ArevaEPRDCPEm Resource

From: Pederson Ronda M (AREVA NP INC) [Ronda.Pederson@areva.com]
Sent: Wednesday, August 26, 2009 7:04 PM
To: Tesfaye, Getachew
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); SLIVA Dana (AREVA NP INC); VAN NOY Mark (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 211, FSAR Ch. 3, Supplement 2
Attachments: RAI 211 Supplement 2 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to 6 of the 10 questions of RAI No. 211 on May 26, 2009. AREVA NP submitted Supplement 1 to the response on July 13, 2009, to address 3 of the remaining questions. The attached file, "RAI 211 Supplement 2 Response US EPR DC.pdf" provides technically correct and complete responses to the remaining question, as committed.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which supports the response to RAI 211 Question 03.03.02-3.

The following table indicates the respective pages in the response document, RAI 211 Supplement 2 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 211 — 03.03.02-3	2	5

This concludes the formal AREVA NP response to RAI 211, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Ronda Pederson
ronda.pederson@areva.com
Licensing Manager, U.S. EPR Design Certification
AREVA NP Inc.
An AREVA and Siemens company
3315 Old Forest Road
Lynchburg, VA 24506-0935
Phone: 434-832-3694
Cell: 434-841-8788

From: Pederson Ronda M (AREVA NP INC)
Sent: Monday, July 13, 2009 5:42 PM
To: 'Getachew Tesfaye'
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); VAN NOY Mark (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 211, FSAR Ch. 3, Supplement 1

Getachew,

AREVA NP Inc. (AREVA NP) provided responses to 6 of the 10 questions of RAI No. 211 on May 26, 2009. The attached file, “RAI 211 Supplement 1 Response US EPR DC.pdf” provides technically correct and complete responses to 3 of the remaining 4 questions, as committed.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the responses to RAI 211 Questions 03.03.01-3, and 03.04.02-7.

The following table indicates the respective pages in the response document, “RAI 211 Supplement 1 Response US EPR DC.pdf” that contain AREVA NP’s response to the subject questions.

Question #	Start Page	End Page
RAI 211 — 03.03.01-3	2	3
RAI 211 — 03.04.02-7	4	4
RAI 211 — 03.05.03-10	5	5

The schedule for a technically correct and complete response to the remaining 1 question is unchanged and provided below:

Question #	Response Date
RAI 211 — 03.03.02-3	August 26, 2009

Sincerely,

Ronda Pederson

ronda.pederson@areva.com
Licensing Manager, U.S. EPR Design Certification
AREVA NP Inc.
An AREVA and Siemens company
3315 Old Forest Road
Lynchburg, VA 24506-0935
Phone: 434-832-3694
Cell: 434-841-8788

From: Pederson Ronda M (AREVA NP INC)
Sent: Tuesday, May 26, 2009 3:09 PM
To: 'Getachew Tesfaye'
Cc: BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); VAN NOY Mark (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 211, FSAR Ch. 3

Getachew,

Attached please find AREVA NP Inc.’s response to the subject request for additional information (RAI). The attached file, “RAI 211 Response US EPR DC.pdf” provides technically correct and complete responses to 6 of the 10 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which supports the response to RAI 211 Questions 03.09.03-21, 03.12-12, 03.12-13, and 03.12-16.

The following table indicates the respective pages in the response document, “RAI 211 Response US EPR DC.pdf,” that contain AREVA NP’s response to the subject questions.

Question #	Start Page	End Page
RAI 211 — 03.03.01-3	2	3
RAI 211 — 03.03.02-3	4	6
RAI 211 — 03.04.02-7	7	7
RAI 211 — 03.05.03-10	8	8
RAI 211 — 03.08.01-31	9	10
RAI 211 — 03.09.03-21	11	11
RAI 211 — 03.12-12	12	12
RAI 211 — 03.12-13	13	14
RAI 211 — 03.12-15	15	15
RAI 211 — 03.12-16	16	16

A complete answer is not provided for 4 of the 10 questions. The schedule for technically correct and complete responses to these questions is provided below.

Question #	Response Date
RAI 211 — 03.03.01-3	July 14, 2009
RAI 211 — 03.03.02-3	August 26, 2009
RAI 211 — 03.04.02-7	July 14, 2009
RAI 211 — 03.05.03-10	July 14, 2009

Sincerely,

Ronda Pederson

ronda.pederson@areva.com
Licensing Manager, U.S. EPR Design Certification
AREVA NP Inc.
An AREVA and Siemens company
3315 Old Forest Road
Lynchburg, VA 24506-0935
Phone: 434-832-3694
Cell: 434-841-8788

From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Thursday, April 23, 2009 7:46 PM
To: ZZ-DL-A-USEPR-DL
Cc: David Jeng; Jim Xu; Abdul Sheikh; Kaihwa Hsu; Anthony Hsia; Michael Miernicki; Joseph Colaccino; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 211 (2435, 2437,2438, 2439, 2462, 2442, 2376), FSAR Ch. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on April 7, 2009, and discussed with your staff on April 20, 2009. Draft RAI Question 03.12-14 was deleted as a result of that discussion. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

Thanks,
Getachew Tesfaye
Sr. Project Manager
NRO/DNRL/NARP
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 757

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Subject: Response to U.S. EPR Design Certification Application RAI No. 211, FSAR Ch. 3, Supplement 2
Sent Date: 8/26/2009 7:04:19 PM
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From: Pederson Ronda M (AREVA NP INC)

Created By: Ronda.Pederson@areva.com

Recipients:
"BENNETT Kathy A (OFR) (AREVA NP INC)" <Kathy.Bennett@areva.com>
Tracking Status: None
"DELANO Karen V (AREVA NP INC)" <Karen.Delano@areva.com>
Tracking Status: None
"SLIVA Dana (AREVA NP INC)" <Dana.Sliva@areva.com>
Tracking Status: None
"VAN NOY Mark (EXT)" <Mark.Vannoy.ext@areva.com>
Tracking Status: None
"Tesfaye, Getachew" <Getachew.Tesfaye@nrc.gov>
Tracking Status: None

Post Office: AUSLYNCMX02.adom.ad.corp

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Response to

Request for Additional Information No. 211, Supplement 2

4/23/2009

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.03.01 - Wind Loading
SRP Section: 03.03.02 - Tornado Loads
SRP Section: 03.04.02 - Analysis Procedures
SRP Section: 03.05.03 - Barrier Design Procedures
SRP Section: 03.08.01 - Concrete Containment
SRP Section: 03.09.03 - ASME Code Class 1, 2, and 3 Components
SRP Section: 03.12 - ASME Code Class 1, 2, and 3 Piping Systems and Piping Components and Their Associated Supports

Application Section: FSAR Ch. 3

QUESTIONS for Structural Engineering Branch 2 (ESBWR/ABWR Projects) (SEB2)
QUESTIONS for Engineering Mechanics Branch 1 (AP1000/EPR Projects) (EMB1)

Question 03.03.02-3:

a. In Question 03.03.02-1(2) of RAI 126, the staff had asked what methods were used to qualify the Nuclear Auxiliary Building (NAB) for tornado loading. AREVA in its written response stated that the methodology of ASCE 43 and Limit State A would be utilized to ensure that the NAB does not collapse under tornado loads and affect adjacent Seismic Category I Nuclear Island Common Basemat structures. The staff has concluded that the response needs additional information in order to be acceptable. The concern of the staff is that ASCE 43-05 provides seismic design criteria for SSCs in nuclear facilities and has not been accepted by the staff for general use. The limit states and other criteria in ASCE 43-05 were developed for seismic loads not wind loads. Limit states define levels of acceptable damage with structures designed to Limit State A expected to have significant damage. AREVA also stated that the NAB is evaluated for tornado loadings per RG 1.143 due to its classification as RW-IIa per RG 1.143. RG 1.143 provides design tornado wind loads that are 3/5ths of the tornado wind load of RG 1.76. These design loads are appropriate for a stand-alone facility, but in this instance the NAB is adjacent to Category I structures. SRP Section 3.7.2, subsection 3.7.2 II.8 C, which addresses the interaction of a non Category I structure with a Category I structure states that a non-Category I structure analyzed and designed to prevent its failure under SSE conditions, should have a margin of safety that is equivalent to that of a Category I structure. The same design approach is applicable to the design of non Category I structures for tornado loads as the tornado wind represents an extreme environmental load and the level of protection provided the Category I structure should be no less than that provided under a seismic load. AREVA should provide and discuss the design tornado wind velocity, tornado loads, loading combinations, and design code used in the design and analysis of the NAB structure. If its design under tornado loading conditions will not provide a margin of safety that is equivalent to that of a Category I structure, AREVA should provide the methods of analysis, acceptance criteria, expected damage, critical sections and calculated displacements of the NAB for staff review.

b. In FSAR Section 3.3.2.3 (Effect of Failure of Structures or Components not Designed for Tornado Loads), it states that for the ACB and the TB 'one of the above methods' will be utilized to ensure that due to tornado loading, the adjacent Nuclear Island Basemat Structure is protected from the failure of either the ACB or TB. In Question 03.03.02-1(3) of RAI 126, the staff had asked for additional information as it was not clear what methods were being referenced and how they were to be used to ensure that adjacent Nuclear Island Basemat Structures were protected from failure of the ACB or TB due to tornado loading. In its written response, AREVA stated that the methods referred to are the three bulleted items in U.S. EPR FSAR Tier 2, Section 3.3.2.3. Specifically, the three methods referred to are:

- The adjacent non-Seismic Category I structure is designed to resist applicable tornado loadings.
- The integrity of a Seismic Category I structure is evaluated for failure of an adjacent non-Seismic Category I structure during a design basis tornado to verify the functionality and continued operation of the Seismic Category I structure during and after the tornado.
- A structural barrier(s) is provided to protect the Seismic Category I structure from failure of the adjacent non-Seismic Category I as a result of a tornado.

AREVA stated that U.S. EPR FSAR Tier 2, Section 3.3.2.3, will be updated to state: "The ACB is a reinforced concrete or steel frame building. One of the methodologies identified in the preceding three bullets will be utilized to provide reasonable assurance that the ACB will not collapse under tornado loads and affect Seismic Category I Nuclear Island Common Basemat structures." U.S. EPR FSAR Tier 2, Section 3.3.2.3, will be updated to state: "The TB is a steel frame building. One of the methodologies identified in the preceding three bullets will be utilized to provide reasonable assurance that the TB will not collapse under tornado loads and affect Seismic Category I Nuclear Island Common Basemat structures." U.S. EPR FSAR Tier 2, Section 3.3.2.3, 3rd bullet will be updated to state: "A structural barrier(s) is provided to protect the Seismic Category I structure from failure of the adjacent non-Seismic Category I structure as a result of a tornado."

The staff has concluded that the above response is not acceptable. For both the ACB and the TB the applicant states that the FSAR will be changed to state that one of the methodologies identified in the three bullets will be utilized to provide reasonable assurance that the ACB (or TB) will not collapse under tornado loads and affect Seismic Category I structures. However, only the first bullet deals with designing the structure to resist applicable tornado loads. The second and third bullet assume the structure will collapse and other measures will be implemented to assure the collapse does not affect the functionality and continued operation of adjacent seismic Category I structures. To provide assurance that the design method used on the non-Seismic Category I structure is adequate to resist applicable tornado loads, an acceptable method is to implement the guidance provided in SRP Section 3.7.2, subsection 3.7.2 II.8, i.e. the structure should be designed with the same margin of safety as that of a Category I structure. If the margin of safety is not equivalent to that of the Category I structure, AREVA should provide and discuss the detailed methods of analysis, acceptance criteria, expected damage, critical sections and calculated displacements for the staff's review. If the second bullet is to be implemented, AREVA should provide and discuss the methods by which this will be accomplished including the methods of analysis, mode of failure, impact loads and impact analysis of adjacent Category I structures or a similar description if a structural barrier identified in the third bullet is used. Also include the design basis adopted for the barrier as well as design codes and acceptance criteria used in evaluating barrier response under the impact load of the failed structure.

c. Acceptance Criteria 3 A. Concrete Structures of SRP Section 3.8.3 Loads and Load Combinations states that all loads and load combinations are to be in accordance with ACI 349 and RG 1.142. The reduction to 25% live load with tornado load as stated in FSAR Sections 3.3.2 (Tornado Loading) and 3.8.4.3.2 (Loading Combinations) contradict the requirements of ACI 349 and RG 1.143 Table 3 which use full live load instead of the 25% live load noted above. In Question 03.03.02-1(5) of RAI 126, the staff had asked for the bases of this live load reduction in combination with tornado load and for AREVA to justify this deviation from pertinent provisions of the SRP 3.8.3. AREVA in its response stated that one hundred percent of the live load is used for structural design activities and that U.S. EPR FSAR Tier 2, Section 3.3.2, will be updated to state: "One hundred percent of the design live load is considered with tornado load combinations." The staff finds this to be acceptable. The reference to use twenty-five percent of the live load in U.S. EPR FSAR Tier 2, Sections 3.8.1.3.2, 3.8.4.4.1, and 3.8.5.4.1 will be updated to state: "Twenty-five percent of the design live load is considered during static analysis with seismic load combinations. The full potential live load is used for local analysis of structural members." The staff has concluded that this part of the response needs additional clarification in order to be acceptable. The meaning of the first sentence in this revised statement is not clear and does not agree with the load combinations in U.S. EPR FSAR Tier 2, Sections 3.8.1.3.2 or 3.8.4.3.2 in which the load combinations that contain either tornado load or seismic load also include the full live load. Also, the first sentence of the statement seems to contradict the second sentence which states that the full potential live load is used for local analysis of structural members, although it is not clear what is meant by local analysis of structural members. The applicant is requested to clarify the meaning of the revised statements and update the text in U.S. EPR FSAR Sections 3.8.1.3.2, 3.8.4.4.1, and 3.8.5.4.1 to be consistent with the relevant load combinations which include the full live load in combination with tornado loads and seismic loads.

Response to Question 03.03.02-3:

a) U.S. EPR FSAR Tier 2, Section 3.3.2 pertains to tornado design. U.S. EPR FSAR Tier 2, Section 3.3.2.3 will be revised to remove reference to ASCE 43.

The Nuclear Auxiliary Building (NAB) is a non-safety-related structure classified as Radwaste Seismic and, due to its location, has the potential to interact with Seismic Category I structures. The NAB is classified as RW-IIA and is designed to comply with RG 1.143 requirements as a minimum. Tornado wind effects will be considered in NAB design because of its potential to interact with adjacent Category I structures. RG 1.76 tornado wind characteristics above the requirements of RG 1.143 tornado wind loading will be considered in NAB design so that no unanalyzed loads are transferred to adjacent Category I SSC.

b) The Access Control Building (ACB) and Turbine Building (TB) are site-specific structures that are not part of the U.S. EPR certified design and the codes and standards employed in their design are the responsibility of the combined license (COL) applicant as described in U.S. EPR FSAR Tier 2, Table 1.8-2, COL Item 3.3-3.

However, due to the proximity of these non-Category I structures to safety-related structures, there is the potential for structural interaction. RG 1.76 tornado wind characteristics are considered in TB and ACB design so that safety functions of adjacent Seismic Category I structures are not impaired. U.S. EPR FSAR Tier 2, Section 3.3.2 will be revised to clarify this point.

c) U.S. EPR FSAR Tier 2, Section 3.8.1.3.2, Section 3.8.4.4.1, and Section 3.8.5.4.1 will be revised to clarify that the full potential live load is used in the load combinations. Statements regarding tornado loading that are similar to "the full potential live load is used for local analysis of structural members" will be removed from U.S. EPR FSAR Tier 2, Section 3.8.3.4.4 and Section 3.8.4.4.1.

U.S. EPR FSAR Tier 2, Section 3.7.2.3.1 describes the methods used to develop seismic forces.

The Response to RAI 155, Supplement 2, Question 03.08.01-7 and Question 03.08.03-5 revised load combinations provided in U.S. EPR FSAR Tier 2, Section 3.8.1.3.2 and Section 3.8.3.3.2, respectively.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 3.3.2.3, Section 3.3.3, Section 3.8.1.3.2, Section 3.8.4.4.1, and Section 3.8.5.4.1 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

Exterior walls and roofs of Seismic Category I structures are designed for the maximum differential pressure of 1.2 psi. When the tornado pressure boundary is not established by exterior walls or roofs, the differential pressure is taken as zero.

3.3.2.2.1 Note on Values Used

The use of the values stated previously for $K_z = 1.0$ and $I = 1.0$ provides essentially identical results as those recommended in NUREG 0800, SRP Section 3.3.2, for $K_z = 0.87$ and $I = 1.15$. That is, the product of the U.S. EPR values is 1.0 x 1.0 = 1.0, whereas the product of SRP Section 3.3.2 values is 0.87 x 1.15 = 1.0005.

3.3.2.3 Effect of Failure of Structures or Components not Designed for Tornado Loads

03.03.02-3

~~Non-Seismic Category I structures are not designed for tornado loads unless their failure during a tornado could adversely affect nearby Seismic Category I SSC. Seismic Category I structures are protected from failure of adjacent non-Seismic Category I structures during a tornado by one of the following methods:~~

- ~~The adjacent non-Seismic Category I structure is designed to resist applicable tornado loadings.~~
- ~~The integrity of a Seismic Category I structure is evaluated for failure of an adjacent non-Seismic Category I structure during a design basis tornado to verify the functionality and continued operation of the Seismic Category I structure during and after the tornado.~~
- ~~A structural barrier(s) is provided to protect the Seismic Category I structure from failure of the adjacent non-Seismic Category I structure as a result of a tornado.~~

The non-Seismic Category I structures that are adjacent to the Seismic Category I Nuclear Island Common Basemat Structure, Emergency Power Generation Buildings (EPGB), and Essential Service Water Buildings (ESWB) include the Vent Stack (VSTK), Nuclear Auxiliary Building (NAB), Radioactive Waste Processing Building (RWB), Access Building (ACB), and Turbine Building (TB). Figure 3B-1 provides a site plan of the U.S. EPR standard plant showing the plant layout.

The Vent Stack is a steel structure which is categorized as a Seismic Category II structure. It is supported on the roof slab of the Seismic Category I stair tower located between the Seismic Category I Fuel Building and the Seismic Category I Safeguard Building 4. Due to the proximity of the vent stack to other Seismic Category I structures, it is conservatively treated as a Seismic Category I structure for the purposes of global design.

03.03.02-3

The NAB, ACB, and TB are non-Seismic Category 1 structures. However, due to proximity of these structures to Seismic Category 1 structures there is a potential for

03.03.02-3

tornado wind load induced interaction. Therefore, RG 1.76 tornado wind characteristic guidance is incorporated in the design of these structures. Tornado wind loads are calculated and the results considered in the design of these non-Seismic Category I structures are in accordance with approved structural design codes for each structure so that no unanalyzed loads are transferred to the protected Category I SSC.

~~The NAB is a reinforced concrete structure. The methodology of ASCE 43 (Limit State A) (Reference 4) is utilized to ensure that the NAB will not collapse under tornado loads and affect Seismic Category I Nuclear Island Common Basemat structures. Additionally, the NAB is evaluated for tornado loadings per RG 1.143 due to its classification as RW-IIa per RG 1.143.~~

The RWB is a reinforced concrete structure which is required to be designed for tornado loading per RG 1.143 due its classification as RW-IIa per RG 1.143. RWB has no potential to interact with either the NI Common Basemat Structures or the other nearby Seismic Category I Structure, the EPGB. The NAB is located between the RWB and the NI Common Basemat Structure and shields it from potential interaction. Potential interaction between the RWB and the EPGB is precluded by separation and design. The RWB is embedded over 31.5 ft below grade and has a clear height above grade of 52.5 ft; whereas, the clearance between the two structures is 52.06 ft.

03.03.02-3

~~Furthermore the failure of the RWB in such a manner as to adversely impact the functionality and continued operation of the EPGB is not considered credible because of the design of the RWB for ½ SSE.~~

~~The ACB is a reinforced concrete or steel frame building. One of the methodologies identified in the preceding three bullets will be utilized to provide reasonable assurance that the ACB will not collapse under tornado loads and affect Seismic Category I Nuclear Island Common Basemat structures.~~

~~The TB is a steel frame building. One of the methodologies identified in the preceding three bullets will be utilized to provide reasonable assurance that the TB will not collapse under tornado loads and affect Seismic Category I Nuclear Island Common Basemat structures.~~

3.3.3 References

1. ASCE/SEI Standard 7-05, "Minimum Design Loads for Buildings and Other Structures," American Society of Civil Engineers/Structural Engineering Institute, 2005.

2. ASCE paper No. 3269, "Wind Forces on Structures," Transactions of the American Society of Civil Engineers, Vol. 126, Part II, 1961.

3. ANSI/AISC-N690-1994, "Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities," with Supplement 2, American Institute of Steel Construction, October 2004.

Next File

03.03.02-3

4. ~~ASCE 43-05, "Seismic Design Criteria for Structures, Systems and Components in Nuclear Facilities," American Society of Civil Engineers, January 2005.~~Deleted

5. ACI 349-01/349R-01, "Code Requirements for Nuclear Safety Related Structures and Commentary," American Concrete Institute, January 2001.

hydrostatic load (F), buoyant force (F_b), and soil load/lateral earth pressure (H). The load factors for hydrostatic load (F) and buoyant force (F_b) are matched to that of the dead load (D) for each loading combination, while the load factor for soil load/lateral earth pressure (H) is matched to that of the live load (L). Section 3.8.1.3.1 provides details regarding all loads considered for the design of the RCB. The following guidance is used for applying load combinations for the design of the RCB:Loading combinations used for the design of the RCB, including its steel liner plate, are in accordance with guidance provided in NUREG-0800, Standard Review Plan, Section 3.8.1 (Reference 3) (GDC 1, GDC 2, GDC 4, GDC 16, and GDC 50). The following guidance is used for applying load combinations for design of the RCB:

- The live load (L) is applicable after construction of containment. Construction loadings, temporary or otherwise, may also be considered as live loads and included within appropriate loading combinations.

03.03.02-3

- Twenty-five percent of the design live load is considered during static analysis with seismic load combinations. The full potential live load is used for local analysis of structural members.

- Unless a time-history analysis is performed to justify otherwise, the maximum values of load combinations including the loads P_a, T_a, R_a, R_{rr}, R_{rj}, R_{rm}, or G are used, including an appropriate dynamic load factor.

- For concrete members, U_S is defined as the required section strength for service loads based on the allowable stresses defined in Subarticle CC-3430 of the ASME BPV Code, Section III, Division 2, with additional guidance provided by NUREG-0800.

- For concrete members, U_F is defined as the required section strength for factored loads based on the allowable stresses defined in Subarticle CC-3420 of the ASME BPV Code, Section III, Division 2, with additional guidance provided by NUREG-0800.

- The following requirements are met for the design of concrete components for factored load conditions:

  – Primary forces must not bring the local section to a general yield state with respect to any component of section membrane strain or section flexural curvature. General yield state is the point beyond which additional section deformation occurs without an increase in section forces.

  – Under combined primary and secondary forces on a section, the development of a general yield state with respect to those membrane strains or flexural curvatures that correspond to secondary stress components is acceptable, and is subject to rebar strain limits specified in Subarticle CC 3420 of the ASME BPV Code, Section III, Division 2. The concept of a general yield state is not applicable to strains associated with radial shear stress.

3.8.3.4.3 Static Analysis and Design

Dead loads (D), live loads (L), hydrostatic loads (F), pipe reactions (R_o), and normal thermal loads (T_o) are considered in the analysis and design of RB internal structures for the static normal load concrete and service load steel loading combinations. Normal thermal loads are considered as self-relieving for the overall RB internal structures. Concrete and steel members are designed to accommodate these static loads within the elastic range of their section strength.

Static fluid pressure loads are considered for design of the walls and floors of the IRWST and refueling canal. Moving loads are considered for mobile plant equipment (e.g., the polar crane, refueling machine, and other cranes and hoists).

3.8.3.4.4 Seismic and Other Dynamic Analyses and Design

Seismic analyses and designs of the RB internal structures conform to the procedures described in Section 3.7.2. The procedures in ASCE Standard 4-98 are used in the analysis and design of structural elements and members subjected to load combinations that include seismic loadings. Seismic accelerations are determined from the structural stick model described in Section 3.7.2. These accelerations are applied to the ANSYS model of the RB internal structures as static-equivalent loads at the elevations used in the stick model. Seismic acceleration modification factors are used to adjust the equivalent static forces and moments to be consistent with the SSI model results.

03.03.02-3 → Seismic SSE (E') loads are obtained by multiplying the dead load and 25 percent of the design live load by the structural acceleration obtained from the seismic analysis of the structure. Seismic loads are also considered due to the mass of fluids in tanks and canals as described herein (Section 3.8.3.4.4). ~~The design live load is used for the local analysis of structural elements and members.~~ Consideration is given to the amplification of these accelerations due to local flexibility of structural elements and members. Construction loads are not included when determining seismic loads. Other temporary loads are evaluated for contributing to the seismic loads on a case-by-case basis.

Seismic loads from the three components of the earthquake are combined using the SRSS method or the 100-40-40 percent rule described in ASCE 4-98. The 100-40-40 combination is expressed mathematically as follows:

~~Where:~~

Let R_1, R_2, R_3 be the maximum responses of an SSC caused by each of the three earthquake components calculated separately. The maximum seismic response attributable to earthquake loading in three orthogonal directions shall be

The design of bolted connections in combination with welded connections is in accordance with Section Q.15.10 of ANSI/AISC N690.

Loads and load combinations defined in Section 3.8.4.3 are used to determine strength requirements of members and elements of other Seismic Category I structures. Abnormal pipe break accident loads only apply to limited areas of structures located on the NI Common Basemat Structure. The following criteria apply for load combinations for concrete and steel other Seismic Category I structures:

- The one-third increase in allowable stresses for concrete and steel members due to seismic (E') or wind (W and Wt) loadings is not permitted.
- Where any load reduces the effects of other loads, the corresponding coefficient for that load is 0.9 if it can be demonstrated that the load occurs simultaneously with other loads.
- Where the structural effects of differential settlement, creep, or shrinkage may be significant, they are included with the dead load (D) as applicable.
- For load combinations in which a reduction of the maximum design live load (L) has the potential to produce higher member loads and stresses, multiple cases are considered where the live load (L) is varied between its maximum design value and zero.
- Roofs with a slope of less than 0.25 inches per foot are analyzed for adequate stiffness to preclude progressive deflection as water ponding is created from the snow load or from rainfall on the surface. The analysis considers the potential blockage of the primary drainage system of the area that is subject to ponding loads. The analysis uses the larger of the snowmelt depth or rain load.
- ~~For steel members, thermal loads may be neglected when it can be shown that they are secondary and self limiting in nature.~~
- For load combinations including the loads P_a, T_a, R_a, R_{rr}, R_{rj}, or R_{rm}, the maximum values of these loads, including a dynamic load factor, are used unless a time-history analysis is performed to justify otherwise.
- For load combinations including loads R_{rr}, R_{rj}, R_{rm}, or W_m, these load combinations are first satisfied with these loads set to zero. However, when considering these concentrated loads, local section strength capacities may be exceeded under the effect of these concentrated loads, provided there is not a loss of intended function of the structural member or a loss of function of any safety-related SSC.

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- ~~Twenty-five percent of the design live load is considered during static analysis with seismic load combinations. The full potential live load is used for the local analysis of structural members.~~

Static Analysis and Design

Dead loads (D), live loads (L), hydrostatic loads (F), soil loads and lateral earth pressure loads (H), wind loads (W), pipe reactions (R_o), and normal thermal loads (T_o) are considered in the analysis and design of other Seismic Category I structures for the static normal load concrete and service load steel loading combinations. Concrete and steel members are designed to accommodate these static loads within the elastic range of their section strength. For concrete structures, uncracked section properties are used to proportion loadings to members. However ultimate strength design is used to reinforce concrete elements and members subjected to the normal factored loading combinations defined in Section 3.8.4.3.2.

Static fluid pressure loads are considered for design of the walls and floors of tanks and storage pools. Moving loads are considered for mobile plant equipment (e.g., cranes, hoists, truck bays in buildings, maintenance aisles).

Seismic and Other Dynamic Analyses and Design

Seismic analyses and designs of other Seismic Category I structures conform to the procedures described in Section 3.7.2. The requirements of ASCE 4-98 are used in the analysis and design of structural elements and members subjected to load combinations that include seismic loadings. Seismic accelerations are determined from structural stick models as described in Section 3.7.2. These accelerations are applied to the finite element computer models of other Seismic Category I structures as static-equivalent loads at the elevations used in the stick model. Seismic acceleration modification factors are used to adjust the equivalent static forces and moments to be consistent with the SSI model results.

Seismic SSE (E') loads are obtained by multiplying the dead load and 25 percent of the design live load by the structural accelerations obtained from the seismic analyses of each structure. A minimum of 75 percent of the roof snow load is included in the structural mass for seismic analysis of Seismic Category I structures. Seismic loads are also considered due to the mass of fluids in tanks and canals as described below for

03.03.02-3 hydrodynamic loads. ~~The full potential live load, including precipitation, is used for the local analysis of structural elements and members.~~ Consideration is given to the amplification of seismic accelerations obtained from the structural stick model of each structure, due to local flexibility of structural elements and members. Construction loads are not included when determining seismic loads. Other temporary loads are evaluated for contributing to the seismic loads on a case-by-case basis.

~~Seismic loads from the three components of the earthquake motion are combined using the SRSS method or the 100-40-40 percent rule described in ASCE 4-98. The 100-40-40 combination is expressed mathematically as follows:~~

~~Where:~~

- For load combinations in which a reduction of the maximum design live load (L) has the potential to produce higher member loads and stresses, multiple cases are considered where the live load (L) is varied between its maximum design value and zero.

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- ~~Twenty-five percent of the design live load is considered during static analysis with seismic load combinations. The full potential live load is used for the local analysis of structural members.~~

- For load combinations that include a tornado load (W_t), the tornado load parameter combinations described in Section 3.3 are used.

Loads and load combinations defined in Section 3.8.5.3 are used to determine strength requirements of members and elements of Seismic Category I foundations. Concrete and steel structural elements and members are designed for axial tension and compression forces, bending moments, torsion, and in-plane and out-of-plane shear forces for the controlling loading combinations that are determined from analysis. Concrete and steel members and elements remain elastic for loadings other than impact. Local yielding is permitted for localized areas subjected to tornado-generated missile loads, pipe break accident loadings, and beyond design basis loadings. The structural integrity of members and elements is maintained for the loading combinations described in Section 3.8.5.3.

For the loading combinations identified in Section 3.8.5.3, the minimum factors of safety required to prevent sliding and overturning are specified in Table 3.8-11—Minimum Required Factors of Safety Against Overturning, Sliding, and Flotation for Foundations.

Normal lateral earth pressure loads consider saturated soil up to a groundwater elevation of -3.3 feet relative to site finished grade. Lateral soil loads due to external floods consider saturated soil up to elevation -1.0 feet relative to site finished grade. Seismic loads from all three components of the earthquake motion are combined using the SRSS method or the 100-40-40 percent rule described in ASCE 4-98, the same as described in Section 3.8.4.4. The SSE components of soil loads are determined using densities for saturated soil to account for the weight of the soil plus the weight of either normal or flood water levels. Earthquake-induced lateral soil pressures are obtained from SSI analyses for NI common basemat structures and are developed in accordance with Section 3.5.3 of ASCE 4-98 for the other Category I structures. The design of embedded elements, such as embedded walls on basemats, assumes that the lateral pressure due to the SSE is in phase with the inertial loads. In cases where passive pressure is assumed to act on embedded structures in the stability check against sliding, the walls of the structure are evaluated to withstand such earth pressure. Section 3.8.4.4.2 provides further information on how seismic-induced lateral earth pressures are determined for the NI Common Basemat Structure. These lateral load effects are considered in structure sliding and overturning analyses. Refer to