

ArevaEPRDCPEm Resource

From: RYAN Tom (AREVA) [Tom.Ryan@areva.com]
Sent: Friday, August 16, 2013 8:17 AM
To: Snyder, Amy
Cc: Miernicki, Michael; ANDERSON Katherine (EXTERNAL AREVA); DELANO Karen (AREVA); LEIGHLITER John (AREVA); ROMINE Judy (AREVA); LOSEKE Brian (AREVA); WILLIFORD Dennis (AREVA); HOTTLE Nathan (AREVA); LEWIS Ray (EXTERNAL AREVA)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 25
Attachments: RAI 370 Supplement 25 Response - US EPR DC.pdf

Amy,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 11 to the response on June 27, 2011, to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 12 to the response on October 26, 2011, to provide a revised schedule for the final response to Question 03.07.02-64 and a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 13 on November 17, 2011, and Supplement 14 on December 14, 2011, to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 15 on January 25, 2012 to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 16 on February 21, 2012 to provide a revised schedule for the two remaining questions. AREVA NP submitted Supplement 17 on March 27, 2012 to provide a revised schedule for the two remaining questions. AREVA NP submitted Supplement 18 on July 3, 2012 to provide a revised schedule for one of the two remaining questions. AREVA NP submitted Supplement 19 on August 23, 2012 to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 20 on September 27, 2012 to provide a revised schedule for Question 03.07.01-27. On January 17, 2013 and February 5, 2013, AREVA NP submitted Supplements 21 and 22, respectively, to provide a technically correct and complete response to Question 03.07.01-27. AREVA NP submitted Supplement 23 on March 19, 2013 to provide a revised final response to Question 03.07.01-27. AREVA NP submitted Supplement 24 on May 17, 2013 to provide a final response to Question 03.07.02-64.

The attached file, "RAI 370 Supplement 25 Response - US EPR DC.pdf," provides a revised final response to Question 03.07.02-64. This RAI response for Question 03.07.02-64 was revised due to RAI 587 Question 03.07.02-79, response to Question 03.07.02-79 sent by separate letter.

The following table indicates the pages in the response document, "RAI 370 Supplement 25 Response US EPR DC.pdf" that contain AREVA NP's revised final response to the subject question.

Question #	Start Page	End Page
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This concludes the formal AREVA NP response to RAI 370, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Tom Ryan

Manager, US EPR DCD

Regulatory Affairs

AREVA NP

An AREVA and Siemens company

7207 IBM Drive - CLT2B

Charlotte, NC 28262

Phone: 704-805-2643, Cell : 704-292-5627

Fax: 434-382-6657

From: WILLIFORD Dennis (RS/NB)

Sent: Friday, May 17, 2013 2:31 PM

To: Amy.Snyder@nrc.gov

Cc: Michael.Miernicki@nrc.gov; ANDERSON Katherine (External AREVA NP INC.); DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)

Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 24

Amy,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 11 to the response on June 27, 2011, to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 12 to the response on October 26, 2011, to provide a revised schedule for the final response to Question 03.07.02-64 and a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 13 on November 17, 2011, and Supplement 14 on December 14, 2011, to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 15 on January 25, 2012 to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 16 on February 21, 2012 to provide a revised schedule for the two remaining questions. AREVA NP submitted Supplement 17 on March 27, 2012 to provide a revised schedule for the two remaining questions. AREVA NP submitted Supplement 18 on July 3, 2012 to provide a revised schedule for one of the two remaining questions. AREVA NP submitted Supplement 19 on August 23,

2012 to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 20 on September 27, 2012 to provide a revised schedule for Question 03.07.01-27. On January 17, 2013 and February 5, 2013, AREVA NP submitted Supplements 21 and 22, respectively, to provide a technically correct and complete response to Question 03.07.01-27. AREVA NP submitted Supplement 23 on March 19, 2013 to provide a revised final response to Question 03.07.01-27.

The attached file, "RAI 370 Supplement 24 Response US EPR DC – PUBLIC.pdf," provides a revised final response to Question 03.07.02-64. 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 will be provided in a 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 370 Question 03.07.02-64.

The following table indicates the pages in the response document, "RAI 370 Supplement 24 Response US EPR DC– PUBLIC.pdf" that contain AREVA NP's final response to the subject question.

Question #	Start Page	End Page
RAI 370 - 03.07.02-64	2	39

This concludes the formal AREVA NP response to RAI 370, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Tuesday, March 19, 2013 3:40 PM
To: Amy.Snyder@nrc.gov
Cc: Michael.Miernicki@nrc.gov; DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WILLS Tiffany (CORP/QP)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 23

Amy,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to

provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 11 to the response on June 27, 2011, to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 12 to the response on October 26, 2011, to provide a revised schedule for the final response to Question 03.07.02-64 and a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 13 on November 17, 2011, and Supplement 14 on December 14, 2011, to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 15 on January 25, 2012 to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 16 on February 21, 2012 to provide a revised schedule for the two remaining questions. AREVA NP submitted Supplement 17 on March 27, 2012 to provide a revised schedule for the two remaining questions. AREVA NP submitted Supplement 18 on July 3, 2012 to provide a revised schedule for one of the two remaining questions. AREVA NP submitted Supplement 19 on August 23, 2012 to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 20 on September 27, 2012 to provide a revised schedule for Question 03.07.01-27. On January 17, 2013 and February 5, 2013, AREVA NP submitted Supplements 21 and 22, respectively, to provide a technically correct and complete response to Question 03.07.01-27.

The attached file, "RAI 370 Supplement 23 Response US EPR DC.pdf" provides a revised technically correct and complete response to Question 03.07.01-27 to incorporate changes discussed with NRC staff on March 19, 2013. Appended to this file are the affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 370 Question 03.07.01-27.

The following table indicates the pages in the response document, "RAI 370 Supplement 23 Response US EPR DC.pdf" that contain AREVA NP's final response to the subject question.

Question #	Start Page	End Page
RAI 370 — 03.07.01-27	2	5

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

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 26, 2011 (Actual) June 17, 2011 (Actual)	May 21, 2013

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

7207 IBM Drive, Mail Code CLT 2B
 Charlotte, NC 28262
 Phone: 704-805-2223
 Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Tuesday, February 05, 2013 5:00 PM
To: Amy.Snyder@nrc.gov
Cc: Michael.Miernicki@nrc.gov; DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom

Amy,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 11 to the response on June 27, 2011, to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 12 to the response on October 26, 2011, to provide a revised schedule for the final response to Question 03.07.02-64 and a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 13 on November 17, 2011, and Supplement 14 on December 14, 2011, to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 15 on January 25, 2012 to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 16 on February 21, 2012 to provide a revised schedule for the two remaining questions. AREVA NP submitted Supplement 17 on March 27, 2012 to provide a revised schedule for the two remaining questions. AREVA NP submitted Supplement 18 on July 3, 2012 to provide a revised schedule for one of the two remaining questions. AREVA NP submitted Supplement 19 on August 23, 2012 to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 20 on September 27, 2012 to provide a revised schedule for Question 03.07.01-27. On January 17, 2013, AREVA NP submitted Supplement 21 to provide a technically correct and complete response to Question 03.07.01-27.

The attached file, "RAI 370 Supplement 22 Response US EPR DC.pdf" provides a revised technically correct and complete response to Question 03.07.01-27 to incorporate NRC staff comments received during the Civil/Structural Jan 28, 2013 SSI Audit. Appended to this file are the affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 370 Question 03.07.01-27.

The following table indicates the pages in the response document, "RAI 370 Supplement 22 Response US EPR DC.pdf" that contain AREVA NP's final response to the subject question.

Question #	Start Page	End Page
RAI 370 — 03.07.01-27	2	4

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

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 26, 2011 (Actual) June 17, 2011 (Actual)	May 21, 2013

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Thursday, January 17, 2013 2:56 PM
To: Amy.Snyder@nrc.gov
Cc: Michael.Miernicki@nrc.gov; DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WILLS Tiffany (CORP/QP); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 21

Amy,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 11 to the response on June 27, 2011, to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 12 to the response on October 26, 2011, to provide a revised schedule for the final response to Question 03.07.02-64 and a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 13 on November 17, 2011, and Supplement 14 on December 14, 2011, to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 15 on January 25, 2012 to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 16 on February 21, 2012 to provide a revised schedule for the two remaining questions. AREVA NP submitted Supplement 17 on March 27, 2012 to provide a revised schedule for the two remaining questions. AREVA NP submitted Supplement 18 on July 3, 2012 to provide a revised schedule for one of the two remaining questions. AREVA NP submitted Supplement 19 on August 23, 2012 to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 20 on September 27, 2012 to provide a revised schedule for Question 03.07.01-27.

The attached file, "RAI 370 Supplement 21 Response US EPR DC.pdf" provides a technically correct and complete response to Question 03.07.01-27. Appended to this file are the affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 370 Question 03.07.01-27.

The following table indicates the pages in the response document, "RAI 370 Supplement 21 Response US EPR DC.pdf" that contain AREVA NP's final response to the subject question.

Question #	Start Page	End Page
RAI 370 — 03.07.01-27	2	4

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

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 26, 2011 (Actual) June 17, 2011 (Actual)	May 21, 2013

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Thursday, September 27, 2012 6:30 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 20

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 11 to the response on June 27, 2011, to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 12 to the response on October 26, 2011, to provide a revised schedule for the final response to Question 03.07.02-64 and a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 13 on November 17, 2011, and Supplement 14 on December 14, 2011, to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 15 on January 25, 2012 to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 16 on February 21, 2012 to provide a revised schedule for the two remaining

questions. AREVA NP submitted Supplement 17 on March 27, 2012 to provide a revised schedule for the two remaining questions. AREVA NP submitted Supplement 18 on July 3, 2012 to provide a revised schedule for one of the two remaining questions. AREVA NP submitted Supplement 19 on August 23, 2012 to provide a revised schedule for Question 03.07.02-64.

The schedule for the final response to Question 03.07.01-27 has been changed as provided below. The schedule for the final response to Question 03.07.02-64 remains unchanged.

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.01-27	NA	January 17, 2013
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 26, 2011 (Actual) June 17, 2011 (Actual)	May 21, 2013

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager

AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Thursday, August 23, 2012 6:10 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 19

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 11 to the response on June 27, 2011, to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 12 to the response on October 26, 2011, to provide a revised schedule for the final response to Question 03.07.02-64 and a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 13 on November 17, 2011, and Supplement 14 on December 14, 2011, to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 15 on

January 25, 2012 to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 16 on February 21, 2012 to provide a revised schedule for the two remaining questions. AREVA NP submitted Supplement 17 on March 27, 2012 to provide a revised schedule for the two remaining questions. AREVA NP submitted Supplement 18 on July 3, 2012 to provide a revised schedule for one of the two remaining questions.

The schedule for the final response to Question 03.07.02-64 has been changed as provided below. The schedule for the final response to Question 03.07.01-27 remains unchanged.

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.01-27	NA	August 30, 2013
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 26, 2011 (Actual) June 17, 2011 (Actual)	May 21, 2013

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

7207 IBM Drive, Mail Code CLT 2B
 Charlotte, NC 28262
 Phone: 704-805-2223
 Email: Dennis.Williford@areva.com

From: RYAN Tom (RS/NB)
Sent: Tuesday, July 03, 2012 2:00 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); Michael.Miernicki@nrc.gov; WILLIFORD Dennis (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 18

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 11 to the response on June 27, 2011, to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 12 to the response on October 26, 2011, to provide a revised schedule for the final response to Question 03.07.02-64 and a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 13 on November 17, 2011, and Supplement 14 on December 14, 2011, to provide a

preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 15 on January 25, 2012 to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 16 on February 21, 2012 to provide a revised schedule for the two remaining questions. AREVA NP submitted Supplement 17 on March 27, 2012 to provide a revised schedule for the two remaining questions.

Based on additional comments and discussions with NRC staff, the schedule for the final response to question 03.07.02-64 has been changed as provided below. The schedule for the final response to Question 03.07.01-27 remains unchanged.

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.01-27	NA	August 30, 2013
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 26, 2011 (Actual) June 17, 2011 (Actual)	November 14, 2012

Sincerely,

Tom Ryan
Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

7207 IBM Drive, Mail Code CLT 2B
 Charlotte, NC 28262
 Phone: 704-805-2223
 Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Tuesday, March 27, 2012 1:57 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 17

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 11 to the response on June 27, 2011, to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 12 to the

response on October 26, 2011, to provide a revised schedule for the final response to Question 03.07.02-64 and a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 13 on November 17, 2011, and Supplement 14 on December 14, 2011, to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 15 on January 25, 2012 to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 16 on February 21, 2012 to provide a revised schedule for the two remaining questions.

Based on additional comments and discussions with NRC staff, the schedule for the final response to question 03.07.02-64 has been changed as provided below. The schedule for the final response to Question 03.07.01-27 remains unchanged.

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.01-27	NA	August 30, 2013
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 26, 2011 (Actual) June 17, 2011 (Actual)	July 5, 2012

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

7207 IBM Drive, Mail Code CLT 2B
 Charlotte, NC 28262
 Phone: 704-805-2223
 Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Tuesday, February 21, 2012 9:20 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 16

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 11 to the response on June 27, 2011, to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 12 to the response on October 26, 2011, to provide a revised schedule for the final response to Question

03.07.02-64 and a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 13 on November 17, 2011, and Supplement 14 on December 14, 2011, to provide a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 15 on January 25, 2012, to provide a preliminary revised schedule to Question 03.07.01-27.

The schedule for the final response to the remaining two questions has been changed as provided below. This schedule was transmitted to the NRC in AREVA NP letter 12:008 dated February 21, 2012.

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.01-27	NA	August 30, 2013
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 26, 2011 (Actual) June 17, 2011 (Actual)	March 29, 2012

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager

AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Wednesday, January 25, 2012 10:05 AM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); Michael.Miernicki@nrc.gov
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 15

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 11 to the response on June 27, 2011, to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 12 to the response on October 26, 2011, to provide a revised schedule for the final response to Question 03.07.02-64 and a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 13 on November 17, 2011, and Supplement 14 on December 14, 2011, to provide a preliminary revised schedule to Question 03.07.01-27.

The preliminary revised schedule for a technically correct and complete response to Question 03.07.01-27 has been changed as provided below. This schedule is being reevaluated and a new supplement with a revised schedule will be transmitted by February 21, 2012. The schedule for the final response to Question 03.07.02-64 remains unchanged.

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.01-27	NA	February 21, 2012
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 26, 2011 (Actual) June 17, 2011 (Actual)	February 28, 2012

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

7207 IBM Drive, Mail Code CLT 2B
 Charlotte, NC 28262
 Phone: 704-805-2223
 Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Wednesday, December 14, 2011 10:23 AM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 14

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 11 to the response on June 27, 2011, to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 12 to the response on October 26, 2011, to provide a revised schedule for the final response to Question 03.07.02-64 and a preliminary revised schedule to Question 03.07.01-27. AREVA NP submitted Supplement 13 to the response on November 17, 2011 to provide a preliminary revised schedule to Question 03.07.01-27.

The preliminary revised schedule for a technically correct and complete response to Question 03.07.01-27 has been changed as provided below. This schedule is being reevaluated and a new supplement with a revised schedule will be transmitted by January 25, 2012. The schedule for the final response to Question 03.07.02-64 remains unchanged.

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.01-27	NA	January 25, 2012
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 26, 2011 (Actual) June 17, 2011 (Actual)	February 28, 2012

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Thursday, November 17, 2011 6:10 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 13

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 11 to the response on June 27, 2011, to provide a revised schedule for Question 03.07.02-64. AREVA NP submitted Supplement 12 to the response on October 26, 2011, to provide a revised schedule for the final response to Question 03.07.02-64 and a preliminary revised schedule to Question 03.07.01-27.

The preliminary revised schedule for a technically correct and complete response to Question 03.07.01-27 has been revised as provided below. This schedule is being reevaluated and a new supplement with a revised schedule will be transmitted by December 14, 2011.

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.01-27	NA	December 14, 2011
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 26, 2011 (Actual)	February 28, 2012

June 17, 2011 (Actual)

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager

AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Wednesday, October 26, 2011 4:53 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 12

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 11 to the response on June 27, 2011, to provide a revised schedule for Question 03.07.02-64.

The schedule for the final response to Question 03.07.02-64 has been revised, as indicated in bold below. In addition, a preliminary revised schedule for a technically correct and complete response to Question 03.07.01-27 is provided below. This schedule is being reevaluated and a new supplement with a revised schedule will be transmitted by November 17, 2011.

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.01-27	NA	November 17, 2011
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 26, 2011 (Actual) June 17, 2011 (Actual)	February 28, 2012

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WILLIFORD Dennis (RS/NB)
Sent: Monday, June 27, 2011 2:02 PM
To: Tesfaye, Getachew
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 11

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64. On June 17, 2011, AREVA NP submitted Supplement 10 to provide a revised INTERIM response to Question 03.07.02-64.

The schedule for the final response to Question 03.07.02-64 is being revised, as indicated in bold below. The schedule for the remaining question is unchanged.

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

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.01-27	NA	December 28, 2011
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 26, 2011 (Actual) June 17, 2011 (Actual)	October 26, 2011

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.
7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262

From: RYAN Tom (RS/NB)
Sent: Friday, June 17, 2011 2:38 PM
To: 'Tefaye, Getachew'
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); CORNELL Veronica (External RS/NB); WILLIFORD Dennis (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 10

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On May 25, 2011, AREVA NP submitted Supplement 9 to provide a revised INTERIM response to Question 03.07.02-64.

The attached file, "RAI 370 Supplement 10 Response US EPR DC-INTERIM.pdf" provides a technically correct and revised INTERIM response to Question 03.07.02-64. Appended to this file are the affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 370 Question 03.07.02-64.

The following table indicates the pages in the response document, "RAI 370 Supplement 10 Response US EPR DC-INTERIM.pdf" that contains AREVA NP's revised INTERIM response to the subject question.

Question #	Start Page	End Page
RAI 370 — 03.07.02-64	2	4

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

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.01-27	NA	December 28, 2011
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 26, 2011 (Actual) June 17, 2011 (Actual)	September 23, 2011

Sincerely,

Tom Ryan for
Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

7207 IBM Drive, Mail Code CLT 2B

From: WILLIFORD Dennis (RS/NB)
Sent: Thursday, May 26, 2011 3:30 PM
To: Tesfaye, Getachew
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 9

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64. AREVA NP submitted Supplement 8 to the response on May 2, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64.

The attached file, "RAI 370 Supplement 9 Response US EPR DC-INTERIM.pdf" provides a technically correct and revised INTERIM response to Question 03.07.02-64. The following table indicates the pages in the response document, "RAI 370 Supplement 9 Response US EPR DC-INTERIM.pdf" that contains AREVA NP's revised INTERIM response to the subject question.

Question #	Start Page	End Page
RAI 370 — 03.07.02-64	2	4

The schedule for a technically correct and complete response to the remaining questions is unchanged as provided below.

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.01-27	NA	December 28, 2011
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual) May 25, 2011 (Actual)	September 23, 2011

Sincerely,

Dennis Williford, P.E.
U.S. EPR Design Certification Licensing Manager
AREVA NP Inc.

7207 IBM Drive, Mail Code CLT 2B
Charlotte, NC 28262
Phone: 704-805-2223
Email: Dennis.Williford@areva.com

From: WELLS Russell (RS/NB)
Sent: Monday, May 02, 2011 10:30 AM
To: Tesfaye, Getachew
Cc: CORNELL Veronica (External RS/NB); BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 8

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a supplemental INTERIM response and a FINAL response schedule for Question 03.07.02-64. AREVA NP submitted Supplement 6 to the response on February 11, 2011, to provide a revised schedule for Question 03.07.01-27 and Question 03.07.02-64. On February 25, 2011, AREVA NP submitted Supplement 7 to provide a revised INTERIM response to Question 03.07.02-64.

Due to changes in the schedule for FSAR Sections 3.7 and 3.8 as discussed with NRC, the schedule for Questions 03.07.01-27 and 03.07.02-64 is being revised.

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

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.01-27	NA	December 28, 2011
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual)	September 23, 2011

Sincerely,

Russ Wells
U.S. EPR Design Certification Licensing Manager
AREVA NP, Inc.
3315 Old Forest Road, P.O. Box 10935
Mail Stop OF-57
Lynchburg, VA 24506-0935
Phone: 434-832-3884 (work)
434-942-6375 (cell)
Fax: 434-382-3884
[*Russell.Wells@Areva.com*](mailto:Russell.Wells@Areva.com)

From: WELLS Russell (RS/NB)
Sent: Friday, February 25, 2011 5:24 PM
To: Tesfaye, Getachew
Cc: BRYAN Martin (External RS/NB); BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, Supplement 7, FSAR Ch. 3

Getachew,

AREVA NP Inc. letter NRC 11:018 dated February 25, 2011 provides a provides a revised supplemental INTERIM response to question 03.07.02-64. AREVA NP considers some of the material contained in the response to be proprietary information. As required by 10 CFR 2.390(b), an affidavit is provided to support the withholding of the proprietary information from public disclosure. Proprietary and non-proprietary versions of the enclosure to this letter are provided separately.

The following table indicates the page in the response document, "RAI 370 Supplement 7 Response US EPR DC-INTERIM.pdf" that contains AREVA NP's response to the subject question.

Question #	Start Page	End Page
RAI 370 — 03.07.02-64	2	36

The response schedule for the remaining questions is unchanged and is shown below.

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011 (Actual)	May 13, 2011
RAI 370 - 03.07.01-27	NA	July 22, 2011

Sincerely,

Russ Wells

U.S. EPR Design Certification Licensing Manager

AREVA NP, Inc.

3315 Old Forest Road, P.O. Box 10935

Mail Stop OF-57

Lynchburg, VA 24506-0935

Phone: 434-832-3884 (work)

434-942-6375 (cell)

Fax: 434-382-3884

Russell.Wells@Areva.com

From: BRYAN Martin (External RS/NB)

Sent: Friday, February 11, 2011 1:37 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. 370, FSAR Ch. 3, Supplement 6

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38. On November 15, 2010, AREVA NP submitted Supplement 5 to provide a new schedule for a supplemental INTERIM response and FINAL response to Question 03.07.02-64.

The schedule for the revised INTERIM response and FINAL response to Question 03.07.02-64 has changed. In addition, the schedule for Question 03.07.01-27 has changed.

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

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.02-64	November 15, 2010 (Actual) February 25, 2011	May 13, 2011
RAI 370 - 03.07.01-27	NA	July 22, 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 15, 2010 4:36 PM
To: 'Tesyfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB); 'Miernicki, Michael'
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 5, Part 2 of 2

Getachew,

Attached is Part 2 of 2 for the INTERIM response to RAI 370 Question 03.07.02-64.

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 15, 2010 4:32 PM
To: 'Tesyfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB); 'Miernicki, Michael'
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 5, Part 1 of 2

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65. AREVA NP submitted Supplement 4 to the response on September 2, 2010, to provide a final response to Question 03.07.03-38.

The schedule for Supplemental INTERIM and FINAL responses to Question 03.07.02-64 is added to provide additional information on the potential for seismic interaction between the Nuclear Auxiliary Building and Seismic Category I structures. The attached file, "RAI 370 Supplement5 Response US EPR DC-INTERIM.pdf" provides a technically correct and complete INTERIM response to Question 03.07.02-64. Because of the file size, this response is being transmitted in two parts. The schedule for the remaining question is unchanged.

Appended to "part 2 of 2" of this file (transmitted separately) is the affected page of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which supports the response to RAI 370 Supplement 5.

The following table indicates the respective pages in the response document, "RAI 370 Supplement 5 Response US EPR DC-INTERIM," that contain the AREVA NP response to the subject question.

Question #	Start Page	End Page
RAI 370 - 03.07.02-64	2	19

The schedule for the technically correct and complete response to the remaining question is provided below.

Question #	Interim Response Date	Response Date
RAI 370 - 03.07.02-64	November 15, 2010 (Actual)	February 15, 2011
RAI 370 - 03.07.01-27	NA	May 18, 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, September 02, 2010 5:41 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB); Miernicki, Michael
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 4

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions. AREVA NP submitted Supplement 3 to the response on August 10, 2010, to provide final responses to Questions 03.07.02-64 and 03.07.02-65.

The attached file, "RAI 370 Supplement 4 Response US EPR DC.pdf" provides a technically correct and complete response to Question 03.07.03-38, as committed. The schedule for the remaining question is unchanged.

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 370 Supplement 4.

The following table indicates the respective pages in the response document, "RAI 370 Supplement 4 Response US EPR DC," that contain the AREVA NP response to the subject question.

Question #	Start Page	End Page
RAI 370 - 03.07.03-38	2	3

The schedule for the technically correct and complete response to the remaining question is provided below.

Question #	Response Date
RAI 370-03.07.01-27	May 18, 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, August 10, 2010 6:44 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. 370, FSAR Ch. 3, Supplement 3

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 and Supplement 2 to the response on June 8, 2010 and June 24, 2010, respectively, to provide a schedule for the remaining 4 questions.

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 attached file, "RAI 370 Supplement 3 Response US EPR DC-PUBLIC.pdf" provides technically correct and complete responses to Questions 03.07.02-64 and 03.07.02-65, as committed.

The schedule for Question 03.07.03-38 is being revised to allow additional time for AREVA NP to address NRC comments. The schedule for Question 03.07.01-27 question is unchanged.

The following table indicates the respective pages in the response document, "RAI 370 Supplement 3 Response US EPR DC -PUBLIC," that contain the AREVA NP response to the subject questions.

Question #	Start Page	End Page
RAI 370 - 03.07.02-64	2	3
RAI 370 - 03.07.02-65	4	7

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

Question #	Response Date
RAI 370-03.07.01-27	May 18, 2011
RAI 370-03.07.03-38	September 2, 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, June 24, 2010 12:31 PM
To: 'Tsfaye, 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); RYAN Tom (AREVA NP INC); GARDNER George Darrell (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 2

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010. AREVA NP submitted Supplement 1 to the response on June 8, 2010, to provide a schedule for the remaining 4 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 revised schedule for the technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 370-03.07.01-27	May 18, 2011
RAI 370-03.07.02-64	August 10, 2010
RAI 370-03.07.02-65	August 10, 2010
RAI 370-03.07.03-38	August 10, 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: Tuesday, June 08, 2010 3:57 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. 370, FSAR Ch. 3, Supplement 1

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI No. 370 on April 26, 2010.

The schedule for question 03.07.01-27 is not being changed by this supplement. The schedule for Questions 03.07.02-64, 03.07.02-65 and 03.07.03-38 has been changed. The dates for the 4 remaining questions will be evaluated and revised, as necessary, based on the information that will be presented at the June 9, 2010, public meeting and subsequent NRC feedback.

Question #	Response Date
RAI 370-03.07.01-27	August 3, 2010
RAI 370-03.07.02-64	July 8, 2010
RAI 370-03.07.02-65	July 8, 2010
RAI 370-03.07.03-38	July 8, 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: Monday, April 26, 2010 1:18 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. 370, FSAR Ch. 3

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 370 Response US EPR DC.pdf" provides technically correct and complete responses to 1 of the 5 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 370 Question 03.07.03-39.

The following table indicates the respective pages in the response document, "RAI 370 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 370 - 03.07.01-27	2	2
RAI 370 -03.07.02-64	3	3
RAI 370 -03.07.02-65	4	5
RAI 370 -03.07.03-38	6	6
RAI 370 -03.07.03-39	7	8

A complete answer is not provided for 4 of the 5 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 370 - 03.07.01-27	August 3, 2010
RAI 370 -03.07.02-64	June 10, 2010
RAI 370 -03.07.02-65	June 10, 2010
RAI 370 -03.07.03-38	June 10, 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: Tesfaye, Getachew [<mailto:Getachew.Tesfaye@nrc.gov>]
Sent: Thursday, March 25, 2010 2:00 PM
To: ZZ-DL-A-USEPR-DL

Cc: Chakravorty, Manas; Hawkins, Kimberly; Miernicki, Michael; Patel, Jay; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 370 (4292,4272,4275), FSAR Ch. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on February 18, 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: 4647

Mail Envelope Properties (88F9B30A3139B1498DA89BEBA7B31B9017D2D5)

Subject: Response to U.S. EPR Design Certification Application RAI No. 370, FSAR Ch. 3, Supplement 25
Sent Date: 8/16/2013 8:16:51 AM
Received Date: 8/16/2013 8:18:23 AM
From: RYAN Tom (AREVA)

Created By: Tom.Ryan@areva.com

Recipients:

"Miernicki, Michael" <Michael.Miernicki@nrc.gov>
Tracking Status: None
"ANDERSON Katherine (EXTERNAL AREVA)" <katherine.anderson.ext@areva.com>
Tracking Status: None
"DELANO Karen (AREVA)" <Karen.Delano@areva.com>
Tracking Status: None
"LEIGHLITER John (AREVA)" <John.Leighliter@areva.com>
Tracking Status: None
"ROMINE Judy (AREVA)" <Judy.Romine@areva.com>
Tracking Status: None
"LOSEKE Brian (AREVA)" <Brian.Loseke@areva.com>
Tracking Status: None
"WILLIFORD Dennis (AREVA)" <Dennis.Williford@areva.com>
Tracking Status: None
"HOTTLE Nathan (AREVA)" <Nathan.Hottle@areva.com>
Tracking Status: None
"LEWIS Ray (EXTERNAL AREVA)" <Ray.Lewis.ext@areva.com>
Tracking Status: None
"Snyder, Amy" <Amy.Snyder@nrc.gov>
Tracking Status: None

Post Office: FUSLYNCMX03.fdom.ad.corp

Files	Size	Date & Time
MESSAGE	77712	8/16/2013 8:18:23 AM
RAI 370 Supplement 25 Response - US EPR DC.pdf		5321299

Options

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

Response to

Request for Additional Information No. 370, Supplement 25

2/5/2012

U.S. EPR Standard Design Certification

AREVA NP Inc.

Docket No. 52-020

SRP Section: 03.07.01 - Seismic Design Parameters

SRP Section: 03.07.02 - Seismic System Analysis

SRP Section: 03.07.03 - Seismic Subsystem Analysis

Application Section: 03.07

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

Question 03.07.02-64:**Follow Up to RAI 248, Question 03.07.02-53:**

The applicant has proposed utilizing a lateral-force resisting system (LFRS) with a controlled collapse zone as the design basis for the NAB under an SSE event. In order for the staff to evaluate the acceptability of this design feature and whether it meets Acceptance Criteria 8 of SRP 3.7.2, the staff is requesting the following additional information:

1. The design codes applicable to the LFRS and the controlled collapse zone.
2. A detailed description of the LFRS and the controlled collapse zone.
3. Figures that depict the physical dimensions of the LFRS and the collapse zone of the NAB.
4. A description of the loads and the loading combinations applicable to each portion of the building.
5. A description of the methods used to control the collapse of the non-seismic portion of the NAB in such a way that the collapse zone does not impact a Category I structure or reduce the structural integrity of the LFRS.
6. A description of the seismic analysis method including assumptions, description of the model, description and point of application of the seismic input, and a description of how the seismic loads are determined and applied to the NAB structure.
7. A description of the method used to calculate the seismic displacement of the NAB from which it is concluded that the gap between the NAB and Safeguard Building (SB4) and the gap between the NAB and Fuel Building (FB) is sufficient to prevent an interaction with these adjacent Category I structures.
8. The results of an analysis that demonstrates that the NAB does not slide or overturn into adjacent Category I structures.
9. The interaction between the LFRS and the controlled collapse zone including the collapse or impact loads that are expected to be applied to the LFRS by the collapse zone.
10. The interaction between the NAB and the RWB including a detailed description of how the NAB prevents an indirect transfer of load from the RWB to Seismic Category I structures. Include in your response a description of the loads that will be transmitted to the NAB by a failure of the RWB and describe how these loads will be accounted for in the design of the LFRS.
11. Examples of a LFRS and collapse zone design concept used in the seismic design of structures that have been built especially structures at nuclear power plants.

Response to Question 03.07.02-64:

The Response to RAI 370, Supplement 3, Items 1 through 6 and Items 9 through 11, was submitted on August 10, 2010.

This response addresses RAI 370, Supplement 25, Question 03.07.02-64, Items 7 and 8, regarding the methodology and results for Nuclear Auxiliary Building (NAB) stability analysis and the potential for the NAB to interact with Seismic Category I structures. The Response to RAI 370, Supplement 24 was submitted on May 17, 2013, to address Question 03.07.02-64,

Items 7 and 8. This Response to RAI 370, Supplement 25 replaces the Response to RAI 370, Supplement 24 to address NRC comments. U.S. EPR FSAR markups were not impacted, so the U.S. EPR FSAR markups associated with the Response to RAI 370, Supplement 24 remain unchanged.

The NAB has been relocated to eliminate the potential for interaction with the Nuclear Island (NI). The move of the NAB also impacts the Radiation Waste Processing Building (RWB). U.S. EPR FSAR Tier 2, Figure 3B-1 shows a 30-inch gap between the NAB and NI and a 53.06 ft gap between the RWB and the Emergency Power Generating Building (EPGB) 3/4. U.S. EPR FSAR Tier 1, Sections 2.1.3 and 2.1.4 will be updated to show the revised gap dimensions for the NAB and RWB, respectively.

Item 7:

The NAB (Seismic Category II structure) interaction potential with the NI (Seismic Category I structure) is evaluated by time-history analysis performed on a 3D finite element model (FEM) of the structure using the ANSYS computer code. The three dimensional NAB FEM stability model represents the NAB superstructure, foundation mat, and the nonlinearity associated with the mat-to-soil interface. Nonlinearities are explicitly considered as compression-only of the concrete/soil interface in the vertical direction and the sliding coefficient of friction between the foundation basemat and underlying soil.

The NAB superstructure is represented with shells, solids, and mass elements. Shell elements are used to represent slabs and walls in the superstructure. Solid elements, four layers through the thickness, represent the NAB basemat. The concrete-only mass of the structure is accounted for through the use of the material weight density associated with each finite element that forms the structure. Mass elements are used to represent the additional masses from added dead loads, 25 percent of the live loads, and 75 percent of the maximum precipitation loads for this superstructure model. Cracked concrete stiffness is used for the superstructure. The cracked concrete stiffness is approximated in two ways:

- a) Flexural stiffness is reduced to 50 percent code value, and the full value is retained for shear and axial stiffness.
- b) Flexural and shear stiffness is reduced to 50 percent code value, and the full value is retained for axial stiffness.

Three translational and three rotational soil springs are derived using Gazetas' methodology presented in Reference 1. Dashpots for three translational directions are also calculated according to Reference 1. Springs and dashpots are developed for each soil case described in U.S. EPR FSAR Tier 2, Table 3.7.1-6. Elliptical spring distributions for each soil case are determined. The distribution methodology is the same as described in U.S. EPR FSAR Tier 2, Section 3.8.5.4.2, for the NI. The foundation is modeled using three translational springs that allow for compression-only load transfer at the concrete/soil interface in the vertical direction. Spring distributions are elliptical over the plan area of the basemat. Rotational spring values are compared with the available rotational springs from the distribution of translational springs. The development and distribution of soil springs are explained in Attachment A. The sliding interface between the concrete basemat and underlying soil is modeled using surface-to-surface sliding/contact elements that incorporate a coefficient of friction and capable of switching between static to dynamic friction in the case of sliding. While uplift is indicated by the compression-only vertical springs, translational springs at the location of uplift cannot provide lateral resistance. The buoyancy effects of the groundwater are included for water level 1 ft

below the ground surface and applied as uplift pressure at the bottom surface of basemat for all soil cases.

Side wall soil springs are modeled on south and east sides in the NAB stability model using the nonlinear force deflection relationship based on at-rest, active, and passive soil pressure coefficients. For sidewall springs, at-rest, active and passive pressure coefficients used are 0.50, 0.33, and 3.0, respectively; and considered unchanged irrespective of the ground water. The basis of these side spring coefficients and calculation of sidewall pressure are described in Attachment C. Time histories of side spring forces, total driving shear forces, and lateral displacements are shown in Attachment C. Side soil springs on the east side considers the partial embedment of NAB superstructure and surcharge loads from the RWB.

For the purpose of NAB stability analysis, both the certified seismic design response spectra (CSDRS), and a R.G. 1.60-based target spectra is used. The R.G. 1.60 target spectra are enhanced in the lower frequency range compared to the CSDRS. This lower frequency content is more conservative for predicting displacements.

The CSDRS include the European Utility Requirements (EUR) soft, medium, and hard input motions; as well as the high-frequency lower-bound (hflb), best-estimate (hfbe), and upper-bound (hfab) input motions, described in U.S. EPR FSAR Tier 2, Section 3.7.1.1.

The RG 1.60 target spectra (TS) input motions are anchored to a peak ground acceleration of 0.3g. However, the time-history peak ground accelerations are 0.3g in X direction, 0.36g in Y direction and 0.3g in the vertical direction. Three independent motions (two horizontal and one vertical baseline corrected for velocity and displacement) are created in accordance with SRP 3.7.1. These motions are referred as "RG 1.60 TS-based seismic motion." The seed records are taken from the NRC CEUS database representing a magnitude seven earthquake rich in low-frequency content. These transient results are developed in accordance with the requirements of Option 1, Approach 2 of the SRP 3.7.1.

RG 1.60 TS-based seismic motions are applied at the base of the springs supporting the NAB structure for 1n2ue, 2sn4ue, 4ue, 1n5ae, and 5ae cases. The EUR soft, medium, and hard input motions are considered for the NAB structure for 1n2ue, 2sn4ue, 4ue, 1n5ae, and 5ae soil profiles. The high-frequency (HF) motions are considered for the NAB structure for hflb, hfbe, and hfab soil profiles. The methodology for the application of RG 1.60, EUR and HF motions in NAB stability model is explained in Attachment D.

In-structure response spectra produced from application of the CSDRS seismic motions in the ANSYS NAB stability model are compared to those determined from application of the CSDRS motions in the SASSI NAB dynamic model to validate the stability analysis.

The NAB sliding stability analysis is performed with a static coefficient of friction of 0.5 and a dynamic coefficient of friction of 0.25. The NAB overturning stability analysis is performed with a static coefficient of friction of 0.7.

The NAB stability model is used to calculate the bearing pressures as well as maximum lateral displacements of the NAB structure. At first, NAB stability analysis is performed with linear soil springs and side soil springs without hysteresis loop. Then, NAB stability analysis is performed with nonlinear vertical soil springs and side springs with hysteretic loop. The study is performed for input motions obtained from SASSI analyses, with both subtraction and direct methods. However, results from motions with subtraction method are either conservative or comparable to direct method results (see Attachment E for the comparison)

The maximum displacement of the FB and SB4 superstructure are calculated from the soil structure interaction (SSI) analysis and added to the displacement results from the NI basemat model analysis (see Response to RAI 371, Question 3.7.2-66). Maximum lateral displacement of FB and SB4 are added to maximum displacements of the NAB. Additionally, the one-half inch in 50 ft tilt described in U.S. EPR FSAR Tier 2, Section 2.5.4.10.2, is considered for both NI and NAB structures to calculate the reduction in gap between NAB and NI. Absolute values of the results are summed to produce conservative reductions in the shake space between the two structures and compared against the available gap between NI and NAB to calculate the factor of safety against possible interaction. U.S. EPR FSAR Tier 2, Figure 3B-1 shows a 30-inch gap between NI and NAB. Results of NI model and NAB model (with linear vertical soil springs and side springs without hysteretic loop) displacements from seismic analysis, tilt displacements, and corresponding factors of safety are shown in Table 03.07.02-64-1 and Table 03.07.02-64-2 for 50 percent reduced flexural stiffness and 50 percent reduced flexural and shear stiffness, respectively. Results of NI model and NAB model (with non-linear vertical soil springs and side springs with hysteretic loop) displacements from seismic analysis, tilt displacements, and corresponding factors of safety are shown in Table 03.07.02-64-3 for 50 percent reduced flexural and shear stiffness, respectively.

For NAB with linear vertical soil springs and side springs without hysteretic loop as well as 50 percent reduced flexural and shear stiffness, the maximum reduction in the NI-NAB gap is 10.04 inches due to seismic and tilt displacement based on the absolute value summation method. With a minimum 30-inch gap between NI and NAB, a minimum factor of safety of 2.99 exists against possible interactions. For NAB with nonlinear vertical soil springs and side springs with hysteretic loop as well as 50 percent reduced flexural and shear stiffness, the maximum reduction in NI-NAB gap is 12.58 inches due to seismic and tilt displacement based on the absolute value summation method. With a minimum 30 inch gap between NI and NAB, a minimum factor of safety of 2.38 exists against possible interactions. The minimum factor of safety of 2.38 meets the minimum factor of safety required by Section 7.3 of ASCE 43-05.

Maximum dynamic bearing pressure demand is calculated from the results of EUR soft, medium, and hard input motions as well as the high-frequency hflb, hfbe, and hfub input motions described in U.S. EPR FSAR Tier 2, Section 3.7.1.1. The dynamic bearing pressure demands for NAB are determined from the nonlinear NAB stability analysis from a combination of static and seismic loads with linear and nonlinear vertical springs. This load combination includes static weight of the superstructure (including 100 percent dead load, 25 percent live load, and 75 percent precipitation load); buoyancy pressure (for water level one ft below the ground); and seismic time histories (either from RG 1.60 or EUR motions). Tables 03.07.02-64-4, 03.07.02-64-5, 03.07.02-64-7, and Table 03.07.02-64-8, list the maximum bearing pressure demand for all soil cases and for corresponding input motions analyzed with the NAB stability model supported by linear vertical springs. The maximum dynamic bearing pressure demands are 105.85 ksf for soil case 5ae. Maximum bearing pressures are observed locally at the corner of the basemat due to singularity effect at the corners. These high-corner bearing pressures will be redistributed due to localized yielding of the soil. The redistribution of bearing pressure is calculated assuming a bilinear soil spring modulus variation. The details of bilinear soil springs are described in Attachment B. Table 03.07.02-64-9 lists the maximum bearing pressure demand for all soil cases and for corresponding input motions analyzed with the NAB stability model supported by non-linear vertical springs. Table 03.07.02-64-9 demonstrates that the maximum dynamic bearing pressure demands are 37.30 ksf for soil cases 1n2ue, 2sn4ue, 4ue, 1n5ae, hflb, hfbe, hfub; and 59.01 ksf for soil case 5ae, after redistribution due to nonlinear soil springs.

Figures 03.07.02-64-1 through 03.07.02-64-5 show distribution bearing pressure for soil cases 1n2ue, 2sn4ue, 4ue, 1n5ae, and 5ae at the time of peak maximum bearing pressure.

The NAB superstructure will not overturn and interact with the NI structures since the maximum basemat uplift is 0.78 in for all soil cases. The amount of basemat uplift area at the time of maximum bearing pressure is shown in Figures 03.07.02-64-6 through 03.07.02-64-10 for nonlinear soil springs. For the NAB to overturn, it has to overturn against one of the edges of the NAB basemat and the soil near the edges has to reach its yield capacity. Soil pressure under the basemat will be redistributed near the edges. Figures 03.07.02-64-1 through 03.07.02-64-5 demonstrate that edge bearing pressures are significantly lower than the corner bearing pressures. The bearing capacity calculation, shown in Attachment B, is conservative since the effect of the soil overburden pressure, dead weight of adjacent structures, and shear strength of soil is ignored. Soil case 2sn4ue shows the maximum basemat uplift for soil with nonlinear vertical soil springs (see Table 03.07.02-64-9). At the time of maximum bearing pressure, edge pressures vary between 9.95 to 14.92 ksf (69.07~103.62 psi on Figure 03.07.02-64-2), which is less than maximum corner pressure 21.88 ksf. There is sufficient margin in the ultimate bearing pressure for edges to accommodate the redistribution increase. Therefore, the NAB superstructure will not overturn.

U.S. EPR FSAR Tier 2, Table 1.8-2, COL Item 2.5-4 will be revised to separate the Seismic Category I and NAB bearing pressure requirements. In addition, U.S. EPR FSAR Tier 2, Table 1.8-2 and Section 2.5.4.10.1 will be revised to add the following COL Information Item (2.5-13) for the NAB. U.S. EPR FSAR Tier 2, Section 3.7.2.8 will be revised to describe the NAB stability analysis:

The COL applicant that references the U.S. EPR design certification will perform a site-specific analysis to determine the bearing pressure demand and peak displacement of the NAB. The foundation soils beneath the NAB foundation basemat shall have the capacity to support the bearing pressure with a factor of safety of 3.0 under static conditions, or 2.0 under combined static and dynamic conditions, whichever is greater. The minimum required separation distance is a factor of two times the calculated absolute sum of the maximum combined site-specific NAB and U.S. EPR NI design displacements, but not less than 30 in.

U.S. EPR FSAR Tier 2, Table 3.7.2-29 will be revised to indicate that the COL applicant will demonstrate that the gap distance between the NAB and NI is sufficient to prevent interaction.

The static bearing pressure demands are also determined from the nonlinear NAB stability analysis from static weight (including 100 percent dead load, 25 percent live load, and 75 percent precipitation load) of the superstructure along with and without buoyancy pressure. The maximum static bearing pressure demand is 24.30 ksf. Table 03.07.02-64-11 lists the maximum static bearing pressure demand for the soil cases.

Table 03.07.02-64-1—Factor of Safety for NI and NAB Interaction with Flexural Stiffness of NAB Reduced 50 Percent along with Linear Vertical Springs

Soil Case	Seismic NI Maximum Displacement (inch)		Seismic NAB Maximum Displacement (inch)		NI and NAB Total Tilt Displacement (inch)		NI and NAB Total Displacement = Seismic + Tilt (inch)		Factor of Safety ¹	
	X-Dir	Y-Dir	X-Dir	Y-Dir	X-Dir	Y-Dir	X-Dir	Y-Dir	X-Dir	Y-Dir
5ae	0.37	0.28	1.08	2.32	2.80	2.74	4.25	5.34	7.06	5.62
1n5ae	0.39	0.29	1.44	5.51			4.63	8.54	6.48	3.51
4ue	0.73	0.49	1.66	5.64			5.19	8.87	5.78	3.38
2sn4ue	0.87	0.58	3.82	5.08			7.49	8.40	4.01	3.57
1n2ue	0.92	0.89	2.33	5.01			6.05	8.64	4.96	3.47
hfbe	0.08	0.07	0.99	0.72			3.87	3.53	7.75	8.50

Note:

- Factor of safety is based on a 30-inch gap between NI and NAB in both X and Y directions.

Table 03.07.02-64-2—Factor of Safety for NI and NAB Interaction with Flexural and Shear Stiffness of NAB Reduced 50 Percent along with Linear Vertical Springs

Soil Case	Seismic NI Maximum Displacement (inch)		Seismic NAB Maximum Displacement (inch)		NI and NAB Total Tilt Displacement (inch)		NI and NAB Total Displacement = Seismic + Tilt (inch)		Factor of Safety ¹	
	X-Dir	Y-Dir	X-Dir	Y-Dir	X-Dir	Y-Dir	X-Dir	Y-Dir	X-Dir	Y-Dir
5ae	0.37	0.28	1.27	1.86	2.80	2.74	4.44	4.88	6.76	6.15
1n5ae	0.39	0.29	1.88	5.87			5.07	8.90	5.92	3.37
4ue	0.73	0.49	2.30	6.81			5.83	10.04	5.15	2.99
2sn4ue	0.87	0.58	4.11	5.04			7.78	8.36	3.86	3.59
1n2ue	0.92	0.89	2.48	5.23			6.20	8.86	4.84	3.39
hfbe	0.08	0.07	0.99	0.72			3.87	3.53	7.75	8.50

Note:

- Factor of safety is based on a 30-inch gap between NI and NAB in both X and Y directions.

Table 03.07.02-64-3—Factor of Safety for NI and NAB Interaction with Flexural and Shear Stiffness of NAB Reduced 50 Percent with Nonlinear Vertical Springs

Soil Case	Seismic NI Maximum Displacement (inch)		Seismic NAB Maximum Displacement (inch)		NI and NAB Total Tilt Displacement (inch)		NI and NAB Total Displacement = Seismic + Tilt (inch)		Factor of Safety ¹	
	X-Dir	Y-Dir	X-Dir	Y-Dir	X-Dir	Y-Dir	X-Dir	Y-Dir	X-Dir	Y-Dir
5ae	0.37	0.28	2.56	7.65	2.80	2.74	5.73	10.67	5.24	2.81
1n5ae	0.39	0.29	3.32	9.55			6.51	12.58	4.61	2.38
4ue	0.73	0.49	3.24	6.31			6.77	9.54	4.43	3.14
2sn4ue	0.87	0.58	4.76	6.23			8.43	9.55	3.56	3.14
1n2ue	0.92	0.89	4.53	6.80			8.25	10.43	3.64	2.88
hfbe	0.08	0.07	0.69	1.11			3.57	3.92	8.40	7.65

Note:

- Factor of Safety is based on a 30-inch gap between NI and NAB in both X and Y directions.

Figure 03.07.02-64-1—Soil Case 1n2ue: Dynamic Bearing Pressure Distribution for EUR Motions for NAB with 50 Percent Reduced Flexural and Shear Stiffness with Nonlinear Vertical Soil Springs

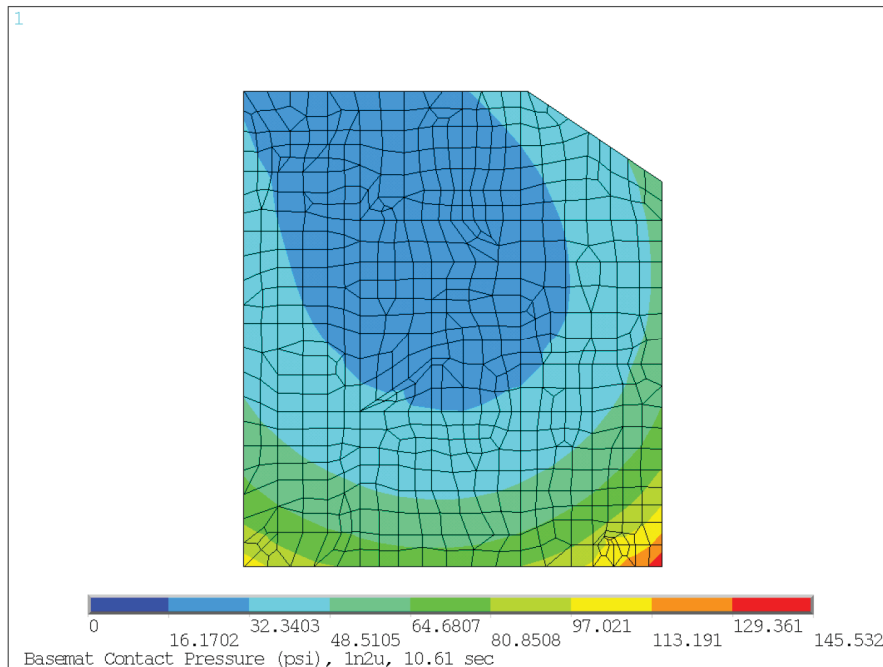


Figure 03.07.02-64-2—Soil Case 2sn4ue: Dynamic Bearing Pressure Distribution for EUR motions for NAB with 50 Percent Reduced Flexural and Shear Stiffness with Nonlinear Vertical Soil Springs

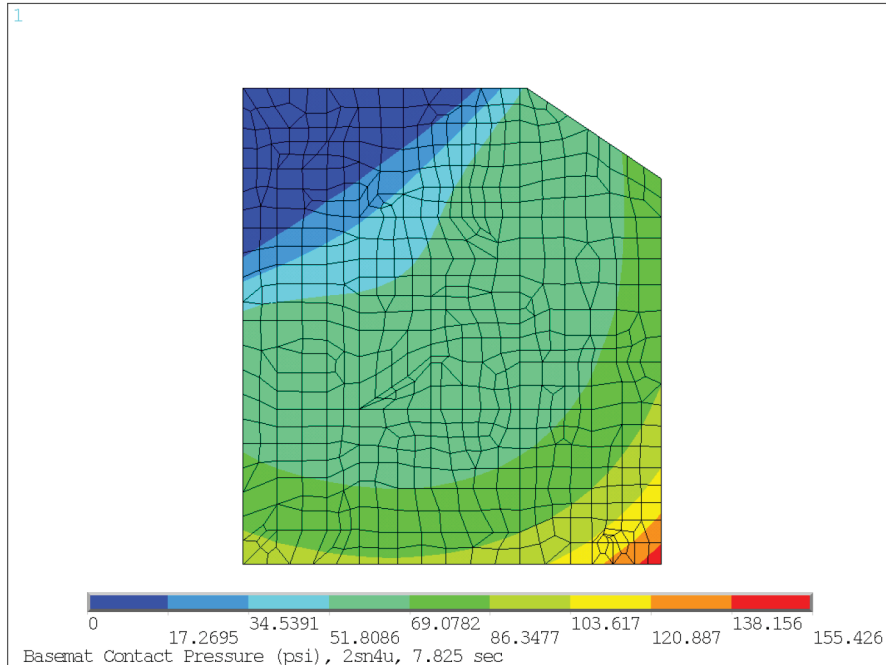


Figure 03.07.02-64-3—Soil Case 4ue: Dynamic Bearing Pressure Distribution for EUR motions for NAB with 50 Percent Reduced Flexural and Shear Stiffness with Nonlinear Vertical Soil Springs

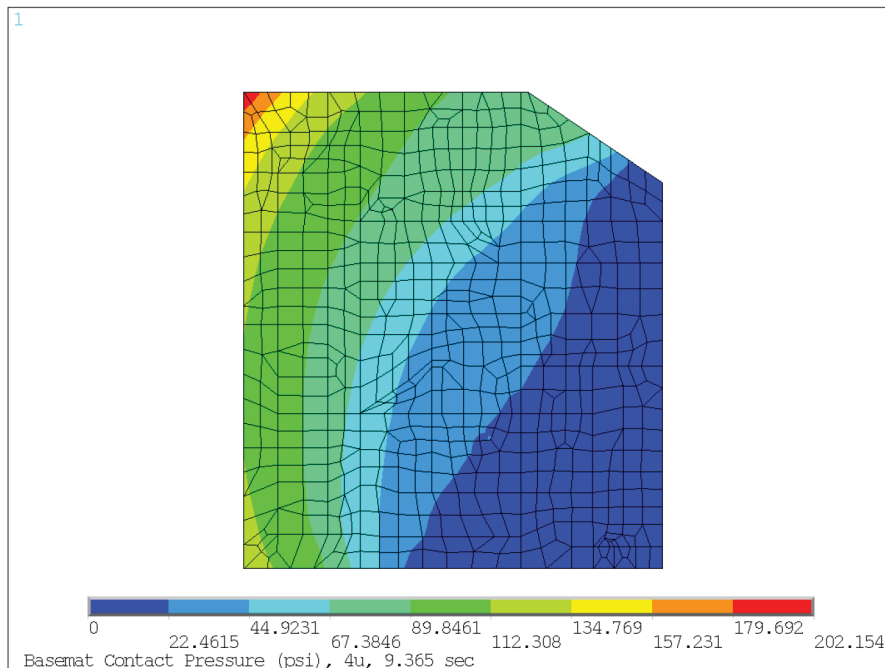


Figure 03.07.02-64-4—Soil Case 1n5ae: Dynamic Bearing Pressure Distribution for EUR motions for NAB with 50 Percent Reduced Flexural and Shear Stiffness with Nonlinear Vertical Soil Springs

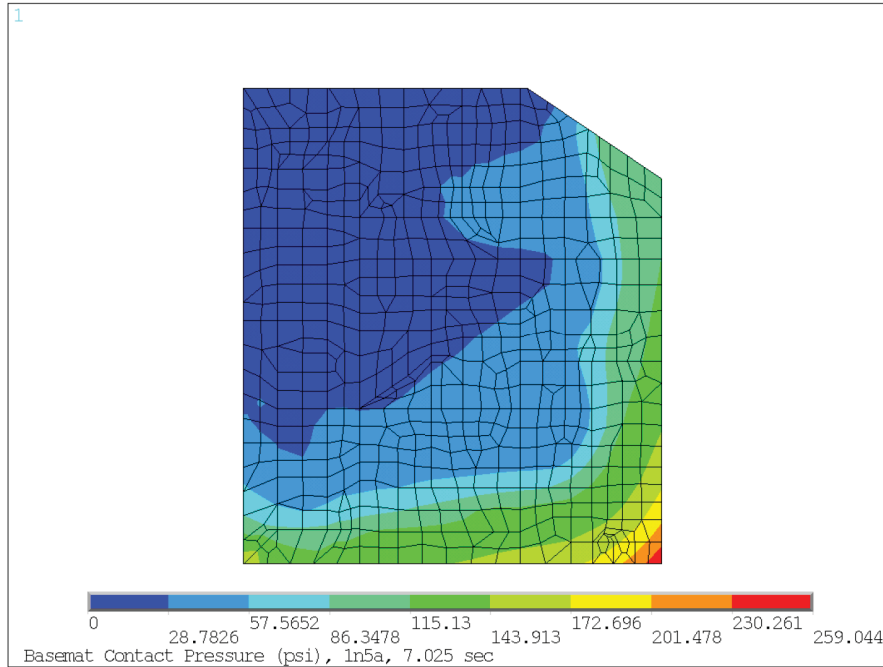


Figure 03.07.02-64-5—Soil Case 5ae: Dynamic Bearing Pressure Distribution for EUR motions for NAB with 50 Percent Reduced Flexural and Shear Stiffness with Nonlinear Vertical Soil Springs

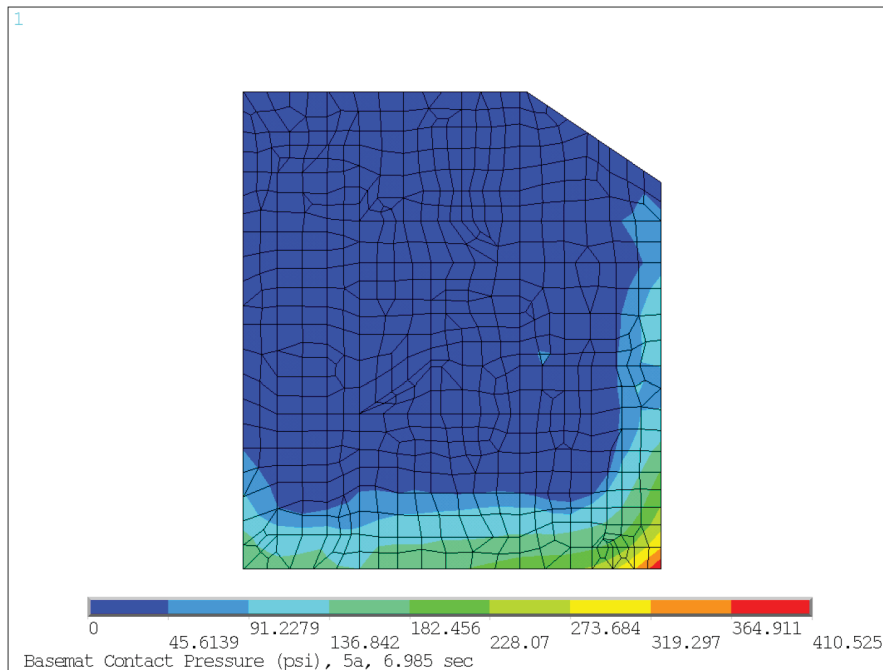


Figure 03.07.02-64-6—Soil Case 1n2ue: Basemat Uplift at the Time of Maximum Dynamic Bearing Pressure for EUR motions for NAB with 50 Percent Reduced Flexural and Shear Stiffness with Nonlinear Vertical Soil Springs

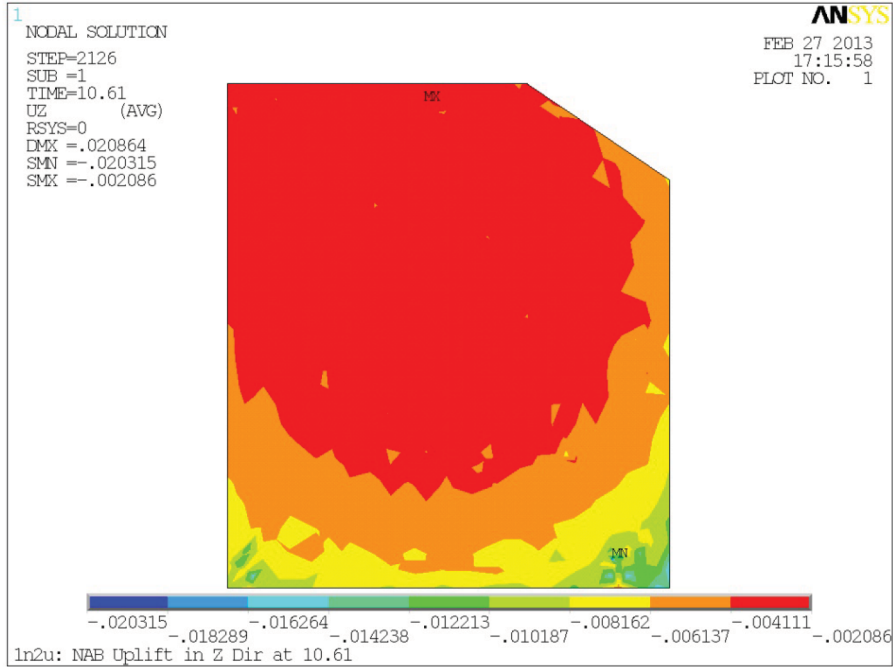


Figure 03.07.02-64-7—Soil Case 2sn4ue: Basemat Uplift at the Time of Maximum Dynamic Bearing Pressure for EUR motions for NAB with 50 Percent Reduced Flexural and Shear Stiffness with Nonlinear Vertical Soil Springs

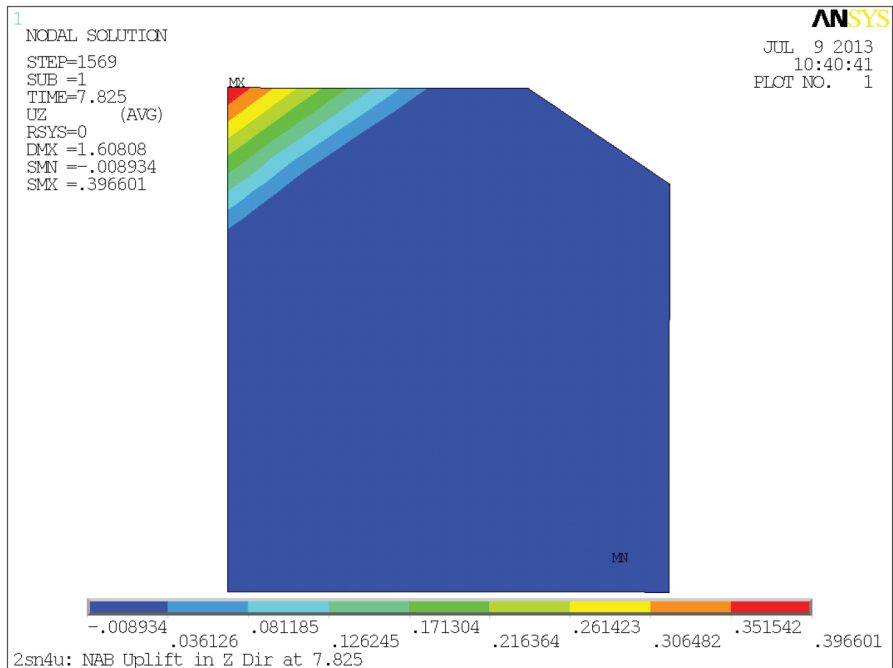


Figure 03.07.02-64-8—Soil Case 4ue: Basemat Uplift at the Time of Maximum Dynamic Bearing Pressure for EUR motions for NAB with 50 Percent Reduced Flexural and Shear Stiffness with Nonlinear Vertical Soil Springs

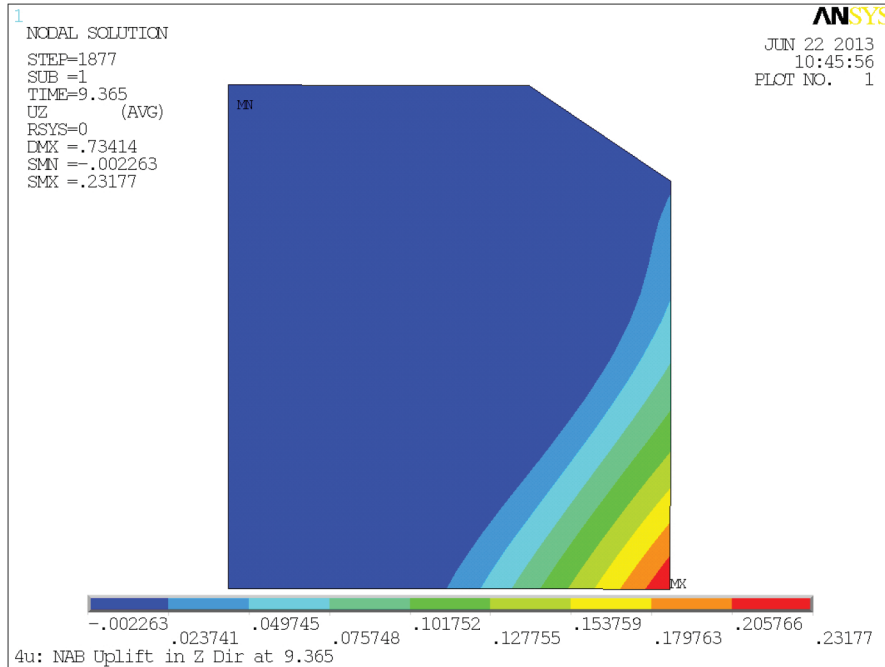


Figure 03.07.02-64-9—Soil Case 1n5ae: Basemat Uplift at the Time of Maximum Dynamic Bearing Pressure for EUR motions for NAB with 50 Percent Reduced Flexural and Shear Stiffness with Nonlinear Vertical Soil Springs

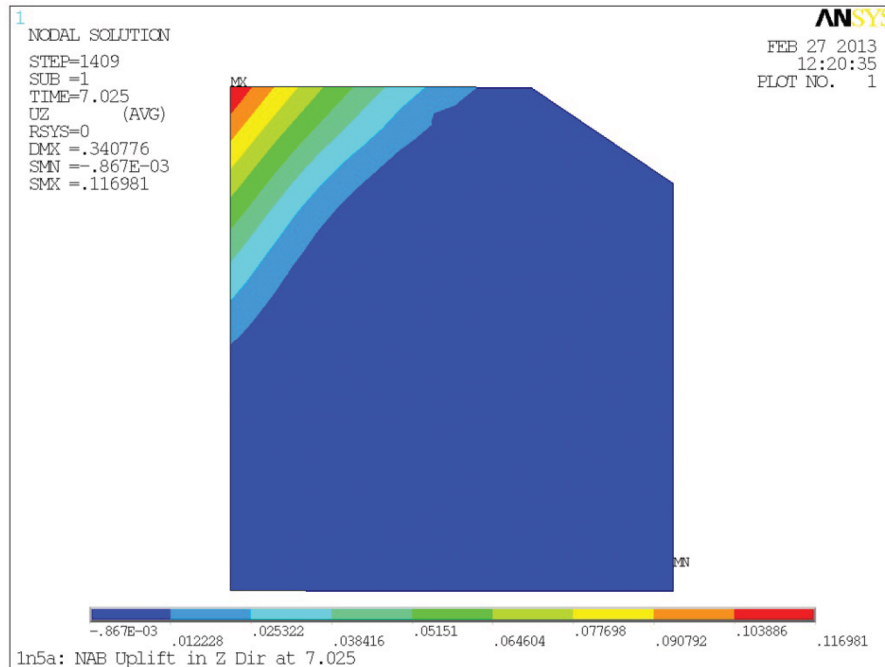
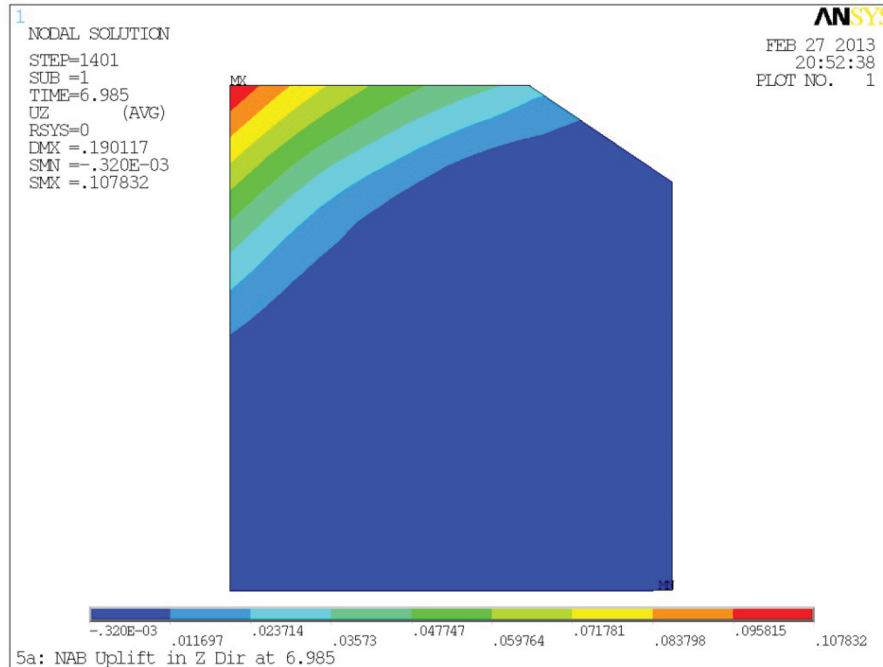


Figure 03.07.02-64-10—Soil Case 5ae: Basemat Uplift at the Time of Maximum Dynamic Bearing Pressure for EUR motions for NAB with 50 Percent Reduced Flexural and Shear Stiffness with Nonlinear Vertical Soil Springs



Item 8:

Bounding Case for Sliding of the NAB

As described in Item 7 above, a nonlinear sliding analysis with the NAB stability model with a static friction coefficient of 0.5 and dynamic friction coefficient of 0.25 was performed. A study is performed with linear vertical soil springs and side springs without hysteretic loop. Results of maximum dynamic bearing pressure, maximum sliding and uplift, and maximum lateral movements of NAB nodes near NI are listed in Tables 03.07.02-64-4 and 03.07.02-64-5 for 50 percent reduced flexural stiffness and 50 percent reduced flexural and shear stiffness, respectively. The study is extended for NAB model with non-linear vertical springs and side springs with hysteretic loop to calculate additional lateral movement due to redistribution of soil bearing pressure and consideration of passive earth pressure for lateral movement of sidewall towards the soil. Results of maximum dynamic bearing pressure, maximum sliding and uplift, and maximum lateral movements of NAB nodes near NI are listed in Table 03.07.02-64-6 for 50 percent reduced flexural and shear stiffness, along with nonlinear vertical soil springs.

Table 03.07.02-64-4—Maximum Dynamic Bearing Pressure, Maximum Sliding/Uplift and Lateral Movements of NAB for RG 1.60 TS Based Seismic Motions for 50 Percent Reduced Flexural Stiffness along with Linear Vertical Springs

Soil Case	Maximum Static plus Dynamic Bearing Pressure Demand	Maximum Sliding in X-direction (inch)	Maximum Sliding in Y-direction (inch)	Maximum Uplift (inch)	NAB Peak Displacement in X-Direction (inch)	NAB Peak Displacement in Y-Direction (inch)
	Observed Locally at Corner (ksf)					
1n2ue	36.46	1.49	4.36	0.00	1.46	5.01
2sn4ue	31.20	3.55	4.67	0.09	3.82	5.08
4ue	52.84	1.61	5.45	0.07	1.66	5.64
1n5ae	69.95	1.41	5.36	0.08	1.44	5.51
5ae	141.00	0.70	2.07	0.23	1.08	2.32

Table 03.07.02-64-5—Maximum Dynamic Bearing Pressure, Maximum Sliding/Uplift and Lateral Movements of NAB for RG 1.60 TS Based Seismic Motions for 50 Percent Reduced Flexural and Shear Stiffness along with Linear Vertical Springs

Soil Case	Maximum Static plus Dynamic Bearing Pressure Demand	Maximum Sliding in X-direction (inch)	Maximum Sliding in Y-direction (inch)	Maximum Uplift (inch)	NAB Peak Displacement in X-Direction (inch)	NAB Peak Displacement in Y-Direction (inch)
	Observed Locally at Corner (ksf)					
1n2ue	86.28	1.50	4.54	0.00	1.50	5.23
2sn4ue	31.67	3.69	4.57	0.13	4.11	5.04
4ue	53.95	2.24	6.53	0.18	2.30	6.81
1n5ae	105.64	1.81	5.64	0.20	1.88	5.87
5ae	199.15	0.68	1.48	0.31	1.27	1.86

Table 03.07.02-64-6—Maximum Dynamic Bearing Pressure, Maximum Sliding/Uplift and Lateral Movements of NAB for RG 1.60 TS Based Seismic Motions for 50 Percent Reduced Flexural and Shear Stiffness along with Non-Linear Vertical Springs

Soil Case	Maximum Static plus Dynamic Bearing Pressure Demand	Maximum Sliding in X-direction (inch)	Maximum Sliding in Y-direction (inch)	Maximum Uplift (inch)	NAB Peak Displacement in X-Direction (inch)	NAB Peak Displacement in Y-Direction (inch)
	Observed Locally at Corner (ksf)					
1n2ue	22.03	0.30	0.57	0.00	4.53	6.80
2sn4ue	20.92	3.84	4.43	0.62	4.76	6.23
4ue	22.75	2.98	5.94	0.26	3.24	6.31
1n5ae	36.09	3.23	9.39	0.22	3.32	9.55
5ae	74.60	2.47	7.51	0.21	2.56	7.65

Bounding Case for Overturning of the NAB

As described in Item 7 above, a nonlinear overturning analysis with NAB stability model with a static coefficient of friction 0.7 was performed. The study was performed with linear vertical soil springs and side springs without hysteretic loop. Results of maximum dynamic bearing pressure, maximum sliding/uplift, and maximum lateral movements of NAB nodes near NI are listed in Table 03.07.02-64-7 and Table 03.07.02-64-8 for 50 percent reduced flexural stiffness and 50 percent reduced flexural and shear stiffness, respectively. The study is extended for NAB model with non-linear vertical springs and side springs with hysteretic loop to calculate the redistribution of soil bearing pressure as well as additional uplift due to consideration of passive earth pressure for lateral movement of sidewall towards the soil. Results of maximum dynamic bearing pressure, maximum sliding and uplift, and maximum lateral movements of NAB nodes near NI are listed in Table 03.07.02-64-9 for 50 percent reduced flexural and shear stiffness along with nonlinear vertical soil springs.

Table 03.07.02-64-7—Maximum Dynamic Bearing Pressure, Maximum Sliding/Uplift and Lateral Movements of NAB for EUR and High Frequency Motions for 50 Percent Reduced Flexural Stiffness along with Linear Vertical Soil Springs

Soil Case	Maximum Static plus Dynamic Bearing Pressure Demand	Maximum Sliding in X-direction (inch)	Maximum Sliding in Y-direction (inch)	Maximum Uplift (inch)	NAB Peak Displacement in X-Direction (inch)	NAB Peak Displacement in Y-Direction (inch)
	Observed Locally at Corner (ksf)					
1n2ue	30.02	0.23	0.27	0.15	2.33	3.77
2sn4ue	53.51	0.53	1.24	0.78	1.91	1.95
4ue	79.45	0.26	0.70	0.21	1.17	1.17
1n5ae	66.38	0.09	0.27	0.14	0.37	0.74
5ae	105.85	0.11	0.29	0.27	0.51	0.84
hflb	33.65	0.00	0.01	0.00	0.67	1.78
hfbe	36.67	0.00	0.01	0.01	0.99	0.72
hfub	46.39	0.00	0.01	0.01	1.24	1.80

Table 03.07.02-64-8—Maximum Dynamic Bearing Pressure, Maximum Sliding/Uplift and Lateral Movements of NAB for EUR and High Frequency Motions for 50 Percent Reduced Flexural and Shear Stiffness along with Linear Vertical Soil Springs

Soil Case	Maximum Static plus Dynamic Bearing Pressure Demand	Maximum Sliding in X-direction (inch)	Maximum Sliding in Y-direction (inch)	Maximum Uplift (inch)	NAB Peak Displacement in X-Direction (inch)	NAB Peak Displacement in Y-Direction (inch)
	Observed Locally at Corner (ksf)					
1n2ue	31.71	0.29	0.38	0.21	2.48	3.83
2sn4ue	52.44	0.50	1.13	0.76	1.89	1.92
4ue	85.20	0.22	0.82	0.40	1.14	1.44
1n5ae	86.82	0.08	0.31	0.21	0.56	0.89
5ae	99.61	0.07	0.16	0.18	0.50	0.84
hflb	34.74	0.00	0.01	0.00	0.67	1.79
hfbe	39.08	0.00	0.01	0.00	0.99	0.72
hfub	44.05	0.00	0.01	0.01	1.24	1.79

Table 03.07.02-64-9—Maximum Dynamic Bearing Pressure, Maximum Sliding/Uplift and Lateral Movements of NAB for EUR and High Frequency Motions for 50 Percent Reduced Flexural and Shear Stiffness along with Nonlinear Vertical Soil Springs

Soil Case	Maximum Static plus Dynamic Bearing Pressure Demand	Maximum Sliding in X-direction (inch)	Maximum Sliding in Y-direction (inch)	Maximum Uplift (inch)	NAB Peak Displacement in X-Direction (inch)	NAB Peak Displacement in Y-Direction (inch)
	Observed Locally at Corner (ksf)					
1n2ue	19.70	0.06	0.07	0.00	4.46	6.16
2sn4ue	21.88	0.78	1.79	0.55	2.63	3.40
4ue	28.42	0.34	0.76	0.41	1.25	1.66
1n5ae	37.30	0.08	0.39	0.19	0.70	1.01
5ae	59.01	0.07	0.25	0.17	0.51	0.91
hflb	24.23	0.00	0.01	0.00	0.60	2.02
hfbe	25.61	0.00	0.01	0.00	0.69	1.11
hfub	28.12	0.00	0.01	0.01	2.19	1.51

Based on the 30 in gap between NI and NAB superstructures and factors of safety shown in Table 03.07.02-64-1, Table 03.07.02-64-2, and Table 03.07.02-64-3; the NAB will not slide or overturn into adjacent Category I structures.

Factors of Safety for Sliding, Overturning and Flotation due Tornado, Wind and Flooding

In addition to II/I interaction analysis, factors of safety (FS) for sliding, overturning, and flotation are calculated in accordance with SRP 3.8.5 for tornado, wind, and flooding. The factors of safety for wind loads are at least equal to tornado loads. Minimum factors of safety are compared with required factor of safety with the Seismic Category I structures and shown in Table 03.07.02-64-10. RG 1.221 (Reference 2) will result in an increase of wind load on the NAB structure. However, the wind increase will not be greater than twice the current wind speeds used from RG 1.76. Since the FS for wind on the NAB is 2.8, a doubling of the wind speed will decrease the FS to 1.4, which is still greater than NUREG-0800 requirements. The Response to RAI 541, Question 02-03 will address RG 1.221 wind loads for the U.S. EPR design.

Table 03.07.02-64-10—Factors of Safety for Sliding, Overturning and Flotation under Tornado, Wind, and Flooding

Load Type	Load Combinations	Type of Stability Check	Available Minimum Factor of Safety	Required Minimum Factor of Safety
Tornado	D+H+W _t	Sliding	2.8	1.1
Tornado	D+H+W _t	Overturn	3.8	1.1
Wind	D+H+W	Sliding	2.8	1.5
Wind	D+H+W	Overturn	3.8	1.5
Flooding	D+F'	Flotation	3.0	1.1

Note: D = Dead Loads, H = Lateral Earth Pressure, W = Wind load, W_t = Tornado loads, F' = Flood Water Loads

Maximum Static Bearing Pressure

Table 03.07.02-64-11 lists the static bearing pressure demand under 100 percent dead loads, 25 percent live loads, and 75 percent precipitation loads with and without buoyancy pressure for all soil cases described in U.S. EPR FSAR Tier 2, Table 3.7.1-6.

Table 03.07.02-64-11—NAB Maximum Static Bearing Pressure Demand for Soil Cases along with Nonlinear Vertical Soil Springs.

Soil Case	Flexural and Shear Stiffness Reduced 50% (ksf)	
	With Buoyancy Pressure	Without Buoyancy Pressure
1n2ue	16.6	23.3
2sn4ue	9.8	14.1
4ue	12.6	14.5
1n5ae	18.3	19.3
5ae	23.6	24.3
hflb	19.8	20.6
hfbe	20.5	21.6
hfub	23.9	23.0

References:

1. "Foundation Vibrations," Foundation Engineering Handbook, 2nd Edition, H.Y. Fang, Ed., Van Nostrand Reinholds, Chapter 15, pp.553-593, 1991.
2. RG 1.221, Rev. 0, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," October 2011.

FSAR Impact:

U.S. EPR FSAR Tier 1, Sections 2.1.3 and 2.1.4 were revised as described in the response and provided in U.S. EPR FSAR Revision 5.

U.S. EPR FSAR Tier 2, Table 1.8-2, Sections 2.5.4.10.1 and 3.7.2.8, and Figure 3B-1 were revised as described in the response and provided in U.S. EPR FSAR Revision 5.

ATTACHMENT A: DEVELOPMENT AND DISTRIBUTION OF SOIL SPRINGS

The calculation of NAB soil springs follows the same methodology used for soil spring calculation of the Nuclear Island (NI). The footprint of Nuclear Auxiliary Building (NAB) basemat is approximated as an equivalent square shaped foundation for soil spring and damping constants calculation. The NAB basemat surface area is 12,515.8 ft². The total soil spring constants are calculated from the soil shear wave velocities, Poisson's ratio, soil density, damping properties, as well as dynamic properties of NAB structure determined from SASSI analysis using Gazeta's equations (A.1).

Surface area of the basemat, $A_b = 12,515.8 \text{ ft}^2$.

Equivalent half-width of the square basemat, $a = 55.9 \text{ ft}$

Poisson's ratio, $\nu = 0.40$

Weight density, $\gamma = 120 \text{ pcf}$

Shear wave velocity, $V_s = 3,936 \text{ ft/sec}$

P-wave velocity, $V_p = V_s \sqrt{\frac{2(1-\nu)}{1-2\nu}} = 9,644 \text{ ft/sec}$

Lysmer's wave velocity, $V_L = \frac{3.4}{\pi(1-\nu)} V_s = 7,101 \text{ ft/sec}$

Dynamic shear modulus, $G = \rho V_s^2 = 57,818 \text{ ksf}$ where ρ is mass density

Soil hysteric damping, $\beta = 0.01$

From Modal Analysis: NAB Horizontal frequency, $f_h = 3.15 \text{ Hz}$
NAB Vertical frequency, $f_v = 9.5 \text{ Hz}$

Vertical circular frequency, $\omega_v = 2\pi f_v = 59.69 \text{ radian/sec}$

Horizontal circular frequency, $\omega_h = 2\pi f_h = 19.79 \text{ radian/sec}$

Calculation of Vertical Spring and Dashpot:

Shape factor for vertical direction, $a_{ov} = \frac{\omega_v * a}{V_s} = 0.848$

From the Graphs of Table 15.1 [Reference A.1]:

Graph (a), Dynamic vertical stiffness coefficient, $k_{wv} = 0.86$

Graph (c), Dynamic vertical dashpot coefficient, $c_{wv} = 0.92$

$$\text{Dynamic vertical stiffness, } K_z = k_{wv} \frac{4.54Ga}{1-\nu} = 21,045,700 \text{ kip/ft}$$

$$\text{Dynamic vertical radiation dashpot, } C_{zr} = c_{wv} \rho V_L A_b = 0.305014 \times 10^6 \text{ kip-sec/ft}$$

$$\text{Dynamic vertical material dashpot, } C_{zm} = \frac{2\beta K_z}{\omega_v} = 7052 \text{ kip-sec/ft}$$

$$\text{Dynamic vertical dashpot, } C_z = C_{zr} + C_{zm} = 0.312066 \times 10^6 \text{ kip-sec/ft}$$

Calculation of Horizontal Spring and Dashpot:

$$\text{Shape factor for horizontal direction, } a_{oh} = \frac{\omega_h * a}{V_s} = 0.281$$

From the Graphs of Table 15.1 (Reference A.1):

Graph (b), Dynamic Horizontal Stiffness Coefficient, $k_{wh} = 1.00$

Graph (d), Dynamic Horizontal Dashpot Coefficient, $c_{wh} = 0.80$

$$\text{Dynamic Horizontal Stiffness, } K_h = k_{wh} \frac{9Ga}{2-\nu} = 0.181921 \times 10^8 \text{ kip/ft}$$

$$\text{Dynamic Horizontal radiation dashpot, } C_{hr} = c_{wh} \rho V_S A_b = 147,043 \text{ kip-sec/ft}$$

$$\text{Dynamic Horizontal material dashpot, } C_{hm} = \frac{2\beta K_h}{\omega_h} = 18,383 \text{ kip-sec/ft}$$

$$\text{Dynamic Horizontal dashpot, } C_h = C_{hr} + C_{hm} = 0.165426 \times 10^6 \text{ kip-sec/ft}$$

Calculation of Rotational Springs:

$$\text{Coefficient for Rotational Springs about Horizontal Axis, } k_{rh} = 1 - 0.20a_{ov} = 0.83$$

$$\text{Coefficient for Rotational Springs about Vertical Axis, } k_{rz} = 1 - 0.14a_{oh} = 0.96$$

Dynamic Rotational Spring Constant about horizontal:

$$K_{rh} = k_{rh} \frac{3.6Ga^3}{1-\nu} = 5.042 \times 10^{10} \text{ kip-ft/radian}$$

Dynamic Rotational Spring Constant about vertical:

$$K_{rv} = k_{rz} * 8.3Ga^3 = 8.069 \times 10^{10} \text{ kip-ft/radian}$$

For soil case 4ue, total translational and rotational spring constants for NAB are shown in Table A-1. Average translational soil spring subgrade moduli are calculated as total translational spring constant divided by total area of the basemat. Table A-2 represents the average modulus based on the uniform soil spring distribution.

Table A-1—Translational and Rotational Spring Constants

Soil	Total Translational Soil Springs			Total Rotational Soil Springs		
	K_h	K_h	K_z	K_{rh}	K_{rh}	K_{rv}
Case	kip/ft	kip/ft	kip/ft	kip-ft/radian	kip-ft/radian	kip-ft/radian
4ue	1.819×10^7	1.819×10^7	2.1046×10^7	5.042×10^{10}	5.042×10^{10}	8.069×10^{10}

Table A-2—Average Translational Soil Spring Subgrade Moduli

Soil	Average Soil Spring Subgrade Modulus		
	k_x	k_y	k_z
Case	kip/ft ³	kip/ft ³	kip/ft ³
4ue	1453	1453	1682

The distribution of the horizontal spring stiffness under the basemat is assumed to be uniform. The distribution of horizontal soil spring stiffness is proportional to the distribution of soil reaction (against the lateral forces), which is dependent on relative stiffness of the basemat to soil and amount of basemat uplift. In general, soil springs are stiffer near the edges than at the center of the basemat. The distribution of horizontal soil springs is more prominent for softer soil cases compared to hard soil cases. If uplift occurs, there will be redistribution of lateral spring resistance. For stiff soil, redistribution because of uplift will not significantly change the stiffness redistribution. For soft soil with uplift, the redistribution will cause more prominent stiffness redistribution. The maximum uplift is observed for the medium soil case 2sn4ue, whereas the soft soil case 1n2ue showed nominal uplift. Therefore, the effect of using uniform horizontal springs will have a negligible effect on the structural response.

For the considered soil cases, the elliptical distribution of vertical soil springs are determined from an iterative approach from settlement analysis and bearing pressure distribution. The generalized equation for elliptical soil spring distribution is shown in Equation A-1.

$$C(x, y) = \left(C_1 - C_2 \sqrt{1 - \frac{x^2}{2l^2} - \frac{y^2}{2b^2}} \right) \quad (\text{Equation A-1})$$

and

$$k(x, y) = k_0 \cdot C(x, y) \quad (\text{Equation A-2})$$

where: k and k_0 are the local and average subgrade modulus.

C_1 and C_2 are coefficients obtained from a regression over the distribution of K .

l and b are half of the dimensions of the foundation.

x, y are coordinates of basemat location from the center of NAB.

For soil case 4ue, $k_0 = k_z = 1682 \text{ kip/ft}^3$ (see Table A-2) and vertical soil spring distribution factors are determined as follows:

$$C(x, y) = \left(3.85 - 3.47 \sqrt{1 - \frac{x^2}{2l^2} - \frac{y^2}{2b^2}} \right) \quad (\text{Equation A-3})$$

where: $l = b = 59.2 \text{ ft}$.

NAB stability model is equipped with translational soil springs only, and the soil spring subgrade modulus in each translational direction is calculated as follows:

$$\text{Horizontal soil spring modulus, } k_x = k_y = 1453 \text{ kip/ft}^3 \quad (\text{Equation A-4})$$

$$\text{Vertical soil spring modulus, } k_z = 1682 * \left(3.85 - 3.47 \sqrt{1 - \frac{x^2}{2l^2} - \frac{y^2}{2b^2}} \right) \text{ kip/ft}^3 \quad (\text{Equation A-5})$$

where: $l = b = 59.2 \text{ ft}$.

From the inherent distribution of vertical and horizontal spring subgrade modulus shown in Equation A-4 and A-5, available total rotational soil spring constants for NAB basemat are calculated as follows and shown in Table A-3:

$$k_{rx} = \sum k_z * y^2, \quad k_{ry} = \sum k_z * x^2, \quad k_{rz} = \sum k_y * x^2 + \sum k_x * y^2 \quad (\text{Equation A-6})$$

Table A-3—Available Rotational Soil Spring Subgrade Modulus

Available Rotational Soil Springs from the Distribution of Translational Soil Springs			
Soil	K_{rh}	K_{rh}	K_{rv}
Case	kip-ft/radian	kip-ft/radian	kip-ft/radian
4ue	2.166×10^{10}	2.957×10^{10}	4.774×10^{10}

However, the distribution of vertical and horizontal translational springs yields 43 percent, 59 percent, and 59 percent of rotational springs, about the x, y, and z directions compared to rotational springs calculated from Gazeta's equation (compare rotational springs between Table A-1 and Table A-3).

Consideration of Damping in NAB Stability Analysis:

Horizontal and vertical soil spring constants (K_h and K_z) and dashpot values (C_h and C_z) for soil springs are calculated using Gazeta's formula. Equivalent alpha (α_s) and beta (β_s) values are calculated to consider 7 percent material damping for the superstructure. Alpha and beta damping are proportional to mass and stiffness of elements and are applied to the full system. Since spring elements do not contribute mass to the system, application of alpha damping does not affect the damping. However, beta damping will add additional damping amounts of $\beta_s K_h$ and $\beta_s K_z$ to the horizontal and vertical soil springs, respectively, when it is applied as a material property to soil springs. Therefore, this amount of damping is reduced to calculate effective dashpot values. The calculation of horizontal and vertical damping distribution is shown below:

$$\text{Effective Horizontal Damping, } C_{h,\text{eff}} = C_h - \beta_s K_h$$

$$\text{Effective Vertical Damping, } C_{z,\text{eff}} = C_z - \beta_s K_z$$

$$\text{Distributed Horizontal Spring Dashpot, } c_h = C_{h,\text{eff}}/A_b$$

$$\text{Distributed Vertical Spring Dashpot, } c_z = C_{z,\text{eff}}/A_b$$

where, A_b = Area of the NAB basemat.

$$\text{Horizontal Spring Dashpot for a Node } C_{h1} = c_h * A_n$$

$$\text{Vertical Spring Dashpot for a Node, } C_{z1} = c_z * A_n$$

where, A_n = Contributory NAB Basemat Area to a Node.

For solutions with linear springs, spring dashpot damping is applied as a material property to the soil springs. This spring material property is calculated for the spring elements as follows:

$$\text{Material damping for the horizontal soil spring, } c_{hr1} = c_h * A_n * (2 * \pi * f_h) / (2 * k_{h1})$$

$$\text{Material damping for the vertical soil spring, } c_{zr1} = c_z * A_n * (2 * \pi * f_v) / (2 * k_{z1})$$

where k_{h1} and k_{z1} are horizontal and vertical spring constants for a node, which depends on average distribution of soil spring modulus, spring distribution coefficient from the elliptical distribution assumption, and contributory area of the node.

For solutions with nonlinear vertical springs, soil springs and dampers are modeled separately. Horizontal and vertical soil springs are modeled without material damping. Damping is applied with three additional damper elements in three translational directions. Beta damping will not add additional damping to the soil springs when damping is not applied as material property ($C_{h,eff} = C_h$ and $C_{z,eff} = C_z$). Horizontal and vertical dashpot values for a node are calculated based on the contributory area of the node and distributed damping values. These dashpot values are applied as damping constants for the horizontal and vertical damper elements.

The NAB stability model is further verified through comparison of in-structure response spectra obtained from nonlinear sliding and overturning analysis and linear SASSI analysis at NAB basemat -39.40 ft (-12.01 m), at 97.6 ft (29.75 m) and 117.22 ft (35.75 m) elevations. The comparison of response spectra at those locations of NAB (with cracked properties) for soil cases 1n2ue and 2sn4ue are shown in Figures A-1 and A-2, respectively. The legends 1n2ue-cr and 2sn4ue-cr represent the in-structure response spectra from SASSI analysis for NAB model with cracked properties. The legends 1n2ue-ANSYS and 2sn4ue-ANSYS represent the response spectra from sliding and overturning analysis done in ANSYS for NAB model with cracked properties.

References:

- A.1. H.Y. Fang, Ed., Van Nostrand Reinholds, "Foundation Vibrations," Foundation Engineering Handbook, 2nd Edition, Chapter 15, pp.553-593,1991.

Figure A-1—Comparison of Response Spectra for Soil Case 1n2ue between SASSI and ANSYS

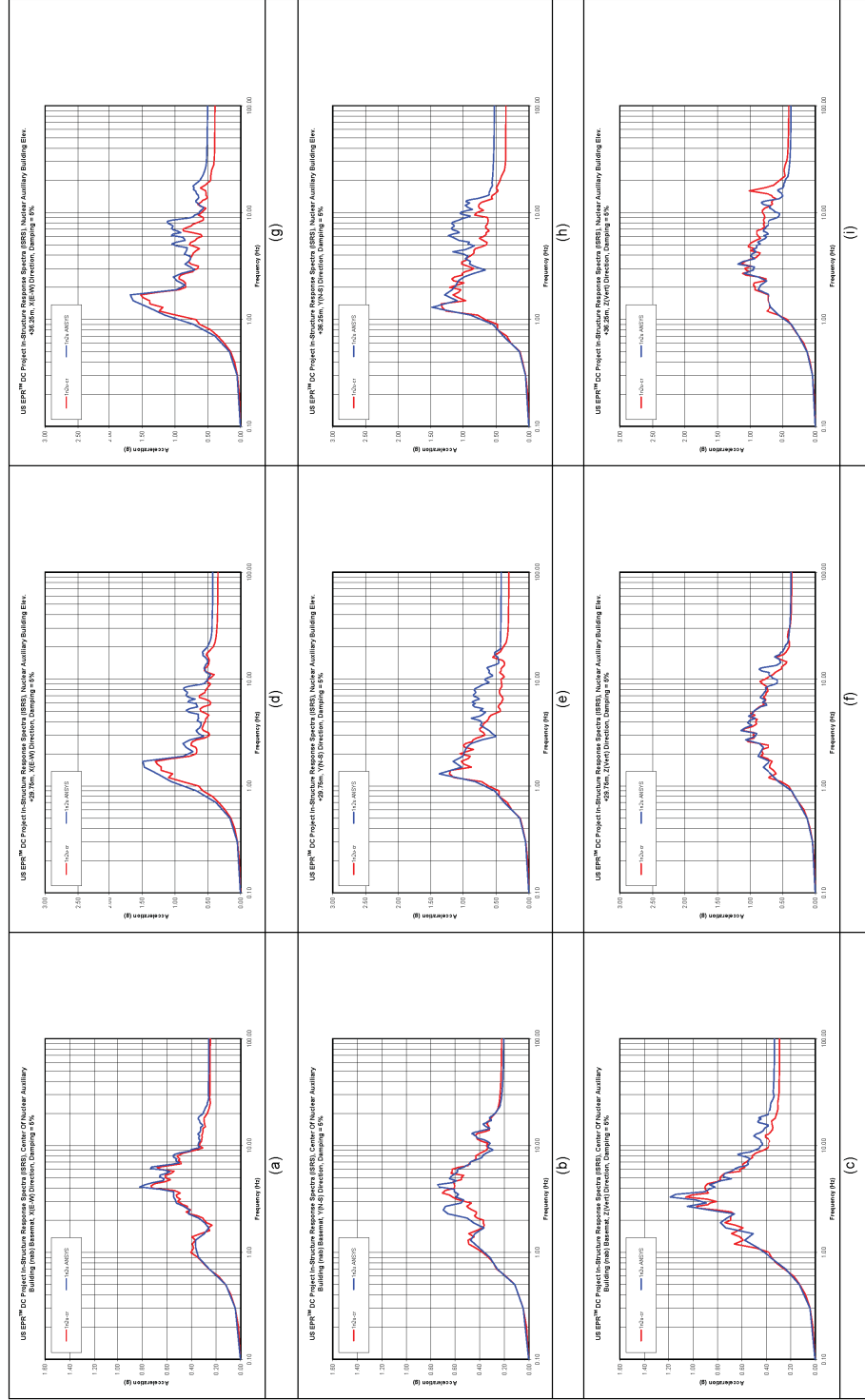
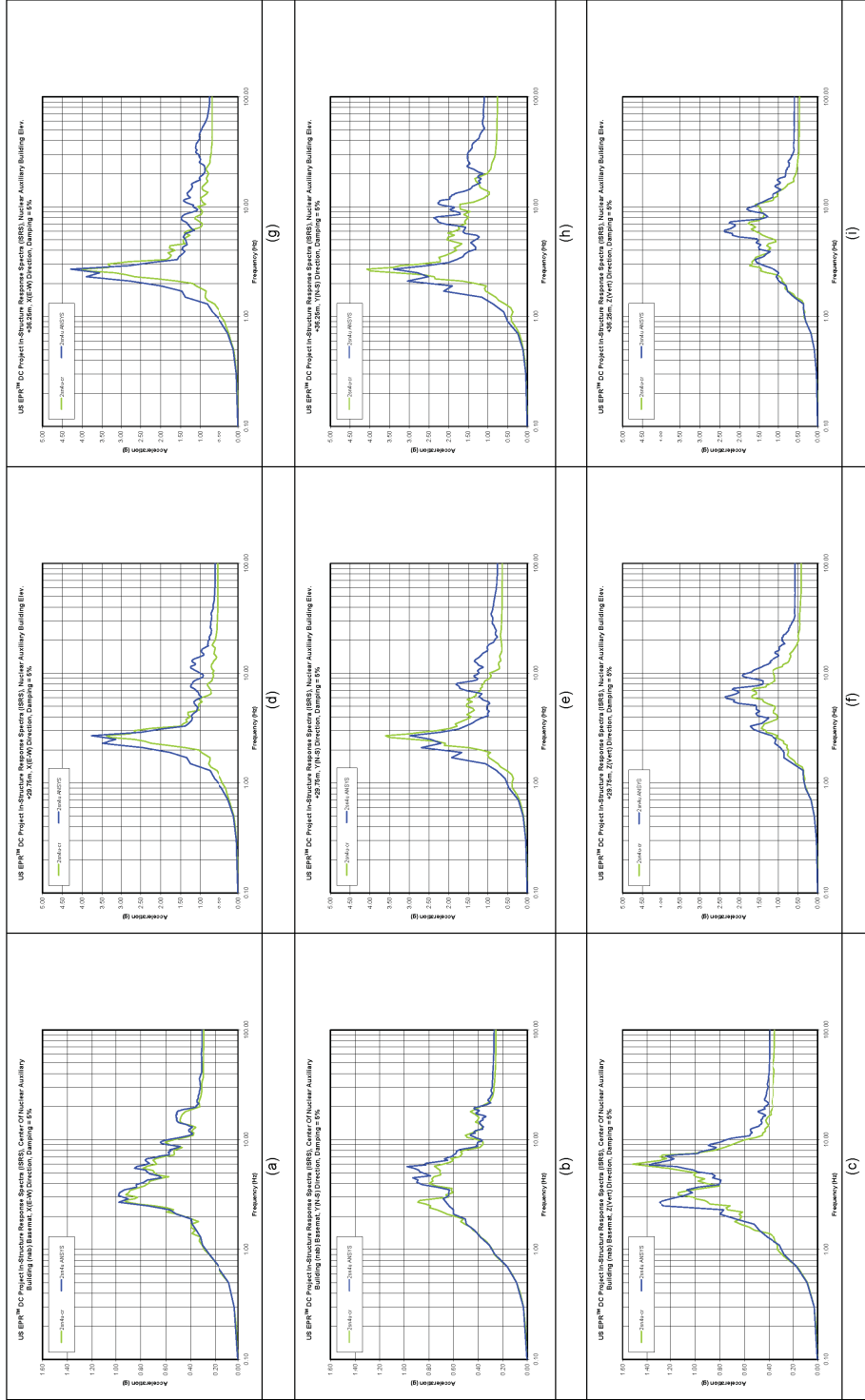


Figure A-2—Comparison of Response Spectra for Soil Case 2sn4ue between SASSI and ANSYS

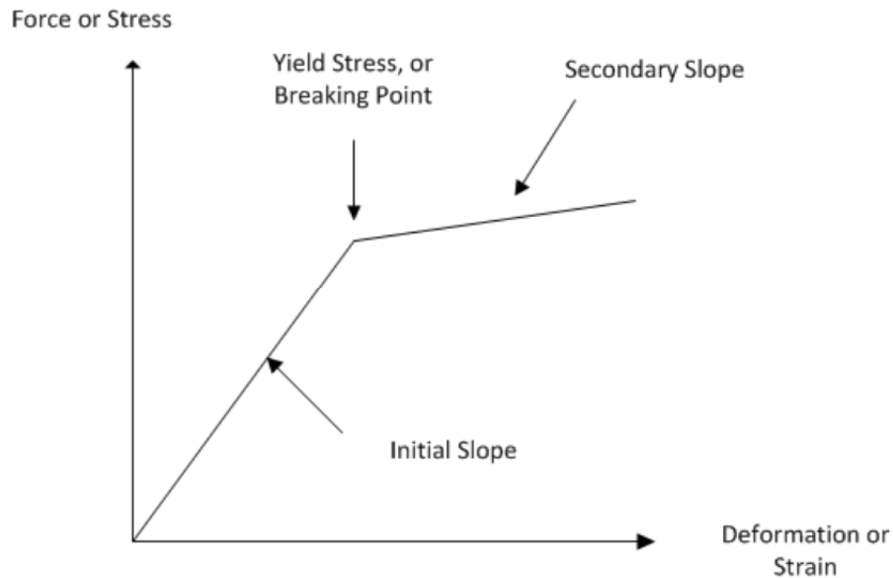


ATTACHMENT B: BILINEAR SOIL SPRINGS DETAILS

The dynamic bearing pressures obtained from time history analysis are usually high at the corners of the basemat due to singularity effect. At these high stresses, soil behaves nonlinearly and pressures are redistributed due to localized yielding of the soil.

The soil elements underneath a foundation redistribute the stresses as they go into the plastic zone. According to the idealized perfectly elastoplastic soil behavior, redistribution takes place at the yield point. After the yield point, the slope of the stress-strain behavior becomes close to zero. In more realistic soil constitutive models (nonlinear soil hardening models), the slope is not actually zero, but is significantly less than the slope for the stresses less than the yield stress. When soil behavior is approximated by bilinear springs, this behavior could be modeled or approximated by defining the yield stress as the breaking point in the curve, initial slope, and secondary slope (see Figure B-1).

Figure B-1—Bilinear Spring Definition



The yield stress for a local soil element underneath the foundation may be correlated to the bearing capacity of the foundation. The bearing capacity of the foundation corresponds to the case, where a series of soil elements undergo plastic deformation forming the classical bearing capacity failure underneath the foundation. However, well below the bearing capacity, the soil elements at the edges of the foundation start experiencing plastic deformations (i.e., they reach the yield stress). The allowable bearing capacity may be used to define this stress level, which is typically three times less than the bearing capacity of the foundation. Yield stress is not expected to be exactly equal to the allowable bearing capacity. However, this is considered a reasonable approximation given the already existing uncertainty involved in modeling soil behavior with linear or bilinear soil springs.

The secondary slope of the force-deformation curve can be assumed approximately ten percent of the initial slope (linear soil spring constant that is realized before the yield stress). Even though idealized elastoplastic soil behavior would require defining a zero secondary slope, this is not considered realistic, and a minor slope (ten percent of initial slope) is used instead.

Available information in the U.S. EPR FSAR is limited to the unit weight and shear wave velocity for each soil profile. Required input parameters such as soil type, cohesion, and friction angle are not available to be used in classical bearing capacity equations. Therefore, allowable bearing capacities are determined based on an approximate relationship between the shear wave velocity, unit weight, and allowable bearing capacity as provided by Reference B.1.

The ultimate bearing capacity is dependent on contribution from the shear strength of the soil, contribution from the surcharge pressure due to the depth of the footing and overburden pressure, and contribution from the self-weight (Reference B.1). When the contributions from shear strength and surcharge pressure are ignored, the allowable bearing capacity (in kPa) is conservatively calculated with a factor of safety 3.0 based on the formulation given in Reference B.1, which is expressed as:

$$q_a = 0.024 \gamma V_s \text{ for } V_s \leq 500 \text{ m/sec} \quad (\text{Equation B-1a})$$

$$= \text{minimum } (0.024 \gamma V_s S_v, 30.6 \gamma) \text{ for } V_s > 500 \text{ m/sec} \quad (\text{Equation B-1b})$$

$$= 30.6 \gamma \text{ for } V_s \geq 2000 \text{ m/sec} \quad (\text{Equation B-1c})$$

Where: γ = unit weight (kN/m^3), v_s = shear wave velocity (m/sec), and S_v = reduction factor

The reduction factor S_v is given by : $S_v = 1 - 3 \times 10^{-6} (V_s - 500)^{1.6}$

Equivalent soil properties are used to calculate the allowable bearing capacity. Equivalent soil properties are determined for a depth equal to B (Width, B = 106.17 ft, and length, L = 120.75 ft), and are based on the weighted average. Most of the soil profiles have constant shear wave velocity under foundation elevation, except for 2sn4ue. The equivalent soil properties are calculated as given in Table B-1. Using the equivalent soil properties given in Table B-1 and Equation B-1, and the allowable bearing capacity for each soil profile are calculated as listed in Table B-2.

Table B-1—Equivalent Soil Properties

Soil Property	SOIL TYPE							
	5ae	1n5ae	4ue	2sn4ue	1n2ue	BBLB	BBBE	BBUB
γ_1 (pcf)	156	156	120	110	110	170	170	170
γ_2 (pcf)	156	156	120	120	110	170	170	170
γ_{Eq} (pcf)	156	156	120	115.5 ¹	110	170	170	170
V_{s1} (ft/sec)	13120	6600	3937	1640	820	5894	7220	8843
V_{s2} (ft/sec)	13120	6600	3937	3937	820	5894	7220	8843
V_{sEq} (ft/sec)	13120	6600	3937	2901 ¹	820	5894	7220	8843

Note:

1. Weighted average is used to calculate the equivalent soil property.

Table B-2—Allowable Bearing Capacities for the Soil Cases

Soil Property	SOIL TYPE							
	5ae	1n5ae	4ue	2sn4ue	1n2ue	BBLB	BBBE	BBUB
q_a (ksf)	15.66	15.66	10.18	7.75	2.17	17.07	17.07	17.07

Bearing Capacity Calculation for Soil Case 2sn4ue:

Soil case 2sn4ue, the soil properties vary through the depth profile. The soil properties for this case are summarized in Table B-3:

Table B-3—Properties for Soil case 2sn4ue

Layer No	Layer Thickness	Weight Density	Shear Wave Velocity V_s	Poisson's Ratio
	(ft)	pcf	(ft/sec)	
1	87.3	110	1,640	0.40
2	Half-Space	120	3,937	0.40

The embedment of the NAB is 39.40 feet. For soil case 2sn4u, the thickness of soil layers for the bearing capacity analysis is determined using a total influence depth of $B = 106.10$ feet below the embedment depth. Table B-4 lists the used soil layer thickness and weighted average of the soil properties:

Table B-4—Layered Thickness and Properties for Soil Case 2sn4ue

Layer No	Layer Thickness	Weight Density	Shear Wave Velocity V_s	Poisson's Ratio
	(ft)	pcf	(ft/sec)	
1	47.9	110	1,640	0.40
2	58.2	120	3,937	0.40
Weighted Average	106.1	115.5	2,901	0.40

The soil parameters, reduction factors, and allowable bearing capacity calculation are shown in Table B-5. Allowable bearing capacity for soil case 2sn4ue is 7.75 ksf.

Table B-5—Soil Case 2sn4ue: Soil Parameters, Reduction Factors, and Allowable Bearing Capacity Calculation

Soil Case	Soil Properties
Weight Density γ , pcf	115.5
Shear Wave Velocity V_s , ft/sec	2,901
Reduction Factor, S_v	0.96
Bearing Capacity, ksf ($0.024 \times V_s \times \gamma \times S_v$)	7.75
Bearing Capacity, ksf ($30.6 \times \gamma$)	11.60

References:

- B.1. S. S. Tezcan, A. Keceli, Z. Ozdemir, "Allowable Bearing Capacity of Shallow Foundations Based on Shear Wave Velocity," Technical Note, Geotechnical and Geological Engineering, 24:203-213, 2006.

ATTACHMENT C: TIME HISTORIES OF SIDE SPRING FORCES, TOTAL DRIVING SHEAR FORCES, AND LATERAL DISPLACEMENTS

Soil pressures on the buried part of the NAB side walls are function of the relative movements of the side walls. The side wall pressures are idealized with nonlinear soil springs with active state, at-rest state, and passive state. The guidelines presented in Foundations & Earth Structures, Design Manual 7.02 (NAVFAC DM-7.02) are used to compute sidewall spring coefficients. The formulas for active and passive pressure are based on a frictionless vertical wall face. The frictionless vertical wall accounts for the use of a waterproofing membrane on the embedded walls. The active pressure (p_a), passive pressure (p_p), and at-rest pressure (p_o) are dependent on the depth of soil z by the following equations:

$$p_a = K_a \gamma z$$

$$p_o = K_o \gamma z$$

$$p_p = K_p \gamma z$$

where: K_a , K_p and K_o are active, passive, and at-rest earth pressure coefficients, and γ is the unit weight of the soil.

The intensities of earth pressures depend on the wall movements, as these control the degree of shear strength mobilization in the surrounding soil. According to NAVFAC DM-7.02, the magnitude of wall rotation required to reach failure for a loose cohesionless soil material is 0.002 for the active state and 0.006 for the passive state. The depth of NAB basemat, H , is 12.04 meter (474 in). Hence, these rotations correspond to wall lateral movements of $0.002H$ (0.948 in) for active state and $0.006H$ (2.844 in) for the passive state for the NAB sidewalls. The values for earth pressure coefficients K_a , K_p , and K_o are 0.33, 3.0, and 0.50, respectively, for a friction angle of 30° . Saturated Soil densities listed in Table B-2 of Attachment B are considered. The side springs are modeled in two ways. First, side spring coefficients are based on initial position of the NAB sidewalls. Figure C-1 shows the coefficients of earth pressure and their corresponding wall movement. Lateral movement of NAB side walls demonstrate that net displacement of NAB is predominantly away from the soil. Therefore, active soil coefficient served as the basis of calculating the sidewall pressure according to Figure C-1. Since the NAB side wall springs are based on the net displacement of side walls, NAB experiences active earth pressure for any lateral movement towards the soil if it is less than net displacement.

The NRC position is that use of active earth pressure coefficient based on net displacement may not be conservative. The NRC understands use of passive earth pressure coefficient for any lateral movement towards the soil and neglecting the net displacement is also not appropriate and conservative. Since the NAB structure experiences large lateral displacements, loading and unloading curve for side wall springs should generate a hysteretic loop. The NAB study modified the sidewall springs, which conservatively considers the passive earth pressure when the soil moves towards the soil with a hysteretic loop as shown in Figure C-2 and performs time history analysis.

Soil case 4u represents the most critical case for lateral movement and shows a maximum lateral movement of 6.81 inch in Y direction (north direction) for NAB superstructure with flexural

and shears stiffness reduced to 50 percent and basemat supported on linear vertical springs. Soil case 4u results are used to check the time history of side spring forces for both side spring cyclic curve:

1. Side spring force-deflection curve without hysteretic loop as shown in Figure C-1.
2. Side spring force-deflection curve with hysteretic loop as shown in Figure C-2.

Figure C-3 shows the results from NAB model with side springs without any hysteretic loop. Figure C-3(a) demonstrates lateral displacement time histories of a side wall node. Figure C-3(b) demonstrate the time history of the lateral resistance generated by the side spring attached to that node. Figures C-3(c) and C-3(d) demonstrate time histories of the total driving shear force at basemat and total force at side wall, respectively. Figure C-4 shows the results similar to Figure C-3 for the NAB model with side springs with hysteretic loop (shown in Figure C-2) for superstructure flexural and shears stiffness reduced to 50 percent and basemat supported on nonlinear vertical springs.

References:

- C.1. NAVFAC DM-7.02, "Foundations and Earth Structures," Design Manual 7.02, Naval Facilities Engineering Command, Alexandria, VA, September 1986.

Figure C-1—Variation of Side Wall Earth Pressure Coefficient without Hysteretic Loop

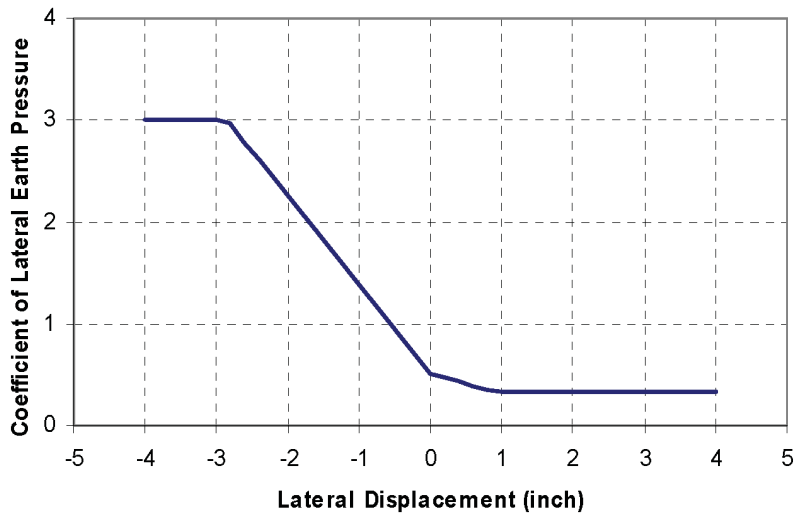


Figure C-2—Variation of Side Wall Earth Pressure Coefficient with Hysteretic Loop

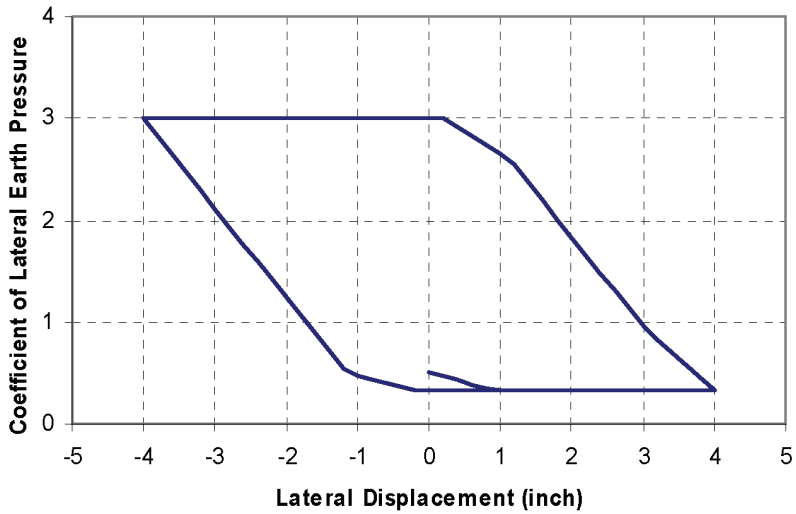
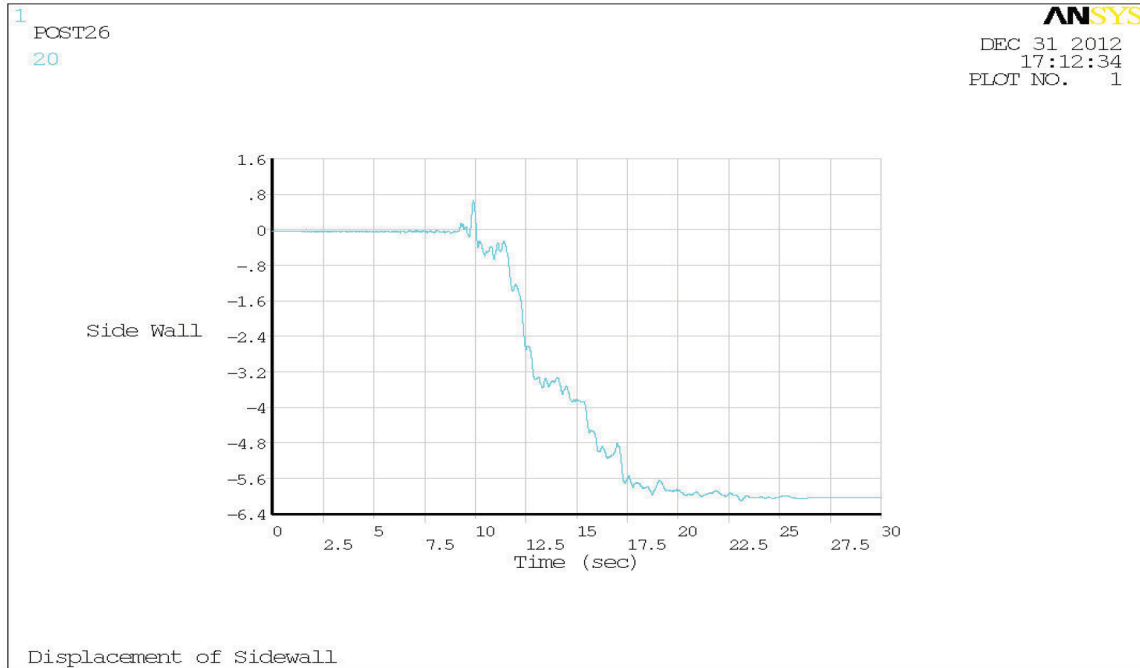


Figure C-3—Time History from NAB Model with Side Springs without Hysteretic Loop

- a) Lateral Displacement in Y Direction for NAB Side Wall Node
(+ Displacements Denote Structure is Moving Towards the Soil)



- b) Side Spring Resistance from the Same Node

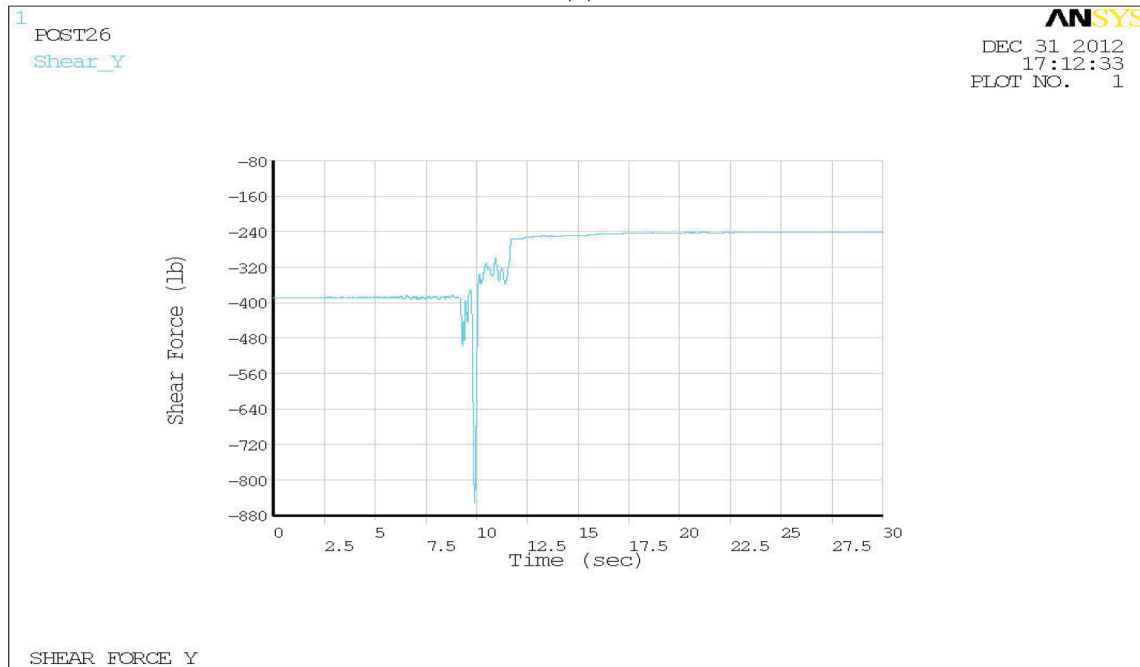
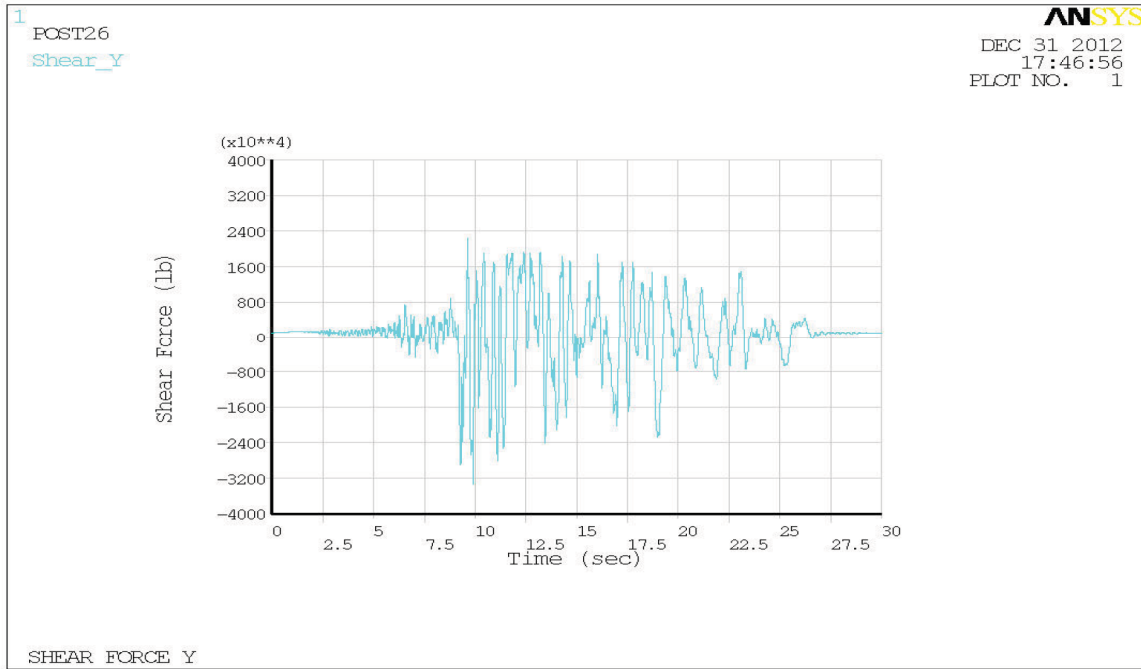


Figure C-3—Time History from NAB Model with Side Springs without Hysteretic Loop
(continued)

c) Total Driving Shear Force



d) Summation of Lateral Spring Forces in Y Direction Located on South Side Wall

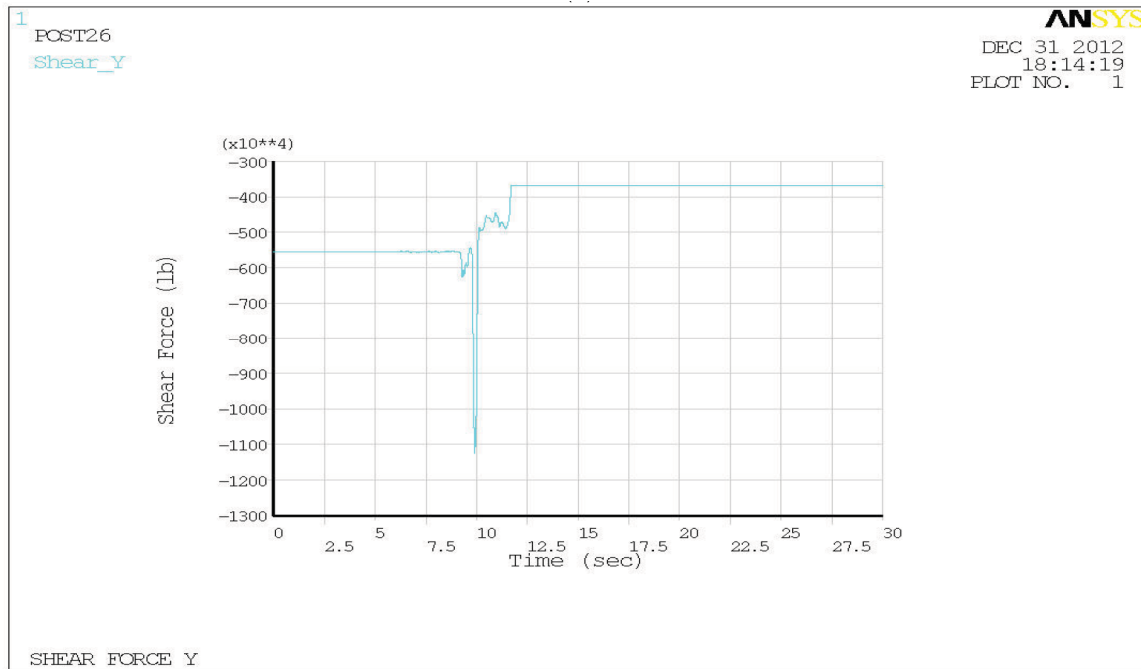
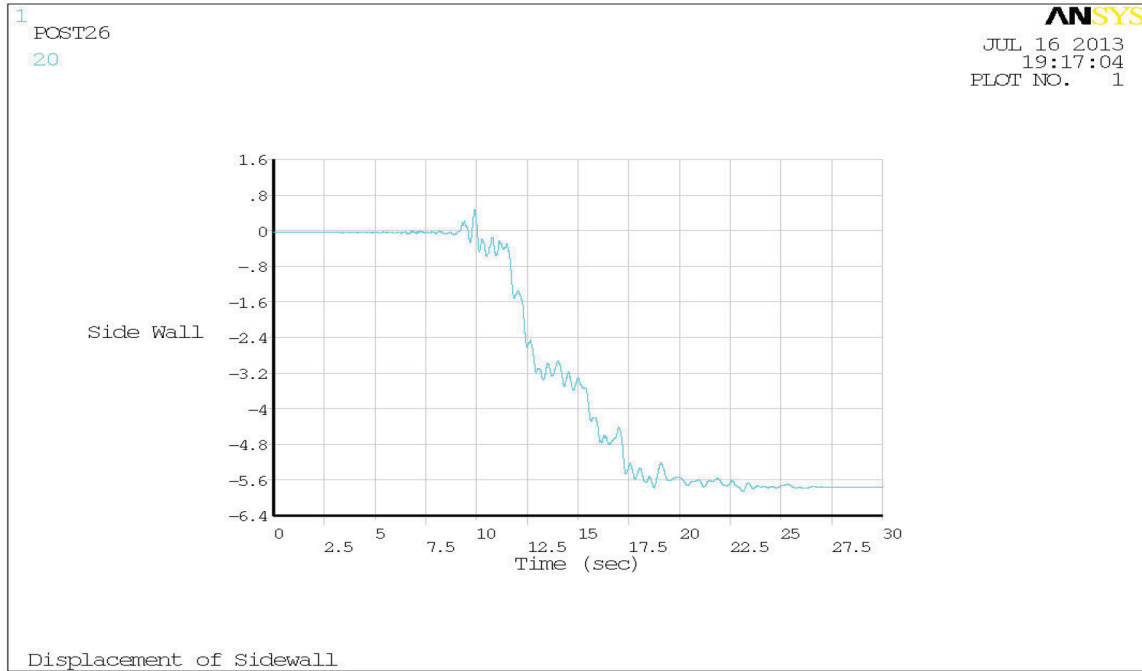


Figure C-4: Time History from NAB Model with Side Springs with Hysteretic Loop

- a) Lateral Displacement in Y Direction for NAB Side Wall Node
(+ Displacements Denote Structure is Moving Towards the Soil)



- b) Side Spring Resistance from the Same Node

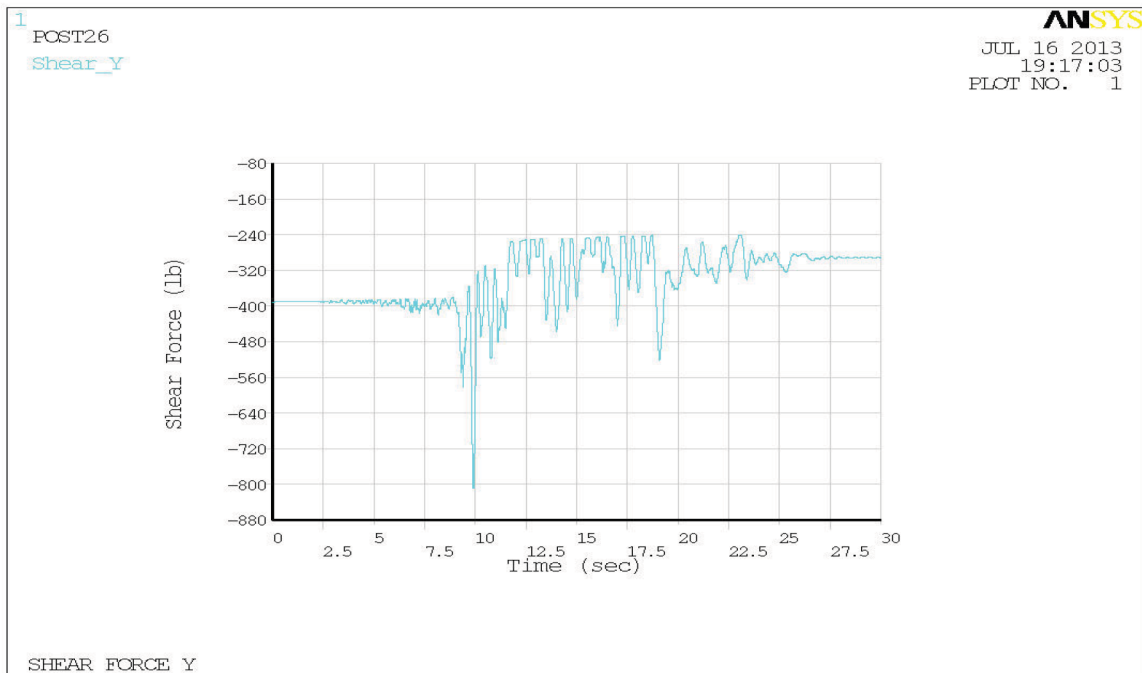
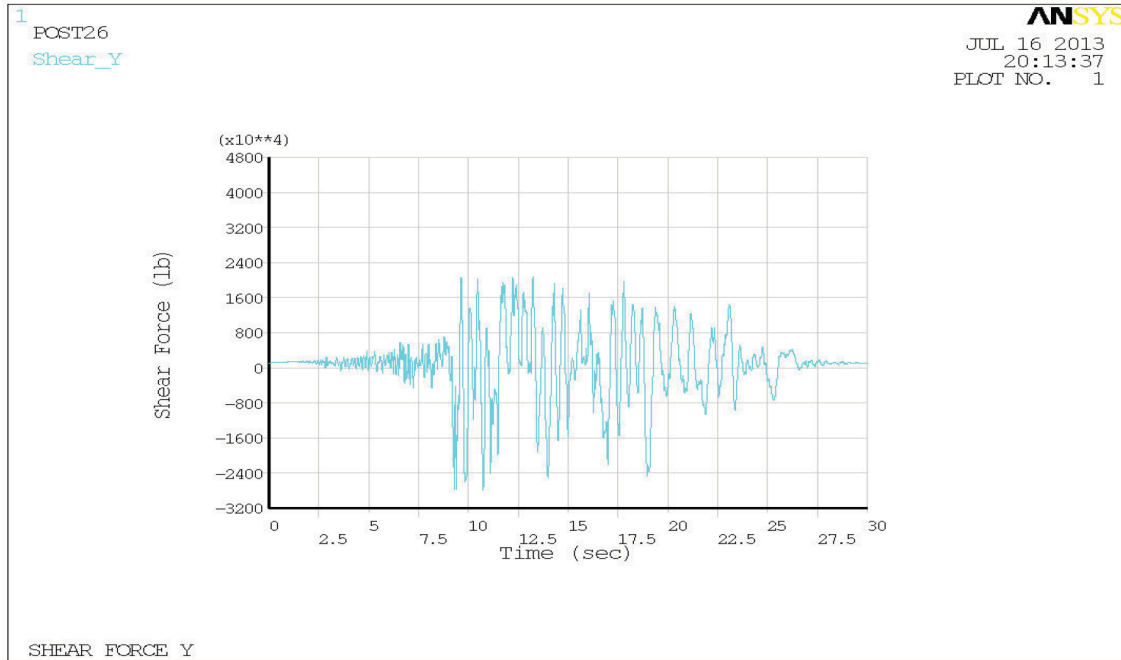
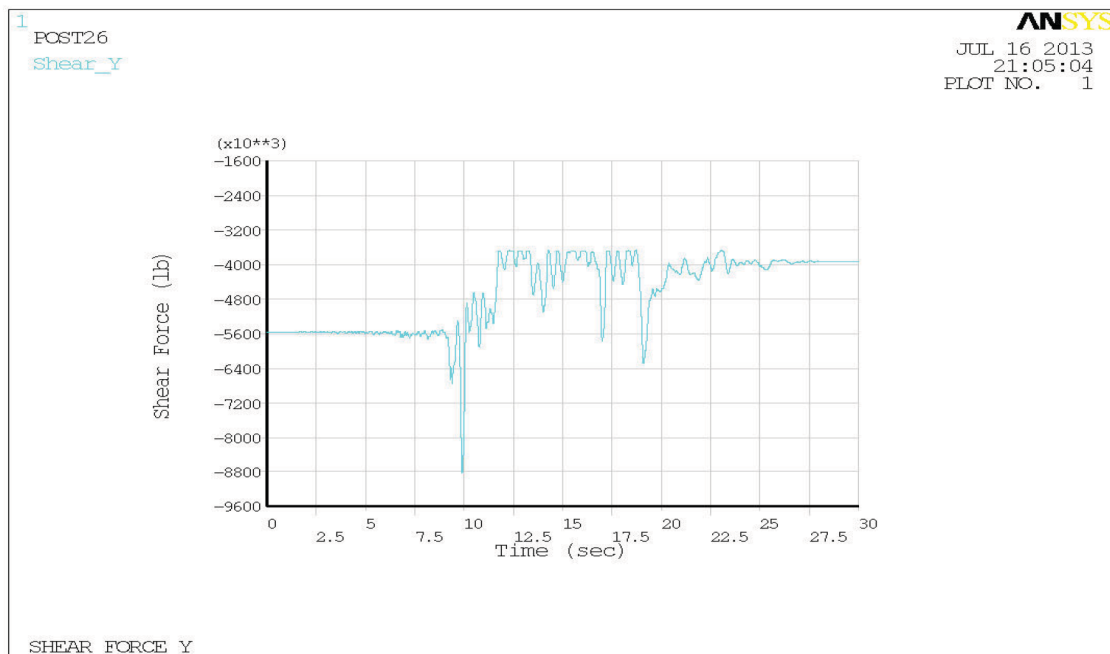


Figure C-4: Time History from NAB Model with Side Springs with Hysteretic Loop
(continued)

c) Total Driving Shear Force



d) Summation of Lateral Spring Forces in Y Direction Located on South Side Wall



ATTACHMENT D: APPLICATION OF INPUT MOTIONS TO NAB STABILITY MODEL

RG 1.60 TS-based seismic motions are directly used for the NAB stability analysis. EUR and HF motions are modified to consider the influence of the NI. These motions are obtained from the SASSI analyses for the US EPR site finite element model with embedded structures, which includes an NAB stick model. These analyses determine three translational and three rotational acceleration time histories at the center of the NAB basemat. These translational and rotational time histories are referred to as “modified EUR” and “modified HF” motions and are used as input for the NAB stability analysis.

NAB stability analyses under seismic motions are performed using finite element code ANSYS. In ANSYS, the transient analyses can be performed by two methods: (1) large mass method, or (2) structure subjected to global acceleration. For the first method, a very large mass (compared to the mass of the superstructure) is attached to the base of the structure. The translational and rotational accelerations are applied to the large mass to simulate base excitation. This methodology is equivalent to application of integrated displacements and rotations (obtained from integration of translational and rotational acceleration time histories) at the base of the structure. The base of the structure is not restrained and the displacement response of the structure is absolute. Relative displacements of a point can be obtained through deduction of displacements of the large mass and the displacement from the large mass rotations, which is a function of the large mass rotations and the distance from that point to the large mass. In the second method, the base of the structure is restrained and the superstructure is excited using the global acceleration inputs. Since the base of the structure is restrained, displacement of the structure is the relative response of the structure. In this method, ANSYS takes the input acceleration as global acceleration input to the system and the system is solved for relative motion of the structure. Relative displacements from the large mass method or the structure subjected to global acceleration method are identical.

RG 1.60 TS-based seismic motions are based on three translational acceleration time histories. Displacement time histories are calculated through integration of acceleration time histories in three directions. These displacement time histories are applied at the base of the NI stability model.

Modified EUR (soft, medium and hard) and HF acceleration motions (three translational and three rotational acceleration time histories) are applied to the superstructure of NAB stability model. Since these motions are obtained from SASSI analysis with NI FEM model and NAB stick model, these motions include the Structure Soil Structure Interaction (SSSI) and Soil Structure Interaction (SSI) effects. However, the NAB stability model contains equivalent soil springs and dampers. Use of the modified EUR and HF motions in the NAB stability analysis has the potential to double count the SSI effects. Comparison of the ISRS, between the NAB stick model response from SASSI and the NAB finite element model response from ANSYS (shown in Attachment A), shows the nominal influence from the potential double counting of the SSI effect.

ATTACHMENT E: COMPARISON OF NAB STABILITY PARAMETERS UNDER INPUT MOTIONS OBTAINED FROM SASSI ANALYSIS WITH SUBTRACTION AND DIRECT METHODS FOR GENERIC SOIL CASES

A comparative study is performed using the acceleration motions from the subtraction and direct methods of SASSI analyses. The NAB stability model with bilinear vertical soil springs and modified side springs is used in this study for the generic soil cases (1n2ue, 2sn4ue, 4ue, 1n5ae, and 5ae). The NAB stability parameters (i.e., the maximum sliding in X and Y directions, uplift in Z directions, maximum bearing pressure, and maximum lateral displacements of NAB peak points) are summarized in Table E-1. Comparison of the NAB results demonstrates that results from subtraction method are either conservative or comparable to direct method results.

Table E-1: Comparison of NAB Stability Parameters between Direct and Subtraction Methods

Item	Generic Soil Cases													
	1n2ue			2sn4ue			4ue			1n5ae			5ae	
	Direct Method	Subtr. Method		Direct Method	Subtr. Method		Direct Method	Subtr. Method		Direct Method	Subtr. Method		Direct Method	Subtr. Method
Maximum Sliding in X Direction (inch)	0.05	0.06		0.45	0.78		0.17	0.34		0.06	0.08		0.08	0.07
Maximum Sliding in Y Direction (inch)	0.06	0.07		0.86	1.79		0.54	0.76		0.32	0.39		0.25	0.25
Maximum Uplift in Z Direction (inch)	0.00	0.00		0.71	0.55		0.33	0.41		0.18	0.19		0.18	0.17
Maximum Bearing Pressure (ksf)	19.75	19.70		20.61	21.88		27.29	28.42		36.46	37.30		59.58	59.02
Maximum Top Displacement in X direction (inch)	3.59	4.46		2.18	2.63		1.16	1.25		0.63	0.70		0.53	0.51
Maximum Top Displacement in Y direction (inch)	4.08	6.16		2.29	3.40		1.45	1.66		0.97	1.01		0.90	0.91