ArevaEPRDCPEm Resource

From: BRYAN Martin (EXTERNAL AREVA) [Martin.Bryan.ext@areva.com]
Sent: Monday, October 25, 2010 4:37 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. 376, FSAR Ch. 3, Supplement 13
Attachments: RAI 376 Supplement 13 Response US EPR DC (INTERIM).pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25. On August 27, 2010, AREVA NP submitted Supplement 10 to provide INTERIM responses for Questions 03.08.05-25 and 03.08.05-29. AREVA NP submitted a revised schedule for the final response to question 03.08.05-30 in Supplements 11 and 12 on September 15, 2010 and October 7, 2010, respectively.

The attached file, "RAI 376 Supplement 13 Response US EPR DC-INTERIM.pdf" provides a technically correct and complete INTERIM response to Questions 03.08.05-28 and 03.08.05-31, as committed.

The following table indicates the respective pages in the response document, RAI 376 Supplement 13 Response US EPR DC - INTERIM.pdf," that contains AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 354 - 03.08.05-28	2	10
RAI 354 - 03.08.05-31	11	12

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 27, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-29	August 27, 2010 (Actual)	October 29, 2010
RAI 376-03.08.05-30	N/A	November 22, 2010
RAI 376-03.08.05-31	October 25, 2010 (Actual)	February 17, 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: Thursday, October 07, 2010 2:50 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. 376, FSAR Ch. 3, Supplement 12

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25. On August 27, 2010, AREVA NP submitted Supplement 10 to provide INTERIM responses for Questions 03.08.05-25 and 03.08.05-29. AREVA NP submitted Supplement 11 on September 15, 2010, to provide a revised schedule for the final response to question 03.08.05-30

The schedule for Question 03.08.05-30 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 technically correct and complete responses to the remaining questions is provided below:

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 27, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 27, 2010 (Actual)	October 29, 2010
RAI 376-03.08.05-30	N/A	**November 22, 2010**
RAI 376-03.08.05-31	October 25, 2010	February 17, 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: Wednesday, September 15, 2010 9:21 AM
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. 376, FSAR Ch. 3, Supplement 11

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25. On August 27, 2010, AREVA NP submitted Supplement 10 to provide INTERIM responses for Questions 03.08.05-25 and 03.08.05-29.

The schedule for Question 03.08.05-30 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 technically correct and complete responses to the remaining 8 questions is unchanged and provided below:

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 27, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 27, 2010 (Actual)	October 29, 2010
RAI 376-03.08.05-30	N/A	October 14, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 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: Friday, August 27, 2010 4:58 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. 376, FSAR Ch. 3, Supplement 10-INTERIM

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25.

The attached file, "RAI 376 Supplement 10 Response US EPR DC- INTERIM.pdf" provides a technically correct and complete INTERIM response to 2 of the remaining 8 questions, as committed.

The following table indicates the respective pages in the response document, "RAI 376 Supplement 10 Response US EPR DC- INTERIM.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 376 — 03.08.05-25	2	3
RAI 376 — 03.08.05-29	4	5

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 27, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 27, 2010 (Actual)	October 29, 2010
RAI 376-03.08.05-30	N/A	September 16, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 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, August 16, 2010 12:34 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. 376, FSAR Ch. 3, Supplement 9

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29.

The schedule for INTERIM response to Question 03.08.05-25 is revised to allow AREVA NP additional time to prepare the response. The FINAL response date for Question 03.08.05-25 has not changed. The FINAL response date for Question 03.08.05-30 is being changed to account for the interaction with NRC being scheduled at a later date than the existing FINAL response date.

The attached file, "RAI 376 Supplement 9 Response - INTERIM.pdf" provides a technically correct and complete INTERIM response to 2 of the remaining 8 questions, as committed.

The following table indicates the respective pages in the response document, "RAI 376 Supplement 9 Response - INTERIM.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 376 — 03.08.05-26	2	2
RAI 376 — 03.08.05-27	3	5

The schedule for technically correct and complete responses to the remaining 8 questions is changed and provided below:

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	**September 8, 2010**	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 27, 2010	October 29, 2010
RAI 376-03.08.05-30	N/A	**September 16, 2010**
RAI 376-03.08.05-31	October 25, 2010	February 17, 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 (EXT)
Sent: Monday, August 09, 2010 5:45 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 8

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed.

The schedule for INTERIM response to Question 03.08.05-29 is revised to allow AREVA NP additional time to prepare the interim response. The final response date for Question 03.08.05-29 has not changed.

The schedule for technically correct and complete responses to the remaining 8 questions is unchanged and provided below:

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 16, 2010	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 27, 2010	October 29, 2010
RAI 376-03.08.05-30	N/A	August 16, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 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 (EXT)
Sent: Thursday, July 29, 2010 7:56 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. 376, FSAR Ch. 3, Supplement 7

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010 to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed.

The attached file, "RAI 376 Supplement 7 FINAL Response US EPR DC.pdf" provides technically correct and complete responses to 2 of the remaining 10 questions, as committed.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 376 Questions 03.08.01-48 and 03.08.03-24.

The following table indicates the respective pages in the response document, RAI 376 Supplement 7 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 376 — 03.08.01-48	2	3
RAI 376 — 03.08.03-24	4	8

The schedule for technically correct and complete responses to the remaining 8 questions is unchanged and provided below:

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 16, 2010	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 9, 2010	October 29, 2010
RAI 376-03.08.05-30	N/A	August 16, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 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 (EXT)
Sent: Monday, July 26, 2010 4:00 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. 376, FSAR Ch. 3, Supplement 6

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, an INTERIM response to question 03.08.05-24.

The attached file, "RAI 376 Supplement 6 Response U.S. EPR DC.pdf" provides a technically correct and complete FINAL response to 3 of the remaining 13 questions, as committed. The schedule for the remaining 10 questions is unchanged.

The following table indicates the respective pages in the response document, "RAI 376 Supplement 6 Response U.S. EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 376 — 03.08.01-47	2	3
RAI 376 — 03.08.03-21	4	5
RAI 376 — 03.08.03-22	6	7

The schedule for technically correct and complete responses to the remaining 13 questions is provided below.

Question #	Interim Response Date	Response Date
RAI 376-03.08.01-48	N/A	July 29, 2010
RAI 376-03.08.03-24	N/A	July 29, 2010
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 16, 2010	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 9, 2010	October 29, 2010
RAI 376-03.08.05-30	N/A	August 16, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 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 (EXT)
Sent: Thursday, July 15, 2010 7:13 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. 376, FSAR Ch. 3, Supplement 5 - Interim

Getachew,

AREVA NP Inc. provided a schedule for a technically correct and complete response to RAI No. 376 on April 26, 2010. AREVA NP submitted Supplement 1 to the response on May 20, 2010 to address 1 of the remaining 14 questions. AREVA NP submitted Supplement 2 to the response on June 8, 2010, to change the schedule for responding to Question 03.08.05-30. AREVA NP submitted Supplement 3 to the response on June 24, 2010, to provide a changed schedule 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. AREVA NP submitted Supplement 4 on July 13, 2010 to provide a revised schedule for question 03.08.05-30. The attached file, "RAI 376 Question 03.08.05-24 Response - INTERIM.pdf" provides a technically correct and complete INTERIM response to 1 of the remaining 13 questions, as committed.

The following table indicates the respective pages in the response document, "RAI 376 Question 03.08.05-24 Response - INTERIM.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 376 — 03.08.05-24	2	5

The schedule for technically correct and complete FINAL responses to the remaining 13 questions is unchanged and provided below:

Question #	Interim Response Date	Response Date
RAI 376-03.08.01-47	N/A	August 17, 2010
RAI 376-03.08.01-48	N/A	July 29, 2010
RAI 376-03.08.03-21	N/A	July 26, 2010
RAI 376-03.08.03-22	N/A	July 26, 2010
RAI 376-03.08.03-24	N/A	July 29, 2010
RAI 376-03.08.05-24	July 15, 2010 **Actual**	February 17, 2011
RAI 376-03.08.05-25	August 16, 2010	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 9, 2010	October 29, 2010
RAI 376-03.08.05-30	N/A	August 16, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 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 (EXT)
Sent: Tuesday, July 13, 2010 6:08 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. 376, FSAR Ch. 3, Supplement 4

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted Supplement 2 to the response on June 8, 2010, to provide a schedule for the remaining 13 questions, which were affected by the work underway to address NRC comments from the April 26, 2010, audit. AREVA NP submitted RAI No. 376 Supplement 3 on June 24, 2010, to reflect the revised RAI response schedule as a result of the civil/structural re-planning activities.

RAI 376 Supplement 4 revises the schedule for the response to Question 03.08.05-30 to allow time to interact with the NRC on the draft response. The schedule for the remaining 12 questions is unchanged.

The schedule for technically correct and complete responses to the remaining 13 questions is provided below.

Question #	Interim Response Date	Response Date
RAI 376-03.08.01-47	N/A	August 17, 2010
RAI 376-03.08.01-48	N/A	July 29, 2010
RAI 376-03.08.03-21	N/A	July 26, 2010
RAI 376-03.08.03-22	N/A	July 26, 2010
RAI 376-03.08.03-24	N/A	July 29, 2010
RAI 376-03.08.05-24	July 15, 2010	February 17, 2011
RAI 376-03.08.05-25	August 16, 2010	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 9, 2010	October 29, 2010
RAI 376-03.08.05-30	N/A	August 16, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 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 (EXT)
Sent: Thursday, June 24, 2010 11:56 AM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); RYAN Tom (AREVA NP INC); VAN NOY Mark (EXT); CORNELL Veronica (EXT); GARDNER George Darrell (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 3

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted Supplement 2 to the response on June 8, 2010, to provide a schedule for the

remaining 13 questions, which were 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 has been changed. The schedule for 03.08.05-30 remains unchanged.

Prior to submittal of the final RAI response, AREVA NP will provide an interim RAI response that includes:

(1) a description of the technical work (e.g., methodology)
(2) U.S. EPR FSAR revised pages, as applicable

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.01-47	N/A	August 17, 2010
RAI 376-03.08.01-48	N/A	July 29, 2010
RAI 376-03.08.03-21	N/A	July 26, 2010
RAI 376-03.08.03-22	N/A	July 26, 2010
RAI 376-03.08.03-24	N/A	July 29, 2010
RAI 376-03.08.05-24	July 15, 2010	February 17, 2011
RAI 376-03.08.05-25	August 16, 2010	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 9, 2010	October 29, 2010
RAI 376-03.08.05-30	N/A	July 14, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 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 (EXT)
Sent: Tuesday, June 08, 2010 3:32 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. 376, FSAR Ch. 3, Supplement 2

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions.

The schedule for the response to Question 03.08.05-30 has been changed. The final schedule for this question as well as the remaining questions below will be evaluated based on the information that will be presented at the June 9, 2010, public meeting and subsequent NRC feedback.

Question #	Response Date
RAI 376-03.08.01-47	July 14, 2010
RAI 376-03.08.01-48	August 3, 2010
RAI 376-03.08.03-21	June 24, 2010
RAI 376-03.08.03-22	June 24, 2010
RAI 376-03.08.03-24	August 3, 2010
RAI 376-03.08.05-24	August 3, 2010
RAI 376-03.08.05-25	August 3, 2010
RAI 376-03.08.05-26	August 3, 2010
RAI 376-03.08.05-27	July 14, 2010
RAI 376-03.08.05-28	August 3, 2010
RAI 376-03.08.05-29	August 3, 2010
RAI 376-03.08.05-30	July 14, 2010
RAI 376-03.08.05-31	August 3, 2010

Sincerely,

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

From: BRYAN Martin (EXT)
Sent: Thursday, May 20, 2010 4:24 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. 376, FSAR Ch. 3, Supplement 1

Getachew,

AREVA NP Inc. provided a schedule for a technically correct and complete response to RAI No. 376 on April 26, 2010. The attached file, "RAI 376 Supplement 1 Response US EPR DC.pdf," provides technically correct and complete responses to 1 of the remaining 14 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 376 Question 03.08.03-23.

The response to one question, 03.08.05-30, cannot be provided at this time due to its dependence on path-to-closure related work-planning currently being rescheduled and reviewed by the NRC.

The following table indicates the respective pages in the response document, "RAI 376 Supplement 1 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 376-03.08.03-23	2	2

A complete answer is not provided for 13 of the 14 questions. The schedule for a technically correct and complete response to these questions has been changed and is provided below.

Question #	Response Date
RAI 376-03.08.01-47	July 14, 2010
RAI 376-03.08.01-48	August 3, 2010
RAI 376-03.08.03-21	June 24, 2010
RAI 376-03.08.03-22	June 24, 2010
RAI 376-03.08.03-24	August 3, 2010
RAI 376-03.08.05-24	August 3, 2010
RAI 376-03.08.05-25	August 3, 2010
RAI 376-03.08.05-26	August 3, 2010
RAI 376-03.08.05-27	July 14, 2010
RAI 376-03.08.05-28	August 3, 2010
RAI 376-03.08.05-29	August 3, 2010
RAI 376-03.08.05-30	June 10, 2010
RAI 376-03.08.05-31	August 3, 2010

Sincerely,

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Martin.Bryan.ext@areva.com

From: BRYAN Martin (EXT)
Sent: Monday, April 26, 2010 12:49 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); RYAN Tom (AREVA NP INC); VAN NOY Mark (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376 (4355,4367,4377), FSAR Ch. 3

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 376 Response US EPR DC.pdf" provides a schedule since a technically correct and complete response to the 14 questions is not provided.

The following table indicates the respective pages in the response document, "RAI 376 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 376-03.08.01-47	2	2

RAI 376-03.08.01-48	3	4
RAI 376-03.08.03-21	5	6
RAI 376-03.08.03-22	7	7
RAI 376-03.08.03-23	8	8
RAI 376-03.08.03-24	9	10
RAI 376-03.08.05-24	11	12
RAI 376-03.08.05-25	13	13
RAI 376-03.08.05-26	14	14
RAI 376-03.08.05-27	15	16
RAI 376-03.08.05-28	17	19
RAI 376-03.08.05-29	20	20
RAI 376-03.08.05-30	21	21
RAI 376-03.08.05-31	22	22

A complete answer is not provided for 14 of the 14 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 376-03.08.01-47	July 14, 2010
RAI 376-03.08.01-48	August 3, 2010
RAI 376-03.08.03-21	June 24, 2010
RAI 376-03.08.03-22	June 24, 2010
RAI 376-03.08.03-23	May 20, 2010
RAI 376-03.08.03-24	August 3, 2010
RAI 376-03.08.05-24	August 3, 2010
RAI 376-03.08.05-25	August 3, 2010
RAI 376-03.08.05-26	August 3, 2010
RAI 376-03.08.05-27	July 14, 2010
RAI 376-03.08.05-28	August 3, 2010
RAI 376-03.08.05-29	August 3, 2010
RAI 376-03.08.05-30	May 20, 2010
RAI 376-03.08.05-31	August 3, 2010

Sincerely,
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Martin.Bryan.ext@areva.com

From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Thursday, March 25, 2010 2:13 PM
To: ZZ-DL-A-USEPR-DL
Cc: Xu, Jim; Hawkins, Kimberly; Miernicki, Michael; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 376 (4355,4367,4377), FSAR Ch. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on March 11, 2010, and on March 24, 2010, you informed us that the RAI is clear and no further clarification is needed. As a result, no change is made to the draft RAI. 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: 2227

Mail Envelope Properties (BC417D9255991046A37DD56CF597DB71080970B1)

Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 13
Sent Date: 10/25/2010 4:37:11 PM
Received Date: 10/25/2010 4:37:26 PM
From: BRYAN Martin (EXTERNAL AREVA)

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

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Files	**Size**	**Date & Time**
MESSAGE	37411	10/25/2010 4:37:26 PM
RAI 376 Supplement 13 Response US EPR DC (INTERIM).pdf	174608	

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

Response to

Request for Additional Information No. 376, Supplement 13

3/25/2010

U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 03.08.01 - Concrete Containment
SRP Section: 03.08.03 - Concrete and Steel Internal Structures of Steel or Concrete Containments
SRP Section: 03.08.05 - Foundations
Application Section: 3.8

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

Question 03.08.05-28:

Follow-up to RAI 155, Question 03.08.05-8

The response to this RAI indicates that a new FEM SSI analysis of the NI Common Basemat Structure has been performed using fully embedded conditions to address sliding and overturning issues as well as to determine dynamic soil bearing pressures. This new analysis models the tendon gallery as a shear key. In light of this new information, several items in the original RAI (related to the "second model" as described in FSAR Section 3.8.5.4 Revision 0) are no longer applicable. Nevertheless, the staff finds that portions of the original RAI are still relevant and require further clarification as discussed below. This clarification is necessary to determine if the foundation design meets the acceptance criteria in SRP 3.8.5.II.

1. The responses to Items 1 through 3 of this RAI indicate that the "second model" in question has been superseded by a new analysis methodology and the second model is no longer applicable. To resolve Items 1 through 3 of this RAI, provide a detailed description of the new FEM SSI analysis methodology, including a figure showing the relevant details of the computer model, and a description of the computer code used to perform the analysis, and all relevant analysis assumptions. This information should be included in FSAR Section 3.8.5.

2. The response to Item 4 of the RAI indicates that "the static coefficient of friction at the soil-concrete interface is based upon the angle of internal friction and on a roughened contact surface." It adds that a coefficient of friction of 0.5 (representing saturated conditions) and 0.7 (representing dry conditions) are used in the new analysis methodology. To resolve Item 4 of this RAI, the staff requests the following information:

(a) The issue of potential sliding at the various interfaces (i.e., basemat-upper mudmat, upper mudmat-membrane, membrane-lower mudmat, lower mudmat-soil) is explicitly identified in SRP 3.8.5.II.4 as an area of staff review; however, this issue has not been addressed. Explain how it is assured (e.g., COL action items) that the coefficients of friction at these various interfaces are higher than those listed in the RAI response. This information should be included in FSAR Section 3.8.5 and other relevant sections of the FSAR.

(b) The coefficient of friction of 0.5 assumed in the new analysis for saturated conditions is lower than indicated in FSAR Sections 2.5.4 and 3.8.5 and in other RAI responses (e.g., RAI 3.8.5-4), and is therefore more conservative. This new information should be incorporated to the relevant sections of the FSAR.

(c) The RAI response explicitly mentions that static coefficients of friction are used in the new analysis. To justify this assumption, confirm that the new analysis findings demonstrate that no sliding of the structure occurs for any soil cases considered in the design certification. Otherwise, as mentioned in the original RAI, dynamic coefficients of friction need to be used (typically having lower values). Information regarding this issue should be provided in conjunction with the response to the follow-up to RAI 3.8.5-4 Item 3. The staff notes that if the coefficients of friction are overestimated then the corresponding factors of safety against sliding could also be overestimated, and it would not be possible to determine if the foundation design meets the acceptance criteria in SRP 3.8.5.II.

3. The response to Item 5 of the RAI indicates that the "second model" in question has been superseded by a new analysis methodology and is no longer applicable. The new analysis uses

an embedded FEM SSI model with the tendon gallery as a shear key. To resolve Item 5 of this RAI, and since the new analysis uses an embedded FEM SSI model, explain the methodology used to determine the dynamic lateral pressure loads at the interface between the soil and the exterior foundation walls, tendon gallery walls, and vertical edges of the NI Common Basemat Structure. This explanation should include a comparison to the lateral pressure loads used in the design of these vertical elements as well as a comparison to the full passive pressures that can be developed in the soil, for all soil cases referenced in the design certification. This information is needed to determine if the foundation design related to soil pressures is in accordance with the criteria in SRP 3.8.5.II.4. Information regarding this issue should be provided in conjunction with the response to the follow-up to RAI 3.8.5-4 Item 5.

4. The response to Item 7 of the RAI indicates that the “second model” in question has been superseded by a new analysis methodology and is no longer applicable. The markup to FSAR Section 3.8.5.4.2 (paragraph 11) included with the RAI response further indicates that the new analysis considers excitation by the three EUR seismic transients (CSDRS) for soil cases 2sn4u, 4u, and 5a corresponding to soft, medium and hard soils. To resolve Item 7 of this RAI, provide the technical justification for not considering in the new analysis the other soil cases referenced in the design certification.

5. The response to Item 8 of the RAI indicates that the “second model” in question has been superseded by a new analysis methodology and is no longer applicable. The new analysis uses an embedded FEM SSI model, with the tendon gallery as a shear key, to address sliding and overturning issues. The response adds that instantaneous demand-to-capacity ratios to determine sliding and overturning factors of safety are generated by time history methods. Finally, the minimum factors of safety against sliding and overturning are listed as 1.16 and 1.78 respectively, which are in conformance with the required factors of safety given in FSAR Table 3.8-11. To resolve Item 8 of this RAI, and to ensure that stability evaluations and calculation of soil pressures are performed in accordance with the criteria in SRP 3.8.5.II, the staff requests the following information:

(a) Provide a detailed description of the methodology used to determine the minimum factors of safety against sliding and overturning “generated by time history methods” from the FEM SSI model. This description should provide numerical results for the three soil cases analyzed and also be included in FSAR Section 3.8.5.

(b) Since the RAI response indicates that the FEM SSI model used in the new analysis assumes linear behavior with a coefficient of friction of 0.5 to 0.7, explain how sliding can be included in the analysis and how is the issue of potential uplift of the NI foundation basemat addressed.

(c) The markup to FSAR Section 3.8.5.4.2 (paragraphs 1 and 9) included with the RAI response indicates that the embedded FEM SSI model is also used to calculate dynamic soil bearing pressures. Confirm that this is the case and provide representative calculation results for all soil cases referenced in the design certification. In addition, there appears to be some inconsistency in the values of the maximum soil bearing pressures listed in the FSAR. The markup to FSAR Section 3.8.5.4.1 (paragraph 8) indicates the maximum static bearing pressure is 34,560 psf, whereas the markup to FSAR Section 3.8.5.5.1 (paragraph 2) lists the maximum static and dynamic bearing pressures as 22,000 psf and 26,000 psf respectively. This inconsistency should be clarified.

(d) The RAI response indicates that the tendon gallery is modeled as a shear key to resist seismic induced shear forces. However, the markup to FSAR Section 3.8.5.1.1 (paragraph 2) included with the RAI response states: “No credit is taken in the design for the tendon gallery transmitting vertical loads into the soil, and the connection of the tendon gallery to the NI Common Basemat Structure foundation basement allows for differential movement between the concrete structures. However, the tendon gallery acts as a shear key and transfers lateral loads into the basemat.” Clarify this statement. In particular, explain how the connection of the tendon gallery to the NI basement allows for differential movement and, simultaneously, transfers seismic induced shear loads. Information regarding this issue should be provided in conjunction with the response to the follow-up to RAI 3.8.5-2.

(e) The RAI response does not mention if the results of the new analysis are utilized in the concrete design of the NI foundation basemat, for load cases involving seismic loads. If this is not the case and the static FE model of the NI Common Basemat Structure (with soil springs as described in FSAR Section 3.8.5.4.2) is used in the design, then confirm that comparative studies have been performed to show that the equivalent-static seismic analysis results (e.g. soil bearing pressures and internal forces and moments in the basemat) are in agreement with the results of the new FEM SSI analysis. Information regarding this issue should be provided in conjunction with the response to the follow-up to RAIs 3.8.5-5 Item 1 and 3.8.5-6, for all soil cases referenced in the design certification.

6. Since a new FEM model and analyses are being performed as discussed in this RAI, and other changes in the analysis methods (e.g., a new FEM used in the SSI analyses, revised set of soil cases) are being implemented, as noted during the meeting with AREVA on December 14 and 15, 2009, AREVA is requested to reconcile this and the other applicable RAIs regarding these changes.

Response to Question 03.08.05-28:

Item 1

A detailed description of the embedded 3D finite element model (FEM) soil-structure interaction (SSI) analysis methodology, including analysis assumptions, is included in the revised U. S. EPR FSAR Tier 2, Sections 3.7.1 and 3.7.2 in the Response to RAI 320. The Nuclear Island (NI) Common Basemat Structures FEM figures used for the SSI analysis will be included in the Response to RAI 320. MTR/SASSI, which is an enhanced version of the computer program SASSI, is used to perform the SSI analysis. A description of the NI stability analysis will be provided in the final Response to RAI 376, Question 03.08.05-31.

Item 2

a) The minimum coefficient of friction acting on foundation basemats and near surface foundations for Seismic Category I structures is 0.5. The coefficient of friction is specified in U. S. EPR FSAR Tier 2, Section 2.5.4.2 and Table 2.1-1. Existing COL item 2.0-1 specifies that a COL applicant that references the U.S. EPR design certification will compare the characteristics of its proposed site to the site parameters in U.S. EPR FSAR Tier 2, Table 2.1-1. U.S. EPR FSAR Tier 2, Section 3.8.5 includes a cross-reference to U. S. EPR FSAR Tier 2, Section 2.5.4.2.

b) See the response to Item 2a.

c) Static coefficient of friction of 0.5 will be used to verify that the factors of safety against sliding are satisfied. Updates to U.S. EPR FSAR Tier 2, Section 3.8.5.5 and Table 3.8-12 will provide the minimum factors of safety against sliding and overturning and will be included in the final response to this question.

Item 3

Dynamic lateral pressure loads between soil and exterior walls, tendon gallery walls and vertical edges of the NI Common Basemat Structure are discussed below.

The dynamic soil pressures on the NI basemat, sidewalls and shear key were calculated from the dynamic soil reaction force output at the SSI nodes. The time history of total dynamic soil reaction forces at SSI nodes were calculated by algebraically summing the corresponding co-directional forces obtained from separate analysis of the three direction of input motion. The dynamic soil reaction force time histories were transformed to local coordinates of each component (basemat, sidewalls and shear key). The reaction forces in local coordinates of each component consisted of the out-of-plane normal force, in-plane horizontal shear force and in-plane vertical shear force. The dynamic soil forces were applied at each node. The forces are used for the design of structural elements. For nodes located at the juncture of several components, the forces were divided equally between the adjoining components.

The loads used for the static analysis of the walls are based on the lateral wall pressures calculated by the approach described as part of this response. The generation of design loads resulting from soil passive pressures will be included in the final design report for the embedded foundation structure. The results from the basemat analysis using ANSYS model with static soil springs are used to develop design loads for the foundation mat. For additional details, see the Response to Question 5e).

Item 4

The original NI stability analysis considered soil cases 2sn4u, 4u, and 5a. The new NI stability analysis is based on an embedded 3D FEM. Results from this analysis will be for eight soil cases. U.S. EPR FSAR Tier 2, Section 3.8.5.4.2 will be revised to specify the eight soil cases.

Item 5

a) Sliding Stability Check

The foundation sliding is evaluated by calculating the total horizontal driving forces (demand) and resisting forces (capacity), and calculating the ratio of demand/capacity (d/c). The factor of safety against sliding (FS) is defined as the inverse of d/c.

Total Horizontal Driving Force (Demand)

At each time step, the total horizontal driving force at each interaction node is calculated by vectorially summing the following forces, as applicable:

- Lateral static soil forces resulting from the at-rest soil/backfill pressures on sidewalls,
- Lateral static soil surcharge forces due to the effects of turbine building,
- Hydrostatic forces on sidewalls, and

- Two horizontal components of the dynamic SSI forces on sidewalls, basemat and shear key.

The total horizontal driving force, ($F^D x$, $F^D y$), is calculated by vectorially summing the nodal driving forces for the structure, as shown below:

$$(F^D x, F^D y) = (F^{D1} x, F^{D1} y) + (F^{D2} x, F^{D2} y) + (F^{D3} x, F^{D3} y)$$

Where:

$$(F^{D1} x, F^{D1} y) = \text{SUM } [(F_{a,x}, F_{a,y}) + (F_{s,x}, F_{s,y}) + (F_{h,x}, F_{h,y}) + (F_{d,x}, F_{d,y})]^n \quad n=1,\ldots, N_{sw}$$

$$(F^{D2} x, F^{D2} y) = \text{SUM } [(F_{d,x}, F_{d,y})]^n \quad n=1,\ldots, N_{bm}$$

$$(F^{D3} x, F^{D3} y) = \text{SUM } [(F_{d,x}, F_{d,y})]^n \quad n=1,\ldots, N_{sk}$$

and

F^{D1}, F^{D2} and F^{D3} are the total horizontal driving forces on the sidewalls under active state, basemat and shear key, respectively;

F_a, F_s, and F_h are the nodal forces due to at-rest soil pressures, lateral soil surcharge loads and hydrostatic forces on the sidewalls under active state, respectively;

F_d is the dynamic nodal force on all sidewalls, basemat and shear key

N_{sw}, N_{bm} and N_{sk} are the total interaction nodes on the sidewalls, basemat and shear key, respectively; and

x and y are the two horizontal components of driving forces.

Total Horizontal Resisting Force (Capacity)

At each time step, the total horizontal resisting force at each interaction node is calculated by vectorially summing the following forces, as applicable:

- Lateral static soil forces resulting from the passive soil/backfill pressures on sidewalls,
- Lateral static soil surcharge forces due to the effects of turbine building,
- Hydrostatic forces on sidewalls,
- Net static lateral resisting forces on shear key, and
- Lateral static friction forces at the bottom of basemat.

The total horizontal resisting force, ($F^R x$, $F^R y$), is calculated by vectorially summing the nodal resisting forces for the structure, as shown below:

$$(F^R x, F^R y) = (F^{R1} x, F^{R1} y) + (F^{R2} x, F^{R2} y) + (F^{R3} x, F^{R3} y)$$

Where:

$$(F^{R1} x, F^{R1} y) = \text{SUM } [(F_{p,x}, F_{p,y}) + (F_{s,x}, F_{s,y}) + (F_{h,x}, F_{h,y})]^n \quad n=1,\ldots, N_{sw}$$

$$(F^{R2} x, F^{R2} y) = \text{SUM } [Fv]^n . \mu = \text{SUM } [F_{DL,z} + F_{b,z} + F_{d,z}]^n . \mu \quad n=1,\ldots, N_{bm}$$

$$(F^{R3} x, F^{R3} y) = \text{SUM } [(F_{n,x}, F_{n,y})]^n \quad n=1,\ldots, N_{sk}$$

and

F^{R1}, FR^{R2} and F^{R3} are the total horizontal resisting forces on the sidewalls under passive state, basemat and shear key, respectively;

F_p, F_s and F_h are the nodal forces due to passive soil pressures, lateral soil surcharge loads and hydrostatic forces on the sidewalls under passive state, respectively;

$F_{DL,z}$, $F_{b,z}$ are the dead load and buoyancy forces acting on the basemat nodes in z-direction;

$F_{d,z}$ is the dynamic nodal forces acting on all sidewalls, basemat and shear key in the z-direction; and

μ is the base friction coefficient.

At each time step, the total net vertical force, SUM $[Fv]^n$, acting on the basemat is calculated by adding the vertical component of dynamic boundary forces acting on the structure to the total dead plus live load forces and subtracting the weight of the displaced water (buoyancy). Summation of vertical forces are carried out at node level, as described above. This permits monitoring of tensile soil stresses on the basemat that may result in debonding. For nodes that exhibit tensile soil stress (i.e. debonding), no frictional resistance is considered. Vertical forces are included in the calculation of the net vertical bearing force. Vertical seismic forces are considered to act in either direction.

Factor of Safety against Sliding

The instantaneous demand/capacity (d/c) ratio in the x and y directions were calculated for a friction coefficient μ, as shown below:

$$(d/c)_x = | F^D x / F^R x |$$

$$(d/c)_y = | F^D y / F^R y |$$

The FS is the inverse of the (d/c) ratio.

Overturning Stability Check

The foundation overturning was evaluated by calculating the total overturning moment (demand) and restoring moment (capacity) about a tipping edge, and calculating the ratio of demand/capacity (d/c). The FS against overturning is defined as the inverse of d/c.

Total Overturning Moment (Demand)

At each time step, the total dynamic overturning moment about the center of basemat exerted by the dynamic soil forces acting on the structure is calculated. If the x-component of the overturning moment is positive, then the rotational tendency is to tip the structure along the extreme edge on the negative side of y-axis. Conversely, a negative x-component of the driving moment indicates potential tipping about the extreme edge of the basemat on the positive side of y-axis. Similarly, the tipping basemat edge for the y-component of the overturning moment is determined.

Following the determination of tipping edges at each time step, the total overturning moment at each interaction node is calculated by vectorially summing the following moments about the tipping edge, as applicable:

- Static overturning moment resulting from the at-rest soil/backfill pressures on sidewalls,
- Static overturning moment resulting from lateral static soil surcharge forces due to the effects of turbine building,
- Static overturning moment resulting from hydrostatic forces on sidewalls,
- Static overturning moment resulting from buoyancy forces acting on the basemat, and
- Dynamic overturning moment resulting from three components of the dynamic SSI forces on sidewalls, basemat and shear key.

The total overturning moment, ($M^D x$, $M^D y$), was calculated by vectorially summing the nodal overturning moments for the structure, as shown below:

$$(M^D x, M^D y) = (M^{D1} x, M^{D1} y) + (M^{D2} x, M^{D2} y) + (M^{D3} x, M^{D3} y)$$

Where:

$$(M^{D1} x, M^{D1} y) = \text{SUM}\ [(M_{a,x}, M_{a,y}) + (M_{s,x}, M_{s,y}) + (M_{h,x}, M_{h,y}) + (M_{d,x}, M_{d,y})]^n \quad n=1,\ldots, N_{sw}$$

$$(M^{D2} x, M^{D2} y) = \text{SUM}\ [(M_{b,x}, M_{b,y}) + (M_{d,x}, M_{d,y})]^n \quad n=1,\ldots, N_{bm}$$

$$(M^{D3} x, M^{D3} y) = \text{SUM}\ [(M_{d,x}, M_{d,y})]^n \quad n=1,\ldots, N_{sk}$$

and

M^{D1}, M^{D2} and M^{D3} are the total overturning moments on the sidewalls under active state, basemat and shear key, respectively;

M_a, M_s, and M_h are the nodal moments due to at-rest soil pressures, lateral soil surcharge loads and hydrostatic forces on the sidewalls under active state, respectively;

M_d is the moments due to dynamic forces $F_{d,x}$, $F_{d,y}$ and $F_{d,z}$ acting on all sidewalls, basemat and shear key nodes;

N_{sw}, N_{bm} and N_{sk} are the number of interaction nodes on the sidewalls, basemat and shear key, respectively; and

x and y are the two horizontal directions about which the moments are calculated on the tipping edges.

Total Stabilizing Moment (Capacity)

At each time step, the total stabilizing moment is calculated by vectorially summing the following moments about the tipping edge on the basemat, as applicable.

- Static restoring moment resulting from the passive soil/backfill pressures on sidewalls,
- Static overturning moment resulting from lateral static soil surcharge forces due to the effects of turbine building,

- Static overturning moment resulting from hydrostatic forces on sidewalls, and
- Static restoring moment resulting from dead load of structure.

The total restoring moment, ($M^R x$, $M^R y$), is calculated by vectorially summing the nodal restoring moments for the structure, as shown below:

$$(M^R x, M^R y) = (M^{R1} x, M^{R1} y) + (M^{R2} x, M^{R2} y)$$

Where:

$$(M^{R1} x, M^{R1} y) = \text{SUM } [(M_{p,x}, M_{p,y}) + (M_{s,x}, M_{s,y}) + (M_{h,x}, M_{h,y})]^n \quad n=1,\ldots, N_{sw}$$

$$(M^{R2} x, M^{R2} y) = \text{SUM } [(M_{DL,x}, M_{DL,y})]^n \quad n=1,\ldots, N_{bm}$$

and

M^{R1} and M^{R2} are the total restoring moments on the sidewalls under passive state and basemat, respectively;

M_p, M_s, and M_h are the nodal moments due to passive soil pressures, lateral soil surcharge loads and hydrostatic forces on the sidewalls under passive state, respectively; and

M_{DL} is the moments due to structural dead load, $F_{DL,z}$ acting on basemat nodes.

Factor of Safety against Overturning

The instantaneous demand/capacity (d/c) ratio in the x and y directions are calculated for a friction coefficient μ, as shown below:

$$(d/c)_x = | M^D x / M^R x |$$

$$(d/c)_y = | M^D y / M^R y |$$

The FS is the inverse of the (d/c) ratio.

The mínimum factors of safety against sliding and overturning for all soil cases will be incorporated in the applicable U. S. EPR FSAR Tier 2 sections for the individual Seismic Category I structures.

b) Factors of safety against sliding and overturning are calculated as described in response 5a above. The effect of uplift on the stability check is also described in Item 5a, “Total Horizontal Resisting Force (Capacity).” Analysis and results are for a minimum coefficient of friction of 0.5.

c) The foundation bearing pressures are assumed to have a linear distribution under the NI basemat. At each time step, the maximum and minimum foundation edge pressures, due to the x and y input motions, are calculated separately to satisfy the equilibrium of vertical forces and moments as a result of dead, live, buoyancy, and seismic loads acting on the foundation for each soil case. U.S. EPR FSAR Tier 2, Section 3.8.5.4.1 will be revised to provide the summary of the procedure used to determine the static and dynamic soil bearing pressures. The dynamic bearing pressure capacity will be revised in the Response to RAI 376, Question 03.08.05-29.

d) The tendon gallery is integrally cast with the NI basemat, acts as a shear key, and transmits vertical and lateral loads. The statement regarding differential movement was deleted from Revision 2 of U.S. EPR FSAR Tier 2, Section 3.8.5.1.1. In addition, U.S. EPR FSAR Tier 2, Section 3.8.5.1.1 will be revised to provide clarification and new dimensions of the shear key.

e) An ANSYS 3D FEM basemat model is being developed to generate static and dynamic soil bearing pressures for design of the NI foundation basemat. The soil surrounding the basemat will be represented by soil springs. Local uplift conditions will be accounted for in the basemat model in the form of contact elements at the spring-node interface locations. The NI foundation basemat design will be based on the results obtained from this ANSYS 3D FEM basemat model. The ANSYS 3D FEM basemat model results will be compared to the SASSI FEM model results to confirm compatibility between model results. Eight soil cases are investigated in these analyses. The SSI analysis used for the embedded 3D FEM model is described in Item 1 of this response.

Item 6

The ANSYS 3D FEM basemat model including SSI analyses and eight soil cases will be reconciled in the response to RAI 320. Previously submitted RAI responses impacted by RAI 320 will be submitted concurrent with the final response to RAI 320.

FSAR Impact:

U.S. EPR FSAR Tier 2, Sections 3.8.5.1.1, 3.8.5.4.1 and 3.8.5.4.2 will be revised as described in the response and indicated on the enclosed markup.

Question 03.08.05-31:

Follow-up to RAI 155, Questions 03.08.05-10 and 03.88.05-12

The staff finds that the information provided in the responses to RAIs 3.8.5-10 and 3.8.5-12 requires additional clarification as discussed below. This clarification is needed to determine if the foundation design related to stability evaluations and soil pressures meets the acceptance criteria in SRP 3.8.5.II.

1. Provide a summary of the procedure used to determine the static and dynamic soil bearing pressures, including representative values for all soil cases considered in the design certification, and include this information in the relevant sections of the FSAR. In this regard, the staff notes that the markup to FSAR Section 3.8.5.4.1 (paragraph 1), included with the response to RAI 3.8.5-8, states: "The underlying soil medium is represented by FEM for SSI analysis for the NI and by soil springs for other Category I structures as described in subsequent sections." This statement appears to indicate that the dynamic soil bearing pressures are determined from an equivalent-static seismic analysis with the soil represented by equivalent springs. If this is the case, then final values of soil bearing pressures will need to be reconfirmed after resolution of RAI 3.8.1-28 (adequacy of modification factors used in equivalent-static seismic analysis) and RAI 3.8.5-9 (adequacy of soil springs utilized in the analysis of the EPGB and ESWB).

2. Provide a summary of the procedure used to calculate minimum factors of safety against sliding and overturning, and include this information in the relevant sections of the FSAR.

3. Confirm whether the coefficients of friction used in the sliding stability analyses are consistent with those given in the response to RAI 3.8.5-8 Item 4; that is, static coefficients of friction of 0.5 representing saturated conditions and 0.7 representing dry conditions. If these values are used, additional justification should be provided to demonstrate that no sliding of the structure occurs for any soil cases considered in the design certification. Otherwise, as mentioned in the staff's evaluation of RAI 3.8.5-8 Item 4, dynamic coefficients of friction need to be used, typically having lower values. It is important to note that if the coefficients of friction are overestimated then the corresponding factors of safety against sliding could also be overestimated, and it would not be possible to determine if the foundation design meets the acceptance criteria in SRP 3.8.5.II.

4. Explain the procedures used to calculate seismic induced lateral soil pressures and provide the pressure distributions on foundations for the following cases: (a) seismic SSI analyses, (b) sliding and overturning stability analyses, and (b) design of below-grade foundation walls. In addition, the explanation should demonstrate that these pressures are bounded by the full passive pressures that can be developed in the soil, for all soil cases referenced in the design certification, and that the design of the foundation walls is performed for the envelop of cases (a) and (b) identified above. Finally, in the case of stability analyses, the explanation should be consistent with the sliding/non-sliding assumption discussed in Item 3 above (i.e. full passive pressures in the soil cannot be mobilized if no sliding of the structures occurs). Information regarding this issue should be provided in conjunction with the response to the follow-up to RAI 3.8.5-4 Item 5.

Response to 03.08.05-31:

Item 1

Dynamic bearing pressure determination is described in the Response to RAI 376, Question 03.08.05-28, Item 5c. Static soil bearing pressures are determined using the ANSYS basemat model described in the Response to RAI 376, Question 03.08.05-28, Item 5e. Bearing pressures will be provided in the response to RAI 376 Question 03.08.05-29 and documented in U.S. EPR FSAR, Tier 1 Table 5.0-1 and Tier 2 Table 2.1-1.

Item 2

A summary of the methods used to calculate the minimum factor of safety against sliding and overturning is presented in the Response to RAI 376, Question 03.08.05-28, Item 5a.

Item 3

The coefficients of friction used in the sliding stability analyses are described in the Response to RAI 376, Question 03.08.05-28, Item 2.

Item 4

a) SSI procedures used to determine lateral soil pressures and resulting pressure distributions on foundations is discussed in the Response to RAI 376, Question 03.08.05-28, Item 3.

b) Sliding and overturning stability is discussed in the Response to RAI 376, Question 03.08.05-28, Item 5.

c) Design of below grade walls is described in U.S. EPR FSAR Tier 2, Section 3.8.4.4 and critical sections stresses are reported in U.S. EPR FSAR Tier 2, Appendix 3E. Development of the passive pressure in the soil to resist lateral loads is described in the Response to RAI 376 Question 03.08.05-28, Item 3 and Item 4, including soil cases used in the analysis. The foundation walls are designed for the most severe loading condition as described in U.S. EPR FSAR Tier 2, Section 3.8.5.4.1. U.S. EPR FSAR Tier 2, Section 3.8.4.4.2 will be revised to describe the design methodology for the concrete walls and provide additional details on how different loads are combined to design the walls.

FSAR Impact:

U.S. EPR FSAR Tier 2, Sections 3.8.4.4.2 and 3.8.5.4.1 will be revised as described in the response and indicated on the enclosed markup.

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- Finished floor elevations are at one foot above plant finished grade where openings are provided for personnel and maintenance access.
- Water stops are provided in below grade exterior construction joints.
- Floor drainage is provided for building interior floors to collect water that could potentially enter the buildings.

See Section 3.4 for additional information on flood protection.

3.8.4.4.2 Reactor Shield Building and Annulus, Fuel Building, and Safeguard Buildings – NI Common Basemat Structure

Loads from the loading combinations described in Section 3.8.4.3 are applied to the NI Common Basemat Structure, which includes the RSB, the FB, and SBs. Vertical loads transfer to the NI Common Basemat Structure foundation basemat through concrete exterior walls, concrete interior walls, and concrete and steel columns. Lateral loads transfer to the NI Common Basemat Structure foundation basemat by diaphragm action of the concrete roof slabs and intermediate concrete floor slabs, which transfer loads to the interior and exterior concrete shear walls. Lateral loads transfer to the soil subgrade by friction and passive earth pressure.

The reinforced concrete roof slabs and intermediate floor slabs are analyzed and designed as two-way slabs. Reinforced concrete walls are analyzed and designed as shear walls and compression members, which are also subjected to out-of-plane bending moments, torsion, and out-of-plane shear. Analysis and design of the NI Common Basemat Structure foundation basemat is addressed in Section 3.8.5.

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~~The dynamic increment for the seismic soil surcharge loads on the exterior below-grade walls of NI Common Basemat Structure is determined by multiplying the surcharge static load by the maximum vertical zero period acceleration (ZPA) at the ground surface determined in the seismic analyses described in Section 3.7.2.~~ Lateral pressure due to seismic loads for the below grade NI perimeter walls are obtained from a FEM SSI analysis. ~~Seismic-induced lateral soil pressures on below-grade walls are evaluated for the following cases:~~

- ~~The seismic soil pressure is equal to the sum of the static earth pressure plus the dynamic earth pressure calculated in accordance with ASCE 4-98, Section 3.5.3.2.~~
- ~~The seismic soil pressure is equal to the passive earth pressure for structures other than NI common basemat structures.~~

The NI Common Basemat Structure is included in the ANSYS V10.0 SP1 finite element overall computer model of the NI Common Basemat Structure that is described in Section 3.8.1.4.1. The NI Common Basemat Structure model includes the RSB, FB, and SBs as well as the RCB, RB internal structures, and the NI Common

- ESWB foundation basemats. The ESWBs house the ESWCTs and the ESWPBs.

Foundations for buried items are included in Section 3.8.4. Section 3.7.2 addresses design requirements for Non-Seismic Category I structures to preclude adverse interaction effects on Seismic Category I structures.

Figure 3B-1 provides a site plan of the U.S. EPR standard plant showing the outline of the foundation basemats for the NI Common Basemat Structure, EPGBs, and ESWBs, along with the location of each foundation basemat.

Structures described within this section are not shared with any other power plant units (GDC 5).

A COL applicant that references the U.S. EPR design certification will describe site-specific foundations for Seismic Category I structures that are not described in this section.

3.8.5.1.1 Nuclear Island Common Basemat Structure Foundation Basemat

The NI Common Basemat Structure foundation basemat is a heavily reinforced concrete slab that supports the NI Common Basemat Structure Seismic Category I structures. The RCB and the RSB are located near the center of the NI Common Basemat Structure foundation basemat, and they are surrounded by the FB and the four SBs. The NI Common Basemat Structure foundation basemat is a cruciform shape that has outline dimensions of approximately 360 feet by 360 feet by 10 feet thick. The bottom of the NI Common Basemat Structure foundation basemat is founded approximately at elevation -41 feet and is embedded into the supporting soil approximately 40 feet. The NI Common Basemat Structure foundation basemat outline and section views are presented in Figures 3B-1, 3.8-11, 3.8-12, 3.8-13, 3.8-50, 3.8-51, 3.8-52, 3.8-63, 3.8-74, and 3.8-85.

The NI Common Basemat Structure foundation basemat provides anchorage of the vertical post-tensioning tendons in the RCB, which is described in Section 3.8.1. The portion of the NI Common Basemat Structure foundation basemat that is considered to provide support and anchorage for the RCB is the area under the circumference of the outer face of the RSB wall, as shown on Figure 3.8-11, Figure 3.8-12, Figure 3.8-13, and Figure 3.8-118. This portion of the NI Common Basemat Structure foundation basemat is designed in accordance with the ASME Code 2004 Edition, Section III, Division 2. A circular gallery is provided beneath the NI Common Basemat Structure foundation basemat for maintenance access to the bottom of the vertical post-tensioning tendons provided in the RCB shell wall. The tendon access gallery is approximately ~~11~~20 feet wide by ~~14~~18 feet high, including an approximately ~~36~~72 inch thick foundation slab under the gallery structure. ~~No credit is taken in the design for the tendon gallery transmitting vertical loads into the soil. However, t~~The tendon gallery, which is integrally cast with the basemat, acts as a shear key and transfers

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lateral and vertical loads from the basemat into the soil. The walls and slab of the tendon access gallery are designed according to ACI 349.

Sections 3.8.1 and 3.8.3 describe the interface of the RCB containment liner plate and upper internal basemat above the liner for supporting the RB internal structures. Sections 3.8.4 describes the interface of the RSB, FB, and SBs with the NI Common Basemat Structure foundation basemat. Concrete walls and columns of these NI Common Basemat Structure Seismic Category I structures are anchored into the NI Common Basemat Structure foundation basemat with reinforcing bars to transmit vertical, horizontal, and bending moment loads into the basemat and to enhance the rigidity of the basemat.

Horizontal shear loads are transferred from the NI Common Basemat Structure foundation basemat to the underlying soil by friction between the bottom of the basemat, mud mat (or both), and the soil, and by passive earth pressure on the below-grade walls of the NI Common Basemat Structure Seismic Category I structures. In addition, the tendon gallery is classified as a Seismic Category I structure and analyzed as a shear key to transfer loads to the soil. Section 2.5.4.2 describes the friction coefficient properties of soil addressed for the U.S. EPR.

Buildings adjacent to the NI Common Basemat Structure are separated from the NI Common Basemat Structure foundation basemat to allow for differential seismic movements between buildings. Refer to Figure 3B-1, which illustrates the gaps between buildings.

3.8.5.1.2 Emergency Power Generating Buildings Foundation Basemats

Each EPGB foundation basemat supports a building superstructure and associated equipment. At the super-structure and foundation basemat interface, heavily reinforced concrete shear walls function as bearing walls to transfer loads from floors and the roof. Each foundation basemat is embedded approximately five feet into the supporting soil and has overall dimensions of approximately 178 feet long by 94.5 feet wide by 6 feet thick. In the areas of the two diesel fuel oil storage tanks, the foundation basemat reduces in width from 94.5 feet to 42 feet.

Figure 3.8-89 illustrates the general arrangement plan, which also shows the primary shear walls at column lines A, C, E, G and J in the east-west direction, and column lines 11, 13, 17 and 19 in the north-south direction. Additional figures, provided in Appendix 3E, illustrate both the shear walls at the super-structure and foundation basemat interface and the foundation basemat reinforcement.

Figures 3.8-93 and 3.8-94 provide section views of the EPGB structure, which further clarify the relationship between the superstructure and the foundation basemat. Isometric views of the GT STRUDL model representing the overall structure are provided in Section 3.7.2.

3.8.5.4 Design and Analysis Procedures

Design and analysis procedures are similar for the various Seismic Category I foundations but vary somewhat from structure to structure. The general analysis and design procedures applicable to Seismic Category I foundations are provided in the following sections. Procedures specific to the following Seismic Category I foundations also are described.

- NI Common Basemat Structure foundation basemat.
- EPGBs foundation basemats.
- ESWBs foundation basemats.

3.8.5.4.1 General Procedures Applicable to Seismic Category I Foundations

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Concrete foundation basemats for Seismic Category I structures are analyzed as flat slabs on elastic supports to represent the underlying soil. ~~The underlying soil medium is represented by FEM for SSI analyses for the NI and by soil springs for other Category I structures as described in subsequent sections.~~ Loads are applied to the foundation basemats by the interfacing reinforced concrete walls and structural steel columns that comprise the building structures being supported, as well as by equipment supported directly on the foundations. Intersecting concrete walls also serve to stiffen the foundation basemat slabs to increase resistance to bending moments resulting from soil pressures under the slabs. Foundations are analyzed for the various factored loads and load combinations identified in Section 3.8.5.3.

Seismic Category I foundation basemat structures transfer vertical loads from the buildings to the subgrade by direct bearing of the basemats on the subgrade. Horizontal shears, such as those produced by wind, tornados, and earthquakes are transferred to the subgrade by friction along the bottom of the foundation basemat, shear key, or by passive earth pressure.

The stability evaluations for the NI Common Basemat is based on SSI analysis results. The coefficient of passive soil pressure corresponding to the sidewall movements into the soil are estimated from the SSI analysis and are used to calculate the passive soil pressure resisting sidewall movement.

Passive soil pressure capacities are based on constitutive models, typically used for granular media, such as Drucker-Prager or Coulomb-Mohr. For soil sites, a granular fill backfill material is used against side walls and underneath the structures. Backfill shall be installed to meet 95 percent of the modified proctor density (ASTM D-1557). For rock sites, controlled low strength material, as described by ACI-229R, will be specified on the faces of the tendon gallery acting as a shear key as an interface requirement. Cohesive materials will be addressed on a site-specific basis.

The capability of the soil beneath the shear keys is checked using a slip-circle and/or log-spiral mechanism.

The estimated maximum sidewall movement into the soil that results in the highest K_p value may not necessarily occur when the minimum factor of safety is calculated. Therefore, the minimum factor of safety is investigated using appropriate sidewall movements (using corresponding K_p) at the time of minimum sliding factor of safety.

Design and analysis procedures for Seismic Category I foundations are the same as those described in Sections 3.8.1.4 and 3.8.4.4 for the respective structures that apply loads on the foundations.

Seismic Category I concrete foundations are designed in accordance with ACI 349-01 and its appendices (GDC 1). Exceptions to code requirements specified in RG 1.142 are incorporated into the design and are accommodated in the loading combinations described in Section 3.8.5.3. In addition, the portion of the NI Common Basemat Structure foundation basemat that supports the RCB/RSB is designed in accordance with the ASME Code–2004 Edition, Section III, Division 2 for support and anchorage of the concrete RCB as described in Section 3.8.1.

The design of concrete foundations for Seismic Category I structures is performed using the strength-design methods described in ACI 349-01. The ductility provisions of ACI 349-01 are satisfied to provide a steel reinforcing failure mode and to prevent concrete failure for design basis loadings.

Foundation design is performed for the spectrum of soil cases described in Section 3.7.1. Section 2.5 and Section 3.7 describe seismic parameters and design methods used for analyzing and designing Seismic Category I structures.

Soil-structure interaction and structure-soil-structure interaction effects are considered in the seismic analyses of Seismic Category I structures as described in Section 3.7.2. Figure 3B-1 illustrates separation distances between Seismic Category I structures upon which these interaction evaluations are based.

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For calculating edge pressures, the foundation bearing pressures are assumed to have a linear distribution under the NI basemat. At each time step, the maximum and minimum foundation edge pressures, due to the x and y input motions, are calculated separately to satisfy the equilibrium of vertical forces and moments as a result of dead, live, buoyancy, and seismic loads acting on the foundation for each soil case.

The NI Common Basemat Structure is designed for ~~an average~~ static soil bearing pressure of 15,000 ~~14,500~~ pounds per square foot and a dynamic~~maximum static~~ bearing pressure of 35,000~~34,560~~ pounds per square foot. Accordingly, Seismic

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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.

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.