ArevaEPRDCPEm Resource

From: BRYAN Martin (EXTERNAL AREVA) [Martin.Bryan.ext@areva.com]
Sent: Monday, November 22, 2010 7:40 PM
To: Tesfaye, Getachew
Cc: DELANO Karen (AREVA); ROMINE Judy (AREVA); BENNETT Kathy (AREVA); CORNELL Veronica (EXTERNAL AREVA)
Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3, Supplement 13
Attachments: RAI 354 Supplement 13 Response US EPR DC - INTERIM.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 1 of the 22 questions of RAI No. 354 on April 15, 2010, and a schedule for the remaining 21 questions. AREVA NP submitted Supplement 1 on June 3, 2010, to provide a schedule for the remaining 21 questions. Supplement 2 was submitted on June 24, 2010, and included a revised schedule for Questions 03.08.02-11, 12, 13, 14, 15, 16; 03.08.05-22 and 03.08.05-23. AREVA NP submitted Supplement 3 on July 7, 2010, responding to 1 of the remaining 21 questions. AREVA NP submitted Supplement 4 on July 30, 2010, to provide final responses to Questions 03.06.02-32, 03.06.02-41 and 03.08.02-16 and a revised schedule for Questions 03.06.02-33 through 03.06.02-40. On August 5, 2010, AREVA NP provided a revised schedule for Questions 03.06.02-42 and 03.08.05-23 in Supplement 5. AREVA NP submitted Supplement 6 on August 31, 2010, to provide final responses to 5 of the remaining 17 questions. On September 8, 2010, AREVA NP submitted Supplement 7 to provide a revised schedule for the response to Question 03.08.05-21. On September 13, 2010, AREVA NP provided an INTERIM response to Question 03.08.05-22 in Supplement 8. In Supplement 9, AREVA NP submitted a revised schedule for Question 03.08.05-23 on October 1, 2010. AREVA NP submitted Supplement 10 on October 7, 2010 and Supplement 11 on November 1, 2010 to provide a revised schedule for the response to Question 03.08.02-13. On November 17, 2010, AREVA NP submitted Supplement 12 to provide a revised schedule for Questions 03.06.02-33 through 03.06.02-40 and 03.08.05-23.

The attached file, "RAI 354 Supplement 13 Response US EPR DC-INTERIM.pdf" provides a technically correct and complete INTERIM response to question 03.08.05-22, as committed.

Appended to this file are the affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which supports the response to RAI 354 Supplement 13 question 03.08.05-22.

The following table indicates the respective pages in the response document, "RAI 354 Supplement 13 Response US EPR DC-INTERIM.pdf," that contain AREVA NP's response to the subject question.

Question #	Start Page	End Page
RAI 354 — 03.08.05-22	2	11

A new schedule for supplemental responses to Questions 03.08.02-11 and 03.08.02-12 is added. The supplemental responses will address open items identified during the NRC October 28-29, 2010, containment appurtenances audit. The schedule for the remaining questions is unchanged.

The schedule for the technically correct and complete responses to the remaining questions is provided below.

Question #	Interim Response Date	Response Date
RAI 354 - 03.08.02-11		February 15, 2011
RAI 354 - 03.08.02-12		February 15, 2011
RAI 354 - 03.08.02-13		February 15, 2011
RAI 354 - 03.08.05-22	September 15, 2010 (Actual September 13, 2010)	January 13, 2011

Question #	Interim Response Date	Response Date
	November 22, 2010 (Actual)	

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

From: BRYAN Martin (External RS/NB)
Sent: Wednesday, November 17, 2010 11:35 AM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); WELLS Russell (RS/NB); 'Miernicki, Michael'
Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3, Supplement 12

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 1 of the 22 questions of RAI No. 354 on April 15, 2010, and a schedule for the remaining 21 questions. AREVA NP submitted Supplement 1 on June 3, 2010, to provide a schedule for the remaining 21 questions. Supplement 2 was submitted on June 24, 2010, and included a revised schedule for Questions 03.08.02-11, 12, 13, 14, 15, 16; 03.08.05-22 and 03.08.05-23. AREVA NP submitted Supplement 3 on July 7, 2010, responding to 1 of the remaining 21 questions. AREVA NP submitted Supplement 4 on July 30, 2010, to provide final responses to Questions 03.06.02-32, 03.06.02-41 and 03.08.02-16 and a revised schedule for Questions 03.06.02-33 through 03.06.02-40. On August 5, 2010, AREVA NP provided a revised schedule for Questions 03.06.02-42 and 03.08.05-23 in Supplement 5. AREVA NP submitted Supplement 6 on August 31, 2010, to provide final responses to 5 of the remaining 17 questions. On September 8, 2010, AREVA NP submitted Supplement 7 to provide a revised schedule for the response to Question 03.08.05-21. On September 13, 2010, AREVA NP provided an INTERIM response to Question 03.08.05-22 in Supplement 8. In Supplement 9, AREVA NP submitted a revised schedule for Question 03.08.05-23 on October 1, 2010. AREVA NP submitted Supplement 10 on October 7, 2010 and Supplement 11 on November 1, 2010 to provide a revised schedule for the response to Question 03.08.02-13.

A meeting with NRC regarding Questions 03.06.02-33 through 03.06.02-40 was held on November 1. 2010. As a result of that meeting the schedule for the final response to Questions 03.06.02-33 through 03.06.02-40 is being revised to allow additional time for AREVA NP to address NRC comments. Additionally, AREVA plans to prepare a technical report to be submitted with the final response to reflect the information on jet impingement that has been provided to NRC in the RAI responses and the meeting on November 1. 2010. The schedule for Question 03.08.05-23 is also being revised to allow additional time for AREVA NP to interact with the NRC. The schedule for the remaining questions is unchanged.

The schedule for the technically correct and complete responses to the remaining questions is provided below.

Question #	Interim Response Date	Response Date
RAI 354 - 03.08.02-13		February 15, 2011
RAI 354 - 03.08.05-22	September 15, 2010 (Actual September 13, 2010) November 22, 2010	January 13, 2011
RAI 354 - 03.08.05-23		January 7, 2011
RAI 354 - 03.06.02-33		March 31, 2011
RAI 354 - 03.06.02-34		March 31, 2011
RAI 354 - 03.06.02-35		March 31, 2011
RAI 354 - 03.06.02-36		March 31, 2011
RAI 354 - 03.06.02-37		March 31, 2011
RAI 354 - 03.06.02-38		March 31, 2011
RAI 354 - 03.06.02-39		March 31, 2011
RAI 354 - 03.06.02-40		March 31, 2011

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

From: BRYAN Martin (External RS/NB)
Sent: Monday, November 01, 2010 5:39 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3, Supplement 11

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 1 of the 22 questions of RAI No. 354 on April 15, 2010, and a schedule for the remaining 21 questions. AREVA NP submitted Supplement 1 on June 3, 2010, to provide a schedule for the remaining 21 questions. Supplement 2 was submitted on June 24, 2010, and included a revised schedule for Questions 03.08.02-11, 12, 13, 14, 15, 16; 03.08.05-22 and 03.08.05-23. AREVA NP submitted Supplement 3 on July 7, 2010, responding to 1 of the remaining 21 questions. AREVA NP submitted Supplement 4 on July 30, 2010, to provide final responses to Questions 03.06.02-32, 03.06.02-41 and 03.08.02-16 and a revised schedule for Questions 03.06.02-33 through 03.06.02-40. On August 5, 2010, AREVA NP provided a revised schedule for Questions 03.06.02-42 and 03.08.05-23 in Supplement 5. AREVA NP submitted Supplement 6 on August 31, 2010, to provide final responses to 5 of the remaining 17 questions. On September 8, 2010, AREVA NP submitted Supplement 7 to provide a revised schedule for the response to Question 03.08.05-21. On September 13, 2010, AREVA NP provided an INTERIM response to Question 03.08.05-22 in Supplement 8. In Supplement 9, AREVA NP submitted a revised schedule for Question 03.08.05-23 on October 1, 2010. AREVA NP submitted Supplement 10 on October 7, 2010, to provide a revised schedule for the response to Question 03.08.02-13.

The schedule for Question 03.08.02-13 is being revised to allow additional time for AREVA NP to address NRC comments. The schedule for the remaining questions is unchanged.

The schedule for the technically correct and complete responses to the remaining questions is provided below.

Question #	Interim Response Date	Response Date
RAI 354 - 03.08.02-13		February 15, 2011
RAI 354 - 03.08.05-22	September 15, 2010 (Actual September 13, 2010) November 22, 2010	January 13, 2011
RAI 354 - 03.08.05-23		November 18, 2010
RAI 354 - 03.06.02-33		November 18, 2010
RAI 354 - 03.06.02-34		November 18, 2010
RAI 354 - 03.06.02-35		November 18, 2010
RAI 354 - 03.06.02-36		November 18, 2010
RAI 354 - 03.06.02-37		November 18, 2010
RAI 354 - 03.06.02-38		November 18, 2010
RAI 354 - 03.06.02-39		November 18, 2010
RAI 354 - 03.06.02-40		November 18, 2010

Sincerely,

Martin (Marty) C. Bryan
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AREVA NP Inc.
Tel: (434) 832-3016
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From: BRYAN Martin (External RS/NB)
Sent: Thursday, October 07, 2010 2:41 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3, Supplement 10

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 1 of the 22 questions of RAI No. 354 on April 15, 2010, and a schedule for the remaining 21 questions. AREVA NP submitted Supplement 1 on June 3, 2010, to provide a schedule for the remaining 21 questions. Supplement 2 was submitted on June 24, 2010, and included a revised schedule for Questions 03.08.02-11, 12, 13, 14, 15, 16; 03.08.05-22 and 03.08.05-23. AREVA NP submitted Supplement 3 on July 7, 2010, responding to 1 of the remaining 21 questions. AREVA NP submitted Supplement 4 on July 30, 2010, to provide final responses to Questions 03.06.02-32, 03.06.02-41 and 03.08.02-16 and a revised schedule for Questions 03.06.02-33 through 03.06.02-40. On August 5, 2010, AREVA NP provided a revised schedule for Questions 03.06.02-42 and 03.08.05-23 in Supplement 5. AREVA NP submitted Supplement 6 on August 31, 2010, to provide final responses to 5 of the remaining 17 questions. On September 8, 2010, AREVA NP submitted Supplement 7 to provide a revised schedule for the response to Question 03.08.05-21. On September 13, 2010, AREVA NP provided an INTERIM response to Question 03.08.05-22 in Supplement 8. In Supplement 9, AREVA NP submitted a revised schedule for Question 03.08.05-23 on October 1, 2010.

The attached file, “RAI 354 Supplement 10 Response US EPR DC.pdf” provides a technically correct and complete FINAL response to Question 03.08.05-21, as committed. The following table indicates the respective

pages in the response document, “RAI 354 Supplement 10 Response US EPR DC.pdf,” that contains AREVA NP’s response to the subject question.

Question #	Start Page	End Page
RAI 354 - 03.08.05-21	2	3

The schedule for a revised INTERIM response to Question 03.08.05-22 is added to provide the NRC additional information on AREVA NP’s settlement approach. The schedule for the remaining questions is unchanged.

The schedule for the technically correct and complete responses to the remaining questions is provided below.

Question #	Interim Response Date	Response Date
RAI 354 - 03.08.02-13		November 1, 2010
RAI 354 - 03.08.05-22	September 15, 2010 (Actual September 13, 2010) **November 22, 2010**	January 13, 2011
RAI 354 - 03.08.05-23		November 18, 2010
RAI 354 - 03.06.02-33		November 18, 2010
RAI 354 - 03.06.02-34		November 18, 2010
RAI 354 - 03.06.02-35		November 18, 2010
RAI 354 - 03.06.02-36		November 18, 2010
RAI 354 - 03.06.02-37		November 18, 2010
RAI 354 - 03.06.02-38		November 18, 2010
RAI 354 - 03.06.02-39		November 18, 2010
RAI 354 - 03.06.02-40		November 18, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

From: BRYAN Martin (External RS/NB)
Sent: Friday, October 01, 2010 2:31 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3, Supplement 9

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 1 of the 22 questions of RAI No. 354 on April 15, 2010, and a schedule for the remaining 21 questions. AREVA NP submitted Supplement 1 on June 3, 2010, to provide a schedule for the remaining 21 questions. Supplement 2 was submitted on June 24, 2010, and included a revised schedule for Questions 03.08.02-11, 12, 13, 14, 15, 16; 03.08.05-22 and 03.08.05-23. AREVA NP submitted Supplement 3 on July 7, 2010, responding to 1 of the remaining 21 questions. AREVA NP submitted Supplement 4 on July 30, 2010, to provide final responses to Questions 03.06.02-32, 03.06.02-41 and 03.08.02-16 and a revised schedule for Questions 03.06.02-33 through 03.06.02-40. On August 5, 2010, AREVA NP provided a revised schedule for Questions 03.06.02-42 and 03.08.05-23 in Supplement 5. AREVA NP submitted Supplement 6 on August 31, 2010, to provide final responses to 5 of the remaining 17

questions. On September 8, 2010, AREVA NP submitted Supplement 7 to provide a revised schedule for the response to Question 03.08.05-21. On September 13, 2010, AREVA NP provided an INTERIM response to Question 03.08.05-22 in Supplement 8.

The schedule for Question 03.08.05-23 is being revised to allow additional time for AREVA NP to interact with the NRC. The schedule for the remaining questions is unchanged.

The schedule for the technically correct and complete responses to the remaining questions is provided below.

Question #	Interim Response Date	Response Date
RAI 354 - 03.08.02-13		November 1, 2010
RAI 354 - 03.08.05-21		October 7, 2010
RAI 354 - 03.08.05-22	September 15, 2010 (Actual September 13, 2010)	January 13, 2011
RAI 354 - 03.08.05-23		November 18, 2010
RAI 354 - 03.06.02-33		November 18, 2010
RAI 354 - 03.06.02-34		November 18, 2010
RAI 354 - 03.06.02-35		November 18, 2010
RAI 354 - 03.06.02-36		November 18, 2010
RAI 354 - 03.06.02-37		November 18, 2010
RAI 354 - 03.06.02-38		November 18, 2010
RAI 354 - 03.06.02-39		November 18, 2010
RAI 354 - 03.06.02-40		November 18, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
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From: BRYAN Martin (External RS/NB)
Sent: Monday, September 13, 2010 5:09 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3, Supplement 8

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 1 of the 22 questions of RAI No. 354 on April 15, 2010, and a schedule for the remaining 21 questions. AREVA NP submitted Supplement 1 on June 3, 2010, to provide a schedule for the remaining 21 questions. Supplement 2 was submitted on June 24, 2010, and included a revised schedule for Questions 03.08.02-11, 12, 13, 14, 15, 16; 03.08.05-22 and 03.08.05-23. AREVA NP submitted Supplement 3 on July 7, 2010, responding to 1 of the remaining 21 questions. AREVA NP submitted Supplement 4 on July 30, 2010, to provide final responses to Questions 03.06.02-32, 03.06.02-41 and 03.08.02-16 and a revised schedule for Questions 03.06.02-33 through 03.06.02-40. On August 5, 2010, AREVA NP provided a revised schedule for Questions 03.06.02-42 and 03.08.05-23 in Supplement 5. AREVA NP submitted Supplement 6 on August 31, 2010, to provide final responses to 5 of the remaining 17 questions. On September 8, 2010, AREVA NP submitted Supplement 7 to provide a revised schedule for the response to Question 03.08.05-21.

AREVA NP recently notified the NRC of its intent to submit an INTERIM response to Question 03.08.05-22. The attached file, "RAI 354 Supplement 8 Response US EPR DC-INTERIM.pdf" provides a technically correct and complete INTERIM response to Question 03.08.05-22, as committed. The schedule for the remaining questions is unchanged.

The following table indicates the respective pages in the response document, RAI 354 Supplement 8 Response US EPR DC - INTERIM.pdf," that contains AREVA NP's response to the subject question.

Question #	Start Page	End Page
RAI 354 - 03.08.05-22	2	3

The revised schedule for the technically correct and complete responses to the remaining questions is provided below.

Question #	Interim Response Date	Response Date
RAI 354 - 03.08.02-13		November 1, 2010
RAI 354 - 03.08.05-21		October 7, 2010
RAI 354 - 03.08.05-22	September 15, 2010 (Actual September 13, 2010)	January 13, 2011
RAI 354 - 03.08.05-23		October 1, 2010
RAI 354 - 03.06.02-33		November 18, 2010
RAI 354 - 03.06.02-34		November 18, 2010
RAI 354 - 03.06.02-35		November 18, 2010
RAI 354 - 03.06.02-36		November 18, 2010
RAI 354 - 03.06.02-37		November 18, 2010
RAI 354 - 03.06.02-38		November 18, 2010
RAI 354 - 03.06.02-39		November 18, 2010
RAI 354 - 03.06.02-40		November 18, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

From: BRYAN Martin (External RS/NB)
Sent: Wednesday, September 08, 2010 6:09 PM
To: Tesfaye, Getachew
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); 'Miernicki, Michael'; CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3, Supplement 7

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 1 of the 22 questions of RAI No. 354 on April 15, 2010, and a schedule for the remaining 21 questions. AREVA NP submitted Supplement 1 on June 3, 2010, to provide a schedule for the remaining 21 questions. Supplement 2 was submitted on June 24, 2010, and included a revised schedule for Questions 03.08.02-11, 12, 13, 14, 15, 16; 03.08.05-22 and 03.08.05-23.

AREVA NP submitted Supplement 3 on July 7, 2010, responding to 1 of the remaining 21 questions. AREVA NP submitted Supplement 4 on July 30, 2010, to provide final responses to Questions 03.06.02-32, 03.06.02-41 and 03.08.02-16 and a revised schedule for Questions 03.06.02-33 through 03.06.02-40. On August 5, 2010 AREVA NP provided a revised schedule for Questions 03.06.02-42 and 03.08.05-23 in Supplement 5. On August 31, 2010, AREVA NP submitted final responses to 5 of the remaining 17 questions.

The schedule for Question 03.08.05-21 is being revised to allow additional time for AREVA NP to interact with the NRC on the draft response. The schedule for the remaining questions is unchanged.

The schedule for the technically correct and complete responses to the remaining questions is provided below.

Question #	Response Date
RAI 354 - 03.08.02-13	November 1, 2010
RAI 354 - 03.08.05-21	**October 7, 2010**
RAI 354 - 03.08.05-22	January 13, 2011
RAI 354 - 03.08.05-23	October 1, 2010
RAI 354 - 03.06.02-33	November 18, 2010
RAI 354 - 03.06.02-34	November 18, 2010
RAI 354 - 03.06.02-35	November 18, 2010
RAI 354 - 03.06.02-36	November 18, 2010
RAI 354 - 03.06.02-37	November 18, 2010
RAI 354 - 03.06.02-38	November 18, 2010
RAI 354 - 03.06.02-39	November 18, 2010
RAI 354 - 03.06.02-40	November 18, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

From: BRYAN Martin (External RS/NB)
Sent: Tuesday, August 31, 2010 4:28 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3, Supplement 6

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 1 of the 22 questions of RAI No. 354 on April 15, 2010, and a schedule for the remaining 21 questions. AREVA NP submitted Supplement 1 on June 3, 2010, to provide a schedule for the remaining 21 questions. Supplement 2 was submitted on June 24, 2010, and included a revised schedule for Questions 03.08.02-11, 12, 13, 14, 15, 16; 03.08.05-22 and 03.08.05-23. AREVA NP submitted Supplement 3 on July 7, 2010, responding to 1 of the remaining 21 questions. AREVA NP submitted Supplement 4 on July 30, 2010, to provide final responses to Questions 03.06.02-32, 03.06.02-41 and 03.08.02-16 and a revised schedule for Questions 03.06.02-33 through 03.06.02-40. On August 5, 2010 AREVA NP provided a revised schedule for Questions 03.06.02-42 and 03.08.05-23 in Supplement 5.

The attached file, “RAI 354 Supplement 6 Response US EPR DC.pdf” provides technically correct and complete FINAL responses to Questions 03.06.02-42 and 03.08.02-11 to 03.08.02-15, as committed. Because

the response file contains security-related sensitive information that should be withheld from public disclosure in accordance with 10 CFR 2.390, a public version is provided with the security-related sensitive information redacted. This email and attached file do not contain any security-related information. An unredacted security-related version is provided under separate email.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 354 Supplement 6.

The schedule for Question 03.08.02-13 is being revised to allow additional time for AREVA NP to address NRC comments. The schedule for the remaining questions is unchanged.

The following table indicates the respective pages in the response document, RAI 354 Supplement 6 Response US EPR DC.pdf," that contains AREVA NP's response to the subject question.

Question #	Start Page	End Page
RAI 354 - 03.08.02-11	2	4
RAI 354 - 03.08.02-12	5	6
RAI 354 - 03.08.02-14	7	8
RAI 354 - 03.08.02-15	9	10
RAI 354 - 03.06.02-42	11	12

The revised schedule for the technically correct and complete responses to the remaining questions is provided below.

Question #	Response Date
RAI 354 - 03.08.02-13	**November 1, 2010**
RAI 354 - 03.08.05-21	September 8, 2010
RAI 354 - 03.08.05-22	January 13, 2011
RAI 354 - 03.08.05-23	October 1, 2010
RAI 354 - 03.06.02-33	November 18, 2010
RAI 354 - 03.06.02-34	November 18, 2010
RAI 354 - 03.06.02-35	November 18, 2010
RAI 354 - 03.06.02-36	November 18, 2010
RAI 354 - 03.06.02-37	November 18, 2010
RAI 354 - 03.06.02-38	November 18, 2010
RAI 354 - 03.06.02-39	November 18, 2010
RAI 354 - 03.06.02-40	November 18, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

From: BRYAN Martin (EXT)
Sent: Thursday, August 05, 2010 6:23 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (EXT); WELLS Russell (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3, Supplement 5

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 1 of the 22 questions of RAI No. 354 on April 15, 2010, and a schedule for the remaining 21 questions. AREVA NP submitted Supplement 1 on June 3, 2010, to provide a schedule for the remaining 21 questions. Supplement 2 was submitted on June 24, 2010, and included a revised schedule for Questions 03.08.02-11, 12, 13, 14, 15, 16; 03.08.05-22 and 03.08.05-23. AREVA NP submitted Supplement 3 on July 7, 2010, responding to 1 of the remaining 21 questions. AREVA NP submitted Supplement 4 on July 30, 2010, to provide final responses to Questions 03.06.02-32, 03.06.02-41 and 03.08.02-16 and a revised schedule for Questions 03.06.02-33 through 03.06.02-40.

The schedule for Questions 03.06.02-42 and 03.08.05-23 is being revised to allow additional time for AREVA NP to address NRC comments. The schedule for the remaining 15 questions is unchanged.

The revised schedule for the technically correct and complete responses to the remaining questions is provided below.

Question #	Response Date
RAI 354 - 03.08.02-11	August 31, 2010
RAI 354 - 03.08.02-12	August 31, 2010
RAI 354 - 03.08.02-13	August 31, 2010
RAI 354 - 03.08.02-14	August 31, 2010
RAI 354 - 03.08.02-15	August 31, 2010
RAI 354 - 03.08.05-21	September 8, 2010
RAI 354 - 03.08.05-22	January 13, 2011
RAI 354 - 03.08.05-23	**October 1, 2010**
RAI 354 - 03.06.02-33	November 18, 2010
RAI 354 - 03.06.02-34	November 18, 2010
RAI 354 - 03.06.02-35	November 18, 2010
RAI 354 - 03.06.02-36	November 18, 2010
RAI 354 - 03.06.02-37	November 18, 2010
RAI 354 - 03.06.02-38	November 18, 2010
RAI 354 - 03.06.02-39	November 18, 2010
RAI 354 - 03.06.02-40	November 18, 2010
RAI 354 - 03.06.02-42	**August 31, 2010**

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
702 561-3528 cell
Martin.Bryan.ext@areva.com

From: BRYAN Martin (EXT)
Sent: Thursday, July 29, 2010 7:40 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); ROMINE Judy (AREVA NP INC); CORNELL Veronica (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3, Supplement 4

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 1 of the 22 questions of RAI No. 354 on April 15, 2010, and a schedule for the remaining 21 questions. AREVA NP submitted Supplement 1 on June 3, 2010, to provide a schedule for the remaining 21 questions. Supplement 2 was submitted on June 24, 2010, and included a revised schedule for Questions 03.08.02-11, 12, 13, 14, 15, 16; 03.08.05-22 and 03.08.05-23. AREVA NP submitted Supplement 3 on July 7, 2010, responding to 1 of the remaining 21 questions.

The attached file, "RAI 354 Supplement 4 Response U.S. EPR DC.pdf" provides technically correct and complete responses to Questions 03.06.02-32, 03.06.02-41, and 03.08.02-16. Because the response file contains security-related sensitive information that should be withheld from public disclosure in accordance with 10 CFR 2.390, a public version is provided with the security-related sensitive information redacted. This email and attached file do not contain any security-related information. An unredacted security-related version is provided under separate email.

The schedules for Questions 03.06.02-33 through 03.06.02-40 are being revised to allow additional time for AREVA NP to address NRC comments. The schedule for the remaining 9 questions is unchanged.

The following table indicates the respective pages in the response document, "RAI 354 Supplement 4 Response U.S. EPR DC," that contain the AREVA NP response to the subject questions.

Question #	Start Page	End Page
RAI 354 - 03.06.02-32	2	3
RAI 354 - 03.06.02-41	4	6
RAI 354 – 03.08.02-16	7	7

The revised schedule for the technically correct and complete responses to the remaining questions is provided below.

Question #	Response Date
RAI 354 - 03.08.02-11	August 31, 2010
RAI 354 - 03.08.02-12	August 31, 2010
RAI 354 - 03.08.02-13	August 31, 2010
RAI 354 - 03.08.02-14	August 31, 2010
RAI 354 - 03.08.02-15	August 31, 2010
RAI 354 - 03.08.05-21	September 8, 2010
RAI 354 - 03.08.05-22	January 13, 2011
RAI 354 - 03.08.05-23	August 10, 2010
RAI 354 - 03.06.02-33	November 18, 2010
RAI 354 - 03.06.02-34	November 18, 2010
RAI 354 - 03.06.02-35	November 18, 2010
RAI 354 - 03.06.02-36	November 18, 2010
RAI 354 - 03.06.02-37	November 18, 2010
RAI 354 - 03.06.02-38	November 18, 2010
RAI 354 - 03.06.02-39	November 18, 2010
RAI 354 - 03.06.02-40	November 18, 2010
RAI 354 - 03.06.02-42	August 5, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

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Martin.Bryan.ext@areva.com

From: BRYAN Martin (EXT)
Sent: Wednesday, July 07, 2010 5:27 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); CORNELL Veronica (EXT); VAN NOY Mark (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3, Supplement 3

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 1 of the 22 questions of RAI No. 354 on April 15, 2010, and a schedule for the remaining 21 questions. AREVA NP submitted Supplement 1 on June 3, 2010, to provide a schedule for the remaining 21 questions.

On June 9, 2010, AREVA NP submitted draft Supplement 2 responses to questions 03.08.05-20, 03.08.05-21, 03.06.02-32, 03.06.02-41 and 03.06.02-42. Supplement 2 was submitted on June 24, 2010, and included a revised schedule to reflect the civil/structural re-planning activities and time allowance to interact with the NRC on the responses for 03.08.02-11, 12, 13, 14, 15, 16; 03.08.05-22 and 03.08.05-23.

The attached file, "RAI 354 Response U.S. EPR DC.pdf" provides a technically correct and complete response to Question 03.08.05-20.

The schedule for Question 03.08.05-21 is being revised to accommodate development of a revised response and to allow time to interact with the NRC on the response. The schedule for Questions 03.06.02-32, 03.06.02-41 and 03.06.02-42 is also being revised to provide additional time to interact with the NRC on the responses. The schedule for the remaining 16 questions is unchanged.

The following table indicates the respective pages in the response document, "RAI 354 Response U.S. EPR DC," that contain the AREVA NP response to the subject questions.

Question #	Start Page	End Page
RAI 354 — 03.08.05-20	2	3

The revised schedule for the technically correct and complete responses to the remaining questions is provided below.

Question #	Response Date
RAI 354 - 03.08.02-11	August 31, 2010
RAI 354 - 03.08.02-12	August 31, 2010
RAI 354 - 03.08.02-13	August 31, 2010
RAI 354 - 03.08.02-14	August 31, 2010
RAI 354 - 03.08.02-15	August 31, 2010
RAI 354 - 03.08.02-16	August 10, 2010
RAI 354 - 03.08.05-21	September 8, 2010
RAI 354 - 03.08.05-22	January 13, 2011
RAI 354 - 03.08.05-23	August 10, 2010
RAI 354 - 03.06.02-32	August 5, 2010
RAI 354 - 03.06.02-33	July 30, 2010

Question #	Response Date
RAI 354 - 03.06.02-34	July 30, 2010
RAI 354 - 03.06.02-35	July 30, 2010
RAI 354 - 03.06.02-36	July 30, 2010
RAI 354 - 03.06.02-37	July 30, 2010
RAI 354 - 03.06.02-38	July 30, 2010
RAI 354 - 03.06.02-39	July 30, 2010
RAI 354 - 03.06.02-40	July 30, 2010
RAI 354 - 03.06.02-41	August 5, 2010
RAI 354 - 03.06.02-42	August 5, 2010

Sincerely,

Martin (Marty) C. Bryan
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
Tel: (434) 832-3016
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Martin.Bryan.ext@areva.com

From: BRYAN Martin (EXT)
Sent: Thursday, June 24, 2010 12:29 PM
To: 'Tesfaye, Getachew'
Cc: ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); CORNELL Veronica (EXT); VAN NOY Mark (EXT); RYAN Tom (AREVA NP INC); GARDNER George Darrell (AREVA NP INC); DELANO Karen V (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3, Supplement 2

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 1 of the 22 questions of RAI No. 354 on April 15, 2010, and a schedule for the remaining 21 questions. AREVA NP submitted Supplement 1 to the response on June 3, 2010, to provide a schedule for the remaining 21 questions, one of which was affected by the work underway to address NRC comments from the April 26, 2010, audit.

Based upon the civil/structural re-planning activities and revised RAI response schedule presented to the NRC during the June 9, 2010, Public Meeting, and to allow time to interact with the NRC on the responses, the schedule for questions 03.08.02-11, 12, 13, 14, 15, 16, 03.08.05-22 and 03.08.05-23 has been changed. The schedule for the remaining 13 questions remains unchanged.

The revised schedule for the technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 354 - 03.08.02-11	August 31
RAI 354 - 03.08.02-12	August 31
RAI 354 - 03.08.02-13	August 31
RAI 354 - 03.08.02-14	August 31
RAI 354 - 03.08.02-15	August 31
RAI 354 - 03.08.02-16	August 10, 2010
RAI 354 - 03.08.05-20	July 7, 2010
RAI 354 - 03.08.05-21	July 7, 2010

RAI 354 - 03.08.05-22	January 13, 2011
RAI 354 - 03.08.05-23	August 10, 2010
RAI 354 - 03.06.02-32	July 7, 2010
RAI 354 - 03.06.02-33	July 30, 2010
RAI 354 - 03.06.02-34	July 30, 2010
RAI 354 - 03.06.02-35	July 30, 2010
RAI 354 - 03.06.02-36	July 30, 2010
RAI 354 - 03.06.02-37	July 30, 2010
RAI 354 - 03.06.02-38	July 30, 2010
RAI 354 - 03.06.02-39	July 30, 2010
RAI 354 - 03.06.02-40	July 30, 2010
RAI 354 - 03.06.02-41	July 7, 2010
RAI 354 - 03.06.02-42	July 7, 2010

Sincerely,

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702 561-3528 cell
Martin.Bryan.ext@areva.com

From: BRYAN Martin (EXT)
Sent: Thursday, June 03, 2010 6:39 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); VAN NOY Mark (EXT); CORNELL Veronica (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3, Supplement 1

Getachew,

AREVA NP Inc. (AREVA NP) provided a response to 1 of the 22 questions of RAI No. 354 on April 15, 2010, and a schedule for the remaining 21 questions. The schedule for questions 03.08.02-11 through 15 is not being changed by this supplement. To allow time to interact with the NRC, the schedule for 16 questions is being changed. The date provided below for question 03.08.05-22 will be revised based on the information that will be presented at the June 9, 2010 public meeting and subsequent NRC feedback.

Question #	Response Date
RAI 354 - 03.08.02-11	July 30, 2010
RAI 354 - 03.08.02-12	July 30, 2010
RAI 354 - 03.08.02-13	July 30, 2010
RAI 354 - 03.08.02-14	July 30, 2010
RAI 354 - 03.08.02-15	July 30, 2010
RAI 354 - 03.08.02-16	July 30, 2010
RAI 354 - 03.08.05-20	July 7, 2010
RAI 354 - 03.08.05-21	July 7, 2010

RAI 354 - 03.08.05-22	July 30, 2010
RAI 354 - 03.08.05-23	July 30, 2010
RAI 354 - 03.06.02-32	July 7, 2010
RAI 354 - 03.06.02-33	July 30, 2010
RAI 354 - 03.06.02-34	July 30, 2010
RAI 354 - 03.06.02-35	July 30, 2010
RAI 354 - 03.06.02-36	July 30, 2010
RAI 354 - 03.06.02-37	July 30, 2010
RAI 354 - 03.06.02-38	July 30, 2010
RAI 354 - 03.06.02-39	July 30, 2010
RAI 354 - 03.06.02-40	July 30, 2010
RAI 354 - 03.06.02-41	July 7, 2010
RAI 354 - 03.06.02-42	July 7, 2010

Sincerely,

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From: BRYAN Martin (EXT)
Sent: Thursday, April 15, 2010 5:46 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); VAN NOY Mark (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 354 Response US EPR DC.pdf" provides technically correct and complete responses to 1 of the 22 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 354 Question 03.08.05-19.

The following table indicates the respective pages in the response document, "RAI 354 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 354 - 03.08.02-11	2	2
RAI 354 - 03.08.02-12	3	3
RAI 354 - 03.08.02-13	4	4
RAI 354 - 03.08.02-14	5	5
RAI 354 - 03.08.02-15	6	6
RAI 354 - 03.08.02-16	7	7
RAI 354 - 03.08.05-19	8	8
RAI 354 - 03.08.05-20	9	9

RAI 354 - 03.08.05-21	10	10
RAI 354 - 03.08.05-22	11	11
RAI 354 - 03.08.05-23	12	12
RAI 354 - 03.06.02-32	13	13
RAI 354 - 03.06.02-33	14	14
RAI 354 - 03.06.02-34	15	15
RAI 354 - 03.06.02-35	16	16
RAI 354 - 03.06.02-36	17	17
RAI 354 - 03.06.02-37	18	18
RAI 354 - 03.06.02-38	19	19
RAI 354 - 03.06.02-39	20	20
RAI 354 - 03.06.02-40	21	21
RAI 354 - 03.06.02-41	22	22
RAI 354 - 03.06.02-42	23	24

A complete answer is not provided for 21 of the 22 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	**Response Date**
RAI 354 - 03.08.02-11	July 30, 2010
RAI 354 - 03.08.02-12	July 30, 2010
RAI 354 - 03.08.02-13	July 30, 2010
RAI 354 - 03.08.02-14	July 30, 2010
RAI 354 - 03.08.02-15	July 30, 2010
RAI 354 - 03.08.02-16	June 3, 2010
RAI 354 - 03.08.05-20	June 3, 2010
RAI 354 - 03.08.05-21	June 3, 2010
RAI 354 - 03.08.05-22	June 3, 2010
RAI 354 - 03.08.05-23	June 3, 2010
RAI 354 - 03.06.02-32	June 3, 2010
RAI 354 - 03.06.02-33	June 3, 2010
RAI 354 - 03.06.02-34	June 3, 2010
RAI 354 - 03.06.02-35	June 3, 2010
RAI 354 - 03.06.02-36	June 3, 2010
RAI 354 - 03.06.02-37	June 3, 2010
RAI 354 - 03.06.02-38	June 3, 2010
RAI 354 - 03.06.02-39	June 3, 2010
RAI 354 - 03.06.02-40	June 3, 2010
RAI 354 - 03.06.02-41	June 3, 2010
RAI 354 - 03.06.02-42	June 3, 2010

Sincerely,

Martin (Marty) C. Bryan
Licensing Advisory Engineer
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Tel: (434) 832-3016
Martin.Bryan.ext@areva.com

From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Tuesday, March 16, 2010 12:29 PM
To: ZZ-DL-A-USEPR-DL
Cc: Xu, Jim; Hawkins, Kimberly; Ng, Ching; Dixon-Herrity, Jennifer; Miernicki, Michael; Patel, Jay; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 354 (4106,4107,4220), FSAR Ch. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on January 8, 2010, and discussed with your staff on February 25, 2010. Drat RAI Questions 03.08.05-23 was modified 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: 2297

Mail Envelope Properties (BC417D9255991046A37DD56CF597DB7108518834)

Subject: Response to U.S. EPR Design Certification Application RAI No. 354, FSAR Ch. 3, Supplement 13
Sent Date: 11/22/2010 7:39:42 PM
Received Date: 11/22/2010 7:40:04 PM
From: BRYAN Martin (EXTERNAL AREVA)

Created By: Martin.Bryan.ext@areva.com

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Tracking Status: None
"CORNELL Veronica (EXTERNAL AREVA)" <Veronica.Cornell.ext@areva.com>
Tracking Status: None
"Tesfaye, Getachew" <Getachew.Tesfaye@nrc.gov>
Tracking Status: None

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Files	**Size**	**Date & Time**	
MESSAGE	42285	11/22/2010 7:40:04 PM	
RAI 354 Supplement 13 Response US EPR DC - INTERIM.pdf			3084185

Options
Priority: Standard
Return Notification: No
Reply Requested: No
Sensitivity: Normal
Expiration Date:
Recipients Received:

Response to

Request for Additional Information No. 354, Supplement 13

3/16/2010

U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.08.02 - Steel Containment
SRP Section: 03.08.05 - Foundations
SRP Section: 03.06.02 - Determination of Rupture Locations and Dynamic Effects Associated with the Postulated Rupture of Piping

Application Section: FSAR Ch 3

QUESTIONS for Structural Engineering Branch 2 (ESBWR/ABWR Projects) (SEB2)

Question 03.08.05-22:

Follow-up to RAI 155, Question Nos. 03.08.05-15

The RAI response states that control of the construction sequence of the NI basemat structures is not necessary for the U.S. EPR design. It adds that settlement control criteria are performance-based, and that these control criteria are sufficient to implement design and construction considerations.

The RAI response, however, implies that there is a construction sequence to be followed during the plant construction. Indeed, the statement that the "largest mass being placed at the center of the basemat early in construction" is equivalent to imposing a sequence on construction, although this is not explicitly stated in the FSAR. Consequently, describe this construction sequence in greater detail (e.g., which structure and to what elevation to be completed in which order), and include this information in the relevant sections of the FSAR so that it can be correctly followed by the COL applicants. In this regard, the staff notes that the purpose of defining a range of sequence of operations is to ensure that segmental cracking will not occur between as-built sections of the facility, particularly for softer soil sites, and that the design of the facility is such as to reduce the need for settlement control during construction.

In addition, as requested in the original RAI, provide details of studies (e.g., models, analysis approach, assumptions, and results) performed to determine the significance of the stresses imposed by the aforementioned construction sequence, as well as the corresponding design implications.

Finally, provide the steps to be taken by the COL applicants whenever measured settlements during construction exceed allowable values. This information should be added to the relevant sections of the FSAR. Also indicate which section of the FSAR sets “differential movement for ... global conditions (3.0 inch differential)” as a limit, and clarify what is meant by this.

Response to Question 03.08.05-22:

AREVA NP established and evaluated a construction sequence for the U.S. EPR design. A description of the evaluation, including acceptance criteria is provided for settlement profiles. The U.S. EPR settlement profiles are prepared for the COL applicant to use for evaluating against site-specific settlement predictions. When actual settlement values are different from predicted settlement values, COL applicant site-specific evaluations or actions are required.

The U.S. EPR Nuclear Island (NI) common basemat design includes a nine to twelve foot thick basemat that provides significant structural stiffness and limits the effects of settlement on the superstructure. The design allows flexibility in the construction sequence of superstructure structural elements.

The tilt settlement control criterion is ½ inch in 50 ft. as shown in U.S. EPR FSAR Tier 2, Table 2.1-1 and described in U.S. EPR FSAR Tier 2, Section 2.5.4.10. The settlement criterion is used for equipment support and performance evaluations. Settlement of the building is to be controlled to ½ inch in 50 ft. such that equipment can be installed and operated as designed. Clarification of the settlement criterion will be provided in U.S. EPR FSAR Tier 1, Table 5.0-1, Tier 2, Table 2.1-1 and Section 2.5.4.10.

A differential settlement evaluation is performed for the NI common basemat structure considering both short term (elastic) and long term (heave and consolidation) effects. The evaluation accounts for the construction sequence, building stiffness, and time duration for loading the NI common basemat structure. The evaluation considers a soft soil site consistent with the soft soil case addressed in U.S. EPR FSAR Tier 2, Table 3.7.1-6. A comparison of the angular distortion of the basemat for various soil cases demonstrates that the soft soil site will control the design for settlement.

The resulting forces and moments throughout the structure are captured by applying soil springs to the 3D finite element structural model of the basemat and superstructure used for designing the basemat. The soil springs are developed to capture the short and long term responses of the soil.

A construction sequence is evaluated for the NI common basemat structure, which assumes that the concrete for the mat foundation is in a single placement prior to the start of placement of concrete for the superstructure. It is assumed that concrete placement for the superstructure continues so that the superstructure is erected uniformly.

The construction sequence considers 11 steps for the NI common basemat structure:

1. Basemat only.
2. Walls up to elevation -16 ft.
3. Floor slabs at elevation -16 ft.
4. Walls up to grade elevation.
5. Floor slabs at grade elevation.
6. Walls up to elevation 55 ft.
7. Floor slabs at elevation 55 ft.
8. Walls up to elevation 96 ft.
9. Floor slabs at elevation 96 ft.
10. Walls up to elevation 144 ft.
11. Remaining structure up to elevation 204 ft.

Soil springs are applied to the 3D finite element structural model to determine the displacement of the basemat and capture the resulting locked-in forces and moments throughout the structure at each construction step. The soil springs are developed using the PLAXIS 3D foundation (Plaxis 3D) software. The Plaxis 3D subgrade modulus K is determined using the following equation.

$$K = \sigma'_{yy} / \delta$$

where σ'_{yy} is the vertical effective stress, and δ is the vertical deformation.

Two sets of soil springs are developed using Plaxis 3D. Both sets are developed considering 100 percent of the dead load, 25 percent of the live load, and 75 percent of the precipitation loads.

The first set of soil springs is developed using only the basemat loading. The soil spring distribution matches a distribution of the NI common basemat with the full elastic modulus, Ec. The springs are applied to the 3D finite element structural model for each construction step through placement of the slabs at grade elevation. The Plaxis 3D model in Figure 03.08.05-22-1 simulates the foundation with plate elements and is used to develop soil springs for the 3D finite element structural model. The basemat thickness in the Plaxis 3D model is adjusted and soil springs are developed and applied to the 3D finite element structural model until a good fit (less than 10 percent difference) is observed in terms of settlements generated by both the 3D finite element structural model and Plaxis 3D model.

The second set of springs is developed using the full NI common basemat structure and the effects from the adjacent structures. The distribution of the second set of soil springs matches the distribution with the NI common basemat completed structure with the full elastic modulus, Ec. The springs are applied to the 3D finite element structural model for the remaining construction steps above the grade elevation slabs. Similar to the process used to develop springs for the flexible superstructure, a Plaxis 3D model with plate elements is used to develop soil springs for the completed NI structure (Figure 03.08.05-22-2). The Plaxis 3D model plate thicknesses are adjusted and soil springs are developed. The soil springs are applied to the 3D finite element structural model until a good fit (less than 10 percent difference) is observed between settlements generated by both the 3D finite element structural model and Plaxis 3D model.

At each construction step in the 3D finite element model structural evaluation, 100 percent of the dead load, 25 percent of the live load, and 75 percent of the precipitation loads are applied to determine locked-in forces and moments for all structural elements.

The full Ec and section modulus are used for hardened concrete. In the basemat evaluation, the soil material will experience initial displacement; however, the basemat will not initially experience the assumed linear stress increase because the concrete is still plastic. Therefore, using the full Ec value is considered conservative when calculating stresses for the initial basemat evaluations.

For the superstructure elements, the walls and slabs are added in a stepwise manner as wet concrete. At each step, the effects of the added mass are considered by reducing Ec to 0.1 x Ec for the superstructure elements. The section properties are converted back to the full Ec prior to evaluating the next step.

The locked-in forces and moments are tabulated, and a separate load file is developed for each construction step. After each construction step during development of the load file, a check is conducted to determine if the basemat concrete has cracked. If the basemat concrete has cracked, a cracked section modulus is used to develop the forces and moments.

The settlement loads are treated as dead loads in load combinations (i.e., the load factors applied correspond to the dead load factor). The basemat design includes symmetrical main reinforcing steel in each direction and on each face to control development of any large cracks in the basemat.

Relative differential settlement contours are developed for each construction step. Examples of relative differential settlement contours are provided in Figures 03.08.05-22-3 and 03.08.05-22-

4. New figures will be added to U.S. EPR FSAR Tier 2 to show differential settlement contours, and will be included in the revised FSAR in the final response to this question.

U.S. EPR FSAR Tier 2, Sections 2.5.4.10, 3.8.5.3, 3.8.5.4 and 3.8.5.5 will be revised to describe the settlement evaluation and acceptance criteria for Seismic Category I structures.

The U.S. EPR construction sequence is not a COL Information Item. However, U.S. EPR certified design relative differential settlement contours will be used by the COL applicant to reconcile with the site-specific construction sequence and geotechnical report settlement predictions.

The effect of settlement on the Emergency Power Generating Building (EPGB) and Essential Service Water Building (ESWB) structures also considers a soft soil site consistent with a soft soil case as shown in U.S. EPR FSAR Tier 2, Table 3.7.1-6. Soil springs are developed to consider both short term (elastic) and long term (heave and consolidation) effects. The 3D finite element models of the EPGB and ESWB basemat and superstructure are used in a static structural analysis with elastic soil springs applied in an elliptical distribution. The consolidation effects are approximated by further softening the elastic soil spring stiffness by a factor of 2. A settlement load file is created considering 100 percent of the dead load, 25 percent of the live load, and 75 percent of the precipitation loads to determine locked-in forces and moments for all structural elements. The full Ec and section modulus is used in the EPGB and ESWB settlement analysis. A check is conducted to determine if the basemat concrete has cracked while developing the load file. If the basemat concrete has cracked, a cracked section modulus is used to develop the forces and moments. The basemat design includes symmetrical main reinforcing steel in each direction and on each face to account for any additional lateral variability in the soil properties and to control development of any large cracks in the basemat.

The foundation settlement contour plots for the EPGB and ESWB will be used by the COL applicant to reconcile with the site-specific geotechnical report settlement predictions. An example of a foundation settlement displacement contour plot for the ESWB is included in Figure 03.08.05-22-5. The EPGB and ESWB differential settlement contours will be included in the revised FSAR in the final response to this question.

U.S. EPR FSAR Tier 2, Sections 3.8.5.4 and 3.8.5.5 will be revised to describe the settlement analysis and acceptance criteria for the EPGB and ESWB structures.

The U.S. EPR design requires separate Seismic Category I (SC-I) structures to be connected by site-specific designed SC-I umbilicals (i.e., ductbank, embedded piping, and/or structural galleries containing piping, cable tray, and/or ductwork). The effects of site-specific differential settlement between the individual U.S. EPR SC-I structures and the site-specific SC-I umbilicals will be considered in the design of the connections and the construction sequence. U.S. EPR FSAR Tier 2, Section 3.8.5.4 will be revised to include this settlement information.

A COL applicant that references the U.S. EPR design certification will provide an assessment of predicted settlement values across the basemat of SC-I structures both during and post construction. The assessment will address short term (elastic) and long term (heave and consolidation) settlement effects with the site-specific soil parameters, including the soil loading effects from adjacent structures (COL Item 2.5-12).

Site-specific considerations for the predicted short and long term effects of settlement will be taken into account. Site-specific considerations include the effects of dewatering, excavation, foundation material preparation, umbilical connections, sequence of placement of the basemat, and site-specific construction sequence of the superstructure.

The predicted angular distortion, as described in U.S. Army Engineering Manual 1110-1-1904, is compared to the angular distortion considered in the U.S. EPR design. If the predicted angular distortion of the basemat of SC-I structures is less than the angular distortion in U.S. EPR design, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate the structural design is adequate. U.S. EPR FSAR Tier 2, Table 1.8-2 will be revised to include new COL Information Items (3.8-18, 3.8-19, and 3.8-20) to address the required comparison. In addition, a note is added to U.S. EPR FSAR Tier 1 Table 5.0-1 and Tier 2 Table 2.1-1 to reference the U.S. EPR differential settlement contours. U.S. EPR FSAR Tier 2, Section 3.8.6 will be revised to include U.S. Army Engineering Manual 1110-1-1904.

The COL Information Item 3.8-13 requires the COL applicant to have a plan for monitoring settlement of SC-I structures against predicted settlements. If the monitoring program indicates settlement values are not following predicted settlement values during construction, condition specific evaluations will be required. This may include adjusting the construction sequence or schedule, or evaluating the existing conditions to demonstrate that the resulting moments and forces imposed on the structure are acceptable. U.S. EPR FSAR Tier 2, Section 3.8.5.7 states that the COL applicant is also required to identify site-specific settlement monitoring requirements for SC-I foundations that are based on site-specific soil conditions. Site-specific soil conditions would be identified in the site-specific geotechnical foundation report.

U.S. EPR FSAR Tier 2, Table 1.8-2, COL item 3.8-13 and Section 3.8.5.7 will be revised to clarify the settlement monitoring requirements.

The U.S. EPR FSAR no longer identifies a global differential settlement value of 3.0 inches. Initially, global differential settlement was established for the design of safety-related umbilicals. These items are not a part of the U.S. EPR certified design. The differential settlement values for the design of safety-related umbilicals are site-specific. The total settlement for the NI common basemat is expected to be between 0 inches for a hard rock site and up to 5 inches for a soft soil site. U.S. EPR FSAR Tier 2, Section 3.8.5.5.5 will be revised to address total settlement.

FSAR Impact:

U.S. EPR FSAR, Tier 1, Table 5.0-1 and U.S. EPR FSAR, Tier 2, Table 1.8-2; Table 2.1-1; Sections 2.5.4.10, 3.8.5.3, 3.8.5.4, 3.8.5.5, 3.8.5.7 and 3.8.6 will be revised as described in the response and indicated on the enclosed markup.

Figure 03.08.05-22-1—Plaxis 3D Model for Basemat Only (Flexible Superstructure)

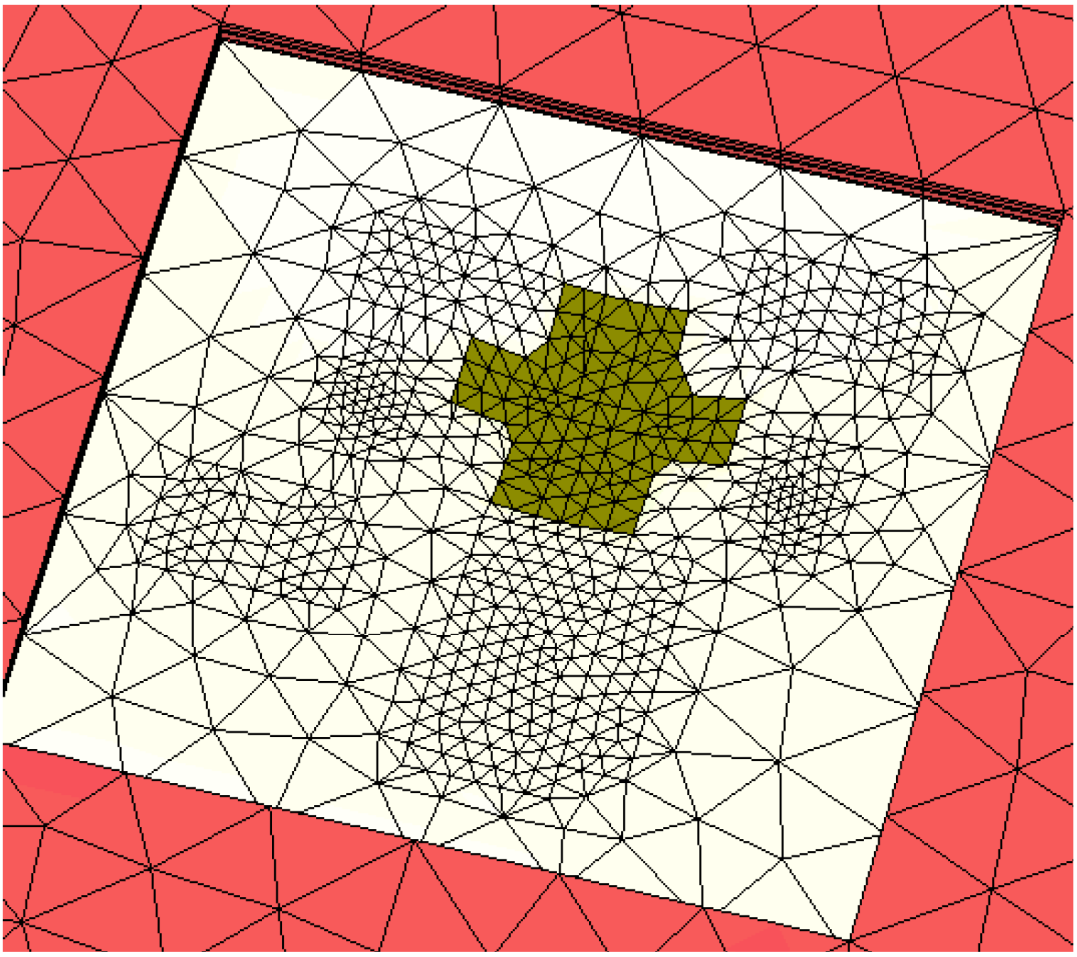


Figure 03.08.05-22-2—Plaxis 3D Model for NI Full Structure with Adjacent Buildings (Rigid Superstructure)

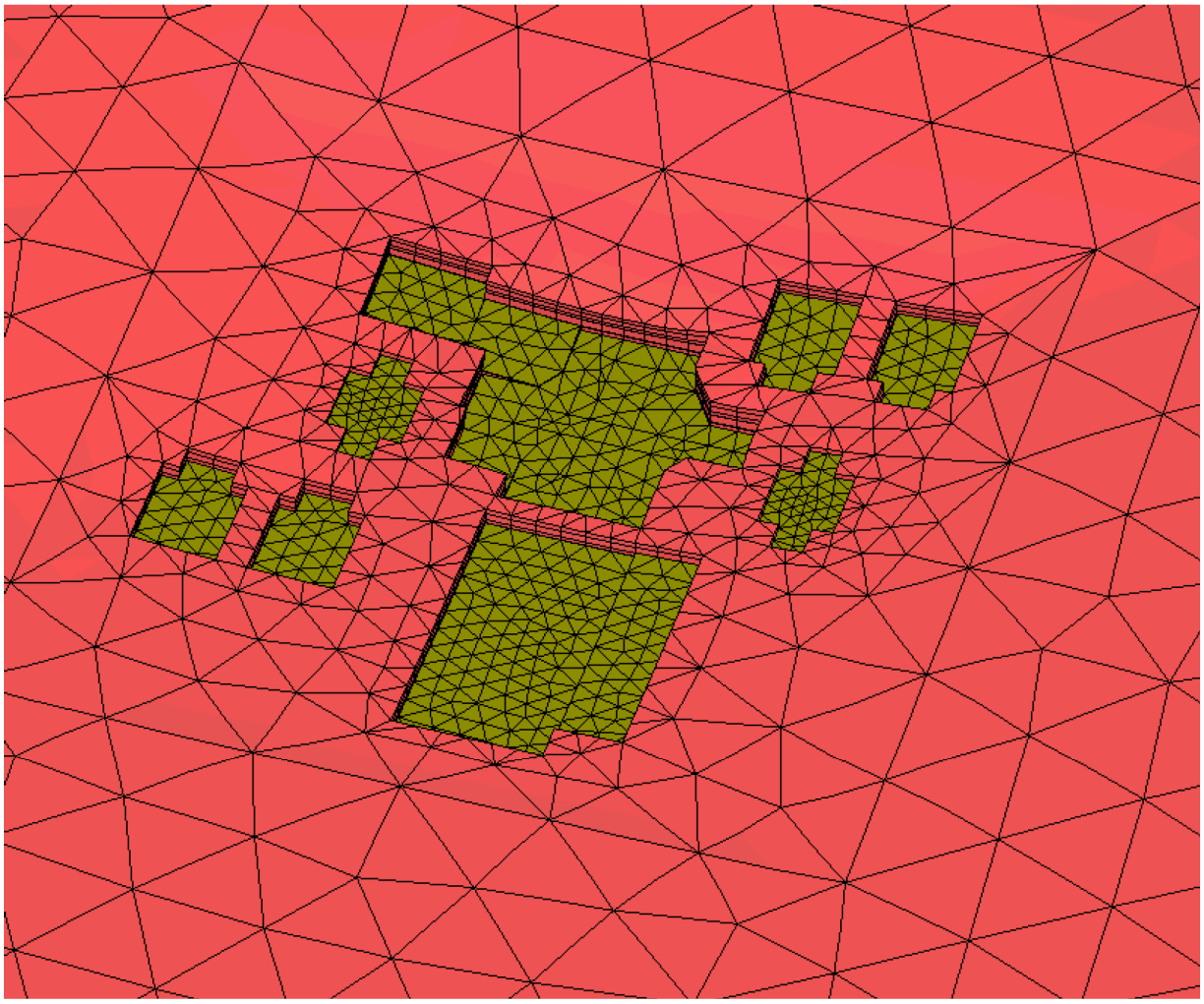


Figure 03.08.05-22-3—Step 1 - Relative Differential Settlement (Basemat Only)

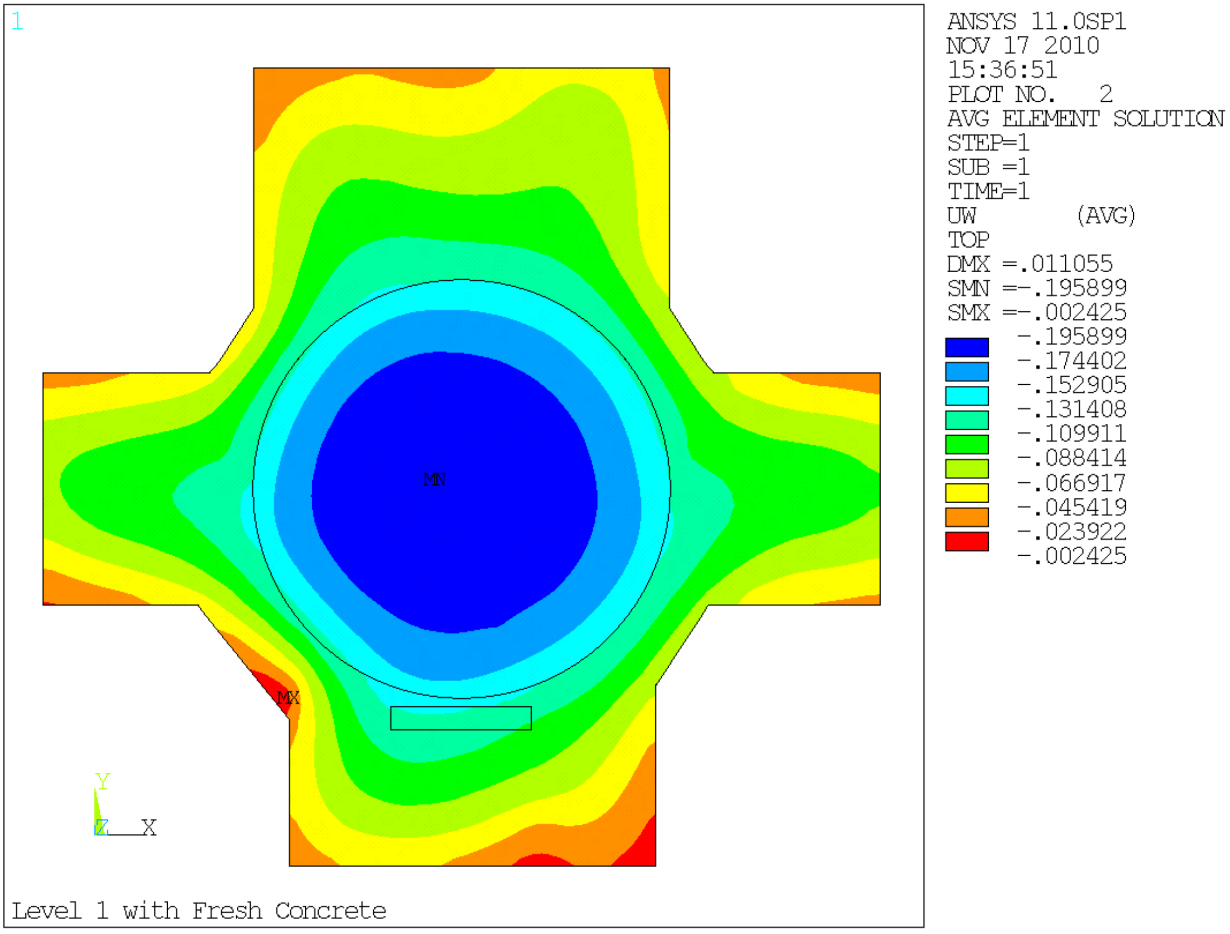


Figure 03.08.05-22-4—Step 11- Relative Differential Settlement (Full NI Superstructure)

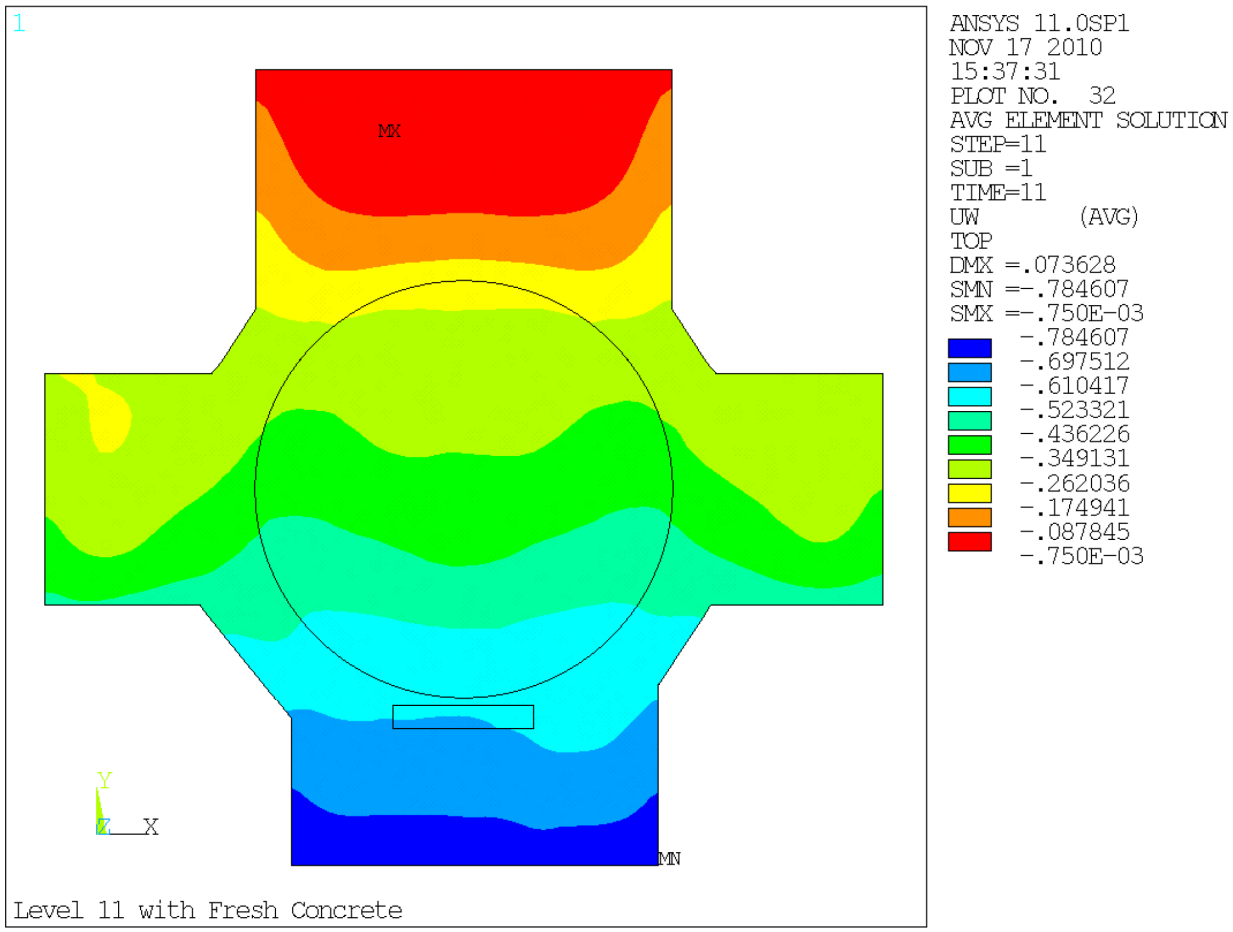
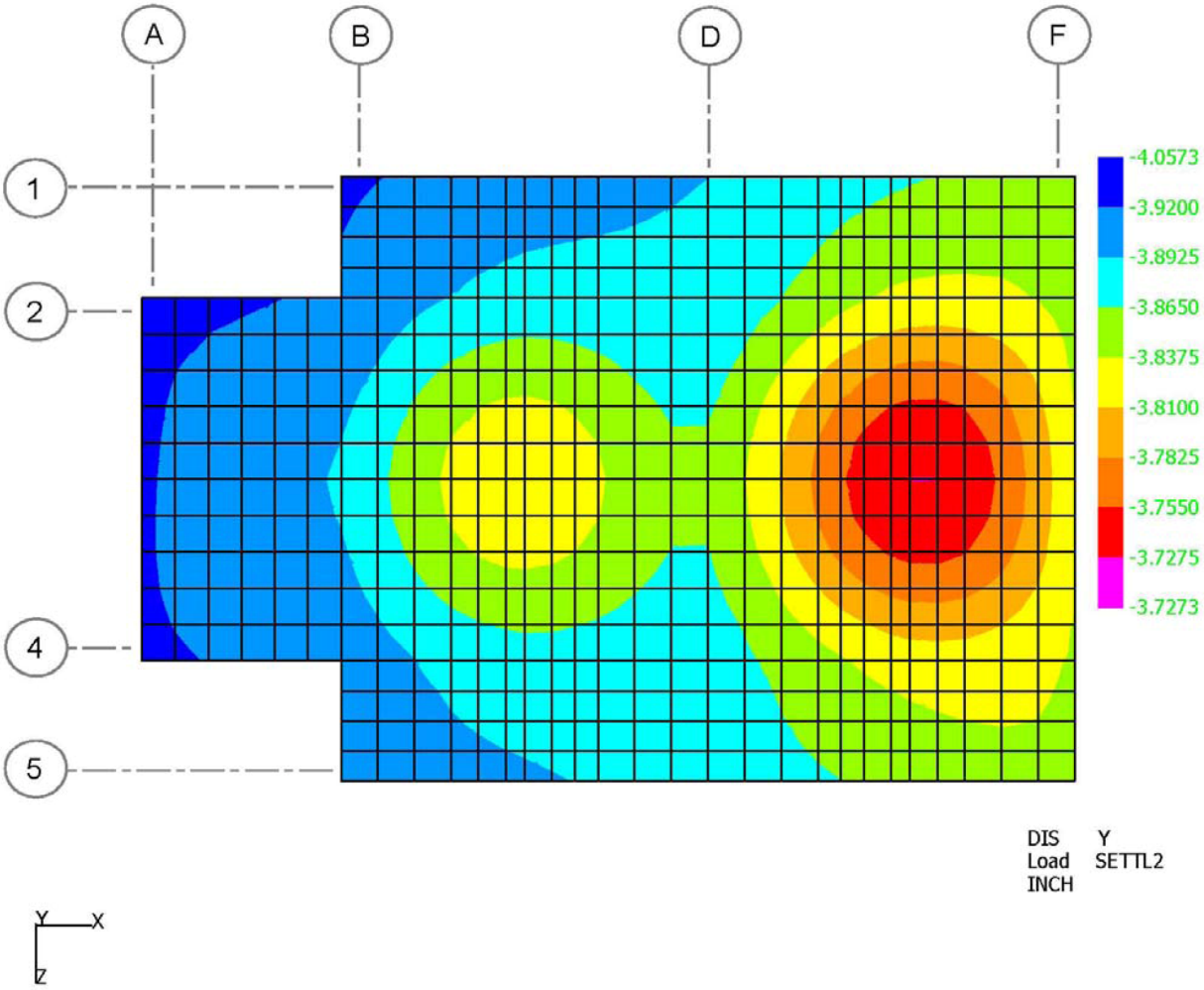


Figure 03.08.05-22-5— Relative Differential Settlement (ESWB)



U.S. EPR Final Safety Analysis Report Markups

Table 5.0-1—Site Parameters for the U.S. EPR Design
(3 Sheets)

Maximum ground water level	Maximum ground water level is 3.3 ft below grade.
Maximum ~~Differential~~ Settlement (across the basemat) Tilt Settlement	 1/2 inch in 50 ft in any direction.
Slope Failure Potential	No slope failure potential is considered in the design of safety-related SSC for U.S. EPR design certification.

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Table 1.8-2—U.S. EPR Combined License Information Items
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Item No.	Description	Section
2.5-7	A COL applicant that references the U.S. EPR design certification will verify that the predicted ~~differential~~tilt settlement value of ½ in per 50 ft in any direction across the foundation basemat of a Seismic Category I structure is not exceeded. Settlement values larger than this may be demonstrated acceptable by performing additional site-specific evaluations.	2.5.4.10.2
2.5-8	A COL applicant that references the U.S. EPR design certification will evaluate site-specific information concerning the stability of earth and rock slopes, both natural and manmade (e.g., cuts, fill, embankments, dams, etc.), of which failure could adversely affect the safety of the plant.	2.5.5
2.5-9	A COL applicant that references the U.S. EPR design certification will reconcile the site-specific soil and backfill properties with those used for design of U.S. EPR Seismic Category I structures and foundations described in Section 3.8	2.5.4.2
2.5-10	A COL applicant that references the U.S. EPR design certification will investigate and determine the uniformity of the underlying layers of site specific soil conditions beneath the foundation basemats. The classification of uniformity or non-uniformity will be established by a geotechnical engineer.	2.5.4.10.3
2.5-11	A COL applicant that references the U.S. EPR design certification will investigate and determine the horizontal variation in the seismic shear wave velocities for Seismic Category I structures. Horizontal variation in the seismic shear wave velocities should be no more than ±20 percent of the average velocity in any layer under a Seismic Category I structure to be considered laterally uniform.	2.5.4.10.3
2.5-12	A COL applicant that references the U.S. EPR design certification will provide an assessment of predicted settlement values across the basemat of SC-I structures during and post construction. The assessment will address both short term (elastic) and long term (heave and consolidation) settlement effects with the site specific soil parameters, including the soil loading effects from adjacent structures.	2.5.4.10.2
3.1-1	A COL applicant that references the U.S. EPR design certification will identify the site-specific QA Program Plan that demonstrates compliance with GDC-1.	3.1.1.1.1
3.2-1	A COL applicant that references the U.S. EPR design certification will identify the seismic classification of applicable site-specific SSC that are not identified in Table 3.2.2-1.	3.2.1

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Table 1.8-2—U.S. EPR Combined License Information Items
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Item No.	Description	Section
3.8-11	A COL applicant that references the U.S. EPR design certification will evaluate the use of epoxy coated rebar for foundations subjected to aggressive environments, as defined in ACI 349-01, Chapter 4. In addition, the waterproofing and dampproofing system of Seismic Category I foundations subjected to aggressive environments will be evaluated for use in aggressive environments. Also, the concrete of Seismic Category I foundations subjected to aggressive environments will meet the durability requirements of ACI 349-01, Chapter 4 or ASME, Section III, Division 2, Article CC-2231.7, as applicable.	3.8.5.6.1
3.8-12	A COL applicant that references the U.S. EPR design certification will describe the program to examine inaccessible portions of below-grade concrete structures for degradation and monitoring of groundwater chemistry.	3.8.5.7
3.8-13	A COL applicant that references the U.S. EPR design certification will identify ~~if any~~ site-specific settlement monitoring requirements ~~are required~~ for Seismic Category I foundations based on site-specific soil conditions.	3.8.5.7
3.8-14	A COL applicant that references the U.S. EPR design certification will describe the design and analysis procedures used for buried conduit and duct banks, and buried pipe and pipe ducts.	3.8.4.4.5
3.8-15	A COL applicant that references the U.S. EPR design certification will use results from site-specific investigations to determine the routing of buried pipe and pipe ducts.	3.8.4.4.5
3.8-16	A COL applicant that references the U.S. EPR design certification will perform geotechnical engineering analyses to determine if the surface load will cause lateral and/or vertical displacement of bearing soil for the buried pipe and pipe ducts and consider the effect of wide or extra heavy loads.	3.8.4.4.5
3.8-17	A COL applicant that references the U.S. EPR design certification will address examination of buried safety-related piping in accordance with ASME Section XI, IWA-5244, "Buried Components."	3.8.4.7
3.8-18	A COL applicant that references the U.S. EPR design certification will compare the NI common basemat site-specific predicted angular distortion, as described in U.S. Army Engineering Manual 1110-1-1904, to the angular distortion in the relative differential settlement contours. If the predicted angular distortion of the NI common basemat structure is less than the angular distortion shown for each of the construction steps, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.	3.8.5.5.1

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Table 1.8-2—U.S. EPR Combined License Information Items
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Item No.	Description	Section
3.8-19	A COL applicant that references the U.S. EPR design certification will compare the EPGB site-specific predicted angular distortion, as described in U.S. Army Engineering Manual 1110-1-1904, to the angular distortion in the relative differential settlement contours. If the predicted angular distortion of the basemat of EPGB structures is less than the angular distortion shown, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.	3.8.5.5.2
3.8-20	A COL applicant that references the U.S. EPR design certification will compare the ESWB site-specific predicted angular distortion, as described in U.S. Army Engineering Manual 1110-1-1904, to the angular distortion in the relative differential settlement contours. If the predicted angular distortion of the basemat of ESWB structures is less than the angular distortion shown, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.	3.8.5.5.3
3.9-1	A COL applicant that references the U.S. EPR design certification will submit the results from the vibration assessment program for the U.S. EPR RPV internals and piping systems specified in U.S. EPR FSAR Tier 2, Section 3.9.2.1, in accordance with RG 1.20.	3.9.2.4
3.9-2	A COL applicant that references the U.S. EPR design certification will prepare the design specifications and design reports for ASME Class 1, 2, and 3 components, piping, supports and core support structures that comply with and are certified to the requirements of Section III of the ASME Code. The COL applicant will address the results and conclusions from the reactor internals material reliability programs applicable to the U.S. EPR reactor internals with regard to known aging degradation mechanisms such as irradiation-assisted stress corrosion cracking and void swelling.	3.9.3
3.9-3	A COL applicant that references the U.S. EPR design certification will examine the feedwater line welds after hot functional testing prior to fuel loading and at the first refueling outage, in accordance with NRC Bulletin 79-13. A COL applicant that references the U.S. EPR design certification will report the results of inspections to the NRC, in accordance with NRC Bulletin 79-13.	3.9.3.1.1
3.9-4	As noted in ANP-10264NP-A, a COL applicant that references the U.S. EPR design certification will confirm that thermal deflections do not create adverse conditions during hot functional testing.	3.9.3.1.1

Table 2.1-1—U.S. EPR Site Design Envelope
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U.S. EPR Site Design Envelope	
Maximum ~~Differential~~ Settlement (across the basemat) Tilt Settlement	1/2 inch in 50 feet in any direction
Slope Failure Potential	No slope failure potential is considered in the design of safety-related SSC for U.S. EPR design certification.
Angle of Internal Friction (in situ and backfill)	26.6 degrees (minimum)
Soil Density (γ)	110 lb/ft^3 ≤ γ ≤ 134 lb/ft^3
Maximum Ground Water	3.3 ft below grade
Minimum Coefficient of Static Friction (representative of soil basemat interface)	0.~~7~~5
Inventory of Radionuclides Which Could Potentially Seep Into the Groundwater	
See Table 2.1-2—Bounding Values for Component Radionuclide Inventory	
Flood Level (Refer to Section 2.4)	
Maximum Flood (or Tsunami)	1 ft below grade
Wind (Refer to Section 3.3)	
Maximum Speed (Other than Tornado)	145 mph (Based on 3-second gust at 33 ft above ground level and factored for 50-yr mean recurrence interval)
Importance Factor	1.15 (Safety-related structures for 100-year mean recurrence interval.)

the dead weight of the structure and components and 25 percent of the live load. The maximum bearing pressure under safe shutdown earthquake loads combined with other loads, as described in Section 3.8.5, is ~~26,000~~35,000 lb/ft^2. Refer to Appendix 3E for details of these bearing pressures under the basemat (GDC 2).

A COL applicant that references the U.S. EPR design certification will verify that site-specific foundation soils beneath the foundation basemats of Seismic Category I structures have the capacity to support the bearing pressure with a factor of safety of 3.0 under static conditions~~.~~ or 2.0 under dynamic conditions, whichever is greater.

2.5.4.10.2 Settlement

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Safety-related structures, systems and components are housed primarily in structures supported by the foundation basemat for the NI Common Basemat Structures and independent foundation basemats for the EPGBs and the ESWBs. ~~The design of the Seismic Category I foundations for the U.S. EPR is based on a maximum differential settlement of ½ inch per 50 feet in any direction across the basemat. Settlements within this limit will not adversely affect the function of safety-related structures, systems, or components based on the design basis for relative displacements between SSC (GDC 2).~~

Total settlement and differential settlement is dependent on site-specific conditions, construction sequence, loading conditions, and excavation and dewatering plans. It is expected that all elastic settlement and most of the consolidation settlement will occur by the time of completion of construction. There are limited interfaces between systems located on different basemats. The effects of total settlement and differential settlement ~~are~~will be considered where these interfaces occur. As described in Section 3.8.4.1.8 and Section 3.8.4.1.9, the design of safety-related buried conduits and piping is site-specific. These features will be designed for site-specific values of total settlement and differential settlement expected at the interface with the foundation basemat after connections are made. Alternatively, site-specific structural features such as tunnels may be used to limit the imposition of differential settlement.

A COL applicant that references the U.S. EPR design certification will provide an assessment of predicted settlement values across the basemat of Seismic Category I structures during and post construction. The assessment will address both short term (elastic) and long term (heave and consolidation) settlement effects with the site-specific soil parameters, including the soil loading effects from adjacent structures.

Site-specific considerations for the predicted short and long term effects of settlement will be taken into account. Site-specific considerations include the effects of dewatering, excavation, foundation material preparation, umbilical connections, sequence of placement of the basemat, and site-specific construction sequence of the superstructure.

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A COL applicant that references the U.S. EPR design certification will verify that the predicted ~~differential~~tilt settlement value of ½ inch per 50 feet in any direction across the foundation basemat of a Seismic Category I structure is not exceeded. Settlement values larger than this may be demonstrated acceptable by performing additional site-specific evaluations.

Tilt settlement of the building is controlled to 1/2 inch in 50 ft such that equipment can be installed and operated as designed.

Section 3.8.5.4 addresses the analyses performed for settlement loading on the Seismic Category I structures. Section 3.8.5.5 addresses the acceptance criteria for settlement on Seismic Category I structures. Section 3.8.5.7 addresses settlement monitoring.

2.5.4.10.3 Uniformity and Variability of Foundation Support Media

The U.S.EPR design considers a broad range of subsurface conditions, and the effects of these various conditions were evaluated by an extensive series of SSI analyses which addressed subsurface stratigraphy, depth-to-bedrock, shear wave velocity, and its variation with depth. While the U.S. EPR design is intended to cover a broad range of soil conditions, it is recognized that it is impractical to address all possible subsurface variations. For this reason site specific subsurface conditions will be evaluated for applicability to the U.S. EPR.

The design of the U.S. EPR is based on analyses that assume the underlying layers of soil and rock are horizontal with uniform properties. Furthermore, the U.S. EPR is designed for application at a site where the foundation conditions do not have extreme variation within the foundation footprints. However, the design does have margin that allows for adaptation to many sites that might be classified as non-uniform or having highly variable properties.

A COL applicant that references the U.S. EPR design certification will investigate and determine the uniformity of the underlying layers of site specific soil conditions beneath the foundation basemats. The classification of uniformity or non-uniformity will be established by a geotechnical engineer.

Soil structure interaction analysis, settlement analysis, and bearing ~~capacity~~pressure analysis for the U.S. EPR assume that the soil layers are horizontal and effects of non-horizontal layering are ignored. However, the layers of soil and rock beneath a specific site may dip with respect to the horizontal. If the dip is less than or equal to 20 degrees, the layer is defined as horizontal and analyses using horizontal layers are applicable, as described in NUREG/CR-0693 (Reference 4).

Guidance for performing a site-specific evaluation of uniformity for soil profiles under the Seismic Category I structures is provided below. Alternate site-specific methodologies may be used with appropriate technical justification.

Loads and load combinations on Seismic Category I foundations are in accordance with ACI 349-01, RG 1.142, RG 1.199, and ANSI/AISC N690-1994, including Supplement 2 (2004) for steel structures (GDC 1, GDC 2, GDC 4 and GDC 5). Loads and load combinations on the portion of the NI Common Basemat Structure foundation basemat that supports the RCB/RSB are in accordance with the ASME Code–2004 Edition, Section III, Division 2 and RG 1.136 (Exception: RG 1.136 endorses the 2001 Edition of the ASME Code with the 2003 addenda (including exceptions taken in RG 1.136). The U.S. EPR standard plant design is based on the 2004 Edition of the Code, inclusive of the exceptions taken in RG 1.136).

The NI Common Basemat Structure is a monolithic concrete structure. However, various portions of the structure have different classifications (i.e., RCB, RB internal structures, and other Seismic Category I structures) and correspondingly different design requirements, as shown in Figure 3.8-118. In some instances, the load combinations identified in SRP Section 3.8.5 do not include certain independent loadings which should be considered to account for potential structure-to-structure effects (i.e., the effect on one structure resulting from loadings applied to a separate, but monolithically connected, structure). To account for potential structure-to-structure effects, the loading combinations from SRP Section 3.8.5 are adjusted by including the necessary additional independent loadings. All load combinations include an additional hydrostatic load (F) while all sliding and overturning load combinations include an additional buoyant force (F_b). 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.

In addition to the load combinations specified above, the following load combinations are applied for Seismic Category I foundations to consider sliding and overturning due to earthquakes, winds, and tornados and against flotation due to floods:

$D + H + W + F + F_b$ $\qquad$ $D + H + E' + F + F_b$

$D + H + W_t + F + F_b$ $\qquad$ $D + F_b + F$

where:

F_b = the buoyant force of the design basis flood at maximum site water level. Refer to Section 3.8.4.3.1 for definitions of the other load parameters.

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The U.S. EPR Seismic Category I foundations are also designed for the effects of short term and long term settlements. The settlement analysis is described in Section 3.8.5.4. Section 2.5 and Section 3.8.5.5 provides the settlement limits considered for the U.S. EPR.

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 Section 2.5.4.2 for the soil parameters used to determine soil loads and lateral earth pressure.

When the effects of vertical seismic acceleration are included in the stability check against sliding, the unfactored dead weight of the structure is used to calculate the resistance to sliding due to friction.

Buoyancy effects of saturated soil due to a groundwater level of elevation -3.3 feet below finished grade or to a flood water level of elevation -1.0 feet below finished grade are considered when performing sliding and overturning analyses. For uplift evaluations (i.e., flotation and seismic overturning), dead load includes the weight of water permanently stored in pools and tanks.

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A differential settlement evaluation is performed for the Seismic Category I structures considering both short term (elastic) and long term (heave and consolidation) effects. The effects of differential foundation settlements are applied concurrently with the dead load using the same load factors. The U.S. EPR design requires separate Seismic Category I structures to be connected by site-specific designed Seismic Category I umbilicals (i.e., ductbank, embedded piping, and/or structural galleries containing piping, cable tray, and/or ductwork). The effects of site-specific differential settlement between the individual U.S. EPR Seismic Category I structures and the site-specific Seismic Category I umbilicals will be considered in the design of the connections and the construction sequence. ~~Also, the effects of varying settlements between adjacent foundations are considered for the design of mechanical and electrical systems (e.g., piping, cables) that are routed between structures founded on separate basemats.~~ See Section 3.8.4.4.5 for analysis and design procedures for Seismic Category I buried items that interface with structures on separate foundations.

3.8.5.4.2 Nuclear Island Common Basemat Structure Foundation Basemat

The NI Common Basemat Structure foundation basemat is analyzed and designed using the ANSYS V10.0 SP1 finite element overall computer model (a static model) for NI Common Basemat Structure Seismic Category I structures, which is described in Section 3.8.1.4.1. The NI Common Basemat Structure model includes the RCB, RB internal structures, RSB, FB, and SBs, as well as the NI Common Basemat Structure foundation basemat. This model is also used to determine the static bearing pressure

An FEM model for SSI analysis of the embedded portions of the NI common basemat was used to evaluate the soil bearing pressures, sliding and overturning due to seismic events. This model explicitly represents the transient nature of the seismic loadings, the properties of the soils, and the dynamic characteristics of the structure. This approach produces a more realistic picture of the NI Common Basemat Structure response to seismic loadings than is possible using the static model alone.

~~The NI Common Basemat Structure superstructure is modeled using lumped parameter systems identical to those used for the soil-structure interaction analysis. The masses, stiffnesses, and eccentricities of the buildings are mathematically computed, and spatially arranged to represent the dynamic characteristics of the NI Common Basemat structures.~~

The model is excited by simultaneous application of ~~three~~ EUR and HF seismic transients (CSDRS) to the base of the foundation basemat for soil cases ~~2sn4u, 4u, and 5a~~2sn4ue, 4ue, 5ae, 1n2ue, 1n5ae, hfub, hfbe, and hflb representing soft, medium and hard soils. Transients are applied, one each, in the three principal building directions. The weight of the building, including the water in the in-containment refueling water storage tank (IRWST), fuel pool, and the four emergency feedwater storage tanks (because this water is always present within the NI Common Basemat Structure), and full buoyancy are the other loadings included in this analysis.

Section 3.8.1, Section 3.8.3, and Section 3.8.4 provide descriptions of interfacing structures that induce loads on the NI Common Basemat Structure foundation basemat. The figures in those sections illustrate the concrete shear walls and columns that transfer loads to the NI Common Basemat Structure foundation basemat. The tendon gallery beneath the NI Common Basemat Structure foundation basemat is relied upon as a shear key to aid in resisting lateral forces on the basemat.

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A differential settlement evaluation is performed for the NI common basemat structure considering both short term (elastic) and long term (heave and consolidation) effects. The evaluation accounts for the construction sequence, building stiffness, and time duration for loading the NI common basemat structure. The evaluation considers a soft soil site consistent with the soft soil case addressed in Table 3.7.1-6. A comparison of the angular distortion of the basemat for various soil cases demonstrates that the soft soil site will control the design for settlement.

The resulting forces and moments throughout the structure are captured by applying soil springs to the 3D finite element structural model of the basemat and superstructure used for designing the basemat. The soil springs are developed to capture the short and long term responses of the soil.

A construction sequence is evaluated for the NI common basemat structure, which assumes that the concrete for the mat foundation is in a single placement prior to the

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start of placement of concrete for the superstructure. It is assumed that concrete placement for the superstructure continues so that the superstructure is erected uniformly.

The construction sequence considers 11 steps for the NI common basemat structure:

1. Basemat only.
2. Walls up to elevation -16 ft.
3. Floor slabs at elevation -16 ft.
4. Walls up to grade elevation.
5. Floor slabs at grade elevation.
6. Walls up to elevation 55 ft.
7. Floor slabs at elevation 55 ft.
8. Walls up to elevation 96 ft.
9. Floor slabs at elevation 96 ft.
10. Walls up to elevation 144 ft.
11. Remaining structure up to elevation 204 ft.

Soil springs are applied to the 3D finite element structural model to determine the displacement of the basemat and capture the resulting locked-in forces and moments throughout the structure at each construction step. The soil springs are developed using the PLAXIS 3D foundation (Plaxis 3D) software. The Plaxis 3D subgrade modulus K is determined using the following equation.

$$K = \sigma'_{yy} / \delta$$

where: σ'_{yy} is the vertical effective stress, and δ is the vertical deformation.

Two sets of soil springs are developed using Plaxis 3D. Both sets are developed considering 100 percent of the dead load, 25 percent of the live load, and 75 percent of the precipitation loads.

The first set of soil springs is developed using only the basemat loading. The soil spring distribution matches a distribution of the NI common basemat with the full elastic modulus, Ec. The springs are applied to the 3D finite element structural model for each construction step through placement of the slabs at grade elevation. The Plaxis 3D model simulates the foundation with plate elements and is used to develop soil springs for the 3D finite element structural model. The basemat thickness in the Plaxis

3D model is adjusted and soil springs are developed and applied to the 3D finite element structural model until a good fit (less than 10 percent difference) is observed in terms of settlements generated by both the 3D finite element structural model and Plaxis 3D model.

The second set of springs is developed using the full NI common basemat structure and the effects from the adjacent structures. The distribution of the second set of soil springs matches the distribution with the NI common basemat completed structure with the full elastic modulus, Ec. The springs are applied to the 3D finite element structural model for the remaining construction steps above the grade elevation slabs. Similar to the process used to develop springs for the flexible superstructure, a Plaxis 3D model with plate elements is used to develop soil springs for the completed NI structure. The Plaxis 3D model plate thicknesses are adjusted and soil springs are developed. The soil springs are applied to the 3D finite element structural model until a good fit (less than 10 percent difference) is observed between settlements generated by both the 3D finite element structural model and Plaxis 3D model.

At each construction step in the 3D finite element model structural evaluation, 100 percent of the dead load, 25 percent of the live load, and 75 percent of the precipitation loads are applied to determine locked-in forces and moments for all structural elements.

The full Ec and section modulus are used for hardened concrete. In the basemat evaluation, the soil material will experience initial displacement; however, the basemat will not initially experience the assumed linear stress increase because the concrete is still plastic. Therefore, using the full Ec value is considered conservative when calculating stresses for the initial basemat evaluations.

For the superstructure elements, the walls and slabs are added in a stepwise manner as wet concrete. At each step, the effects of the added mass are considered by reducing Ec to 0.1 x Ec for the superstructure elements. The section properties are converted back to the full Ec prior to evaluating the next step.

The locked-in forces and moments are tabulated, and a separate load file is developed for each construction step. A check is conducted to determine if the basemat concrete has cracked after each construction step during development of the load file. If the basemat concrete has cracked, a cracked section modulus is used to develop the forces and moments.

The settlement loads are treated as dead loads in load combinations (i.e., the load factors applied correspond to the dead load factor). The basemat design includes symmetrical main reinforcing steel in each direction and on each face to control development of any large cracks in the basemat.

Detailed analysis and design procedures are described in the critical sections presented in Appendix 3E.

Section 3.8.3 provides a description of analysis and design of the RB internal structures basemat, which is located above the containment liner plate.

3.8.5.4.3 Emergency Power Generating Buildings Foundation Basemats

Horizontal shear loads are transferred from the EPGB foundation basemat to the underlying soil by friction between the bottom of the basemat, mud mat, and the soil, and by passive earth pressure.

The EPGB foundation basemat is analyzed and designed using the GT STRUDL v.29.1 finite element analysis code. The finite element model contains both the building superstructure (i.e., reinforced concrete walls and elevated slabs) as well as the foundation basemat. Analysis of the EPGB includes all applicable design loads and design load combinations described in Section 3.8.4.3. Figure 3.8-104—Emergency Power Generating Building Foundation Basemat Model illustrates the foundation basemat portion of the overall EPGB finite element model.

The GT STRUDL finite element model representing the EPGB foundation basemat consists of SBHQ6 rectangular elements, each with six degrees of freedom. This element type is capable of capturing both in-plane and out-of-plane behavior. Elastic boundary conditions are included in the finite element model in order to simulate the stiffness of the supporting soil. Basemat flexibility and SSI are addressed by inclusion of the basemat section properties and aforementioned soil spring boundary conditions in the finite element model.

The foundation basemat is included in the overall GT STRUDL finite element model used for static analysis of the foundation basemat, along with compression-only soil springs representing static soil stiffness properties of soft, medium and hard soils. Compression-only effects are included in the boundary conditions in order to capture uplift effects induced by extreme event loading (e.g., SSE). Illustrations of the complete finite element model representing the EPGB are provided in Section 3.7.2.

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The effect of settlement on the EPGB considers a soft soil site consistent with a soft soil case as shown in Table 3.7.1-6. Soil springs are developed to consider both short term (elastic) and long term (heave and consolidation) effects. The 3D finite element models of the EPGB basemat and superstructure are used in a static structural analysis with elastic soil springs applied in an elliptical distribution. The consolidation effects are approximated by further softening the elastic soil spring stiffness by a factor of two. A settlement load file is created considering 100 percent of the dead load, 25 percent of the live load, and 75 percent of the precipitation loads to determine locked-in forces and moments for all structural elements. The full Ec and section modulus is used in the EPGB settlement analysis. A check is conducted to determine if the basemat

concrete has cracked during development of the load file. If the basemat concrete has cracked, a cracked section modulus is used to develop the forces and moments. The basemat design includes symmetrical main reinforcing steel in each direction and on each face to account for any additional lateral variability in the soil properties and to control development of any large cracks in the basemat.

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Detailed analysis and design procedures are described in the critical sections presented in Appendix 3E for the EPGBs.

3.8.5.4.4 Essential Service Water Building Foundation Basemats

Horizontal shear loads are transferred from the ESWB foundation basemat to the underlying soil by friction between the bottom of the basemat, mud mat, and the soil. In addition, dynamic soil pressure and passive earth pressure have been considered for the below-grade walls, reflecting the total embedment depth of nominally 21 feet.

Similar to the approach for the EPGB, the foundation basemat is analyzed and designed using the GT STRUDL v.29.1 finite element analysis code. The finite element model contains both the building superstructure (i.e., reinforced concrete walls, slabs, and beams) and the foundation basemat. Analysis of the ESWB includes all applicable design loads and design load combinations described in Section 3.8.4.3. Figure 3.8-105—Essential Service Water Building Foundation Basemat Model illustrates the foundation basemat portion of the overall ESWB finite element model.

The GT STRUDL finite element model representing the ESWB foundation basemat consists of SBHQ6 rectangular elements, each with six degrees of freedom. This element type is capable of capturing both in-plane and out-of-plane behavior. Elastic boundary conditions are included in the finite element model in order to simulate the stiffness of the supporting soil. Basemat flexibility and SSI are addressed by inclusion of the basemat section properties and aforementioned soil spring boundary conditions in the finite element model. Illustrations of the complete finite element model representing the ESWB are provided in Section 3.7.2.

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The effect of settlement on the ESWB structure considers a soft soil site consistent with a soft soil case as shown in Table 3.7.1-6. Soil springs are developed to consider both short term (elastic) and long term (heave and consolidation) effects. The 3D finite element model of the ESWB basemat and superstructure are used in a static structural analysis with elastic soil springs applied in an elliptical distribution. The consolidation effects are approximated by further softening the elastic soil spring stiffness by a factor of two. A settlement load file is created considering 100 percent of the dead load, 25 percent of the live load, and 75 percent of the precipitation loads to determine locked-in forces and moments for all structural elements. The full Ec and section modulus is used in the ESWB settlement analysis. A check is conducted to determine if the basemat concrete has cracked during development of the load file. If

the basemat concrete has cracked, a cracked section modulus is used to develop the forces and moments. The basemat design includes symmetrical main reinforcing steel in each direction and on each face to account for any additional lateral variability in the soil properties and to control development of any large cracks in the basemat.

03.08.05-22

Detailed analysis and design procedures are described in the critical sections presented in Appendix 3E for the ESWBs.

3.8.5.4.5 Design Report

Design information and criteria for Seismic Category I structures are provided in Sections 2.4, 2.5, 3.3, 3.5, 3.7, 3.8.1, 3.8.2, 3.8.3, 3.8.4, and 3.8.5. Design results are presented in Appendix 3E for Seismic Category I structure critical sections. A cross-reference between U.S. EPR FSAR sections and information required by SRP Section 3.8.4 Appendix C is provided in Table 3.8-17.

3.8.5.5 Structural Acceptance Criteria

Limits for allowable stresses, strains, deformations, and other design criteria for Seismic Category I concrete foundations are in accordance with ACI 349-01 and its appendices (GDC 1, GDC 2 and GDC 4). Limits for concrete design include the exceptions specified in RG 1.142. In addition, the portion of the NI Common Basemat Structure foundation basemat that supports the RCB/RSB is in accordance with the ASME Code and RG 1.136 for containment loadings as described in Section 3.8.1.

Limits for the allowable stresses, strains, deformations, and other design criteria for structural steel elements of Seismic Category I foundations are in accordance with ANSI/AISC N690-1994 (R2004), including Supplement 2 (GDC 1, GDC 2 and GDC 4).

The design of Seismic Category I foundations is generally controlled by load combinations containing SSE seismic loads. Stresses and strains are within the ACI 349-01 limits, with the exceptions previously listed. Limits for allowable loads on concrete embedments and anchors are in accordance with Appendix D of ACI 349-06 (Appendix D with exception stated in Section 3.8.1.2.1) and guidance given in RG 1.199 (with exception described in Section 3.8.1.4.10). Portions of the NI Common Basemat Structure foundation basemat that support the RCB/RSB are within the limits in accordance with ASME Code, Section III, Division 2.

Seismic Category I foundations are required to satisfy the factors of safety against overturning, sliding, and flotation defined in Table 3.8-11. The calculated minimum factors of safety for the NI Common Basemat Structure are provided in Table 3.8-12—Minimum Factors of Safety Against Overturning, Sliding, and Flotation for Foundations – NI Common Basemat Structure.

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Acceptance criteria for soil conditions for the media supporting Seismic Category I foundations are addressed in Section 2.5.

Acceptance criteria for tilt settlement for Seismic Category I foundations are addressed in Section 2.5.

The acceptance criteria for differential settlement of Seismic Category I foundations are based on the site- specific predicted angular distortion, as described in U.S. Army Engineering Manual 1110-1-1904. Predicted angular distortion is compared to the angular distortion in the relative differential settlement contours. If the predicted angular distortion of the basemat of Seismic Category I structures is less than the angular distortion shown, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.

Additional acceptance criteria for critical areas of these structures are described in Appendix 3E.

An as-built report is prepared to summarize deviations from the approved design and confirm that the as-built Seismic Category I foundations are capable of withstanding the design basis loads described in Section 3.8.5.3 without loss of structural integrity or safety-related functions.

A COL applicant that references the U.S. EPR design certification will evaluate site-specific methods for shear transfer between the foundation basemats and underlying soil for site-specific soil characteristics that are not within the envelope of the soil parameters specified in Section 2.5.4.2.

3.8.5.5.1 Nuclear Island Common Basemat Structure Foundation Basemat

Appendix 3E provides details of the design of the NI Common Basemat Structure foundation basemat critical areas.

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Maximum soil bearing pressures under the NI Common Basemat Structure foundation basemat are 22,000 pounds per square foot for static loading conditions, and 35,000~~26,000~~ pounds per square foot for dynamic loading conditions.

A differential settlement evaluation is performed for the NI common basemat structure considering both short term (elastic) and long term (heave and consolidation) effects. The evaluation accounts for the construction sequence, building stiffness, and time duration of loading of the NI common basemat structure. The resulting forces and moments throughout the structure are captured by application of soil springs to the same 3D finite element structural model of the basemat and superstructure that is used for design of the basemat. The total settlement for the NI common basemat is expected to be between 0 inches for a hard rock site and up to 5 inches for a soft soil site.

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A COL applicant that references the U.S. EPR design certification will compare the NI common basemat site-specific predicted angular distortion, as described in U.S. Army Engineering Manual 1110-1-1904, to the angular distortion in the relative differential settlement contours. If the predicted angular distortion of the basemat of NI common basemat structure is less than the angular distortion shown for each of the construction steps, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.

~~In addition to forces and moments due to soil spring analyses, the NI Common Basemat Structure foundation basemat for the U.S. EPR plant considers other settlement effects (e.g., consolidation, construction sequence, lateral soil variability) by assuming a flexural settlement of 0.25 inches in 50 feet. The effects of other flexural settlement of the NI foundation basemat are investigated through manual calculations by representing the basemat as one foot wide fixed-fixed Bernoulli beams displaced at one support. The total differential displacement at the support of each strip is obtained by linearly extrapolating 0.25 inches per 50 feet for the entire length of the strip. The resulting values of moment and shear are calculated using an effective concrete modulus of elasticity adjusted for creep relaxation. The maximum values for moment and shear are applied over the entire length of the strip. These moment and shear values are then manually included with the results of the ANSYS model to provide a design that accounts for flexure and shear associated with the soil spring analysis and flexure and shear associated with other settlements.~~

~~The effects of tilt settlement on the soil bearing pressure were investigated by rotating the ANSYS model of the Nuclear Island about the East-West axis. The increases in soil bearing pressure within the NI Common Basemat were negligible.~~

~~Differential settlements and local settlements within the perimeter of the foundation are not likely to affect the structures, systems, or components due to the extremely thick foundation stiffened by numerous shear walls. The combined stiffness allows the NI Common Basemat Structure foundation basemat to bridge potential foundation irregularities.~~

For worst-case loading combinations on the NI Common Basemat Structure foundation basemat, the time history methodology used to calculate sliding and uplift safety factors due to seismic loadings is described in Section 3.8.5.4.2. The calculated values meet the requirements of Table 3.8-11.

For worst-case loading combinations on the RB internal structures basemat above the containment liner, the minimum safety factor against sliding is 2.8 and the ~~0.16 occurring for soil case 2sn4u, based solely on friction between the liner and the supporting concrete. Because friction will not prevent sliding, the surrounding concrete haunch wall is designed with sufficient capacity to resist the total base shear~~

~~force. The~~ minimum safety factor against overturning is 1.9~~1.22 occurring for soil case 2sn4u~~.

3.8.5.5.2 Emergency Power Generating Buildings Foundation Basemats

Appendix 3E provides details of the design of the EPGB foundation basemats critical sections.

Maximum soil bearing pressures under the EPGB foundation basemat are 3,800 pounds per square foot for static loading conditions, and 10,800 pounds per square foot for dynamic loading conditions. For uniformity of site characteristics, the required bearing capacity will be the same as for the NI. The factors of safety against overturning, sliding, and flotation are each greater than or equal to 1.1.

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A differential settlement evaluation is performed for the EPGB structure considering both short term (elastic) and long term (heave and consolidation) effects.

A COL applicant that references the U.S. EPR design certification will compare the EPGB site-specific predicted angular distortion, as described in U.S. Army Engineering Manual 1110-1-1904, to the angular distortion in the relative differential settlement contours. If the predicted angular distortion of the basemat of EPGB structures is less than the angular distortion shown, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.

3.8.5.5.3 Essential Service Water Building Foundation Basemats

Appendix 3E provides details of the design of the ESWB foundation basemats critical sections.

Maximum soil bearing pressures under the ESWB foundation basemat are 17,800 pounds per square foot for static loading conditions, and 28,200 pounds per square foot for dynamic loading conditions. For uniformity of site characteristics, the required bearing capacity will be the same as for the NI. The factors of safety against overturning, sliding, and flotation are each greater than or equal to 1.1.

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A differential settlement evaluation is performed for the ESWB structure considering both short term (elastic) and long term (heave and consolidation) effects.

A COL applicant that references the U.S. EPR design certification will compare the ESWB site-specific predicted angular distortion, as described in U.S. Army Engineering Manual 1110-1-1904, to the angular distortion in the relative differential settlement contours. If the predicted angular distortion of the basemat of ESWB structures is less than the angular distortion shown, the site is considered acceptable. Otherwise, further analysis will be required to demonstrate that the structural design is adequate.

3.8.5.6.2 Quality Control

Quality control procedures for Seismic Category I foundations are the same as described in Section 3.8.3.6 (GDC 1).

3.8.5.6.3 Special Construction Techniques

Seismic Category I foundations are constructed using proven methods common to heavy industrial construction. No special, new, or unique construction techniques are used.

Modular construction methods are used to the extent practical for prefabricating portions of reinforcing and concrete formwork. Such methods have been used extensively in the construction industry. Rigging is pre-engineered for heavy lifts of modular sections.

3.8.5.7 Testing and Inservice Inspection Requirements

Monitoring and maintenance of Seismic Category I foundations is performed in accordance with 10 CFR 50.65 and supplemented with the guidance in RG 1.160 (GDC 1).

Additional testing and surveillance requirements for the portion of the foundation basemat that supports the RCB/RSB are the same as described in Section 3.8.1.7.2.

Physical access is provided to perform inservice inspections of exposed portions of Seismic Category I foundations.

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A COL applicant that references the U.S. EPR design certification will identify ~~if any~~ site-specific settlement monitoring requirements for Seismic Category I foundations ~~are required~~ based on site-specific soil conditions.

If the monitoring program indicates actual settlement values are not following predicted settlement values during construction, condition specific evaluations or actions will be required. This may include adjusting the construction sequence or schedule, or evaluation of the existing conditions to demonstrate that the resulting moments and forces imposed on the structure are acceptable.

A COL applicant that references the U.S. EPR design certification will describe the program to examine inaccessible portions of below-grade concrete structures for degradation and monitoring of groundwater chemistry.

3.8.6 References

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