1 presents only the loads that are applied to the RB directly. Other loads that are applied to the RCCV only but have some effect on the RB structures because of a common foundation mat, like P_a and T_a, are also considered in the RB design. Refer to DCD Table 3G.1-11 for an example of application.

(1) The applicable detailed report/calculation that will be available for the NRC audit is 26A6651, *RB Structural Design Report, Revision 1*, November 2005, containing the structural design details of the Reactor Building.

(2) Since this information exists as part of GE's internal tracking system, it is not necessary to add it to the DCD submittal to the NRC.

Markups of DCD Section 3.8.4.3.1.1 and DCD Table 3G.1-11 were submitted under MFN 06-298.

NRC RAI 3.8-71, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

What other loads besides Pa and Ta are considered in the RB design? All loads included in the RB design need to be defined in DCD Section 3.8.4.3.1.1. Also explain why the dynamic effects of the above loads are not considered in the design of the entire Reactor Building.

During the audit, GE agreed to document in the DCD that the effects of SRV and LOCA dynamic loads originated inside the containment will be considered as applicable. This will be documented by adding a footnotes in DCD Tables 3.8-15 and -16.

GE Response

DCD Tables 3.8-15 and 3.8-16 will be revised to add the following in the footnotes to clarify the applicability of loads generated in the RCCV to the entire RB:

"The effects of SRV and LOCA dynamic loads that originate inside the containment are considered as applicable."

DCD Impact

DCD Tier 2 Tables 3.8-15 and 3.8-16 will be revised in the next update as noted in the attached markup.

NRC RAI 3.8-72

Please confirm that application of the 100/40/40 method for combining directional responses is consistent with the staff-accepted method, as delineated in DG-1127. If not, provide the technical basis for the differences.

GE Response

Refer to RAI 3.7-41 for the same question. The 100/40/40 method used is consistent with DG-1127 requirements.

No DCD change was made in response to this RAI.

NRC RAI 3.8-72, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

Unresolved. GE's implementation of 100/40/40 method is NOT consistent with DG-1127 (RG 1.92). Recently identified and discussed with GE via teleconference on 11/21/06.

During the audit: this item will be discussed under RAI 3.8-107.

GE Response

Please refer to NRC RAI 3.8-107, Supplement 1.

DCD Impact

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

NRC RAI 3.8-74

DCD Section 3.8.4.3.3 states that accident pressure loads (Pa) do not exist for the Fuel Building. In Section 3.8.4, the DCD states that the Reactor Building and Fuel Building are built on a common foundation mat and are structurally integrated into one building. The Reactor Building is also structurally connected to the Containment walls at all floor elevations and the Containment structure is also supported on the same foundation as the Reactor Building. Therefore, explain why the fuel Building is not designed for the effects of Ra, Ta, Pa, CO, CHUG, VLC and PS, as defined in Section 3.8.1.3.5 for the Containment, as well as SRV loads, as defined in Section 3.8.1.3.1. Some of these loads may not have a direct effect on the Fuel Building, but the loads may be transmitted to the Fuel Building floors and walls. Also explain why the dynamic effects of the above loads are not considered in the design of the entire Fuel Building.

It is also noted that DCD Section 3G.3.5.2.1.1 does not define either Pa or Ta for the Fuel Building; however, Table 3G.3-4 includes Pa and Ta in two of the three selected load combinations [LOCA (1.5Pa) 72 hours and LOCA + SSE 72 hours]. Explain the LOCA loads considered in these two load combinations and correct the loads defined in Section 3G.3.5.2.1.1 and Section 3.8.4.3.3.

Include this information in DCD Section 3.8.4 and/or Appendix 3G. In addition, (1) identify the applicable detailed report/calculation (number, title, revision and date, and brief description of content) that will be available for audit by the staff, and (2) reference this report/calculation in the DCD.

GE Response

DCD Section 3.8.4.3.3 presents only the loads that are applied to the FB directly. Other loads that are applied to the RCCV only but have some effect on the FB structures because of a common foundation mat, like P_a and T_a, are also considered in the FB design. Refer to DCD Table 3G.3-4 for an example of application.

(1) The applicable detailed report/calculation that will be available for the NRC audit is 26A6655, *FB Structural Design Report, Revision 1*, November 2005.

(2) Since this information exists as part of GE's internal tracking system, it is not necessary to add it to the DCD submittal to the NRC.

Markups of DCD Appendix 3G.3.5.2.1 and DCD Table 3G.3-4 were submitted under MFN 06-298.

NRC RAI 3.8-74, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

This RAI is similar to RAI 3.8-71. What other loads besides Pa and Ta are considered in the FB design? All loads included in the FB design need to be defined in DCD Section 3.8.4.3.3. Also explain why the dynamic effects of the above loads are not considered in the design of the entire Fuel Building.

During the audit, GE agreed to document in the DCD that the effects of SRV and LOCA dynamic loads originated inside the containment will be considered as applicable. This will be documented by adding a footnotes in DCD Tables 3.8-15 and -16.

GE Response

Please refer to NRC RAI 3.8-71, Supplement 1.

DCD Impact

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

NRC RAI 3.8-98

DCD Section 3.8.5.5 refers to DCD Section 3.7.2.14 for a description of the overturning analysis methodology. The staff has previously requested additional information on this subject in RAI 3.7-48. Revise DCD Section 3.8.5.5 if needed as a result of any changes made to Section 3.7.2.14 in response to RAI 3.7-48.

GE Response

Please refer to response to RAI 3.7-48.

No DCD change was required in response to this RAI.

NRC RAI 3.8-98, Supplement 1

NRC Assessment Following the December 14, 2006 Audit

Response to RAI 3.7-48 has been revised, based on the June 2006 3.7 audit; one issue remains, based on the October-November 2006 3.7 audit. GE is addressing this. GE needs to ensure consistency between DCD 3.7.2.14 and DCD 3.8.5.5.

During the audit, it was agreed that this issue is being addressed under RAI 3.7-48 and resolution of this issue will not require a change to DCD Section 3.8.5.5.

GE Response

The markup of DCD Tier 2 Subsection 3.7.2.14 submitted under MFN 06-135S2 with NRC RAI 3.7-48, Supplement 2 is shown below with DCD Tier 2 Subsection 3.8.5.5. The markup of DCD Tier 2 Subsection 3.7.2.14 has no impact on DCD Tier 2 Subsection 3.8.5.5.

3.7.2.14 Determination of Seismic Category I Structure Overturning Moments

When the combined effect of earthquake ground motion and structural response is strong enough, the structure undergoes a rocking motion pivoting about either edge of the base. When the amplitude of rocking motion becomes so large that the center of structural mass reaches a

position right above either edge of the base, the structure becomes unstable and may tip over. The mechanism of the rocking motion is like an inverted pendulum and its natural period is long compared with the linear, elastic structural response. Thus, with regard to overturning, the structure can be treated as a rigid body.

The maximum kinetic energy (E_s) can be conservatively estimated to be:

$$E_s = \frac{1}{2}\sum_i m_i[(V_h)_i^2 + (V_v)_i^2] \qquad (3.7\text{-}20)$$

where $(V_h)_i$ and $(V_v)_i$ are the maximum values of the total lateral velocity and total vertical velocity, respectively, of mass m_i, and are computed as follows:

$$\begin{aligned} |(V_h)_i| &= |(V_x)_i| + |(V_h)_g| \\ |(V_v)_i| &= |(V_z)_i| + |(V_v)_g| \end{aligned} \qquad (3.7\text{-}21)$$

where $(V_h)_g$ and $(V_v)_g$ are the peak horizontal and vertical ground velocity, respectively, and $(V_x)_i$ and $(V_z)_i$ are the maximum values of the relative lateral and vertical velocity of mass m_i.

Letting m_0 be the total mass of the structure and base mat, the potential energy required to overturn the structure is equal to:

$$E_o = m_o g h + W_p - W_b \qquad (3.7\text{-}22)$$

where h is the height to which the center of mass of the structure must be lifted to reach the overturning position, g is the gravity constant, and W_p and W_b are the energy components caused by the effects of embedment and buoyancy, respectively. Because the structure may not be a symmetrical one, the value of h is computed with respect to the edge that is nearer to the center of mass. The structure is defined stable against overturning when the ratio of E_o to E_s is no less than 1.1 for the SSE in combination with other appropriate loads.

3.8.5.5 Structural Acceptance Criteria

The main structural criteria for the containment portion of the foundation are to provide adequate strength to resist loads and sufficient stiffness to protect the containment liner from excessive strain. The acceptance criteria for the containment portion of the foundation mat are presented in Subsection 3.8.1.5. The structural acceptance criteria for the RB, CB and FB foundations are described in Subsection 3.8.4.5.

The allowable factors of safety of the ESBWR structures for overturning, sliding, and flotation are included in Table 3.8-14. The calculated factors of safety are shown in Appendix 3G for each foundation mat evaluated according to the following procedures.

The factor of safety against overturning due to earthquake loading is determined by the energy approach described in Subsection 3.7.2.14.

The factor of safety against sliding is defined as:

$$FS = (F_s + F_p)/(F_d + F_h)$$

where F_s and F_p are the shearing and sliding resistance, and passive soil pressure resistance, respectively. F_d is the maximum lateral seismic force including any dynamic active earth pressure, and F_h is the maximum lateral force due to loads other than seismic loads.

The factor of safety against flotation is defined as:

$$FS = F_{DL}/F_B$$

where F_{DL} is the downward force due to dead load and F_B is the upward force due to buoyancy.

DCD Impact

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

Table 3.2-1

Classification Summary

Principal Components[1]		Safety Class.[2]	Location[3]	Quality Group[4]	QA Req.[5]	Seismic Category[6]	Notes
7.	Motors for seismic category I pumps	N	OO,RB	—	E	I	Same as above.
8.	Other pumps and motors	N	OO	D	E	NS	Same as above.
9.	Electrical modules and cables for RB preaction sprinklers	N	RB	—	E	NS	Same as above.
10.	All other electrical modules and cables	N	ALL	—	E	NS	Same as above.
11.	CO_2 actuation modules	N	TB	—	E	NS	Same as above.
12.	Sprinklers	N	RB, TB, RW, SB, EB, OL	D	E	NS	Same as above.
13.	Foam, preaction or deluge	N	EB, TB, OO	—	E	NS	Same as above.
U44	**Sanitary Waste Discharge System**	N	CB, SB, EB, RB, OO	—	E	NS	
U50	**Equipment and Floor Drain System**						
1.	Piping and valves forming part of the containment boundary	2	CV, RB	B	B	I	
2.	Drain piping and valves in Seismic Category I buildings	N	RB, FB	D	E	II	
3.	Drain piping and valves including supports in other buildings	N	ALL except RB, FB	D	E	NS	
4.	Other mechanical and electrical modules	N	ALL	—	E	NS	
U65	**Other Building Structures**	N	OO, OL	—	E	NS	

Table 3.2-1

Classification Summary

Principal Components[1]		Safety Class.[2]	Location[3]	Quality Group[4]	QA Req.[5]	Seismic Category[6]	Notes
U71	**Reactor Building Structure**						
1.	Main building	3	RB	—	B	I	
2.	Stair towers and elevator shafts	N	RB	—	E	II	
U72	**Turbine Building Structure**	N	TB	—	E	II	
U73	**Control Building Structure**						
1.	Main building	3	CB	—	B	I	
2.	Stair towers and elevator shaft	N	CB	—	E	II	
U74	**Radwaste Building Structure**	N	RW	—	E	NS	Radwaste Management Systems – A quality assurance program meeting the guidance of NRC Regulatory Guide 1.143, Category RW-IIa is applied to radioactive waste management systems during design and construction.
U75	**Service Building Structure**	N	SB	—	E	II	
U77	**Control Building HVAC**						
1.	Ducts, valves, and dampers (including supports) supporting safety-related areas	3	CB	—	B	I	
2.	Other ducts, valves and dampers (including supports)	N	CB	—	E	NS	
3.	Electrical modules and cable with safety-related function	3	CB	—	B	I	
4.	Main control room bottled air system	3	CB, OO	—	B	I	
5.	Other nonsafety-related equipment	N	CB	—	E	NS	
U78	**Cold Machine Shop**	N	OO		E	NS	
U80	**Electrical Building Structure**	N	EB	—	E	NS	
U81	**Seismic Monitoring System**	N	ALL	—	E	NS	
U84	**Service Water Building Structure**	N	SF	—	E	NS	

Table 3.2-1

Classification Summary

Principal Components[1]	Safety Class.[2]	Location[3]	Quality Group[4]	QA Req.[5]	Seismic Category[6]	Notes
U85 Service Water Building HVAC	N	SF	—	E	NS	
U91 Administration Building Structure	N	OL	—	E	NS	
U93 Training Center	N	OL	—	E	NS	
U95 Hot Machine Shop	N	OO	—	E	NS	
U97 Fuel Building Structure						
1. Main building	3	FB	—	B	I	
2. HVAC penthouse, stair towers and elevator shaft	N	FB	—	E	II	
U98 Fuel Building HVAC						
1. Building isolation dampers	3	FB	—	B	I	
2. Ducting penetrating fuel building boundary	3	FB	—	B	I	
3. Controls associated with the isolation dampers	3	FB	—	B	I	
4. Other system components	N	FB	—	E	II	
U99 Stack	N	OO	—	E	NS	
W INTAKE STRUCTURE AND SERVICING EQUIPMENT						
W12 Intake and Discharge Structures	N	OO	—	E	NS	
W24 Cooling Tower	N	OO	—	E	NS	
W32 Screen Cleaning Facility	N	OO	—	E	NS	
W33 Screens, Racks, and Rakes	N	OO	—	E	NS	
W41 Intake Structure Power Supply	N	OO	—	E	NS	
Y YARD STRUCTURES AND EQUIPMENT						
Y12 Roads and Walkways	N	OO	—	E	NS	

3.7 SEISMIC DESIGN

For seismic design purposes, all structures, systems, and components of the ESBWR standard plant are classified into Seismic Category I (C-I), Seismic Category II (C-II), or Non-Seismic (NS) in accordance with the requirements to withstand the effects of the Safe Shutdown Earthquake (SSE) as defined in Section 3.2. For those C-I and C-II structures, systems and components in the reactor building complex, the effects of other dynamic loads caused by reactor building vibration (RBV) caused by suppression pool dynamics are also considered in the design. Although this section addresses seismic aspects of design and analysis in accordance with Regulatory Guide 1.70, the methods of this section are also applicable to RBV dynamic loadings, unless noted otherwise. The method of combination of peak dynamic responses to seismic and RBV loads is the Square Root of the Sum of the Squares (SRSS) in accordance with NUREG-0484 Revision 1. For reinforced concrete structures the section forces or stresses due to each dynamic load are combined in the most conservative manner by systematically varying the sign (+ or -), equivalent to the absolute sum method.

The safe shutdown earthquake (SSE) is that earthquake which is based upon an evaluation of the maximum earthquake potential considering the regional and local geology, seismology, and specific characteristics of local subsurface material. It is the earthquake that produces the maximum vibratory ground motion for which Seismic Category I structures, systems and components (SSC) are designed to remain functional and within applicable stress, strain, and deformation limits. These systems and components are those necessary to ensure the following:

- The integrity of the reactor coolant pressure boundary (RCPB);
- The capability to shut down the reactor and maintain it in a safe condition; or
- The capability to prevent or mitigate the consequences of accidents which could result in potential offsite exposures comparable to the applicable guidelines exposures set forth in 10 CFR 100 (10 CFR 50.34(a)).

ESBWR response to an earthquake up to SSE may achieve shutdown of the reactor and maintenance of it in a safe condition using the Automatic Depressurization System and Gravity Driven Cooling System as described in the Probabilistic Risk Assessment. In this case, depressurization is accomplished in part with Depressurization Valves that remain open in order for the Gravity Driven Cooling System and the Passive Containment Cooling System to perform their safety functions.

Seismic Category II (C-II) includes all plant SSC which perform no safety-related function, and whose continued function is not required, but whose structural failure or interaction could degrade the functioning of a Seismic Category I structure, system or component to an unacceptable safety level, or could result in incapacitating injury to occupants of the control room. Thus, this category includes the SSC whose structural integrity, not their operational performance, is required. The methods of seismic analysis and design acceptance criteria for C-II SSC are the same as C-I; however, the procurement, fabrication and construction requirements for C-II SSC are in accordance with industry practices. Seismic Category II (C-II) items are those corresponding to position C.2 of Regulatory Guide 1.29.

The Operating Basis Earthquake (OBE) is a design requirement. For the ESBWR OBE ground motion is chosen to be one-third of the SSE ground motion. Therefore, no explicit response or

3.8.1.2.3 General Design Criteria, Regulatory Guides, and Industry Standards

(1) 10CFR50, Appendix A, "General Design Criteria for Nuclear Power Plants", Criteria 1, 2, 4, 16 and 50. Conformance is discussed in Section 3.1.

(2) Table 3.8-9 Items 29, 30, 31 and 33

(3) Industry Standards

Only nationally recognized industry standards such as those published by the American Society for Testing and Materials (ASTM) and the American National Standards Institute (ANSI) as referenced by the Applicable Codes, Standards, and Regulations are used.

3.8.1.3 Loads and Load Combinations

The containment is analyzed and designed for all credible conditions of loading, including normal loads, preoperational testing loads, loads during severe environmental conditions, loads during extreme environmental conditions and loads during abnormal plant conditions.

3.8.1.3.1 Normal Loads

(1) D — Dead load of the structure and equipment plus any other permanent loads, including vertical and lateral pressures of liquids.

(2) L — Live loads, including any moveable equipment loads and other loads that vary in intensity and occurrence, such as forces exerted by the lateral pressure of soil. Live load for structures inside the containment is 9.6 kPa during outages and laydown operations. The loads are applied to the containment interior floors, except the suppression pool floor slab.

(3) T_0 — Thermal effects and loads during normal operating, startup or shutdown conditions, including liner plate expansion, equipment and pipe reactions, and thermal gradients based on the most critical transient or steady- state thermal gradient.

(4) R_0 — Pipe reactions during normal operating or shutdown conditions based on the most critical transient or steady-state conditions.

(5) P_0 — Pressure loads resulting from the pressure difference between the interior and exterior of the containment, considering both interior pressure changes because of heating or cooling and exterior atmospheric pressure variations.

(6) Construction Loads — Loads that are applied to the containment from start to completion of construction. The definitions for D, L and T_0 given above are applicable, but are based on actual construction methods and/or conditions.

(7) SRV — Safety relief valve loads. Oscillatory dynamic pressure loadings resulting from discharge of safety relief valves (SRVs) into the suppression pool.

3.8.1.3.2 Preoperational Testing Loads

(1) P_t — Test loads are loads which are applied during the Structural Integrity Test (SIT) or Integrated Leak Rate Test (ILRT).

(2) T_t — Thermal effects and loads during the SIT or ILRT.

chamber pressure during the differential pressure test. This test differential pressure is 115% of the design-differential pressure. At no time during the SIT shall the drywell pressure exceed a maximum value of 356.8 kPag.

During these tests, the suppression chamber, GDCS pools, IC/PCCS pools (including expansion pools), reactor cavity, Dryer/Separator pool, and Fuel Buffer pool are filled with water to the normal operational water level. Deflection and concrete crack measurements are made to determine that the actual structural response is within the limits predicted by the design analysis.

In addition to the deflection and crack measurements, the first prototype containment structure is instrumented for the measurement of strains in accordance with the provisions of Subarticle CC-6370 of ASME Code Section III, Division 2.

3.8.1.7.2 Preoperational and In-Service Integrated Leak Rate Test

Preoperational and in-service integrated leak rate testing is discussed in Subsection 6.2.6.

3.8.1.7.3 Preservice and Inservice Inspection

3.8.1.7.3.1 Scope

This subsection describes the preservice and inservice inspection program requirements for the Containment Structure, ASME B&PV Code, Class CC and MC pressure retaining components and their integral attachments. It describes those programs implementing the requirements of the ASME B&PV Code Section XI (ASME Section XI). Subsection IWE of ASME Section XI applies to Class MC and metallic shell and penetration liners of Class CC pressure retaining components and their integral attachments. Subsection IWL of ASME Section XI applies to the Class CC reinforced concrete.

The design to perform preservice inspection is in compliance with the requirements of the ASME Section XI, 2001 Edition with 2003 Addenda. The preservice and inservice inspection program plans is based on the ASME Section XI, Edition and Addenda specified in accordance with 10 CFR 50, Section 50.55a. The Containment Structure is designed to provide access for the examinations required by ASME Section XI, IWE-2500 and IWL-2500. The actual Edition of ASME Section XI to be used is specified based on the procurement date of the component per 10 CFR 50, Section 50.55a. The ASME Code requirements discussed in this section are provided for information and are based on the 2001 Edition of ASME Section XI with 2003 Addenda.

3.8.1.7.3.2 Exclusions

During detailed design phase, the number of inaccessible areas will be minimized in order to reduce the number of exclusions below. Furthermore, remote tooling will be used in high radiation areas where feasible.

Portions of the Containment Structure are excluded from preservice and inservice examination requirements of ASME Section XI, Subsections IWE and IWL as follows:

(1) For Class MC components and metallic shell and penetration liners of Class CC components and their integral attachments :

3.8.2.1.4 Drywell Head

A 10,400 mm 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. The stainless steel clad thickness for the drywell head is 2.5 mm 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.

3.8.2.2 Applicable Codes, Standards, and Specifications

3.8.2.2.1 Codes and Standards

In addition to the codes and standards specified in Subsection 3.8.1.2.2, the following codes and standards 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

3.8.2.2.2 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

The pools on one side are contained by the RCCV wall and on the other side by walls made of structural steel.

The GDCS pool walls away from the RCCV are made of carbon steel plates lined with stainless steel cladding and backed up with vertical and horizontal steel structural framing system.

3.8.3.1.6 Miscellaneous Platforms

Miscellaneous platforms are designed to allow access and to provide support for equipment and piping. The platforms consist of steel beams and open grating to facilitate movement of air and liquids in case of pipe breaks. Platforms are classified as Seismic Category I (C-I) structures when they support safety-related functions. Otherwise they are classified as Seismic Category II (C-II). Similarly, other miscellaneous structural components inside containment that do not support safety-related functions are classified as C-II.

3.8.3.1.7 Miscellaneous Commodities

See Subsections 3.8.4.1.6 for Cable trays, Conduits, and their supports. See Subsections 3.8.4.1.7 for HVAC ducts and their supports.

3.8.3.2 Applicable Codes, Standards, and Specifications

The design of the concrete and steel internal structures of the containment conform to the applicable codes, standards, and specifications and regulations listed in Table 3.8-6 except where specifically stated otherwise.

Structure or Component	Specific Reference Number in Table 3.8-6
Diaphragm Floor	1-12, 15-20
RPV Support Bracket	15-20
Vent wall	1-12, 15-20
Reactor Shield Wall	15-20
GDCS Pool Wall	15-20
Miscellaneous Platforms	15-20

Anchorage of steel internal structures complies with Regulatory Guide 1.199.

3.8.3.3 Loads and Load Combinations

3.8.3.3.1 Load Definitions

The loads and applicable load combinations for which a containment internal structure is designed depend on the conditions to which the particular structure is subjected.

The containment internal structures are designed in accordance with the loads described in Subsection 3.8.1.3. These loads and the effects of these loads are considered in the design of all internal structures as applicable. The reactor shield wall is also designed to the Annulus Pressurization (AP) loads, which are loads and pressures directly on the reactor shield wall caused by a rupture of a pipe within the reactor vessel shield wall annulus region.

3.8.3.7 Testing and In-service Inspection Requirements

A formal program of testing and in-service inspection is not planned for the internal structures except the diaphragm floor, and vent wall. The other internal structures are not directly related to the functioning of the containment system; therefore, no testing or inspection is performed.

However, during the operating life of the plant the condition of these other internal structures is monitored per 10 CFR 50.65 as clarified in RG 1.160, in accordance with Section 1.5 of RG 1.160.

Testing and in-service inspection of the diaphragm floor and vent wall are directly related to the functioning of the containment system and are discussed in Subsection 3.8.1.7.

Space Control is exercised in the ESBWR by means of a 3D model. It is the means by which interference checking and space control is accomplished. It includes all safety and non-safety related SSCs. Items are added to the model as it is being developed by stages depending on criticality to the plant and construction sequence of the item. Accessibility to equipment, valves, instrumentation, welds, supports, etc. for operation, inspection or removal is characterized by sufficient space to allow unobstructed access and reach of site personnel. Therefore, aisles, platforms, ladders, handrails, etc. are reviewed as the components are laid out. Interferences with access ways, doorways, walkways, truck ways, lifting wells, etc. are constantly monitored.

This method of configuration control is maintained and documented during the plant layout process. Remote tooling is considered only if for some layout reasons the required inspection could not be carried out otherwise.

3.8.3.8 Welding Methods and Acceptance Criteria for Structural and Building Steel

Welding activities are performed with written procedures, combining with the requirements of the American Institute of Steel Construction (AISC) Manual of Steel Construction. The visual acceptance criteria comply with American Welding Society (AWS) Structural Welding Code D1.1 and Nuclear Construction Issue Group (NCIG) Standard, "Visual Weld Acceptance Criteria for Structural Welding at Nuclear Plants", NCIG-01.

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 Reactor Building (RB), Control Building (CB) and Fuel Building (FB). 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 Regulatory Guide 1.143 under Safety Class RW-IIa. The RB and FB are built on a common foundation mat and structurally integrated into one building. The other structures in close proximity to these structures are the Turbine Building and Service Building. They are structurally separated from the other ESBWR Standard Plant buildings. Seismic gaps capable of a minimum 100 mm free movement are provided 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

Turbine Building. 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 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 Reactor Building (RB) are summarized in Table 3.8-8.

The RB encloses the concrete containment and its internal systems, structures, and components. In addition, the RB contains the Isolation Condenser/Passive Containment Cooling (IC/PCC), expansion pools and the services pools for storage of Dryer/Separator on the top of the concrete containment. Main Steam and Feedwater lines are routed to the Turbine Building through the Main Steam Tunnel in the RB as described in Subsection 3.8.4. The RB is a Seismic Category I structure.

The RB is a rigid box type shear wall building constructed of reinforced concrete. Vertical loads are carried by a system of external walls box-shaped surrounding a large cylindrical shaped concrete containment.

Lateral loads are resisted by external shear walls as well as the internal concentric cylindrical structure.

These structures are tied together by a system of internal concrete bearing walls and concrete floor slabs. Floor slabs are designed, in general, as composite structures supported by temporary beams during construction.

The load resisting characteristic of the building is that of a concrete box type shear wall structure.

The summary report for the RB is in Appendix 3G Subsection 3G.1. This report contains a description of the RB, the loads, load combinations, reinforcement stresses, and concrete reinforcement details for the basemat, seismic walls, and floors.

3.8.4.1.2 Control Building

The Control Building (CB) is adjacent to but structurally independent of the Reactor Building (see Figures 1.2-2 through 1.2-5 and Figure 1.2-11). The key dimensions of the CB are summarized in Table 3.8-8.

The CB houses the essential electrical, control and instrumentation equipment, the control room for the Reactor and Turbine Buildings and the CB HVAC equipment. The CB is a Seismic Category I structure that houses control equipment and operation personnel.

The CB is a reinforced concrete box type shear wall structure consisting of walls and slabs and is supported on a foundation mat. Steel framing is composite with concrete slab and is used to support the slabs for vertical loads. The CB is a shear wall structure designed to accommodate all seismic loads with its walls and connected floors. Therefore, frame members such as beams or columns are designed to resist vertical loads and to accommodate deformations of the walls in case of earthquake conditions.

The summary report for the CB is in Appendix 3G Subsection 3G.2. This report contains a description of the CB, the loads, load combinations, reinforcement stresses, and concrete reinforcement details for the basemat, seismic walls, and floors.

3.8.4.1.3 Fuel Building

The Fuel Building (FB) is integrated with the RB, sharing a common wall between the RB and the FB and a large common foundation mat (see Section 1.2). The key dimensions of the FB are summarized in Table 3.8-8.

The FB houses the spent fuel pool facilities and their supporting system and HVAC equipment. The FB is a Seismic Category I structure except for the penthouse that houses HVAC equipment. The penthouse is a Seismic Category II structure.

The FB is a reinforced concrete box type shear wall structure consisting of walls and slabs and is supported on a foundation mat. Concrete and/or steel framing is composite with a concrete slab and is used to support the slabs for vertical loads. The FB is a shear wall structure designed to accommodate all seismic loads with its walls and connected floors. Therefore, frame members such as beams or columns are designed to resist vertical loads and to accommodate deformations of the walls in case of earthquake conditions.

The summary stress report for the FB is in Appendix 3G Subsection 3G.3. This report contains a description of the FB, the loads, load combinations, reinforcement stresses, and concrete reinforcement details for the basemat, seismic walls, and floors.

3.8.4.1.4 (Deleted)

3.8.4.1.5 Radwaste Building

The Radwaste Building (RW) is shown in Section 1.2.

The Radwaste Building (RW) is a reinforced concrete box type structure consisting of walls and slabs and is supported on a foundation mat. The key dimensions of the RW are summarized in Table 3.8-8.

The RW houses the equipment and floor drain tanks, sludge phase separators, resin hold up tanks, detergent drain tanks, a concentrated waste tank, chemical drain collection tank, associated pumps and mobile systems for the radioactive liquid and solid waste treatment systems.

The RW is a Non-Seismic Category (NS) structure. The RW is designed according to the safety classifications defined in Regulatory Guide 1.143 Category RW-IIa.

3.8.4.1.6 Seismic Category I Cable Trays, Cable Tray Supports, Conduits, and Conduit Supports

Electrical cables are carried on continuous horizontal and vertical runs of steel trays or through steel conduits. The tray and conduit locations are based on the requirements of the electrical cable network. Trays or conduits are supported at intervals by supports made of hot or cold rolled steel sections. The supports are attached to walls, floor, and ceilings of structures as required by the arrangement. The type of support and spacing is determined by allowable tray or conduit spans which are governed by rigidity and stress. Bracing is provided where required. Dynamic Analysis methods are described in Section 3.7. The loads, loading combinations, and allowable stresses are in accordance with applicable codes, standards, and regulations consistent with Tables 3.8-6 and 3.8-9. Analysis methods follow those presented in Sections 3.7 and 3.8. Design and location requirements for conduit and cable tray supports are also specified in Subsections 3.9.2 and 3.10.3.2.

3.8.4.1.7 Seismic Category I HVAC Ducts and HVAC Duct Supports

HVAC duct locations and elevations are based on the requirements of the HVAC system. HVAC ducts are made of steel sheet metal and are supported at intervals by supports made of hot or cold rolled steel sections. The supports are attached to walls, floor, and ceilings of structures as required by the arrangement. The type of support and spacing is determined by allowable duct spans that are governed by rigidity and stress. Bracing is provided where required. Dynamic Analysis methods are described in Section 3.7. The loads, loading combinations, and allowable stresses are in accordance with applicable codes, standards, and regulations consistent with Tables 3.8-6 and 3.8-9. Analysis methods follow those presented in Sections 3.7 and 3.8. Design and location requirements for HVAC Ducts and HVAC Duct supports are also specified in Subsections 3.9.2, 9.4.1.3, 9.4.2.3 and 9.4.6.3.

3.8.4.2 Applicable Codes, Standards, and Specifications

3.8.4.2.1 Reactor Building

The major portion of the Reactor Building outside Containment structure is not subjected to the abnormal and severe accident conditions associated with a containment. Applicable documents for the RB design are shown in Table 3.8-9, except items 4, 11, 30 and 32.

3.8.4.2.2 Control Building

Applicable documents for the CB design are the same as the RB, which are listed in Table 3.8-9.

3.8.4.2.3 Fuel Building

Applicable documents for the FB design are same as the RB, which are listed in Table 3.8-9. Applicable documents for the spent fuel racks and associated structures are specified in Section 9.1.2.

3.8.4.2.4 Radwaste Building

Applicable codes, standards, specifications and regulations used in the design and construction of RW are items 1, 2, and 32 listed in Table 3.8-9.

3.8.4.2.5 Welding of Pool Liners

All pool liner welds, including the spent fuel pool liner welds, are visually inspected before starting any other NDE method. The visual weld acceptance criteria are defined in AWS Structural Welding Code, D1.1. In accordance with approved procedures, the welded seams of the liner plate are inspected by:

- Liquid Penetrant Examinations. To be carried out on all liner plate butt, fillet, corner and tee welds in accordance with ASME, Section V, Article 6 requirements. The acceptance criteria are in accordance with the requirements of ASME Section III, NE 5352.
- Helium sniffer test or vacuum box technique in accordance with ASME Section V, Article 10 requirements. Any evidence of leakage is unacceptable.

After construction is finished, each isolated pool is leak tested.

The liner welds for all pools outside of the RCCV, including the spent fuel pool, are backed by leak chase channels and a leak detection system to monitor any leakage during plant operation. The leak chase channels are grouped according to the different pool areas and direct any leakage to area drains. This allows both leak detection and determination of where leaks originate. The functioning of the leak chase channels are checked prior to completion of the pool liner installation.

3.8.4.2.6 (Deleted)

3.8.4.3 Loads and Load Combinations

3.8.4.3.1 Reactor Building

3.8.4.3.1.1 Loads and Notations

This section presents only the loads that are applied to the RB directly. Other loads, which are applied to the RCCV only but have effects on RB structures because of common foundation mat, like P_a and T_a, are also considered in the RB design.

Loads and notations are as follows:

D = Dead load of structure plus any other permanent load.

L = Conventional floor or roof live loads, movable equipment loads, and other variable loads such as construction loads. The following live loads are used:

- Concrete floor slabs – 4.8 kPa.
- Concrete roofs – 2.9 kPa.
- Construction live load on floor framing in addition to dead weight of floor – 2.4 kPa.

Live Load L, includes floor area live loads, laydown loads, nuclear fuel and fuel transfer casks, equipment handling loads, trucks, railroad vehicles and similar items. The floor area live load is omitted from areas occupied by equipment whose weight is specifically included in dead load. Live load is not omitted under equipment where access is provided, for instance, an elevated tank on four legs.

Table 3.8-6

Codes, Standards, Specifications, and Regulations Used in the Design and Construction of Seismic Category I Internal Structures of the Containment

Specification Reference Number	Specification or Standard Designation	Title
23	Regulatory Guide 1.199	Anchoring Components and Structural Supports in Concrete, November 2003.
24	ASME N509-2002	Nuclear Power Plant Air-Cleaning Units and Components
25	ASME/ANSI AG-1-2003	Code on Nuclear Air and Gas Treatment
26	AISI-2001 Edition and 2004 Supplement	AISI Specification for the Design of Cold-Formed Steel Structural Members
27	SMACNA 1481, Third Edition, 2005	HVAC Duct Construction Standards-Metal and Flexible
28	IEEE-344-1987	Recommended Practices for Seismic Qualification of Class IE Equipment for Nuclear Power Generating Stations

Explanation of Abbreviation

ACI American Concrete Institute
AISC American Institute of Steel Construction
AISI American Iron and Steel Institute
ANSI American National Standards Institute
ASME American Society for Mechanical Engineers
AWS American Welding Society
EPRI Electric Power Research Institute
IEEE Institute of Electrical and Electronics Engineers, Inc.
NCIG Nuclear Construction Issues Group
SMACNA Sheet Metal and Air Conditioning Contractors' National Association

Note:

(1) To comply with NUREG-1503, Appendix G, NRC Position on the use of ANSI/AISC N690 (1984), for impact and impulsive loads, the ductility factors μ in Table Q1.5.8.1 are replaced with the ductility factors in Appendix A to SRP Section 3.5.3.

Table 3.8-7

Load Combination, Load Factors and Acceptance Criteria for Steel Structures Inside the Containment*1,*2

Category	No.	Load Combination														Acceptance Criteria*5
		D	L	P_o	P_a	T_o	T_a	E'	W	W'	R_o	R_a	Y*4	SRV*6,*7	LOCA*6,*7	
Normal	1	1.0	1.0	1.0												S
	2	1.0	1.0	1.0		1.0					1.0					$S^{(a)}$
Severe Environmental	3	1.0	1.0	1.0					1.0					1.0		S
	4	1.0	1.0	1.0				1.0						1.0		S
	5	1.0	1.0	1.0		1.0			1.0		1.0			1.0		$S^{(a)}$
	6	1.0	1.0	1.0		1.0		1.0			1.0			1.0		$S^{(a)}$
Extreme Environmental	7	1.0	1.0	1.0		1.0				1.0	1.0			1.0		$1.6S^{(b)(c)}$
	8	1.0	1.0	1.0		1.0		1.0			1.0			1.0		$1.6S^{(b)(c)}$
Abnormal	9	1.0	1.0		1.0		1.0					1.0		1.0	Note*3	$1.6S^{(b)(c)}$
	9a	1.0	1.0		1.0		1.0							1.0	Note*3	$1.6S^{(b)(c)}$
Abnormal/Severe Environmental	10	1.0	1.0		1.0		1.0					1.0	1.0	1.0	Note*3	$1.6S^{(b)(c)}$
Abnormal/Extreme Environmental	11	1.0	1.0		1.0		1.0	1.0				1.0	1.0	1.0	Note*3	$1.7S^{(b)(c)}$

*1 The loads are described in Subsection 3.8.3.3 and acceptance criteria in Subsection 3.8.3.5.

*2 For any load combination, where any load reduces the effects of other loads, the corresponding coefficient for that load shall be taken as 0.9 if it can be demonstrated that the load is always present or occur simultaneously with the other loads. Otherwise, the coefficient for that load shall be taken as zero.

*3 LOCA loads, such us CO, CHUG and PS are time-dependant loads. The sequence of occurrence is given in Appendix 3B. The loads factor for LOCA loads shall be the same as the corresponding Pressure Load P_a. The maximum values of P_a, T_a, R_a, Y including an appropriate Dynamic Load Factor (DLF) shall be used, unless an appropriate time history analysis is performed to justify otherwise. LOCA includes AP loads and effects. LOCA loads shall include hydrostatic pressure (with a load factor of 1.0) due to containment flooding.

*4 Y includes Y_j, Y_m and Y_r.

*5 Allowable elastic working stress (S) is the allowable stress limit specified in Part 1 of ANSI/AISC N-690-1994-s2 (2004).
  (a) For primary plus secondary stress, the allowable limits are increased by a factor of 1.5.
  (b) Stress limit coefficient in shear shall not exceed 1.4 in members and bolts.
  (c) The Stress limit coefficient where axial compression exceeds 20% of normal allowable, shall be 1.5 for load combinations 7, 8, 9, 9a and 10, and be 1.6 for load combination 11.

Table 3.8-9

Codes, Standards, Specifications, and Regulatory Guides Used in the Design and Construction of Seismic Category I Structures

Specification Reference Number	Specification or Standard Designation	Title
29	Regulatory Guide 1.94	Quality Assurance Requirements for Installation, Inspection, and Testing of Structural Concrete and Structural Steel During the Construction Phase of Nuclear Power Plants, Rev. 1 and draft 2
30	Regulatory Guide 1.136	Materials, Construction and Testing of Concrete Containments (Article CC-2000 of the Code for Concrete Reactor Vessels and Containments), Jun. 1981
31	Regulatory Guide 1.142	Safety-Related Concrete Structures for Nuclear Power Plants (Other than Reactor Vessels and Containments), Nov. 2001
32	Regulatory Guide 1.143	Design Guidance for Radioactive Waste Management Systems, Structures and Components installed in Light Water Cooled Nuclear Power Plants, Nov. 2001
33	Regulatory Guide 1.199	Anchoring Components and Structural Supports in Concrete, November 2003.
34	(Applicable ASTM Specifications for Materials and Standards)	
35	ASME N509-2002	Nuclear Power Plant Air-Cleaning Units and Components
36	ASME/ANSI AG-1-2003	Code on Nuclear Air and Gas Treatment
37	AISI-2001 Edition and 2004 Supplement	AISI Specification for the Design of Cold-Formed Steel Structural Members
38	SMACNA 1481, Third Edition, 2005	HVAC Duct Construction Standards-Metal and Flexible
39	IEEE-344-1987	Recommended Practices for Seismic Qualification of Class IE Equipment for Nuclear Power Generating Stations

Explanation of Abbreviation

ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASME	American Society for Mechanical Engineers
AWS	American Welding Society
IEEE	Institute of Electrical and Electronics Engineers, Inc.
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association
SSPC	Steel Structures Painting Council

See Subsections 3.8.1.2 and 3.8.3.2 for Applications

Note:

(1) To comply with NUREG-1503, Appendix G, NRC Position on the use of ANSI/AISC N690 (1984), for impact and impulsive loads, the ductility factors μ in Table Q1.5.8.1 are replaced with the ductility factors in Appendix A to SRP Section 3.5.3.

Table 3.8-15

Load Combinations, Load Factors and Acceptance Criteria for the Safety-Related Reinforced Concrete Structures*1,*2,*3

Load Combination															Acceptance
Category	No.	D	F	L	H	Pa	To	Ta	E'	W	Wt	Ro	Ra	Y*4	Criteria*5
Normal	1	1.4	1.4	1.7	1.7							1.7			U
	2	1.05	1.05	1.3	1.3		1.3					1.3			U
Severe	3	1.4	1.4	1.7	1.7					1.7		1.7			U
Environmental	4	1.05	1.05	1.3	1.3		1.3			1.3		1.3			U
	5	1.2	1.2							1.7					U
Extreme	6	1.0	1.0	1.0	1.0		1.0		1.0			1.0			U
Environmental	7	1.0	1.0	1.0	1.0		1.0				1.0	1.0			U
Abnormal	8	1.0	1.0	1.0	1.0	1.5		1.0					1.0		U
Abnormal/Extreme Environmental	9	1.0	1.0	1.0	1.0	1.0		1.0	1.0				1.0	1.0	U

*1: The loads are described in Subsection 3.8.4.3.1.1 and acceptance criteria in Subsection 3.8.4.5.1. The effects of SRV and LOCA dynamic loads that originate inside the containment are considered as applicable.

*2: For any load combination, where any load reduces the effects of other loads, the corresponding coefficient for that load shall be taken as 0.9 if it can be demonstrated that the load is always present or occur simultaneously with the other loads. Otherwise, the coefficient for that load shall be taken as zero.

*3: Because Pa and Ta are time-dependent loads, their effects are superimposed accordingly.

*4: Y includes Y_j, Y_m and Y_r. The maximum value of Y including an appropriate Dynamic Load Factor (DLF) shall be used, unless an appropriate time history analysis is performed to justify otherwise

*5: U = Required section strength based on the strength design method per ACI 349

Table 3.8-16

Load Combinations, Load Factors and Acceptance Criteria for the Safety-Related Steel Structures[*1,*2,*3]

Category	Load Combination												Acceptance Criteria[*5]
	No.	D[*6]	L	Pa	To	Ta	E'	W	Wt	Ro	Ra	Y[*4]	
Normal	1	1.0	1.0										S
	2	1.0	1.0		1.0					1.0			S (a)
Severe Environmental	3	1.0	1.0					1.0					S
	4	1.0	1.0		1.0			1.0		1.0			S (a)
Extreme Environmental	5	1.0	1.0		1.0		1.0			1.0			1.6S (b)(c)
	6	1.0	1.0		1.0				1.0	1.0			1.6S (b)(c)
Abnormal	7	1.0	1.0	1.0		1.0					1.0		1.6S (b)(c)
Abnormal/Extreme Environmental	8	1.0	1.0	1.0		1.0	1.0				1.0	1.0	1.7S (b)(c)

*1: The loads are described in Subsection 3.8.4.3.1.1 and acceptance criteria in Subsection 3.8.4.5.1. The effects of SRV and LOCA dynamic loads that originate inside the containment are considered as applicable.

*2: For any load combination, where any load reduces the effects of other loads, the corresponding coefficient for that load shall be taken as 0.9 if it can be demonstrated that the load is always present or occur simultaneously with the other loads. Otherwise, the coefficient for that load shall be taken as zero.

*3: Because Pa and Ta are time-dependent loads, their effects are superimposed accordingly.

*4: Y includes Y_j, Y_m and Y_r. The maximum values of Y including an appropriate Dynamic Load Factor (DLF) shall be used, unless an appropriate time history analysis is performed to justify otherwise.

*5: Allowable elastic working stress (S) is the allowable stress limit specified in Part 1 of ANSI/AISC N-690-1994-s2 (2004).

(a) For primary plus secondary stress, the allowable limits are increased by a factor of 1.5.

(b) Stress limit coefficient in shear shall not exceed 1.4 in members and bolts.

(c) Stress limit coefficient where axial compression exceeds 20% of nominal allowable, shall be 1.5 for load combination 5, 6, 7, and be 1.6 for load combination 8.

*6: Dead Load includes settlements.

W_t = $W_w + 0.5W_p + W_m$

where,

W_t = Total Tornado Load

W_w = Tornado Wind Load

W_p = Tornado Differential Pressure Load

W_m = Tornado Missile Load

3G.1.5.2.1.6 Thermal Loads

Thermal loads are evaluated for the normal operating conditions and abnormal (LOCA) conditions. Figure 3G.1-20 shows the section location for temperature distributions for various structural elements, and Table 3G.1-6 shows the magnitude of equivalent linear temperature distribution.

The evaluation method of temperature effect on the concrete design is based on ACI 349-01 Commentary Figure RA.1.

The two cases, winter and summer, are considered in the analysis.

Stress-free temperature is 15.5°C.

3G.1.5.2.1.7 Pressure Loads

Table 3G.1-7 shows the pressure loads applied to the RCCV during normal operation, structural integrity test, and the LOCA. Pressure loads in the IC/PCCS pools are provided in Table 3G.1-8.

3G.1.5.2.1.8 Condensation Oscillation (CO) and Chugging (CHUG) Loads

The condensation oscillation (CO) and chugging (CHUG) pressure loads along with Dynamic Load Factors (DLF) are provided in Figures 3G.1-21 and 3G.1-22.

3G.1.5.2.1.9 SRV Loads

The SRV loads along with DLF are provided in Figure 3G.1-23.

3G.1.5.2.1.10 Steam Tunnel Subcompartment Pressure

The design pressure in the RB main steam tunnel to account for a main steam line break is 76.0 kPag. Thermal loads need not be included due to short duration of the tunnel pressurization.

3G.1.5.2.1.11 Subcompartment Pressure in Other Compartments

For ESBWR, the Reactor Water Cleanup/Shutdown Cooling (RWCU/SDC) system is considered high energy during normal operation. The maximum design pressure inside the affected subcompartments from the high energy line break (HELB) of the system is 34.5 kPag. Thermal loads need not be included due to short duration of subcompartment pressurization.

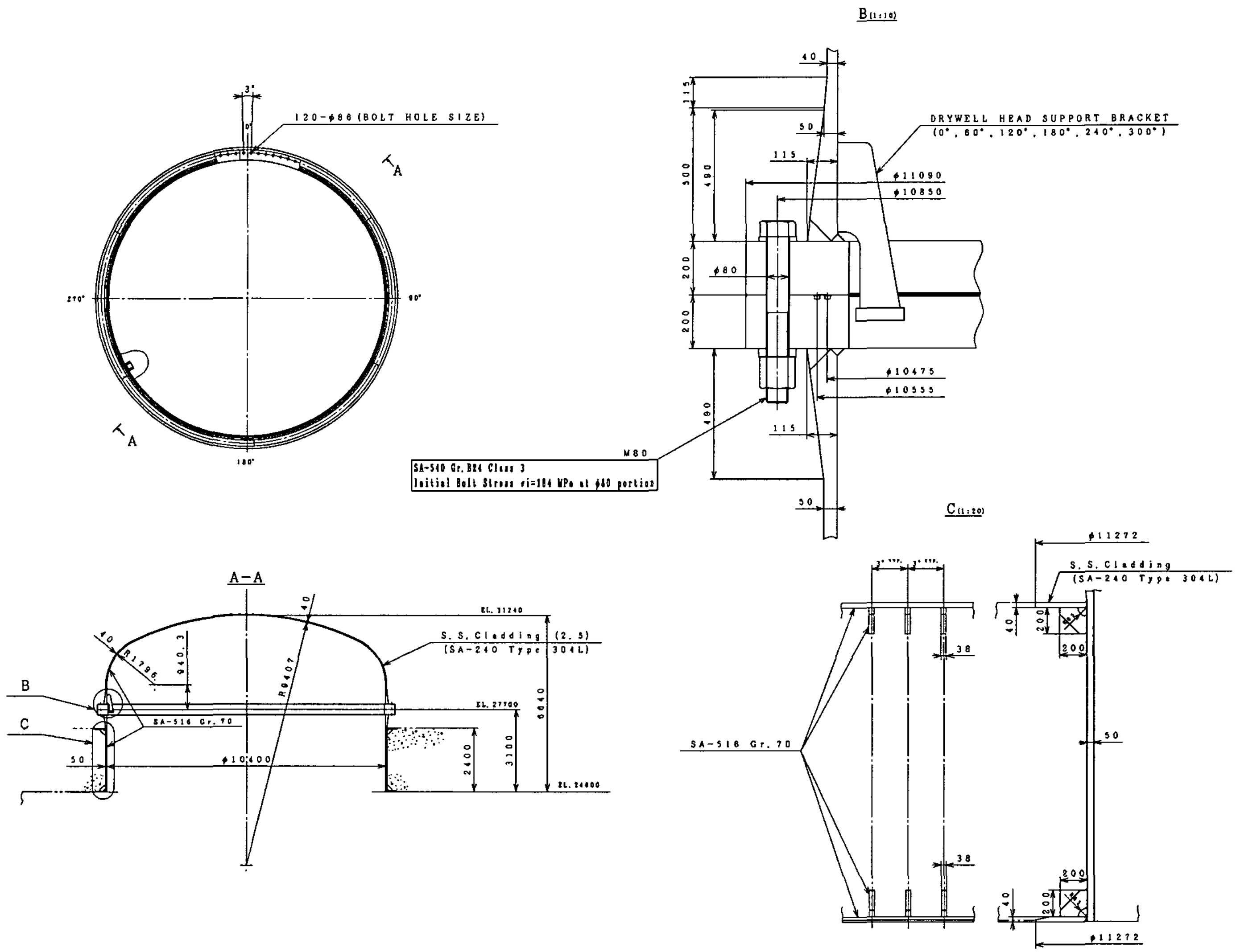


Figure 3G.1-51. Drywell Head

piping after the steam header and flow restrictors. The IC/PCC pool is vented to atmosphere to remove steam generated in the IC pools by the condenser operation. In the event of an IC break, the steam/air mixture is expected to preferentially exhaust through hatches in the refueling floor (see Figure 1.2-9) and into the RB operating area with portions of the steam directed through the pool compartments to the stack, which is vented to the atmosphere. Because the vent path through the hatches leads to the refueling floor area, which is a large open space with no safety implications, this event was excluded from the pressurization analysis.

Main Steam (MS) Tunnel

The Reactor Building main steam tunnel is located between the primary containment vessel and the turbine building. The limiting break is a main steam line longitudinal break. The main steam lines originate at the reactor pressure vessel and are routed through the steam tunnel to the turbine building. The steam/air mixture resulting from a main steam line break is directed to the turbine building through the steam tunnel. The pressure capability of the steam tunnel compartment is discussed in Subsection 3G.1.5.2.1.10. No blowout panels are required in the steam tunnel because the flow path between the steam tunnel and the turbine building is open. The main steam line break is excluded from pressurization analysis given the ability of the steam to blow down into the turbine building.

6.2.3.3 Design Evaluation

Fission Product Containment

There is sufficient water stored within the containment to cover the core during both the blowdown phase of a LOCA and during the long-term post-blowdown condition. Because of this continuous core cooling, fuel damage and fission product release is a very low probability event. If there is a release from the fuel, most fission products are readily trapped in water. Consequently, the large volume of water in the containment is expected to be an effective fission product scrubbing and retention mechanism. Also, because the containment is located entirely within the Reactor Building, multiple structural barriers exist between the containment and the environment. Therefore, fission product leakage from the RB is mitigated.

Compartment Pressurization Analysis

RWCU pipe breaks in the Reactor Building and outside the containment were postulated and analyzed. For compartment pressurization analyses, HELB accidents are postulated due to piping failures in the RWCU system where locations and size of breaks result in maximum pressure values. Calculated pressure responses have been considered in order to define the peak pressure, of the RB compartments, for structural design purposes. The calculated peak compartment pressures, which include a 10% margin, are listed in Table 6.2-12a, out of which the maximum is 32.6 kPag which is below the reactor building compartment pressurization design requirement as discussed in Subsection 3G.1.5.2.1.11.

Values of the mass and energy releases produced by each break are in accordance with ANSI/ANS-56.4. The break fluid enthalpy for energy release considerations is equal to the stagnation enthalpy of the fluid in the rupture pipe. The mass and energy blowdown from the postulated broken pipe terminates when system isolation valves are fully closed after receiving the pertinent isolation closure signal.