ArevaEPRDCPEm Resource

From: WILLIFORD Dennis (AREVA) [Dennis.Williford@areva.com]
Sent: Thursday, July 07, 2011 1:49 PM
To: Tesfaye, Getachew
Cc: BENNETT Kathy (AREVA); DELANO Karen (AREVA); ROMINE Judy (AREVA); RYAN Tom (AREVA); Miernicki, Michael
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 24
Attachments: RAI 376 Supplement 24 Response US EPR DC - PUBLIC - Part 1 of 2.pdf

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25. On August 27, 2010, AREVA NP submitted Supplement 10 to provide INTERIM responses for Questions 03.08.05-25 and 03.08.05-29. AREVA NP submitted a revised schedule for the final response to question 03.08.05-30 in Supplements 11 and 12 on September 15, 2010 and October 7, 2010, respectively. On October 25, 2010, AREVA NP submitted Supplement 13 to provide INTERIM responses for Questions 03.08.05-28 and 03.08.05-31. AREVA NP submitted Supplement 14 on October 25, 2010, to provide a revised schedule for Question 03.08.05-29. On November 22, 2011, AREVA NP submitted Supplement 15 to provide FINAL responses to Questions 03.08.05-27 and 03.08.05-30. AREVA NP submitted Supplement 16 on February 8, 2011, to provide a revised schedule for Question 03.08.05-25 and FINAL responses to Questions 03.08.05-24, 03.08.05-26 and 03.08.05-29. On February 11, 2011, AREVA NP submitted Supplement 17, to provide a revised schedule for Question 03.08.05-28 and Question 03.08.05-31. AREVA NP submitted a revised schedule for Question 03.08.05-25 in Supplements 18 and 19 on March 18, 2011 and April 19, 2011, respectively. On May 2, 2011, AREVA NP submitted Supplement 20, to provide a revised schedule for Question 03.08.05-28 and Question 03.08.05-31. AREVA NP submitted a revised schedule for Question 03.08.05-25 in Supplement 21 on May 20, 2011. On June 9, 2011, AREVA NP submitted Supplement 22, to provide a final response to Question 03.08.05-25. On June 27, 2011, AREVA NP submitted Supplement 23 to provide a revised INTERIM response for Question 03.08.05-28.

The attached file, “RAI 376 Supplement 24 Response US EPR DC - PUBLIC (Part 1 of 2).pdf” and the file “RAI 376 Supplement 24 Response US EPR DC - PUBLIC (Part 2 of 2).pdf” in a subsequent email provides a technically correct INTERIM response to Question 03.08.05-31. Appended to these files are the affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 376 Question 03.08.05-31. Because the response 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.

The following table indicates the page in the response document, “RAI 376 Supplement 24 Response US EPR DC - PUBLIC (Part 1 of 2).pdf” and the file “RAI 376 Supplement 24 Response US EPR DC - PUBLIC (Part 2 of 2).pdf” that contains AREVA NP’s response to the subject question.

Question #	Start Page	End Page
RAI 376 — 03.08.05-31	2	4

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-28	October 25, 2010 (Actual) June 27, 2011 (Actual)	October 10, 2011
RAI 376-03.08.05-31	October 25, 2010 **July 7, 2011 (Actual)**	November 30, 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: WILLIFORD Dennis (RS/NB)
Sent: Monday, June 27, 2011 4:47 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. 376, FSAR Ch. 3, Supplement 23

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25. On August 27, 2010, AREVA NP submitted Supplement 10 to provide INTERIM responses for Questions 03.08.05-25 and 03.08.05-29. AREVA NP submitted a revised schedule for the final response to question 03.08.05-30 in Supplements 11 and 12 on September 15, 2010 and October 7, 2010, respectively. On October 25, 2010, AREVA NP submitted Supplement 13 to provide INTERIM responses for Questions 03.08.05-28 and 03.08.05-31. AREVA NP submitted Supplement 14 on October 25, 2010, to provide a revised schedule for Question 03.08.05-29. On November 22, 2011, AREVA NP submitted Supplement 15 to provide FINAL responses to Questions 03.08.05-27 and 03.08.05-30. AREVA NP submitted Supplement 16 on February 8, 2011, to provide a revised schedule for Question 03.08.05-25 and FINAL responses to Questions 03.08.05-24, 03.08.05-26 and 03.08.05-29. On February 11, 2011, AREVA NP submitted Supplement 17, to provide a revised schedule for Question 03.08.05-28 and Question 03.08.05-31. AREVA NP submitted a revised schedule for Question 03.08.05-25 in Supplements 18 and 19 on March 18, 2011 and April 19, 2011, respectively. On May 2, 2011, AREVA NP submitted Supplement 20, to provide a revised schedule for Question 03.08.05-28 and Question 03.08.05-31. AREVA NP submitted a revised schedule for Question 03.08.05-25 in Supplement 21 on May 20, 2011. On June 9, 2011, AREVA NP submitted Supplement 22 to provide a final response to Question 03.08.05-25.

The attached file, "RAI 376 Supplement 23 Response US EPR DC - INTERIM.pdf (Part 1 of 2).pdf" and the file "RAI 376 Supplement 23 Response US EPR DC - INTERIM.pdf (Part 2 of 2).pdf" in a subsequent email, provide a technically correct INTERIM response to Question 03.08.05-28, as committed. Appended to the file "RAI 376 Supplement 23 Response US EPR DC - INTERIM.pdf (Part 2 of 2).pdf" are the affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 376 Question 03.08.05-28.

The following table indicates the respective pages in the response document, "RAI 376 Supplement 23 Response US EPR DC - INTERIM.pdf (Part 1 of 2).pdf" and "RAI 376 Supplement 23 Response US EPR DC - INTERIM.pdf (Part 2 of 2).pdf" that contain AREVA NP's INTERIM response to Question 03.08.05-28.

Question #	Start Page	End Page
RAI 376 — 03.08.05-28	2	50

The schedule for the final response to Question 03.08.05-28 and Question 03.08.05-31 is being revised. The schedule for technically correct and complete responses to the remaining questions is provided below:

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-28	October 25, 2010 (Actual) **June 27, 2011 (Actual)**	**October 10, 2011**
RAI 376-03.08.05-31	October 25, 2010	**November 30, 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: WILLIFORD Dennis (RS/NB)
Sent: Thursday, June 09, 2011 12:46 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. 376, FSAR Ch. 3, Supplement 22

Getachew,

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

AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25. On August 27, 2010, AREVA NP submitted Supplement 10 to provide INTERIM responses for Questions 03.08.05-25 and 03.08.05-29. AREVA NP submitted a revised schedule for the final response to question 03.08.05-30 in Supplements 11 and 12 on September 15, 2010 and October 7, 2010, respectively. On October 25, 2010, AREVA NP submitted Supplement 13 to provide INTERIM responses for Questions 03.08.05-28 and 03.08.05-31. AREVA NP submitted Supplement 14 on October 25, 2010, to provide a revised schedule for Question 03.08.05-29. On November 22, 2011, AREVA NP submitted Supplement 15 to provide FINAL responses to Questions 03.08.05-27 and 03.08.05-30. AREVA NP submitted Supplement 16 on February 8, 2011, to provide a revised schedule for Question 03.08.05-25 and FINAL responses to Questions 03.08.05-24, 03.08.05-26 and 03.08.05-29. On February 11, 2011, AREVA NP submitted Supplement 17, to provide a revised schedule for Question 03.08.05-28 and Question 03.08.05-31. AREVA NP submitted a revised schedule for Question 03.08.05-25 in Supplements 18 and 19 on March 18, 2011 and April 19, 2011, respectively. On May 2, 2011, AREVA NP submitted Supplement 20, to provide a revised schedule for Question 03.08.05-28 and Question 03.08.05-31. AREVA NP submitted a revised schedule for Question 03.08.05-25 in Supplement 21 on May 20, 2011.

The attached file, "RAI 376 Supplement 22 Response US EPR DC.pdf" provides a technically correct and complete FINAL response to Question 03.08.05-25. 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 376 Question 03.08.05-25.

The following table indicates the pages in the response document, "RAI 376 Supplement 22 Response US EPR DC.pdf" that contain AREVA NP's response to the subject question.

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

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

Question #	Interim Response Date	Response Date
RAI 376—03.08.05-28	October 25, 2010 (Actual)	July 8, 2011
RAI 376—03.08.05-31	October 25, 2010 (Actual)	July 8, 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: WILLIFORD Dennis (RS/NB)
Sent: Friday, May 20, 2011 5:19 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. 376, FSAR Ch. 3, Supplement 21

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25. On August 27, 2010, AREVA NP submitted Supplement 10 to provide INTERIM responses for Questions 03.08.05-25 and 03.08.05-29. AREVA NP submitted a revised schedule for the final response to question 03.08.05-30 in Supplements 11 and 12 on September 15, 2010 and October 7, 2010, respectively. On October 25, 2010, AREVA NP submitted Supplement 13 to provide INTERIM responses for Questions 03.08.05-28 and 03.08.05-31. AREVA NP submitted Supplement 14 on October 25, 2010, to provide a revised schedule for Question 03.08.05-29. On November 22, 2011, AREVA NP submitted Supplement 15 to provide FINAL responses to Questions 03.08.05-27 and 03.08.05-30. AREVA NP submitted Supplement 16 on February 8, 2011, to provide a revised schedule for Question 03.08.05-25 and FINAL responses to Questions 03.08.05-24, 03.08.05-26 and 03.08.05-29. On February 11, 2011, AREVA NP submitted Supplement 17, to provide a revised schedule for Question 03.08.05-28 and Question 03.08.05-31. AREVA NP submitted a revised schedule for Question 03.08.05-25 in Supplements 18 and 19 on March 18, 2011 and April 19, 2011, respectively. On May 2, 2011, AREVA NP submitted Supplement 20 to provide a revised schedule for Question 03.08.05-28 and Question 03.08.05-31.

The schedule for Question 03.08.05-25 is being revised. The schedule for the remaining questions is unchanged.

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

Question #	**Interim Response Date**	**Response Date**
RAI 376-03.08.05-25	August 27, 2010 (Actual)	**July 8, 2011**
RAI 376-03.08.05-28	October 25, 2010 (Actual)	July 8, 2011
RAI 376-03.08.05-31	October 25, 2010 (Actual)	July 8, 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. 376, FSAR Ch. 3, Supplement 20

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25. On August 27, 2010, AREVA NP submitted Supplement 10 to provide INTERIM responses for Questions 03.08.05-25 and 03.08.05-29. AREVA NP submitted a revised schedule for the final response to question 03.08.05-30 in Supplements 11 and 12 on September 15, 2010 and October 7, 2010, respectively. On October 25, 2010, AREVA NP submitted Supplement 13 to provide INTERIM responses for Questions 03.08.05-28 and 03.08.05-31. AREVA NP submitted Supplement 14 on October 25, 2010, to provide a revised schedule for Question 03.08.05-29. On November 22, 2011, AREVA NP submitted Supplement 15 to provide FINAL responses to Questions 03.08.05-27 and 03.08.05-30. AREVA NP submitted Supplement 16 on February 8, 2011, to provide a revised schedule for Question 03.08.05-25 and FINAL responses to Questions 03.08.05-24, 03.08.05-26 and 03.08.05-29. On February 11, 2011, AREVA NP submitted Supplement 17, to provide a revised schedule for Question 03.08.05-28 and Question 03.08.05-31. AREVA NP submitted a revised schedule for Question 03.08.05-25 in Supplements 18 and 19 on March 18, 2011 and April 19, 2011, respectively.

Due to changes in the schedule for FSAR Sections 3.7 and 3.8 as discussed with NRC, the schedule for Questions 03.08.05-28 and 03.08.05-31 is being revised. The schedule for the remaining question is unchanged.

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

Question #	**Interim Response Date**	**Response Date**
RAI 376-03.08.05-25	August 27, 2010 (Actual)	May 26, 2011
RAI 376-03.08.05-28	October 25, 2010 (Actual)	**July 8, 2011**
RAI 376-03.08.05-31	October 25, 2010 (Actual)	**July 8, 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: WELLS Russell (RS/NB)
Sent: Tuesday, April 19, 2011 7:39 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. 376, FSAR Ch. 3, Supplement 19

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25. On August 27, 2010, AREVA NP submitted Supplement 10 to provide INTERIM responses for Questions 03.08.05-25 and 03.08.05-29. AREVA NP submitted a revised schedule for the final response to question 03.08.05-30 in Supplements 11 and 12 on September 15, 2010 and October 7, 2010, respectively. On October 25, 2010, AREVA NP submitted Supplement 13 to provide INTERIM responses for Questions 03.08.05-28 and 03.08.05-31. AREVA NP submitted Supplement 14 on October 25, 2010, to provide a revised schedule for Question 03.08.05-29. On November 22, 2011, AREVA NP submitted Supplement 15 to provide FINAL responses to Questions 03.08.05-27 and 03.08.05-30. AREVA NP submitted Supplement 16 on February 8, 2011, to provide a revised schedule for Question 03.08.05-25 and FINAL responses to Questions 03.08.05-24, 03.08.05-26 and 03.08.05-29. On February 11, 2011, AREVA NP submitted Supplement 17, to provide a revised schedule for Question 03.08.05-28 and Question 03.08.05-31. AREVA NP submitted Supplement 18 on March 18, 2011, to provide a revised schedule for Question 03.08.05-25.

The schedule for Question 03.08.05-25 is being revised to allow AREVA NP additional time to address NRC comments. The schedule for the remaining questions is unchanged.

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-25	August 27, 2010 (Actual)	**May 26, 2011**
RAI 376-03.08.05-28	October 25, 2010 (Actual)	May 4, 2011
RAI 376-03.08.05-31	October 25, 2010 (Actual)	May 26, 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: WELLS Russell (RS/NB)
Sent: Friday, March 18, 2011 4:43 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 18

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25. On August 27, 2010, AREVA NP submitted Supplement 10 to provide INTERIM responses for Questions 03.08.05-25 and 03.08.05-29. AREVA NP submitted a revised schedule for the final response to question 03.08.05-30 in Supplements 11 and 12 on September 15, 2010 and October 7, 2010, respectively. On October 25, 2010, AREVA NP submitted Supplement 13 to provide INTERIM responses for Questions 03.08.05-28 and 03.08.05-31. AREVA NP submitted Supplement 14 on October 25, 2010, to provide a revised schedule for Question 03.08.05-29. On November 22, 2011, AREVA NP submitted Supplement 15 to provide FINAL responses to Questions 03.08.05-27 and 03.08.05-30. AREVA NP submitted Supplement 16 on February 8, 2011, to provide a revised schedule for Question 03.08.05-25 and FINAL responses to Questions 03.08.05-24, 03.08.05-26 and 03.08.05-29. On February 11, 2011, AREVA NP submitted Supplement 17, to provide a revised schedule for Question 03.08.05-28 and Question 03.08.05-31.

The schedule for Question 03.08.05-25 is being revised to allow AREVA NP additional time to interact with the NRC. The schedule for the remaining questions is unchanged.

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-25	August 27, 2010 (Actual)	**April 21, 2011**
RAI 376-03.08.05-28	October 25, 2010 (Actual)	May 4, 2011
RAI 376-03.08.05-31	October 25, 2010 (Actual)	May 26, 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 2:51 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 17

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25. On August 27, 2010, AREVA NP submitted Supplement 10 to provide INTERIM responses for Questions 03.08.05-25 and 03.08.05-29. AREVA NP submitted a revised schedule for the final response to question 03.08.05-30 in Supplements 11 and 12 on September 15, 2010 and October 7, 2010, respectively. On October 25, 2010, AREVA NP submitted Supplement 13 to provide INTERIM responses for Questions 03.08.05-28 and 03.08.05-31. AREVA NP submitted Supplement 14 on October 25, 2010, to provide a revised schedule for Question 03.08.05-29. On November 22, 2011, AREVA NP submitted Supplement 15 to provide FINAL responses to Questions 03.08.05-27 and 03.08.05-30. AREVA NP submitted Supplement 16 on February 8, 2011, to provide a revised schedule for Question 03.08.05-25 and FINAL responses to Questions 03.08.05-24, 03.08.05-26 and 03.08.05-29.

The schedule for Question 03.08.05-28 and Question 03.08.05-31 has changed. The schedule for the remaining question is unchanged.

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-25	August 27, 2010 (Actual)	March 30, 2011
RAI 376-03.08.05-28	October 25, 2010 (Actual)	May 4, 2011
RAI 376-03.08.05-31	October 25, 2010 (Actual)	May 26, 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: Tuesday, February 08, 2011 5:23 PM
To: Tesfaye, Getachew
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 16

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25. On August 27, 2010, AREVA NP submitted Supplement 10 to provide INTERIM responses for Questions 03.08.05-25 and 03.08.05-29. AREVA NP submitted a revised schedule for the final response to question 03.08.05-30 in Supplements 11 and 12 on September 15, 2010 and October 7, 2010, respectively. On October 25, 2010, AREVA NP submitted Supplement 13 to provide INTERIM responses for Questions 03.08.05-28 and 03.08.05-31. AREVA NP submitted Supplement 14 on October 25, 2010, to provide a revised schedule for Question 03.08.05-29. On November 22, 2011, AREVA NP submitted Supplement 15 to provide FINAL responses to Questions 03.08.05-27 and 03.08.05-30.

The attached file, “RAI 376 Supplement 16 Response US EPR DC.pdf” provides technically correct and complete FINAL responses to Questions 03.08.05-24, 03.08.05-26 and 03.08.05-29, as committed.

The following table indicates the respective pages in the response document, RAI 376 Supplement 16 Response US EPR DC.pdf,” that contains AREVA NP’s response to the subject questions.

Question #	Start Page	End Page
RAI 376 – 03.08.05-24	2	5
RAI 376 – 03.08.05-26	6	6
RAI 376 – 03.08.05-29	7	7

The schedule for Question 03.08.05-25 is being revised to allow additional time for AREVA NP to address NRC comments. The schedule for the remaining questions is unchanged.

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-25	August 27, 2010 (Actual)	March 30, 2011
RAI 376-03.08.05-28	October 25, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-31	October 25, 2010 (Actual)	February 17, 2011

Sincerely,

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

Martin.Bryan.ext@areva.com

From: BRYAN Martin (External RS/NB)
Sent: Monday, November 22, 2010 7:33 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 15

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25. On August 27, 2010, AREVA NP submitted Supplement 10 to provide INTERIM responses for Questions 03.08.05-25 and 03.08.05-29. AREVA NP submitted a revised schedule for the final response to question 03.08.05-30 in Supplements 11 and 12 on September 15, 2010 and October 7, 2010, respectively. On October 25, 2010, AREVA NP submitted Supplement 13 to provide INTERIM responses for Questions 03.08.05-28 and 03.08.05-31. AREVA NP submitted Supplement 14 on October 27, 2010, to provide a revised schedule for Question 03.08.05-29.

The attached file, “RAI 376 Supplement 15 Response US EPR DC.pdf” provides technically correct and complete FINAL responses to Questions 03.08.05-27 and 03.08.05-30, as committed.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 376 Question 03.08.05-27.

The following table indicates the respective pages in the response document, RAI 376 Supplement 15 Response US EPR DC.pdf,” that contains AREVA NP’s response to the subject questions. Please note that the similar table for RAI 376 Supplement 13 listed the RAI question as 354 when it should have been 376. The schedule for the remaining questions is unchanged.

Question #	Start Page	End Page
RAI 376 - 03.08.05-27	2	4
RAI 376 - 03.08.05-30	5	5

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 27, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-29	August 27, 2010 (Actual)	February 28, 2011

RAI 376-03.08.05-31	October 25, 2010 (Actual)	February 17, 2011

Sincerely,

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

From: BRYAN Martin (External RS/NB)
Sent: Wednesday, October 27, 2010 1:24 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 14

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted a revised schedule for the remaining 13 questions in Supplements 2 and 3 on June 8, 2010, and June 24, 2010, respectively. AREVA NP submitted Supplement 4 on July 13, 2010, to provide a revised schedule for question 03.08.05-30. AREVA NP submitted Supplement 5 on July 15, 2010, to provide an INTERIM response to question 03.08.05-24. AREVA NP submitted Supplement 6 on July 26, 2010, to provide a FINAL response to 3 of the remaining 13 question, as committed. AREVA NP submitted Supplement 7 on July 29, 2010, to provide a FINAL response to 2 of the remaining 10 question, as committed. AREVA NP submitted Supplement 8 on August 9, 2010, to provide a revised schedule for INTERIM response to question 03.08.05-29. AREVA NP submitted Supplement 9 on August 16, 2010, to provide INTERIM responses for Questions 03.08.05-26 and 03.08.05-27 and a revised schedule for INTERIM response to question 03.08.05-25. On August 27, 2010, AREVA NP submitted Supplement 10 to provide INTERIM responses for Questions 03.08.05-25 and 03.08.05-29. AREVA NP submitted a revised schedule for the final response to question 03.08.05-30 in Supplements 11 and 12 on September 15, 2010 and October 7, 2010, respectively. On October 25, 2010, AREVA NP submitted Supplement 13 to provide INTERIM responses for Questions 03.08.05-28 and 03.08.05-31.

The schedule for Question 03.08.05-29 is being revised to allow additional time for AREVA NP to address NRC comments. The schedule for the remaining questions is unchanged.

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 27, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-29	August 27, 2010 (Actual)	February 28, 2011
RAI 376-03.08.05-30	N/A	November 22, 2010
RAI 376-03.08.05-31	October 25, 2010 (Actual)	February 17, 2011

Sincerely,

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

From: BRYAN Martin (External RS/NB)
Sent: Monday, October 25, 2010 4:37 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. 376, FSAR Ch. 3, Supplement 13

Getachew,

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

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

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

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

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 27, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010 (Actual)	February 17, 2011

RAI 376-03.08.05-29	August 27, 2010 (Actual)	October 29, 2010
RAI 376-03.08.05-30	N/A	November 22, 2010
RAI 376-03.08.05-31	October 25, 2010 (Actual)	February 17, 2011

Sincerely,

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

From: BRYAN Martin (External RS/NB)
Sent: Thursday, October 07, 2010 2:50 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 12

Getachew,

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

The schedule for Question 03.08.05-30 is being revised to allow additional time for AREVA NP to address NRC comments. The schedule for the remaining questions is unchanged.

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 27, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 27, 2010 (Actual)	October 29, 2010
RAI 376-03.08.05-30	N/A	**November 22, 2010**
RAI 376-03.08.05-31	October 25, 2010	February 17, 2011

Sincerely,

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

From: BRYAN Martin (External RS/NB)
Sent: Wednesday, September 15, 2010 9:21 AM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 11

Getachew,

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

The schedule for Question 03.08.05-30 is being revised to allow additional time for AREVA NP to interact with the NRC. The schedule for the remaining questions is unchanged.

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 27, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 27, 2010 (Actual)	October 29, 2010
RAI 376-03.08.05-30	N/A	October 14, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 2011

Sincerely,

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

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

From: BRYAN Martin (External RS/NB)
Sent: Friday, August 27, 2010 4:58 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 10-INTERIM

Getachew,

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

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

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

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

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 27, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 27, 2010 (Actual)	October 29, 2010
RAI 376-03.08.05-30	N/A	September 16, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 2011

Sincerely,

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

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

From: BRYAN Martin (External RS/NB)
Sent: Monday, August 16, 2010 12:34 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 9

Getachew,

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

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

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

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

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

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	**September 8, 2010**	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010 (Actual)	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 27, 2010	October 29, 2010
RAI 376-03.08.05-30	N/A	**September 16, 2010**
RAI 376-03.08.05-31	October 25, 2010	February 17, 2011

Sincerely,

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

From: BRYAN Martin (EXT)
Sent: Monday, August 09, 2010 5:45 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen (RS/NB); ROMINE Judy (RS/NB); BENNETT Kathy (RS/NB); CORNELL Veronica (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 8

Getachew,

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

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

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 16, 2010	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 27, 2010	October 29, 2010
RAI 376-03.08.05-30	N/A	August 16, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 2011

Sincerely,

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

From: BRYAN Martin (EXT)
Sent: Thursday, July 29, 2010 7:56 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); CORNELL Veronica (EXT); VAN NOY Mark (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 7

Getachew,

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

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

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

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

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

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 16, 2010	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 9, 2010	October 29, 2010
RAI 376-03.08.05-30	N/A	August 16, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 2011

Sincerely,

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

From: BRYAN Martin (EXT)
Sent: Monday, July 26, 2010 4:00 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); VAN NOY Mark (EXT); CORNELL Veronica (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 6

Getachew,

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

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

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

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

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.01-48	N/A	July 29, 2010
RAI 376-03.08.03-24	N/A	July 29, 2010
RAI 376-03.08.05-24	July 15, 2010 (Actual)	February 17, 2011
RAI 376-03.08.05-25	August 16, 2010	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 9, 2010	October 29, 2010
RAI 376-03.08.05-30	N/A	August 16, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 2011

Sincerely,

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

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

From: BRYAN Martin (EXT)
Sent: Thursday, July 15, 2010 7:13 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); VAN NOY Mark (EXT); CORNELL Veronica (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 5 - Interim

Getachew,

AREVA NP Inc. provided a schedule for a technically correct and complete response to RAI No. 376 on April 26, 2010. AREVA NP submitted Supplement 1 to the response on May 20, 2010 to address 1 of the remaining 14 questions. AREVA NP submitted Supplement 2 to the response on June 8, 2010, to change the schedule for responding to Question 03.08.05-30. AREVA NP submitted Supplement 3 to the response on June 24, 2010, to provide a changed schedule based upon the civil/structural re-planning activities and revised RAI response schedule presented to the NRC during the June 9, 2010, Public Meeting, and to allow time to interact with the NRC on the responses. AREVA NP submitted Supplement 4 on July 13, 2010 to provide a revised schedule for question 03.08.05-30. The attached file, "RAI 376 Question 03.08.05-24 Response - INTERIM.pdf" provides a technically correct and complete INTERIM response to 1 of the remaining 13 questions, as committed.

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

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

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.01-47	N/A	August 17, 2010
RAI 376-03.08.01-48	N/A	July 29, 2010
RAI 376-03.08.03-21	N/A	July 26, 2010
RAI 376-03.08.03-22	N/A	July 26, 2010
RAI 376-03.08.03-24	N/A	July 29, 2010
RAI 376-03.08.05-24	July 15, 2010 **Actual**	February 17, 2011
RAI 376-03.08.05-25	August 16, 2010	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 9, 2010	October 29, 2010
RAI 376-03.08.05-30	N/A	August 16, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 2011

Sincerely,

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

From: BRYAN Martin (EXT)
Sent: Tuesday, July 13, 2010 6:08 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); CORNELL Veronica (EXT); VAN NOY Mark (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 4

Getachew,

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

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

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.01-47	N/A	August 17, 2010
RAI 376-03.08.01-48	N/A	July 29, 2010
RAI 376-03.08.03-21	N/A	July 26, 2010
RAI 376-03.08.03-22	N/A	July 26, 2010
RAI 376-03.08.03-24	N/A	July 29, 2010
RAI 376-03.08.05-24	July 15, 2010	February 17, 2011
RAI 376-03.08.05-25	August 16, 2010	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 9, 2010	October 29, 2010
RAI 376-03.08.05-30	N/A	August 16, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 2011

Sincerely,

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

From: BRYAN Martin (EXT)
Sent: Thursday, June 24, 2010 11:56 AM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); RYAN Tom (AREVA NP INC); VAN NOY Mark (EXT); CORNELL Veronica (EXT); GARDNER George Darrell (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 3

Getachew,

AREVA NP Inc. (AREVA NP) provided a schedule for a technically correct and complete response to RAI 376 on April 26, 2010. RAI 376 Supplement 1 provided a technically correct and complete response to 1 of 14 questions. AREVA NP submitted Supplement 2 to the response on June 8, 2010, to provide a schedule for the remaining 13 questions, which were affected by the work underway to address NRC comments from the April 26, 2010, audit.

Based upon the civil/structural re-planning activities and revised RAI response schedule presented to the NRC during the June 9, 2010, Public Meeting, and to allow time to interact with the NRC on the responses, the schedule has been changed. The schedule for 03.08.05-30 remains unchanged.

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

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

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

Question #	Interim Response Date	Response Date
RAI 376-03.08.01-47	N/A	August 17, 2010
RAI 376-03.08.01-48	N/A	July 29, 2010
RAI 376-03.08.03-21	N/A	July 26, 2010
RAI 376-03.08.03-22	N/A	July 26, 2010
RAI 376-03.08.03-24	N/A	July 29, 2010
RAI 376-03.08.05-24	July 15, 2010	February 17, 2011
RAI 376-03.08.05-25	August 16, 2010	February 8, 2011
RAI 376-03.08.05-26	August 16, 2010	February 8, 2011
RAI 376-03.08.05-27	August 16, 2010	February 8, 2011
RAI 376-03.08.05-28	October 25, 2010	February 17, 2011
RAI 376-03.08.05-29	August 9, 2010	October 29, 2010
RAI 376-03.08.05-30	N/A	July 14, 2010
RAI 376-03.08.05-31	October 25, 2010	February 17, 2011

Sincerely,

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

From: BRYAN Martin (EXT)
Sent: Tuesday, June 08, 2010 3:32 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); VAN NOY Mark (EXT); CORNELL Veronica (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 2

Getachew,

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

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

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

Sincerely,

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

From: BRYAN Martin (EXT)
Sent: Thursday, May 20, 2010 4:24 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); VAN NOY Mark (EXT); CORNELL Veronica (EXT)
Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 1

Getachew,

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

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 376 Question 03.08.03-23.

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

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

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

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

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

Sincerely,

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

Getachew,

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

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

Question #	Start Page	End Page
RAI 376-03.08.01-47	2	2
RAI 376-03.08.01-48	3	4
RAI 376-03.08.03-21	5	6
RAI 376-03.08.03-22	7	7
RAI 376-03.08.03-23	8	8
RAI 376-03.08.03-24	9	10
RAI 376-03.08.05-24	11	12
RAI 376-03.08.05-25	13	13
RAI 376-03.08.05-26	14	14
RAI 376-03.08.05-27	15	16
RAI 376-03.08.05-28	17	19
RAI 376-03.08.05-29	20	20
RAI 376-03.08.05-30	21	21
RAI 376-03.08.05-31	22	22

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

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

Sincerely,

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 2:13 PM
To: ZZ-DL-A-USEPR-DL
Cc: Xu, Jim; Hawkins, Kimberly; Miernicki, Michael; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 376 (4355,4367,4377), FSAR Ch. 3

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on March 11, 2010, and on March 24, 2010, you informed us that the RAI is clear and no further clarification is needed. As a result, no change is made to the draft RAI. The schedule we have established for review of your application assumes technically correct and complete responses within 30 days of receipt of RAIs. For any RAIs that cannot be answered within 30 days, it is expected that a date for receipt of this information will be provided to the staff within the 30 day period so that the staff can assess how this information will impact the published schedule.

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

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 3218

Mail Envelope Properties (2FBE1051AEB2E748A0F98DF9EEE5A5D47AF828)

Subject: Response to U.S. EPR Design Certification Application RAI No. 376, FSAR Ch. 3, Supplement 24
Sent Date: 7/7/2011 1:48:54 PM
Received Date: 7/7/2011 1:49:19 PM
From: WILLIFORD Dennis (AREVA)

Created By: Dennis.Williford@areva.com

Recipients:
"BENNETT Kathy (AREVA)" <Kathy.Bennett@areva.com>
Tracking Status: None
"DELANO Karen (AREVA)" <Karen.Delano@areva.com>
Tracking Status: None
"ROMINE Judy (AREVA)" <Judy.Romine@areva.com>
Tracking Status: None
"RYAN Tom (AREVA)" <Tom.Ryan@areva.com>
Tracking Status: None
"Miernicki, Michael" <Michael.Miernicki@nrc.gov>
Tracking Status: None
"Tesfaye, Getachew" <Getachew.Tesfaye@nrc.gov>
Tracking Status: None

Post Office: auscharmx02.adom.ad.corp

Files	**Size**	**Date & Time**
MESSAGE	78827	7/7/2011 1:49:19 PM
RAI 376 Supplement 24 Response US EPR DC - PUBLIC - Part 1 of 2.pdf	3093594	

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

Response to

Request for Additional Information No. 376, Supplement 24

3/25/2010

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

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

Question 03.08.05-31:

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

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

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

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

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

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

Response to 03.08.05-31:

Responses to Items 1 through 5 apply to the Emergency Power Generating Building (EPGB). The Essential Service Water Building (ESWB) will be addressed in a supplemental response to this question. U.S. EPR FSAR Tier 2, Figure 3.7.1-60 shows EPGB and ESWB shear wave velocity profile, and the information will not change in the supplemental response addressing the ESWB.

Item 1

The methodology for determining dynamic bearing pressures for the EPGB is described in the Response to RAI 371, Question 03.07.02-69. Static soil bearing pressures are similarly determined in the SSI analysis. U.S. EPR FSAR Tier 1, Table 5.0-1 and U.S. EPR FSAR Tier 2, Table 2.1-1 will be revised to clarify the site enveloping static and dynamic bearing pressure demands for Seismic Category I structures. The calculated bearing pressure will be determined from the EPGB SASSI analysis and included in the final response to this RAI. U.S. EPR FSAR Tier 2, Sections 3.8.5.4.1, 3.8.5.4.3 and 3.8.5.5.2 will be revised to reflect that the static and dynamic bearing pressures for the EPGB are obtained from the SASSI analysis.

Item 2

A summary of the methods used to calculate the minimum factor of safety against sliding and overturning is provided in the Response to RAI 371, Question 03.07.02-69.

Item 3

The coefficients of friction used in the sliding stability analyses are described in the U. S. EPR FSAR Tier 2, Section 2.5.4.2 and Table 2.1-1 as updated in response to RAI 384, Question 03.04.02-13.

Item 4

a) SSI procedures used to determine lateral soil pressures and resulting pressure distributions on foundations are described in the Response to RAI 376, Question 03.08.05-28, Item 3. U.S. EPR FSAR Tier 2, Sections 2.5.2 and 3.7.1 will be revised to describe the SSI methodology (e.g., description of model and input motion). U.S. EPR FSAR Tier 2, Section 3.7.2 will be revised to include the SSI analysis results (i.e., maximum accelerations and in-structure response spectra).

b) Sliding and overturning stability is discussed in the Response to RAI 376, Question 03.08.05-28, Item 5. U.S. EPR FSAR Tier 1, Table 5.0-1 and Tier 2, Table 2.1-1, and Section 3.8.5.5.2 will be revised to clarify the bearing pressure demands.

c) Design of below grade walls is described in U.S. EPR FSAR Tier 2, Section 3.8.4.4 and critical sections stresses will be provided in U.S. EPR FSAR Tier 2, Appendix 3E. Development of passive pressure in the soil to resist lateral loads is described in the Response to RAI 376, Question 03.08.05-28, Item 3 and Item 4, including soil cases used in the analysis. The foundation walls are designed for the most severe loading condition as described in the Response to RAI 371, Question 03.07.02-66 and U.S. EPR FSAR Tier 2, Section 3.8.5.4.1. U.S. EPR FSAR Tier 2, Section 3.8.4.4.2 will be revised to describe the design methodology for concrete walls and provide additional details on how different loads are combined to design the walls. U.S. EPR FSAR Tier 2, Figures 3.8-93 and 3.8-94 will be revised to show the EPGB shear keys.

FSAR Impact:

U.S. EPR FSAR Tier 1, Table 5.0-1 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR FSAR Tier 2, Sections 2.5.2, 3.7.1, 3.7.2, 3.8.4.4.2, 3.8.4.4.3, 3.8.5.1.2, 3.8.5.4.3, 3.8.5.5.2, Appendix 3E.2, Table 2.1-1, Table 3.8-19, Figure 3.8-93, and Figure 3.8-94 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

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

	The 1% exceedance (seasonal basis) (3) minimum ambient temperature is -10°F.
Wind	
Parameter	**Value(s)**
Maximum Speed (Other than Tornado)	The normal maximum wind speed is 145 mph.
Tornado	
Parameter	**Value(s)**
Tornado (maximum speed, pressure drop, radius of maximum rotational speed, rate of pressure drop, missile spectra)	Maximum tornado wind speed of 230 mph. Maximum rotational speed of 184 mph. Maximum tornado pressure drop of 1.2 pounds per square inch at 0.5 psi per second. Radius of maximum rotational speed is 150 ft.
Soil	
Parameter	**Value(s)**
Soil properties:	
Minimum angle of internal friction (in situ and backfill)	26.6 degrees(4)
Minimum shear wave velocity	Minimum shear wave velocity (low strain best estimate average value at bottom of basemat) of 1000 feet per second.
Minimum static bearing capacity	Minimum Maximum static bearing capacity demand is of 22,000 lbs/ft^2 in localized areas at the bottom of the Nuclear Island basemat and 15,000 lb/ft^2 on is the average across the total area of the bottom offor the Nuclear Island basematSeismic Category I structure basemats. The ultimate static bearing capacity divided by 3.0 is greater than or equal to the maximum static bearing demand. Minimum static bearing capacity of 3,800 lbs/ft^2 in localized areas at the bottom of the EPGB basemat and 2,700 lbs/ft^2 on average across total area at the bottom of the EPGB basemat. Minimum static bearing capacity of 17,800 lbs/ft^2 in localized areas at the bottom of the ESWB basemat and 5,500 lbs/ft^2 on average across total area at the bottom of the ESWB basemat.
Minimum dynamic bearing capacity	Minimum Maximum dynamic bearing demand is capacity of 35,000 26,000 lbs/ft^2 at the bottom toe of the Nuclear Island basemat Seismic Category I structure basemats. The ultimate dynamic bearing capacity divided by 2.0 is greater than or equal to the maximum dynamic bearing demand. Minimum dynamic bearing capacity of 10,800 lbs/ft^2 at the bottom of the EPGB basemat.

Table 2.1-1—U.S. EPR Site Design Envelope
Sheet 2 of 7

U.S. EPR Site Design Envelope	
Soil (Refer to Section 2.5)	
Minimum Static Bearing Capacity	Maximum static bearing demand is 22,000 lbs/ft^2 ksf in localized areas at the bottom of the Seismic Category I structure basematsNuclear Island basemat and 15 ksf on average across the total area of the bottom of the Nuclear Island basemat. The ultimate static bearing capacity divided by 3.0 is greater than or equal to the maximum static bearing demand. • 3,800 lbs/ft^2 in localized areas at the bottom of the EPGB basemat and 2,700 lbs/ft^2 on average across total area at the bottom of the EPGB basemat. • 17,800 lbs/ft^2 in localized areas at the bottom of the ESWB basemat and 5,500 lbs/ft^2 on average across total area at the bottom of the ESWB basemat.
Minimum Dynamic Bearing Capacity	Maximum dynamic bearing demand is 35,000 lbs/ft^{2}26,000 psf at the bottomtoe of the Seismic Category I structure basematsNuclear Island basemat. The ultimate dynamic bearing capacity divided by 2.0 is greater than or equal to the maximum dynamic bearing demand. • 10,800 lbs/ft^2 at the bottom of the EPGB basemat. • 28,200 lbs/ft^2 at the bottom of the ESWB basemat.
Minimum Shear Wave Velocity (Low strain best estimate average value at bottom of basemat)	1000 fps
Liquefaction	None

G. Emergency Power Generator Building (EPGB)—center of basemat ~~elevation +0 ft, 0 in at Node 1172~~ (Figures 3.7.2-101, 3.7.2-102, and 3.7.2-103) and +51 ft, 6 in. (Figures 3.7.2-148, 3.7.2-149, and 3.7.2-150.

H. Essential Service Water Building (ESWB)—Node 10385 on elevation +14 ft, 0 in (Figures 3.7.2-107, 3.7.2-108, and 3.7.2-109) and Node 12733 on elevation +63 ft, 0 in (Figures 3.7.2-104, 3.7.2-105, and 3.7.2-106).

9. Exceedances ~~in excess of the limits discussed in step 8~~ will require additional evaluation to determine if safety-related structures, systems, and components of the U.S. EPR at the location(s) in question will be affected.

As a result of the reconciliation process described above, the applicant may redesign selected features of the U.S. EPR, as required. Redesigned features will be identified as exceptions to the FSAR and addressed by the COL applicant.

2.5.3 Surface Faulting

No surface faulting is considered to be present under foundations for Seismic Category I structures in the U.S. EPR (GDC 2).

A COL applicant that references the U.S. EPR design certification will investigate site-specific surface and subsurface geologic, seismic, geophysical, and geotechnical aspects within 25 miles around the site and evaluate any impact to the design. The COL applicant will demonstrate that no capable faults exist at the site in accordance with the requirements of 10 CFR 100.23 and of 10 CFR 50, Appendix S. If non-capable surface faulting is present under foundations for safety-related structures, the COL applicant will demonstrate that the faults have no significant impact on the structural integrity of safety-related structures, systems, or components.

2.5.4 Stability of Subsurface Materials and Foundations

The stability of subsurface materials under the ~~and~~ foundations for Seismic Category I structures is demonstrated in Section 3.8.5 for the U.S. EPR ~~10 generic~~ soil profiles described in Section 3.7.1 and Section 3.7.2. As described in Section 3.8.5, lateral soil pressure loads under saturated conditions are considered for the design of below-grade walls. Soil loads are based on the parameters described in Section 2.5.4.2.

A COL applicant that references the U.S. EPR design certification will present site-specific information about the properties and stability of soils and rocks that may affect the nuclear power plant facilities under both static and dynamic conditions, including the vibratory ground motions associated with the CSDRS and the site-specific SSE.

2.5.4.1 Geologic Features

Geologic features are site specific and will be addressed by the COL applicant.

2.5.4.7 Response of Soil and Rock to Dynamic Loading

Section 2.5.2 notes that the design of the U.S. EPR is based on the assumption that the shear wave velocities assumed for the ~~10 generic~~ soil profiles described in Section 3.7.1.3 are strain-compatible properties. For SSI analysis for the U.S. EPR, assumed relationships to depict the strain-dependent modulus-reduction and hysteretic damping properties are not explicitly considered. The COL applicant will address site-specific response of soil and rock to dynamic loading, including the determination of strain-dependent modulus-reduction and hysteretic damping properties.

2.5.4.8 Liquefaction Potential

The design of the U.S. EPR assumes that the plant is not founded on liquefiable materials (GDC 2).

The COL applicant will address site-specific liquefaction potential. As stated in Section 3.7.1, the evaluation of liquefaction is performed for the seismic level of the site-specific SSE.

2.5.4.9 Earthquake Site Characteristics

Section 3.7.1 describes the seismic design basis for the U.S. EPR. Section 2.5.2 presents a brief summary of the seismic design basis.

Site-specific earthquake site characteristics will be described by the COL applicant.

2.5.4.10 Static Stability

Static stability pertaining to bearing capacity and settlement for the U.S. EPR is described in the following section. Additional information is provided in Section 3.8.5 for the foundations of Seismic Category I structures.

2.5.4.10.1 Bearing Capacity

The maximum bearing pressure under static loading conditions for the foundation basemat beneath the Seismic Category I structure basemats ~~NI Common Basemat Structures~~ is 22,000 lbs/ft^2, which includes the dead weight of the structure and components and 25 percent of the live load. The maximum bearing pressure under safe shutdown earthquake loads combined with other loads, as described in Section 3.8.5, is ~~26,000~~35,000 lbs/ft^2. Refer to Appendix 3E for details of these bearing pressures under the basemat (GDC 2).

A COL applicant that references the U.S. EPR design certification will verify that site-specific foundation soils beneath the foundation basemats of Seismic Category I enhanced. The full extent of the concerns captured in RG 1.165 and RG 1.208 will be addressed by the combined license (COL) applicant, as described in Section 3.7.1.1.1.

3.7.1.1.1 Design Ground Motion Response Spectra

The European community has collectively developed the European Utility Requirements (EUR) document (Reference 1), which defines a common set of safety requirements. With respect to seismic requirements, the EUR defines three sets of control motions as design ground response spectra, corresponding to hard, medium and soft soil conditions. Table 3.7.1-2—U.S. EPR Design Response Spectra – Amplification Factors for Control Points (as taken from the European Utility Requirements Document) is taken from the EUR document and shows the amplification factors, spectral bounds, and corner frequencies (based on peak ground acceleration normalized to 1.0g), which together define the EUR control motions. For design certification in the U.S. market, the seismic design of the U.S. EPR standard plant is based on design response spectrathe three EUR control motions anchored to 0.30g peak ground acceleration. To capture high frequency content, a fourth control motion is added. The additional control motion is identified as high frequency (HF) motion where high frequency horizontal (HFH) represents the high frequency control motion in the horizontal direction and high frequency vertical (HFV) represents the high frequency control motion in the vertical direction. HFH is anchored to 0.21g PGA and HFV is anchored to 0.18g PGA. The EUR vertical motion is considered to be the same as the EUR horizontal motion, which is considered to be reasonable for a standard design and is generally conservative except for a high magnitude near fault seismic events. The design response spectra of the EUR control motions for five percent damping are shown in Figure 3.7.1-1—Design Response Spectra for EUR (hard, medium and soft sites) and HF Control Motions (hard, medium and soft sites). These EUR and HF Control Motions are used for the seismic analysis and design of the Seismic Category I Nuclear Island (NI) Common Basemat Structures.

The seismic design of the U.S. EPR standard plant also establishes a minimum horizontal design basis that meets the requirements of 10 CFR 50, Appendix S, iv.(a)(1)(i), which states that the design basis for a horizontal component that is in the free-field at the foundation level of the structures must use an appropriate response spectrum with a peak ground acceleration of at least 0.1g. For the U.S. EPR standard plant, the appropriate response spectrum is provided by the envelope of the three EUR design response spectra. Therefore, the minimum horizontal design response spectra is the envelope of the three EUR design response spectra anchored at 0.1g and assumed to occur as a free-field outcrop motion at the bottom of the NI Common Basemat.

The EUR control motions are similar to the RG 1.60 spectra. Figure 3.7.1-2—Comparison of CSDRS to RG 1.60 and the Minimum Required Spectrum, Horizontal Motion, Horizontal Motion, and Figure 3.7.1-3—Comparison of CSDRS to RG 1.60, Vertical Motion, compare the EUR and HF control motions to the design ground motion from RG 1.60 and to the 0.1g minimum horizontal design ground motion. The EUR control motions provide an enhanced high frequency range when compared to RG 1.60 spectra. For horizontal motion, the RG 1.60 horizontal spectrum exceeds the EUR spectra below about 3 Hz and the HFH spectrum below about 10.5 Hz. For vertical motion, the EUR spectra exceed RG 1.60 vertical spectrum RG 1.60 vertical spectrum exceeds the EUR spectra except in the frequency range below approximately 0.65 Hz and the HFV spectrum below about 11.0 Hz. The EUR control motions anchored at 0.3g also exceed the 0.1g minimum horizontal design ground motion.

The three EUR control motions and high frequency content motion, HFH for the horizontal and HFV for the vertical directions, comprise the seismic design basis for the U.S. EPR standard plant (i.e., the certified seismic design response spectra (CSDRS)). The standard plant SSE is the CSDRS since the minimum horizontal design response spectra requirement is also met by the design for the CSDRS. The same CSDRS are used as the standard plant SSE design ground motions for both the horizontal and vertical directions.

For the U.S. EPR standard plant, the bottom of the NI Common Basemat is located 41.33 ft36 ft 5 in (Reactor Building) and 41 ft 4 in (remaining NI Common Basemat Structures) below plant grade. For purposes ofthe seismic analysis of the U.S. EPR standard plant, a simplifying assumption is made to define the point of seismic input is defined at the foundation level (at elevation -41.33 ft38 ft 10-1/2 in). Consistent with the guidance of SRP 3.7.1 (Reference 6) and RG 1.208 as well as the NEI approach for ISG-17, the control point is modeled in site response and soil-structure interaction (SSI) analyses as an outcrop or hypothetical outcrop at the same -41.33 ft 38 ft 10-1/2 in foundation level. This control point concept is illustrated in Figure 3.7.1-29—Idealized Control Motion for Seismic Input to NI Common Basemat. With this specification of control point, the effect of the overlying 41.33 ft of material is not included in the models for site response and SSI analyses. For Seismic Category I structures that are not on the NI Common Basemat, namely, the Emergency Power Generating Buildings (EPGB) and the Essential Service Water Buildings (ESWB), the seismic input at the basemat for those structures is the design basis motion (the CSDRS) modified to account for the effects of structure-soil-structure interaction (SSSI) between those structures and the Nuclear Island Common Basemat Structures. The SSI analyses in Section 3.7.2 provide insight into the effects of seismic-induced structure-soil-structure interaction between the NI Common Basemat Structures and nearby Seismic Category I and non-Seismic Category I structures. The SSI analysis of the NI Common Basemat Structures establishes an SSSI amplification factor (greater than 1.0) applied to the CSDRS, which defines the amplified seismic input to the respective structural model. Modification of the CSDRS at basemat elevations of the EPGB and ESWB takes into account the differences in elevation of each building when considering SSSI effects. The modified CSDRS for the EUR control motions are defined by smooth enveloping all the response spectra at the surface footprint locations of the EPGB and ESWB. The envelope computed inherently includes the SSSI amplification factor. The modified CSDRS for the HF control motions are defined using a three step approach. The first step involves computing SSSI amplification factors. SSSI amplification factors, which are frequency-based, are computed by dividing the computed response spectra at the surface footprint locations of the EPGB and ESWB obtained from the NI SSI analysis by the input response spectra of the surface motion. In the second step, the foundation input response spectra are multiplied with the SSSI amplification factors (greater than or equal to 1.0) to obtain amplified response spectra at each of the EPGB and ESWB foundation locations. In the third step, the modified HF CSDRS are defined by smooth enveloping all the amplified response spectra at the foundation locations of the EPGB and ESWB.

Figure 3.7.1-33—Input Motion for Structures not on the Nuclear Island Common Basemat, Horizontal Motion 5% Damping (EUR) and Figure 3.7.1-34—Input Motion for Structures not on the Nuclear Island Common Basemat, Vertical Motion 5% Damping (EUR), show the modified input motion obtained by modifying the EUR control motions, identified as SSSI motion, for the Seismic Category I Structures that are not on the NI Common Basemat., and Section 3.7.2.4 describes the basis for the development of these spectra in more detail. This input motion does not constitute a second seismic design basis (i.e., a second set of CSDRS); rather it is the logical extension of the seismic design basis CSDRS to provide input motion to structures not on the common basemat. Figure 3.7.1-49—Input Motion for Structures Not on the NI Common Basemat, Horizontal (SSSIHF) and Figure 3.7.1-50—Input Motion for Structures Not on the NI Common Basemat, Vertical (SSSIHF) show the high frequency input motion obtained by modifying the HF control motion, identified as SSSIHF motion, for the ESWB and EPGB. These input motions do not constitute an additional seismic design basis (i.e., a second set of CSDRS); they are the logical extension of the seismic design basis CSDRS that provide input motion to structures not on the common basemat.

Figure 3.7.1-4—EUR Design Ground Spectra for Hard Conditions Normalized to 0.3g, Figure 3.7.1-5—EUR Design Ground Spectra for Medium Conditions Normalized to 0.3g, and Figure 3.7.1-6—EUR Design Ground Spectra for Soft Conditions Normalized to 0.3g, illustrate the seismic demand associated with the CSDRS spectra on SSC as a function of the damping values used in the seismic analysis. Critical damping values used for the seismic analysis of U.S. EPR SSC are provided in Section 3.7.1.2.

3.7.1.1.2 Design Ground Motion Time History

Three sStatistically independent sets of synthetic time histories are generated for the three EUR and HF (HFH and HFV) control motions comprising the CSDRS. The three components of each set are designated according to their respective control motion, for example as EURH1, EURH2, and EURH3 for the EUR control motion for a hard site, with the third designator, EURH3, representing vertical motion. A fourthTwo additional sets of statistically independent synthetic time histories isare developed for seismic input for the Seismic Category I structures not located on the common basemat. As noted above in Section 3.7.1.1.1, the input motions represented by this fourththese additional sets of time histories does not constitute a second set of CSDRS; rather it isthey are the logical extension of the design basis CSDRS to provide input motion to structures not on the common basemat considering the effect of SSSI. The components of the fourthadditional time history set for the SSSI motion are designated as SSSI1 and SSSI2 for the horizontal components and SSSI3 for the vertical component. Similarly, the components of the time history set for the SSSIHF motion are designated as SSSI1HF, SSSI2HF, and SSSI3HF. In both seismic structural analyses and in SSI analyses the three components of each set correspond to the three orthogonal axes of the SSI analysis model. The three EUR-based time history sets for the CSDRS are developed using the CARES computer program. The HF-based time history sets for the CSDRS are developed using the SIMQKE computer program. The fourthadditional time history set developed for the input motion for the analysis of Seismic Category I structures not on the common basemat SSSI motion is developed using the Bechtel computer program BSIMQKE (Reference 8). The time history set for the SSSIHF motion is developed using AFIT. The fourtime history sets are developed in accordance with the requirements of Option 1, Approach 2 of SRP Section 3.7.1 (Reference 6) for synthetic time histories. For each of the four synthetic time history sets, properties such as the cross-correlation coefficients among time history components, the response spectra of the time histories, Arias intensity functions, and maximum values of integrated ground velocities and displacements are computed.

The acceptance criteria for time histories developed under Option 1, Approach 2 are:

- Small time increment and sufficient time duration.
- Minimum Nyquist frequency of 50 Hz or frequency of interest.
- Spectra at five percent damping for 100 points per frequency decade.
- Target spectrum from 0.1 Hz to 50 Hz or Nyquist frequency.
- No more than nine consecutive frequency points (±10 percent frequency window) fall below the target spectrum.
- Minimum no lower than 90 percent and maximum no greater than 130 percent of target spectrum (in lieu of a power spectral density requirement).
- Total duration exceeding 20 seconds and strong motion duration based on cumulative energy ratio from five percent to 75 percent on the Arias intensity function.
- V/A and AD/V^2 are generally consistent with characteristic values for appropriate controlling events defined for the uniform hazard response spectra (UHRS).

- Statistical independence among three components of synthetic time histories as defined by a maximum absolute value of correlation coefficient of 0.16.

These criteria equal or exceed the corresponding guidelines in NUREG/CR-6728 (Reference 9).

Each EUR and SSSI acceleration time history includes 4096 points at an interval of 0.005 seconds. The earthquake duration is 20.48 seconds, which is greater than the 20 second minimum total duration. The duration of the HF motion is 30 seconds, and its acceleration time history includes 6000 points at an interval of 0.005 seconds. The SSSIHF motion is 25 seconds long, and its acceleration time history includes 5000 points at an interval of 0.005 seconds. The time interval of 0.005 seconds corresponds to a Nyquist frequency of $1/(2\Delta t) = 100$ Hz. Plots of the synthetic time histories for acceleration, velocity, and displacement are provided in Figure 3.7.1-7—Synthetic Acceleration Time Histories for EUR Hard CSDRS, Figure 3.7.1-8—Synthetic Velocity Time Histories for EUR Hard CSDRS, Figure 3.7.1-9—Synthetic Displacement Time Histories for EUR Hard CSDRS, Figure 3.7.1-10—Synthetic Acceleration Time Histories for EUR Medium CSDRS, Figure 3.7.1-11—Synthetic Velocity Time Histories for EUR Medium CSDRS, Figure 3.7.1-12—Synthetic Displacement Time Histories for EUR Medium CSDRS, Figure 3.7.1-13—Synthetic Acceleration Time Histories for EUR Soft CSDRS, Figure 3.7.1-14—Synthetic Velocity Time Histories for EUR Soft CSDRS, and Figure 3.7.1-15—Synthetic Displacement Time Histories for EUR Soft CSDRS, for the EUR hard, medium and soft ~~CSDRS, respectively~~motions, and in Figure 3.7.1-42—Synthetic Acceleration Time Histories for HF CSDRS, Figure 3.7.1-43—Synthetic Velocity Time Histories for HF CSDRS, and Figure 3.7.1-44—Synthetic Displacement Time Histories for HF CSDRS, for the HF motion. Figure 3.7.1-35—Synthetic Acceleration, Velocity, and Displacement Time Histories for Structures not on the Nuclear Island Common Basemat, Horizontal (SSSI1) Motion, Figure 3.7.1-36—Synthetic Acceleration, Velocity, and Displacement Time Histories for Structures not on the Nuclear Island Common Basemat, Horizontal (SSSI2) Motion, ~~and~~ Figure 3.7.1-37—Synthetic Acceleration, Velocity, and Displacement Time Histories for Structures not on the Nuclear Island Common Basemat, Vertical (SSSI3) Motion, Figure 3.7.1-53—Synthetic Acceleration, Velocity, and Displacement Time Histories for Structures not on the Nuclear Island Common Basemat, Horizontal (SSSI1HF) Motion, Figure 3.7.1-54—Synthetic Acceleration, Velocity, and Displacement Time Histories for Structures not on the Nuclear Island Common Basemat, Horizontal (SSSI2HF) Motion, and Figure 3.7.1-55—Synthetic Acceleration, Velocity, and Displacement Time Histories for Structures not on the Nuclear Island Common Basemat, Vertical (SSSI3HF) Motion show plots of the acceleration, velocity, and displacement time histories for the set of time histories used for the Seismic Category I structures not located on the common basemat.

For each component, the CARES, codeSIMQKE, BSIMQKE, and AFIT codes generates the synthetic time history in which response spectra achieve approximately a mean-based fit to the target design spectra. Compliance with the preceding acceptance criteria is demonstrated in Figure 3.7.1-17—Response Spectrum of Time History H1 vs. Target Spectrum for EUR Hard Motion (TH1 Target, 1.30*Target and 0.90*Target at 5% Damping), Figure 3.7.1-18—Response Spectrum of Time History H2 vs. Target Spectrum for EUR Hard Motion (TH2 Target, 1.30*Target and 0.90*Target at 5% Damping), Figure 3.7.1-19—Response Spectrum of Time History H3 (Vertical) vs. Target Spectrum for EUR Hard Motion (TH3 Target, 1.30*Target and 0.90*Target at 5% Damping), Figure 3.7.1-20—Response Spectrum of Time History H1 vs. Target Spectrum for EUR Medium Motion (TH1 Target, 1.30*Target and 0.90*Target at 5% Damping), Figure 3.7.1-21—Response Spectrum of Time History H2 vs. Target Spectrum for EUR Medium Motion (TH2 Target, 1.30*Target and 0.90*Target at 5% Damping), Figure 3.7.1-22—Response Spectrum of Time History H3 (Vertical) vs. Target Spectrum for EUR Medium Motion (TH3 Target, 1.30*Target and 0.90*Target at 5% Damping), Figure 3.7.1-23—Response Spectrum of Time History H1 vs. Target Spectrum for EUR Soft Motion (TH1 Target, 0.90* Target and 1.30*Target at 5% Damping), Figure 3.7.1-24—Response Spectrum of Time History H2 vs. Target Spectrum for EUR Soft Motion (TH2 Target, 1.30*Target and 0.90*Target at 5% Damping), Figure 3.7.1-25—Response Spectrum of Time History H3 (Vertical) vs. Target Spectrum for EUR Soft Motion (TH3 Target, 1.30*Target and 0.90*Target at 5% Damping), Figure 3.7.1-45—Response Spectrum of Time History H1 vs. Target Spectrum for HFH Motion (TH1 Target, 090* Target and 1.30*-Target at 5% Damping), Figure 3.7.1-46—Response Spectrum of Time History H2 vs. Target Spectrum for HFH Motion (TH2 Target, 1.30* Target and 0.90*-Target at 5% Damping), Figure 3.7.1-47—Response Spectrum of Time History H3 (Vertical) vs. Target Spectrum for HFV Motion (TH3 Target, 1.30* Target and 0.90*-Target at 5% Damping), Figure 3.7.1-26—Cumulative Energy Ratio Plot for Time History H1, H2, and H3 for EUR Hard Motion, Figure 3.7.1-27—Cumulative Energy Ratio Plot for Time History H1, H2, and H3 for EUR Medium Motion, Figure 3.7.1-28—Cumulative Energy Ratio Plot for Time History H1, H2, and H3 for EUR Soft Motion, Figure 3.7.1-48—Cumulative Energy Ratio Plot for Time History H1, H2, and H3 for HF Motion, Figure 3.7.1-38—Time History Response Spectrum vs. Input Spectrum for Structures not on the Nuclear Island Common Basemat, Horizontal (SSSI1) Component, Figure 3.7.1-39—Time History Response Spectrum vs. Input Spectrum for Structures not on the Nuclear Island Common Basemat, Horizontal (SSSI2) Component, Figure 3.7.1-40—Time History Response Spectrum vs. Input Spectrum for Structures not on the Nuclear Island Common Basemat, Vertical (SSSI3) Component, andFigure 3.7.1-56—Time History Response Spectrum vs. Input Spectrum for Structures not on the Nuclear Island Common Basemat, Horizontal (SSSI1HF) Component, Figure 3.7.1-57—Time History Response Spectrum vs. Input Spectrum for Structures not on the Nuclear Island Common Basemat, Horizontal (SSSI2HF) Component, Figure 3.7.1-58—Time History Response Spectrum vs. Input Spectrum for Structures not on the Nuclear Island Common Basemat, Horizontal (SSSI3HF) Component, Figure 3.7.1-41—Cumulative Energy Plot for Time Histories for Structures not on the Nuclear Island Common Basemat (EUR), and Figure 3.7.1-59—Cumulative Energy Plot for Time Histories for Structures not on the Nuclear Island Common Basemat (HF). The five percent damped response spectra in Figures 3.7.1-17 through 3.7.1-25 compare the respective response spectra for the three time history sets for the EUR control motions to the corresponding smooth CSDRS target spectrum. An internal AREVA code, RESPECAn AREVA code, RESPEC, Version 1.1A, is used to compute these response spectra. Figure 3.7.1-38 thru 3.7.1-40 provide a similar comparison for the time history set used for the Seismic Category I structures not on the NI Common Basematfor the SSSI motion. The computer program BSIMQKE (Reference 8) is used to compute response spectra for this time history set. Similar comparisons for the HF and SSSIHF control motions are shown in Figure 3.7.1-45 through Figure 3.7.1-47 and Figure 3.7.1-56 through Figure 3.7.1-58, respectively. For all of these comparisons the response spectra are computed at a minimum of 100 points per frequency decade, uniformly spaced over the log frequency scale from 0.1 Hz to 50 Hz, or the Nyquist frequency. These figures show that the spectra satisfy the recommended guidelines for response spectrum enveloping. Bounding envelopes shown on these plots also demonstrate that the five percent damping response spectrum of each synthetic time history does not exceed the corresponding target spectrum by more than 30 percent nor does it fall below by more than 10 percent of the target.

Figures 3.7.1-26 to 3.7.1-28, and Figure 3.7.1-41, Figure 3.7.1-48, and Figure 3.7.1-59 show the Arias intensity function (or Cumulative Energy function) and the strong motion duration of each synthetic time history in the five percent to 75 percent Arias intensity. The strong motion durations calculated for the EUR, HF, SSSI, and SSSIHF time histories are shown in Table 3.7.1-3—Strong Motion Duration of Synthetic Time Histories. The minimum strong motion duration is six seconds, which meets the guideline in SRP Section 3.7.1 (Reference 6).

The maximum ground velocity (V) and the maximum ground displacement (D) are obtained from the ground velocity and displacement time histories. The V/A and AD/V^2 values that are calculated using these two parameters are summarized in Table 3.7.1-4—Values of V/A and AD/V^2 for Synthetic Time Histories. As noted in SRP 3.7.1 (Reference 6), time histories that are computed in accordance with Option 1, Approach 2 have characteristics generally consistent with the characteristic values for the magnitude and distance of the appropriate controlling events defined for the UHRS.

The three components of synthetic time history are statistically independent of each other because the cross-correlation coefficients between them, as listed in structures. The NI Common Basemat provides common support for the shield structure, Safeguard Buildings 1 through 4, the Fuel Building, the Reactor Building, the Containment Building, and the Internal Structure. The NI Common Basemat for the standard plant is supported either on rock, native soil, engineered fill, or a combination of these media. The embedment depth, structural foundation dimensions and general details, as well as structural description and details, are found in Section 3.8.5. Figure 3.7.2-64 is a dimensional plan view showing the footprint for the NI Common Basemat.

The supporting media for sSeismic analysis and foundation design for the standard plant isare performed for 10 generic soil profiles including high frequency soil profiles as shown in Table 3.7.1-6—Generic Soil Profiles for the U.S. EPR Standard Plant - NI Common Basemat Structures SSI Analysis Cases. Six profiles representProfiles include uniform half-space profiles and four represent various layered profiles. Each soil profile is associated with one or two of the three EUR generic control motions (i.e., hard, medium, and soft) or HF control motion. The soil profiles labeled 2u and 4u in the table are associated with two EUR control motions. For the NI Common Basemat Structures, the result is 12 analysis cases for SSI analysis which combine the soil profile and the corresponding control motion, as are shown in Table 3.7.1-6. The same 10 generic profiles are used for the SSI analysis of the EPGB and ESWB, but the input motion is the CSDRS modified to account for the affects of SSSI, as described above in Section 3.7.1.1.1. Seismic SSI analyses are described in Section 3.7.2.4 are shown in Table 3.7.1-8—Soil Profiles for the U.S. EPR Standard Plant - EPGB SSI Analysis Cases and Table 3.7.1-9—Soil Profiles for the U.S. EPR Standard Plant - ESWB SSI Analysis Cases, respectively.

Table 3.7.1-6, Table 3.7.1-8, and Table 3.7.1-9 shows the soil layering, the assumed strain-dependent properties, and the EUR design control motion associated with the 12 analysis cases. The variation in shear wave velocity in each of the assumed profiles is illustrated in Figure 3.7.1-31—U.S. EPR Standard Plant GenericSoil Profiles - Shear Wave Velocity for NI Common Basemat Structures for SSI Analysis Cases (EUR), and Figure 3.7.1-32—U.S. EPR Standard Plant Generic Soil Profiles - Shear Wave Velocity for NI Common Basemat Structures for SSI Analysis Cases (HF), Figure 3.7.1-60—U.S. EPR Standard Plant Soil Profiles - Shear Wave Velocity for EPGB and ESWB SSI Analysis Cases (EUR), Figure 3.7.1-61—U.S. EPR Standard Plant Soil Profiles - Shear Wave Velocity for EPGB SSI Analysis Cases (HF), and Figure 3.7.1-62—U.S. EPR Standard Plant Soil Profiles - Shear Wave Velocity for ESWB SSI Analysis Cases (HF). Section 3.7.2.4.1 notes that, for SSI analysis for U.S. EPR design certification, the assumed generic shear wave velocities are taken to be strain-compatible values during seismic events, i.e., assumed relationships to depict the strain-dependent modulus-reduction and hysteretic damping properties are not used.

Soil density is varied to correspond with the assumed generic site conditions associated with the three EUR and HF control motions; for example, the SSI model for an analysis

Table 3.7.1-3—Strong Motion Duration of Synthetic Time Histories

	Time (seconds)		
Motion	**EURH1**	**EURH2**	**EURH3**
Strong Motion Duration (seconds)	5.97 (=6.0)	6.57	6.89
Motion	**EURM1**	**EURM2**	**EURM3**
Strong Motion Duration (seconds)	6.49	6.33	6.55
Motion	**EURS1**	**EURS2**	**EURS3**
Strong Motion Duration (seconds)	7.16	7.41	8.71
Motion	**HFH1**	**HFH2**	**HFV**
Strong Motion Duration (seconds)	8.9	10	8.4
Motion	**SSSI1**	**SSSI2**	**SSSI3**
Strong Motion Duration (seconds)	7.2	7.5	8.7
Motion	**SSSI1HF**	**SSSI2HF**	**SSSI3HF**
Strong Motion Duration (seconds)	11.4	12.4	12.2

Table 3.7.1-4—Values of V/A and AD/V² for Synthetic Time Histories

Motion	EURH1	EURH2	EURH3
Peak Ground Displacement, D (inch)	2.0	2.4	1.7
Peak Ground Velocity, V (in/s)	4.6	5.7	6.1
Peak Ground Acceleration, A (g)	0.3	0.3	0.303
V/A - (cm/s)/g	39.2	48.2	51.0
AD/V^2	10.9	8.45	5.32
Motion	**EURM1**	**EURM2**	**EURM3**
Peak Ground Displacement, D (inch)	2.2	2.2	2.5
Peak Ground Velocity, V (in/s)	7.5	6.1	7.9
Peak Ground Acceleration, A (g)	0.312	0.314	0.310
V/A - (cm/s)/g	60.7	49.3	64.3
AD/V^2	4.83	7.06	4.87
Motion	**EURS1**	**EURS2**	**EURS3**
Peak Ground Displacement, D (inch)	2.6	2.5	2.3
Peak Ground Velocity, V (in/s)	11.9	9.3	10.9
Peak Ground Acceleration, A (g)	0.303	0.311	0.313
V/A - (cm/s)/g	99.6	76.1	88.3
AD/V^2	2.12	3.41	2.28
Motion	**HFH1**	**HFH2**	**HFV**
Peak Ground Displacement, D (inch)	2.4	2.13	2.03
Peak Ground Velocity, V (in/s)	3.40	3.07	1.79
Peak Ground Acceleration, A (g)	0.21	0.21	0.18
V/A - (cm/s)/g	42.3	37.8	25
AD/V^2	16	18	45
Motion	**SSSI1**	**SSSI 2**	**SSSI 3**
Peak Ground Displacement, D (inch)	2.78	2.56	2.32
Peak Ground Velocity, V (in/s)	12.84	10.13	12.40
Peak Ground Acceleration, A (g)	0.38	0.38	0.38
V/A - (cm/s)/g	85.2	67.6	82.7
AD/V^2	2.51	3.66	2.23
Motion	**SSSI1HF**	**SSSI2HF**	**SSSI3HF**
Peak Ground Displacement, D (inch)	5.2	6.2	3.7
Peak Ground Velocity, V (in/s)	5.3	6.6	3.3
Peak Ground Acceleration, A (g)	0.28	0.28	0.30
V/A - (cm/s)/g	47.5	59.4	28.0
AD/V^2	20.1	15.5	39.0

Table 3.7.1-5—Cross-Correlation Coefficients Among Synthetic Time Histories

EURH1 with EURH2	EURH1 with EURH3	EURH2 with EURH3
0.010	0.027	0.030
EURM1 with EURM2	**EURM1 with EURM3**	**EURM2 with EURM3**
0.015	0.034	0.078
EURS1 with EURS2	**EURS1 with EURS3**	**EURS2 with EURS3**
0.038	0.051	0.045
HFH1 with HFH2	**HFH1 with HFV**	**HFH2 with HFV**
0.030	0.086	0.016
SSSI1 with SSSI2	**SSSI1 with SSSI3**	**SSSI2 with SSSI3**
0.04	0.07	0.06
SSSI1HF with SSSI2HF	**SSSI1HF with SSSI3HF**	**SSSI2HF with SSSI3HF**
0.085	0.018	0.098

Table 3.7.1-8—Soil Profiles for the U.S. EPR Standard Plant - EPGB SSI Analysis Cases

Soil Case No.	Seismic Control Motion Applied	Soil Profile (Half-space or Layered)	Shear Wave Velocity of Soil[1]
4u	SSSI	Half-space	3,937 ft/s
5a	SSSI	Half-space	13,123 ft/s
1n5u	SSSI	5 ft uniform layer over a half-space	700 ft/s to 6,601 ft/s
1n2u	SSSI	Linear gradient within a 100 ft layer over a half-space	820 ft/s to 1,640 ft/s
2sn4u	SSSI	49 ft uniform layer over a half-space	1,640 ft/s to 3,937 ft/s
hf_c	SSSIHF	5 ft uniform layer over concrete and stiff rock	720 ft/s to 10,960 ft/s
hf_s	SSSIHF	83 ft of soft (708 - 1,135 ft/s layer over stiff material (> 7000 ft/s)	708 ft/s to 10,960 ft/s

Notes:

1. Shear wave velocities of soil profiles are strain-compatible.
2. See Table 3.7.2-9 for damping values used.

Figure 3.7.1-33—Input Motion for Structures not on the Nuclear Island Common Basemat, Horizontal Motion 5% Damping (EUR)

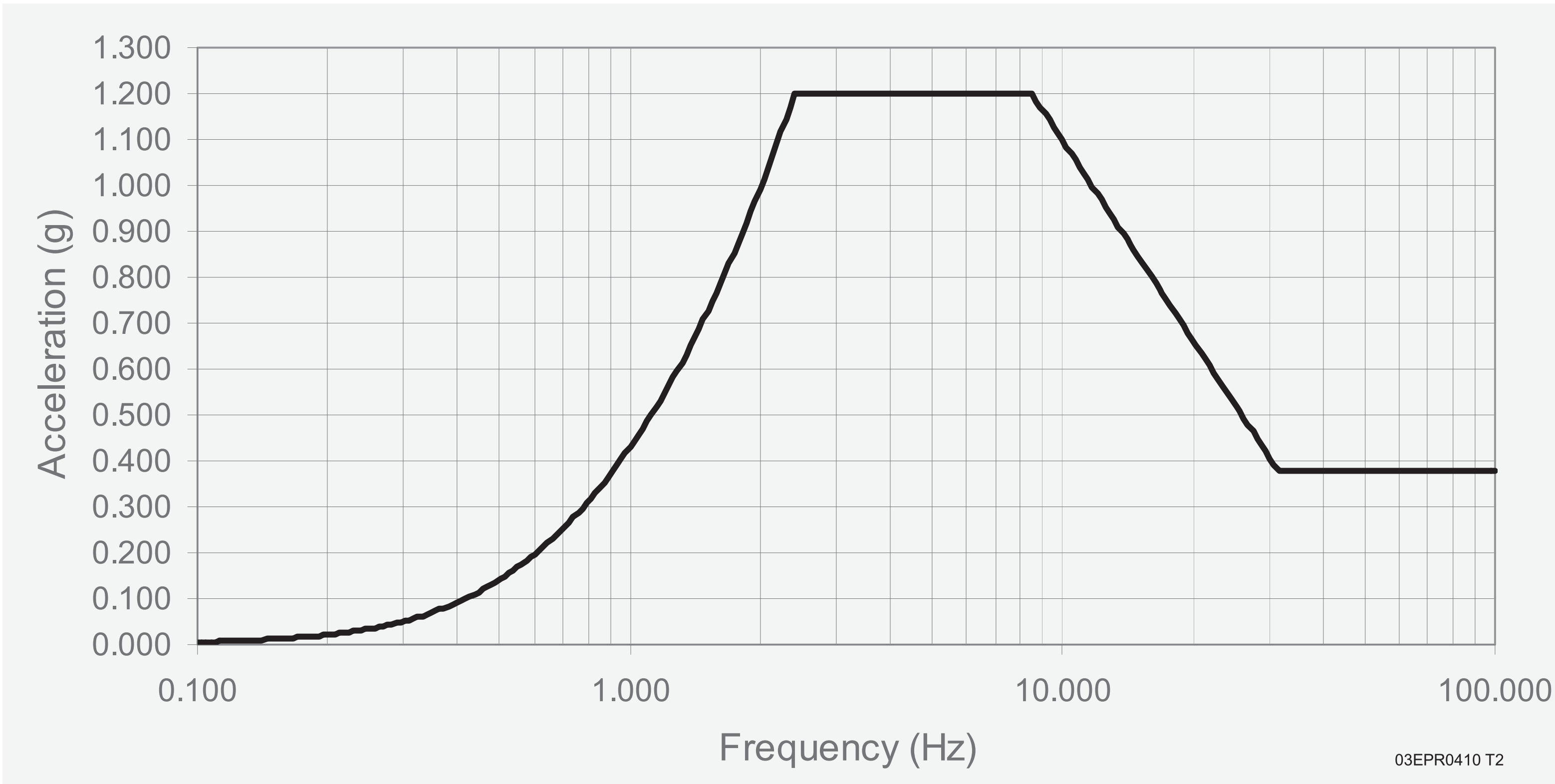


Figure 3.7.1-34—Input Motion for Structures not on the Nuclear Island Common Basemat, Vertical Motion 5% Damping (EUR)

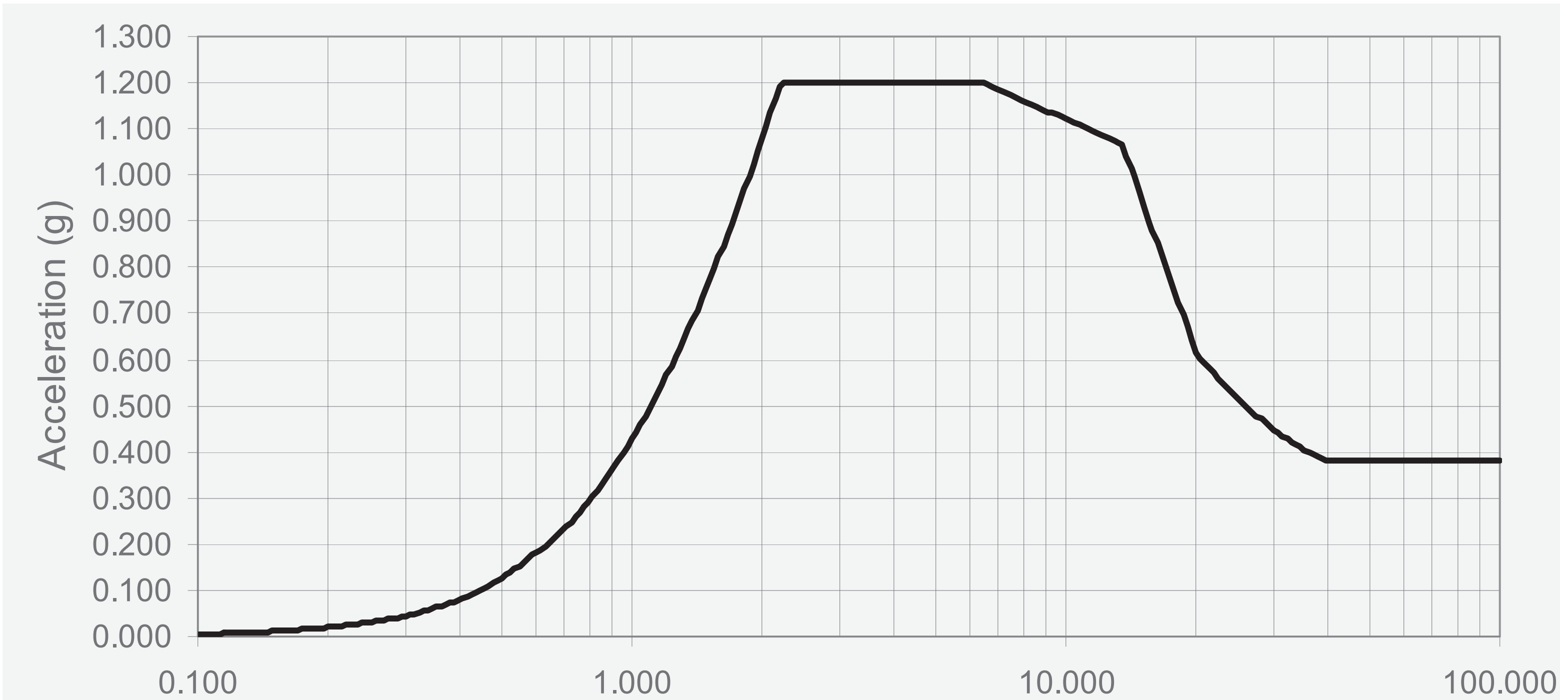


Figure 3.7.1-41—Cumulative Energy Plot for Time Histories for Structures not on the Nuclear Island Common Basemat (EUR)

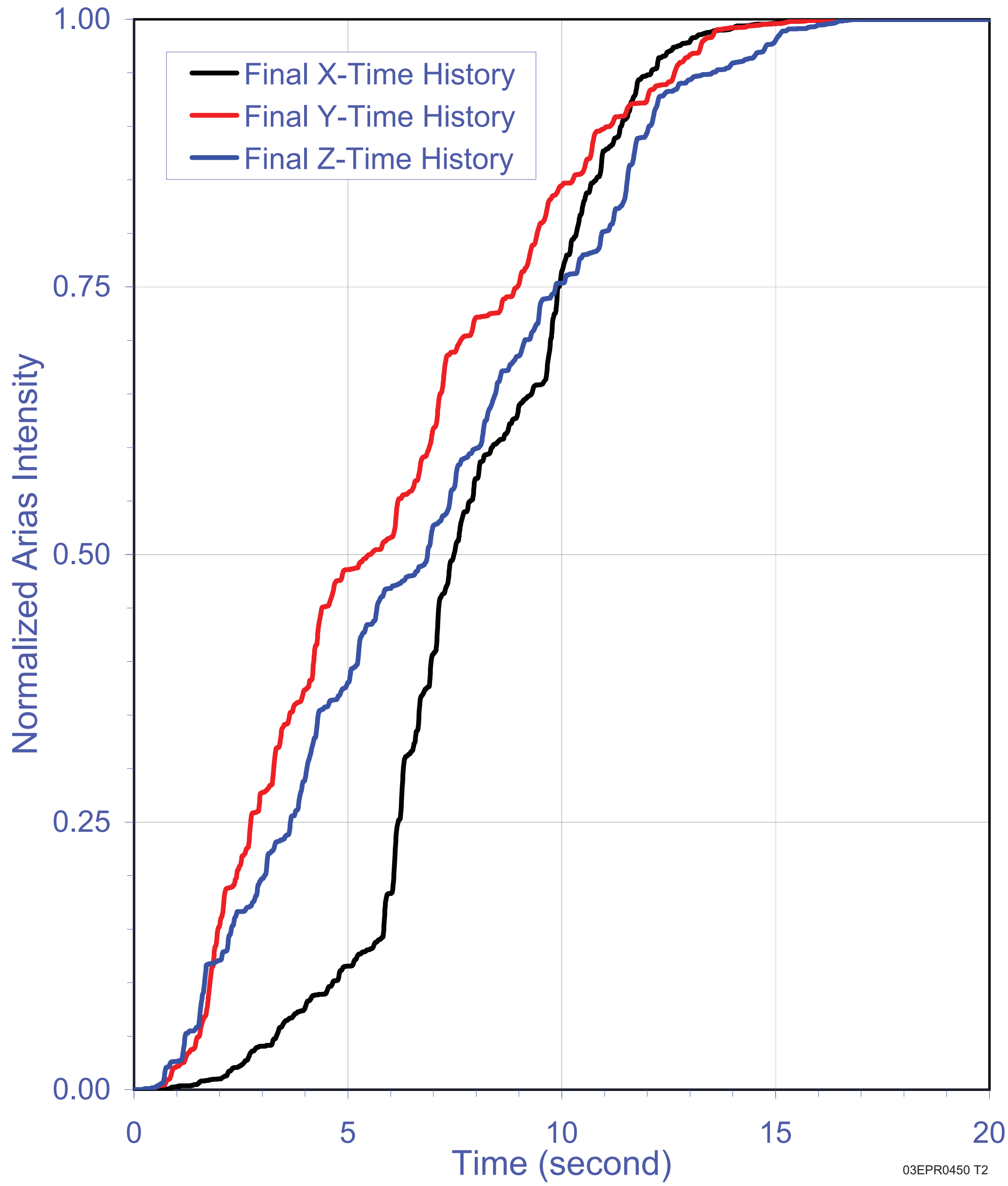


Figure 3.7.1-49—Input Motion for Structures Not on the NI Common Basemat, Horizontal (SSSIHF)

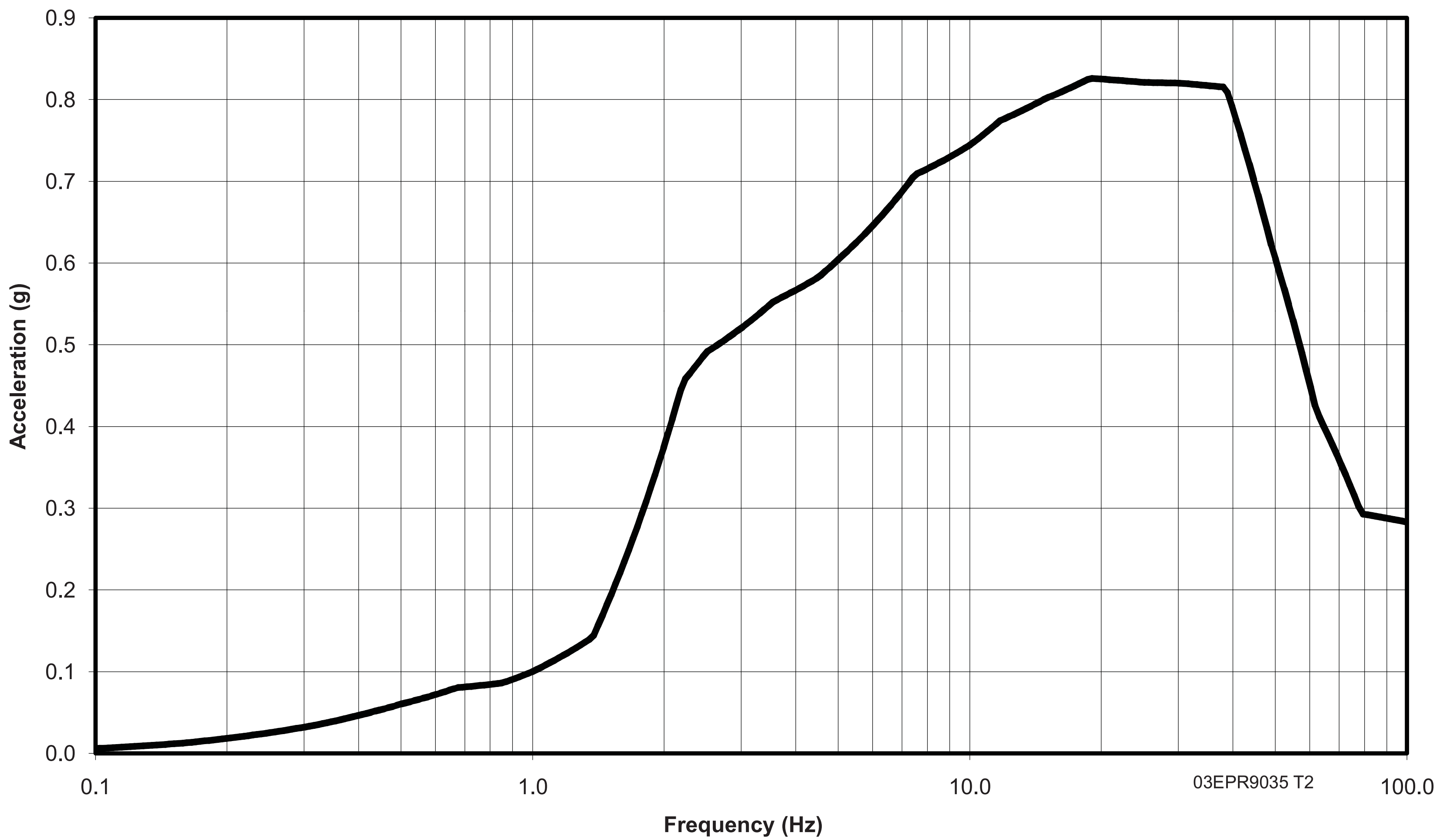


Figure 3.7.1-50—Input Motion for Structures Not on the NI Common Basemat, Vertical (SSSIHF)

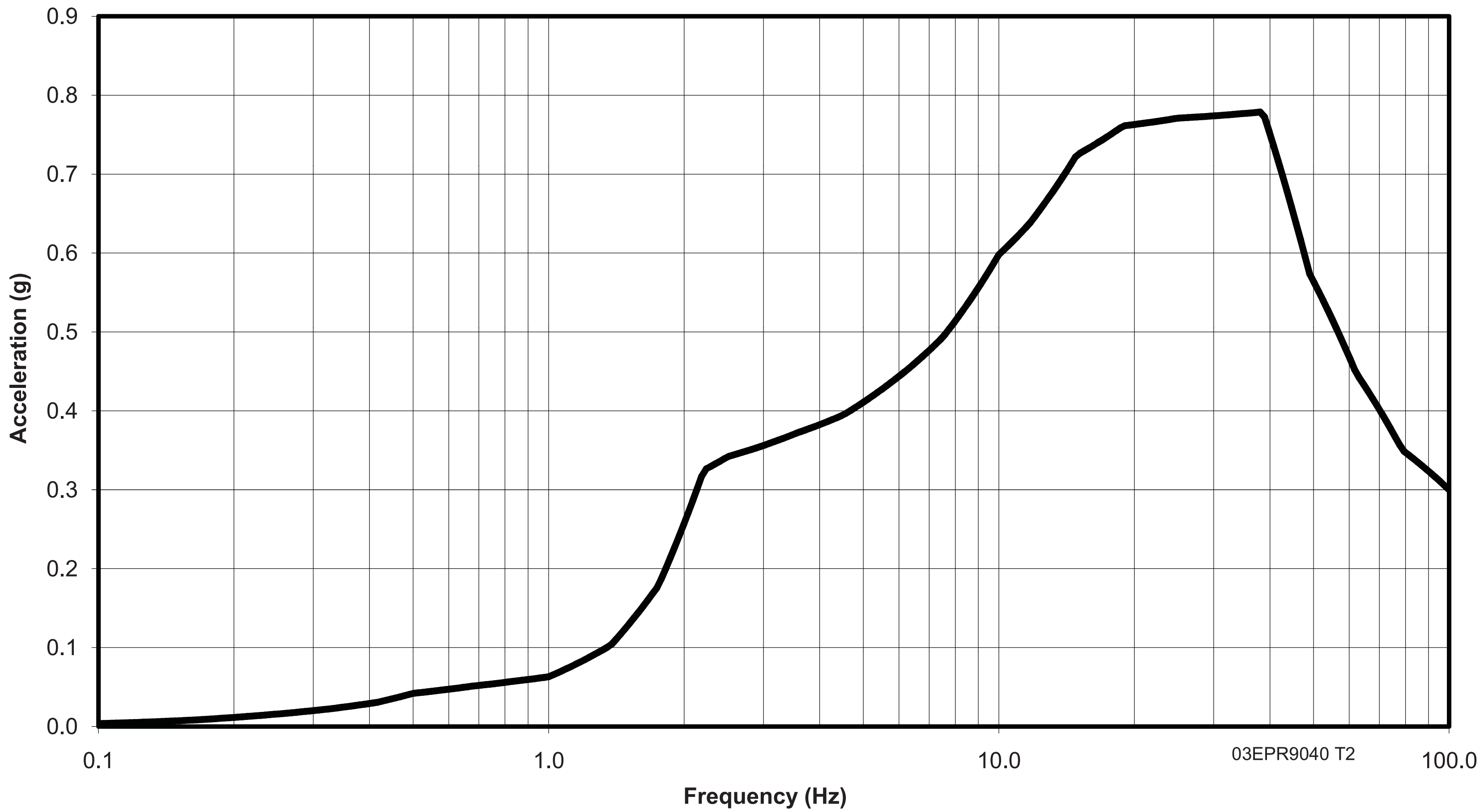
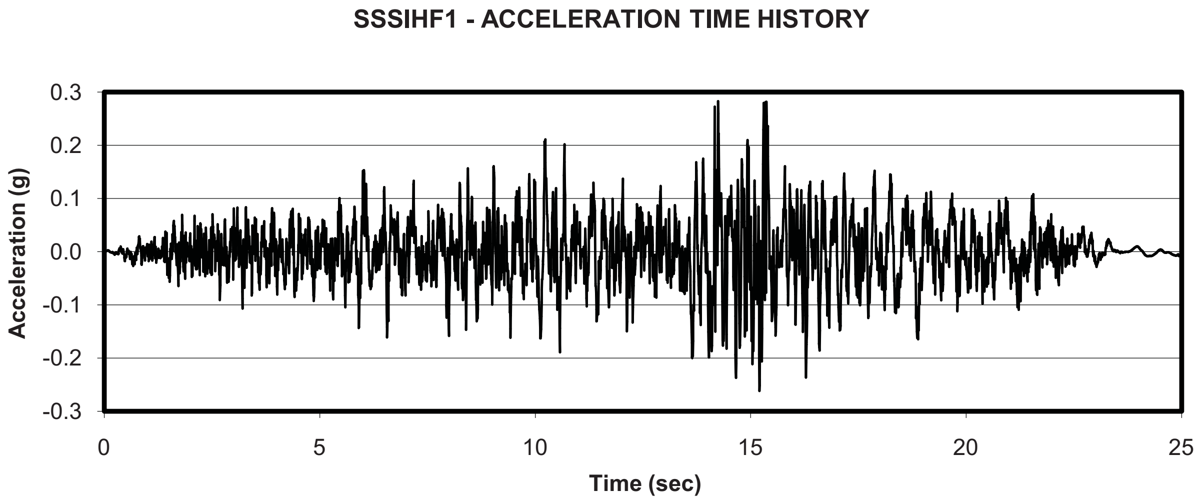
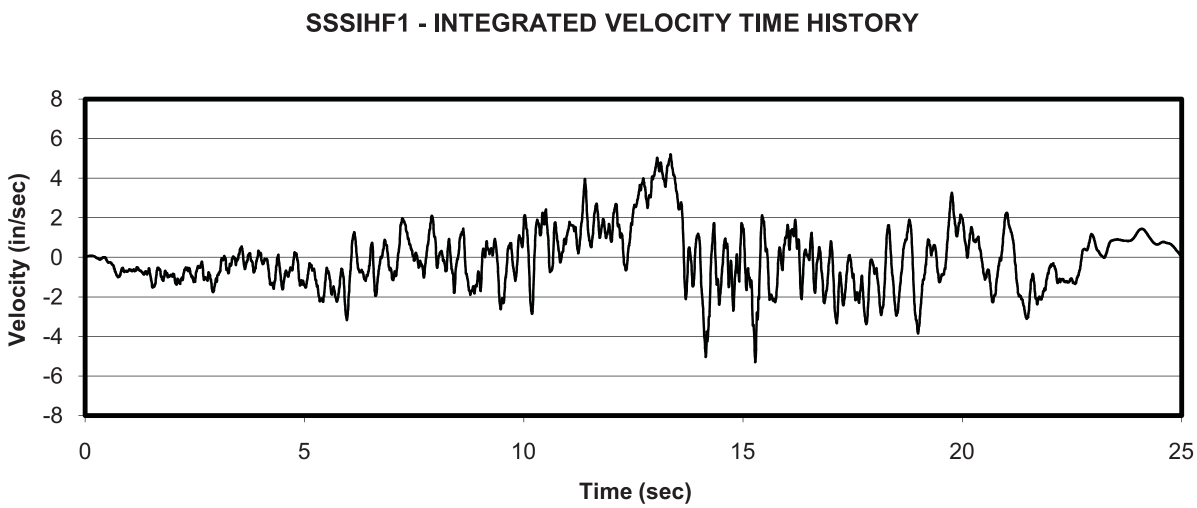


Figure 3.7.1-53—Synthetic Acceleration, Velocity, and Displacement Time Histories for Structures not on the Nuclear Island Common Basemat, Horizontal (SSSI1HF) Motion





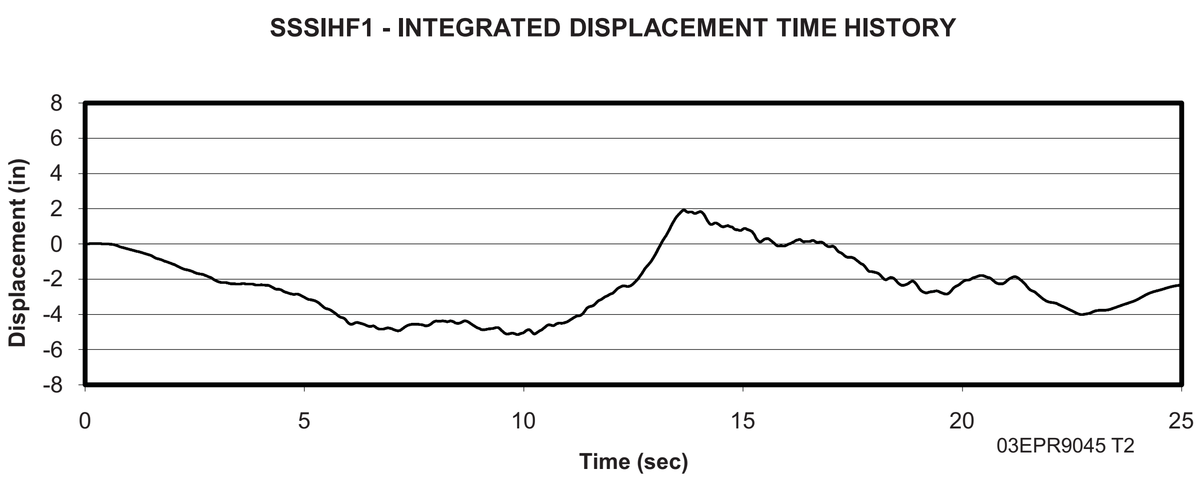


Figure 3.7.1-54—Synthetic Acceleration, Velocity, and Displacement Time Histories for Structures not on the Nuclear Island Common Basemat, Horizontal (SSSI2HF) Motion

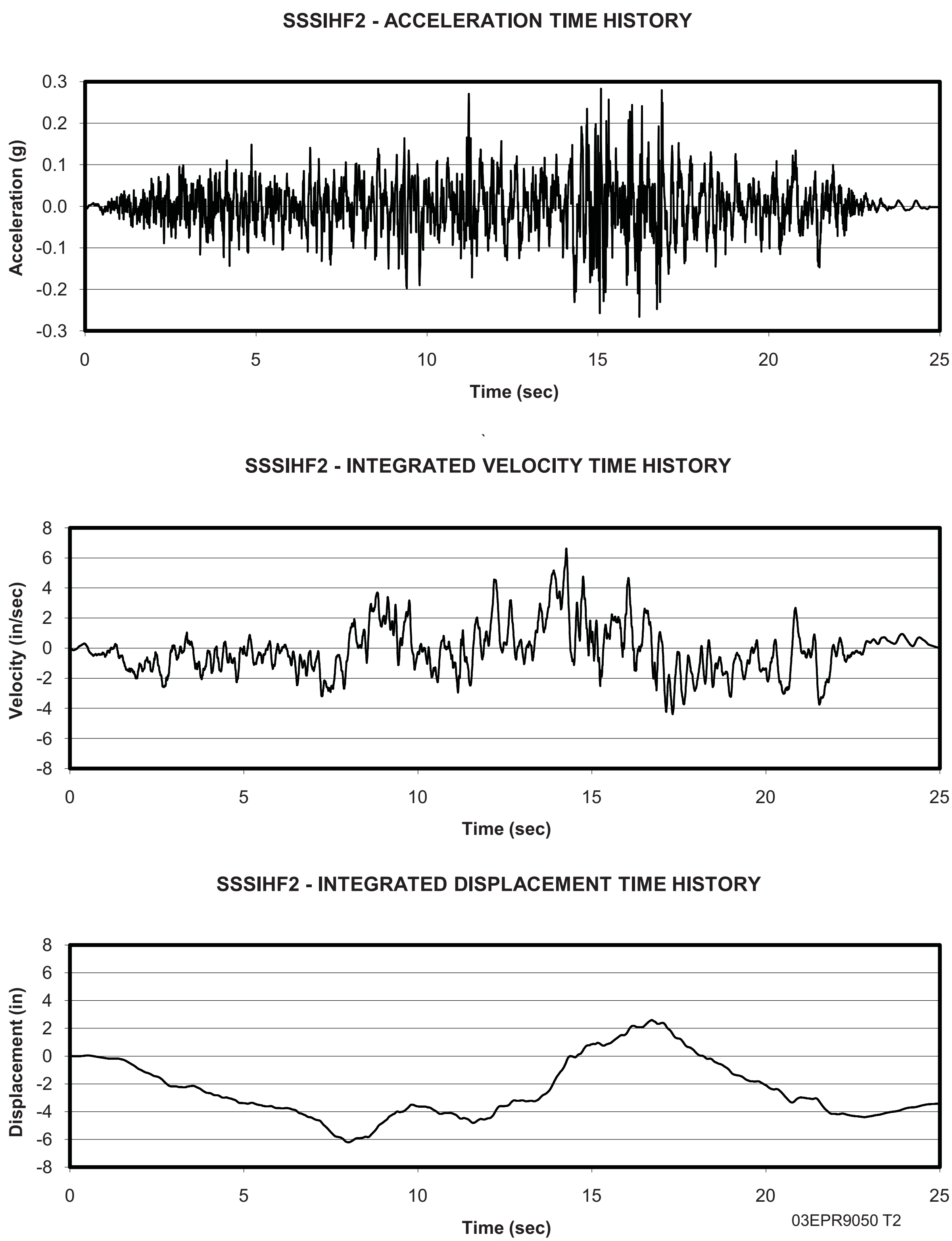
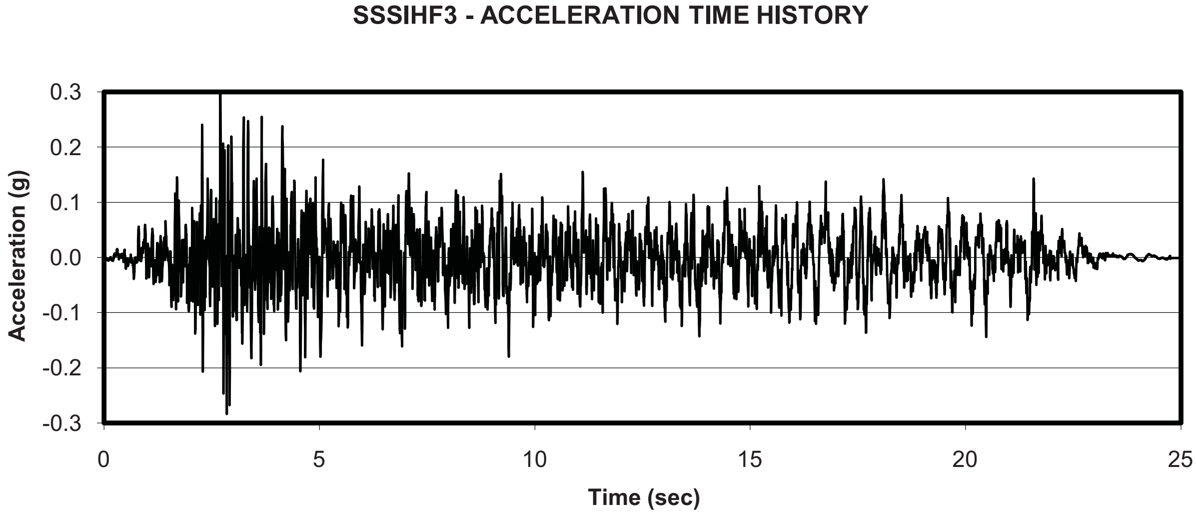
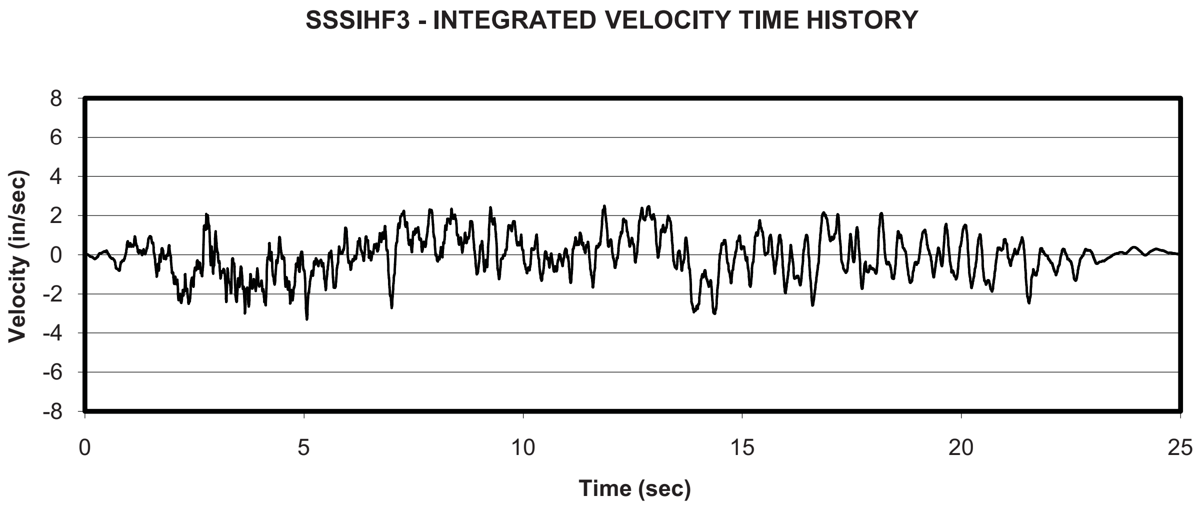


Figure 3.7.1-55—Synthetic Acceleration, Velocity, and Displacement Time Histories for Structures not on the Nuclear Island Common Basemat, Vertical (SSSI3HF) Motion





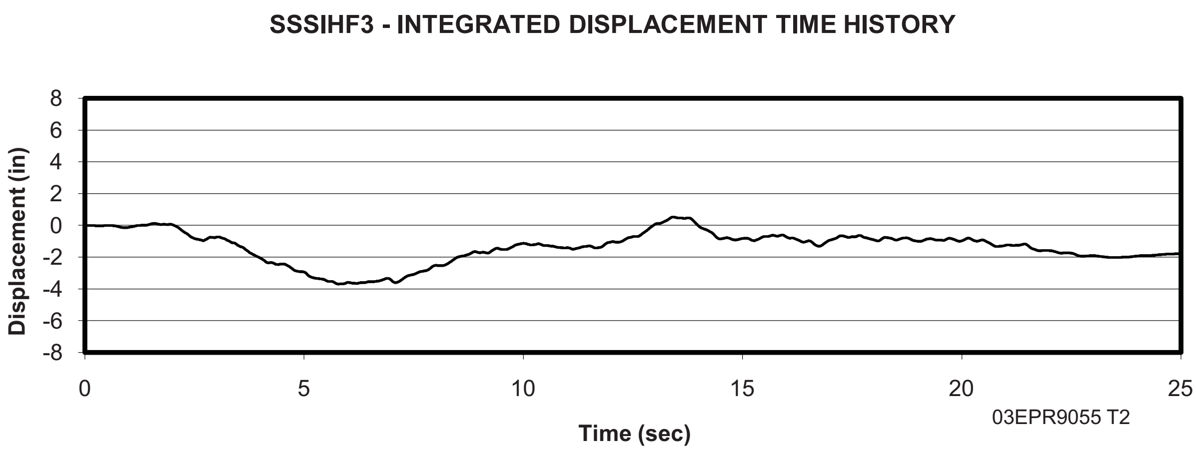


Figure 3.7.1-56—Time History Response Spectrum vs. Input Spectrum for Structures not on the Nuclear Island Common Basemat, Horizontal (SSSI1HF) Component

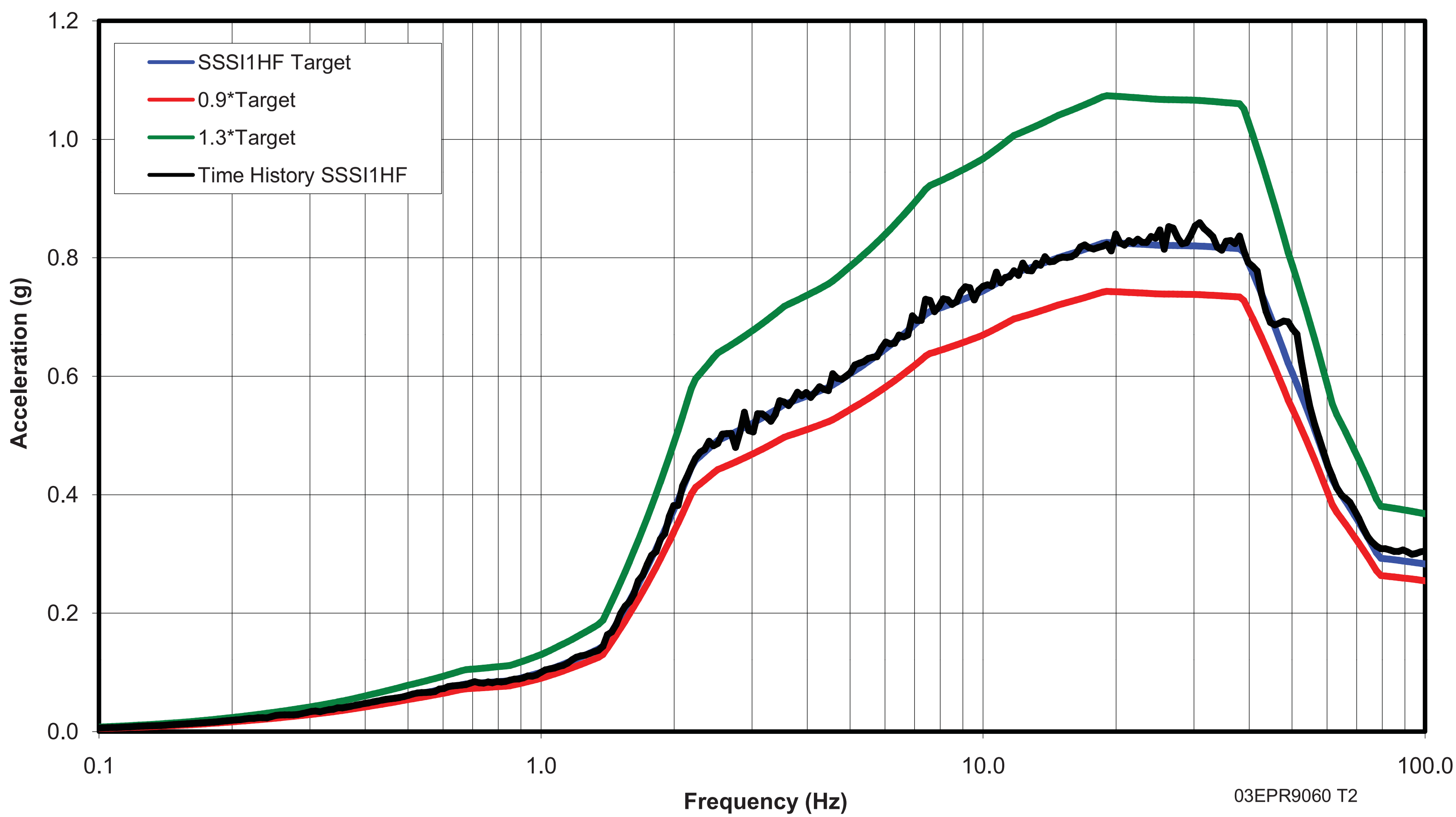


Figure 3.7.1-57—Time History Response Spectrum vs. Input Spectrum for Structures not on the Nuclear Island Common Basemat, Horizontal (SSSI2HF) Component

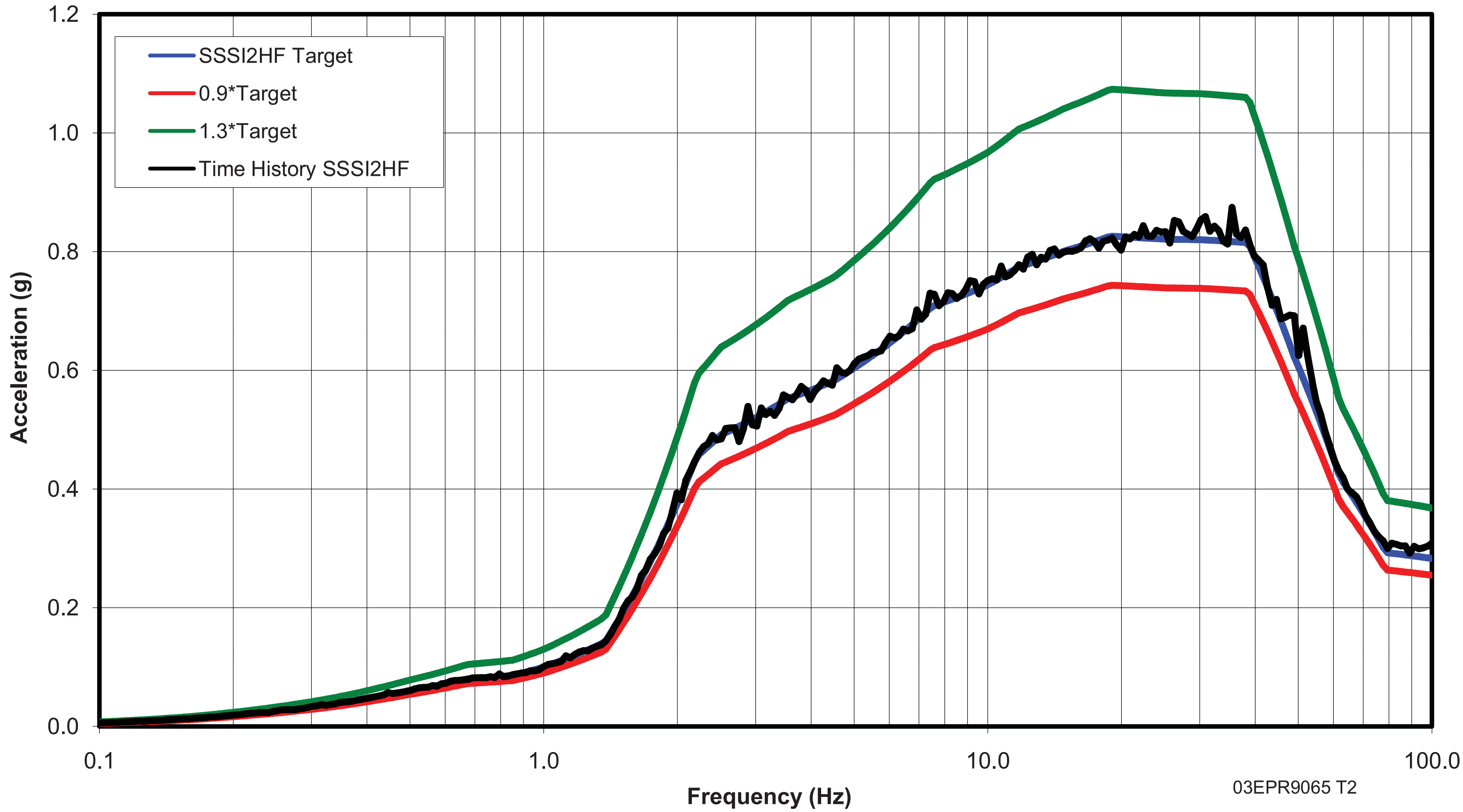


Figure 3.7.1-58—Time History Response Spectrum vs. Input Spectrum for Structures not on the Nuclear Island Common Basemat, Horizontal (SSSI3HF) Component

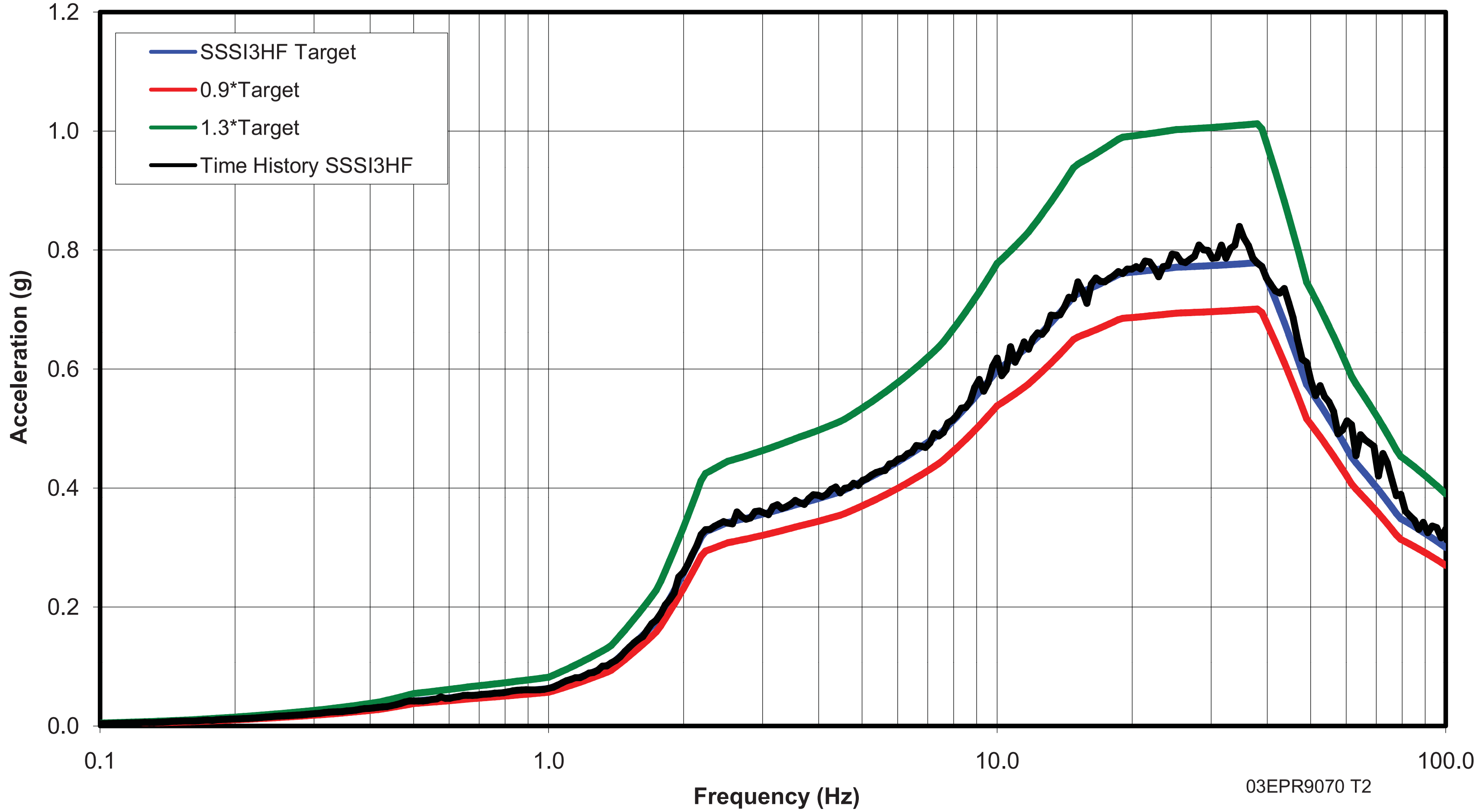
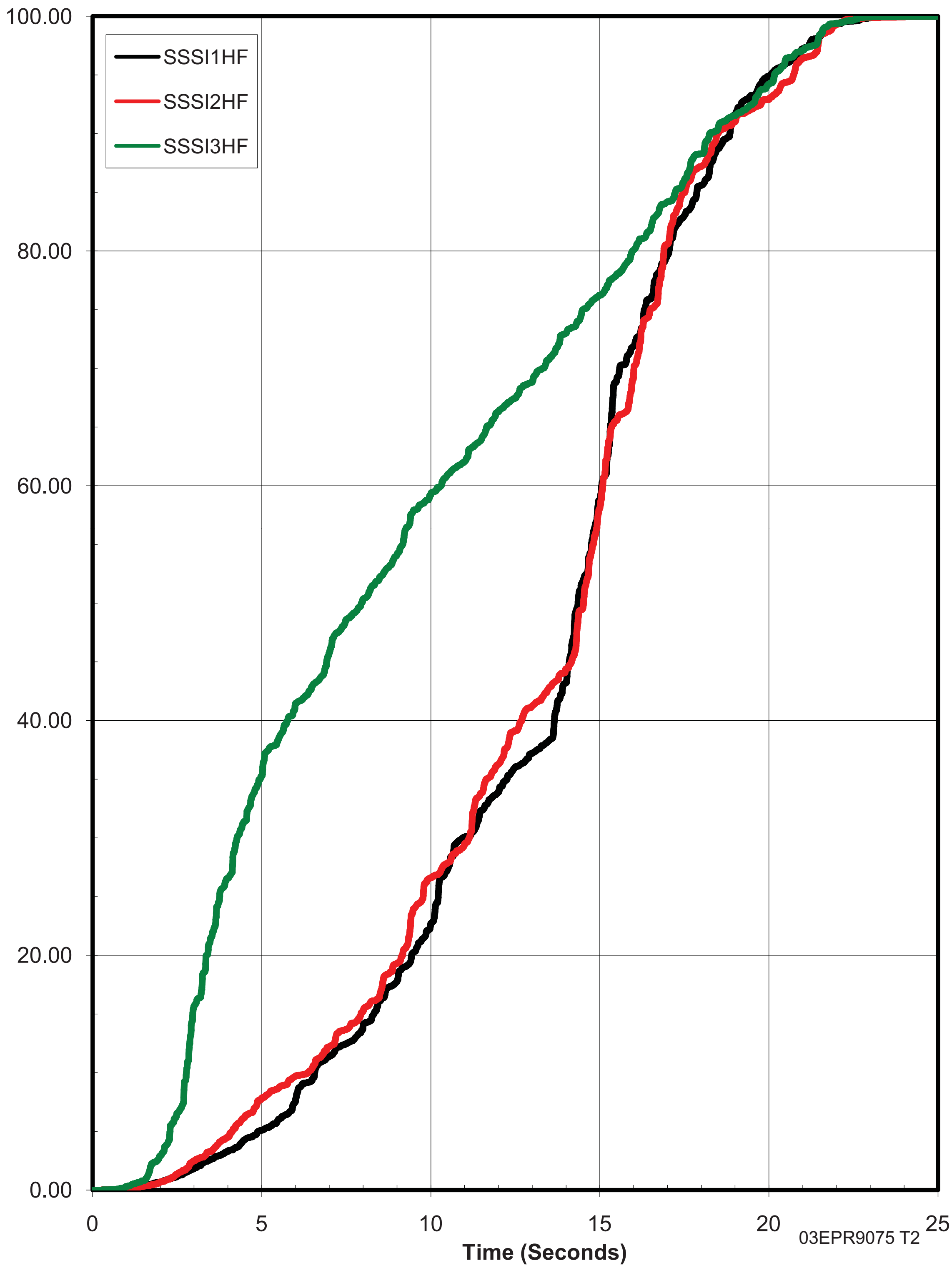


Figure 3.7.1-59—Cumulative Energy Plot for Time Histories for Structures not on the Nuclear Island Common Basemat (HF)



Indicated changes are in response to RAI 376, Supplement 24, Question 03.08.05-31

Figure 3.7.1-60—U.S. EPR Standard Plant Soil Profiles - Shear Wave Velocity for EPGB and ESWB SSI Analysis Cases (EUR)

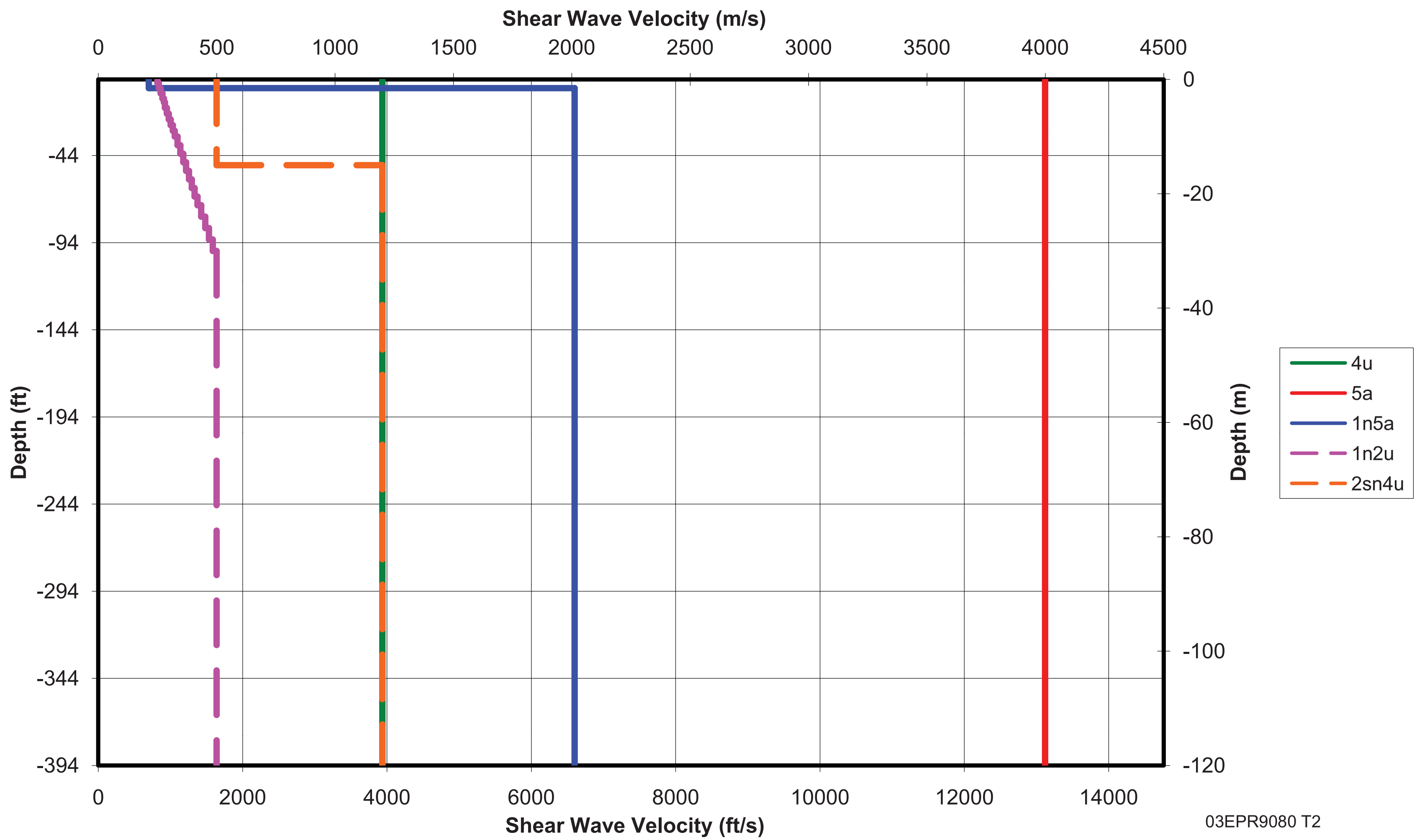
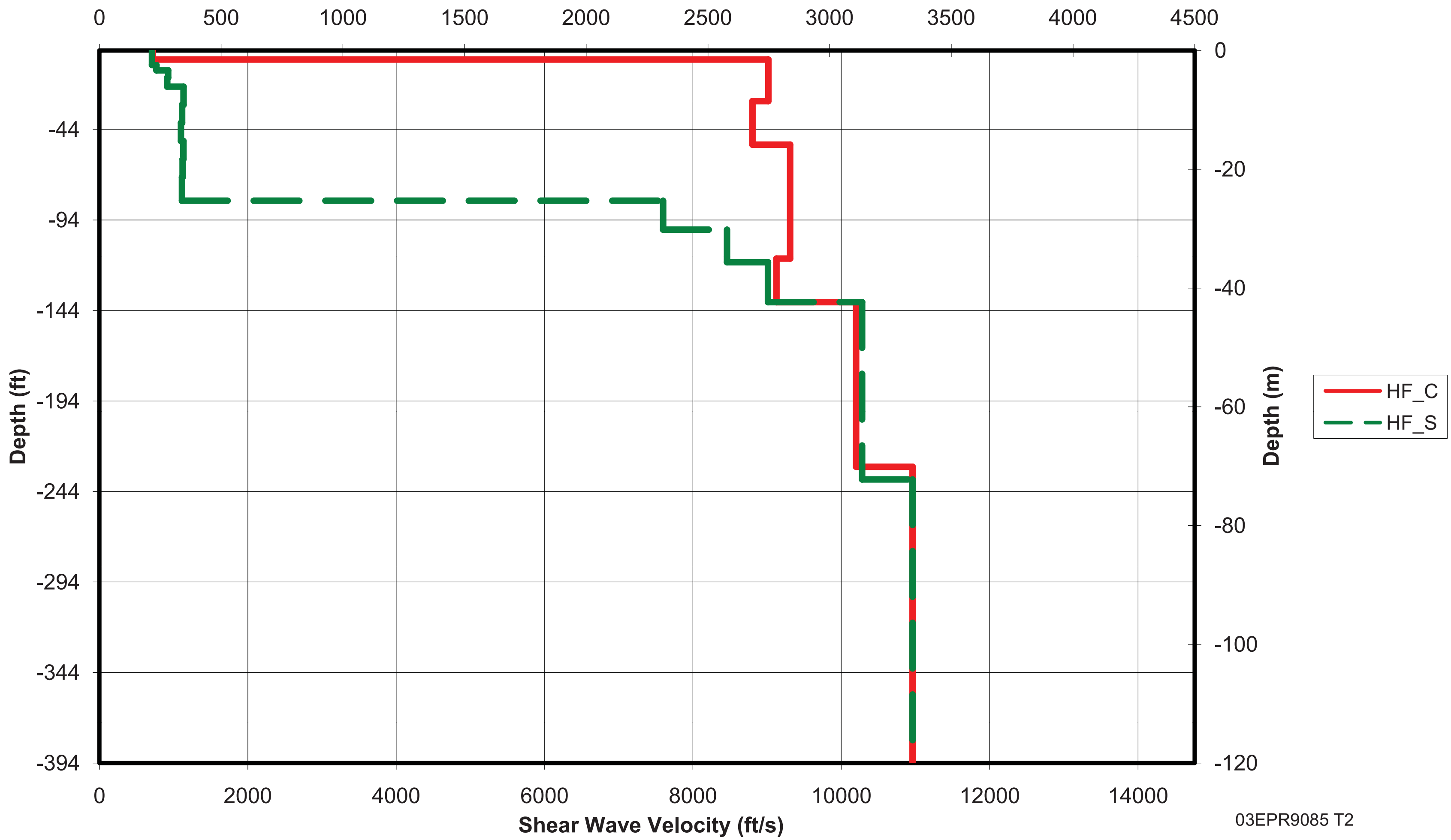


Figure 3.7.1-61—U.S. EPR Standard Plant Soil Profiles - Shear Wave Velocity for EPGB SSI Analysis Cases (HF)



NOTE:
HF_C IS A HIGH FREQUENCY PROFILE WITH CONCRETE AND
HF_S IS A HIGH FREQUENCY PROFILE WITH SOIL.
SEE TABLE 3.7.1-9 FOR MORE INFORMATION.

responses are combined to determine the maximum response of interest in accordance with the combination method described in Section 3.7.2.7.

3.7.2.1.3 Complex Frequency Response Analysis Method

With this analysis method, the damping of the system is not represented by the viscous damping matrix, [C], but as the imaginary part of a complex stiffness matrix. Thus Equation 1 becomes complex and must be solved in the frequency domain. To facilitate the analysis, the time history of input ground motion is transferred to the frequency domain by Fast Fourier Transform (FFT). The seismic responses calculated in the frequency domain are then transferred back to the time domain as outputs by inverse FFT.

The complex frequency response analysis method is used in the seismic SSI analysis of all Seismic Category I structures. ~~AREVA~~The computer code MTR/SASSI, Version ~~4.1B~~8.3, is used in the SSI analysis of the NI Common Basemat Structures and NAB~~.~~, ~~Bechtel computer code SASSI 2000, Version 3.1, is used in the SSI analysis of the~~ EPGBs, and ESWBs. For the SSI analysis results to be sufficient, the following requirements are met:

- A sufficiently high cut-off frequency is selected to ensure all significant SSI frequencies are included.
- A sufficient number of frequency points is used to accurately define the transfer functions within the cut-off frequency.
- The time step size for the input ground motion time histories is sufficiently small to be compatible with the selected cutoff frequency.

The SSI analysis generates the maximum ZPA at various floor locations, the floor acceleration time histories at representative locations for ISRS generation, the maximum member or element forces and moments, and the maximum relative displacements at the structural basemats with respect to the free-field input motions.

The complex frequency response analysis method is also used in the soil column analysis using SHAKE91 ~~Bechtel computer code SHAKE2000, Version 1.1,~~ to compute the free-field "in-column" motion at the foundation level of the NI Common Basemat Structures, EPGB, and ESWB~~,~~ for use as the input motion to the SSI analysis. This is because the SSI analysis of the NI Common Basemat Structures, EPGB, and ESWB considers structural embedment, and the input ground motion specified in Section 3.7.1 corresponds to a hypothetical free-field "outcrop" motion at the foundation level~~ of ESWB~~. MTR/SASSI, Version 8.3~~Bechtel code SASSI 2000~~ requires that the input motion, when specified at the foundation level, be an "in-column" motion converted from the "outcrop" motion through a soil column analysis. Alternatively, a surface motion converted from the "outcrop" motion can also be used.

3.7.2.1.4 Equivalent Static Load Method of Analysis

This analysis method is used to determine the seismic induced element forces and moments in the 3D FEMs of the NI Common Basemat Structures, EPGB, ESWB and NAB. In the analysis, equivalent static loads corresponding to the ZPAs generated from the seismic SSI analyses are applied to the 3D FEMs of the structure and basemat for the applicable SSI analysis cases. Computer codes used in the analyses include ANSYS code Version 10.011.0 for the NI Common Basemat Structures, and GTSTRUDL code Version 2729 for the EPGB, and ESWB, and GTSTRUDL code Version 29 for the NAB.

Consideration of torsional loading induced by accidental eccentricities is presented in Section 3.7.2.11.

3.7.2.2 Natural Frequencies and Response Loads

In the SSI analysis, the NI Common Basemat Structures, are represented by an embedded 3D FEM, and the RCS, and NAB are represented by stick models. and tThe EPGB and ESWB are each represented by a 3D FEMs. The stick models are developed to ensure a reasonable dynamic compatibility with the corresponding 3D FEMs that are used in the equivalent static analysis. Section 3.7.2.3 discusses the development of the structural models.

Table 3.7.2-1—Frequencies and Modal Mass Ratios for NI Common Basemat Structures with All Masses Included, shows the frequencies and modal mass ratios of the dynamic 3D FEM of the NI Common Basemat Structures, and Table 3.7.2-4—Modal Frequencies of the Simplified Stick Model of Reactor Coolant Loop, shows the frequencies of the first 50 modes of the simplified stick model of the RCS. Table 3.7.2-5—Modal Frequencies of the Stick Models of NI Common Basemat Structures and RCS, shows the frequencies and modal mass ratios computed by GTSTRUDL code for the first 256 modes of the stick model of the NI Common Basemat Structures including the vent stack and RCS. This overall stick model of the NI Common Basemat StructuresSTICK-1T is the stick model for the RBIS and includes applicable masses in addition to the masses of the concrete. It consists of three major stick models: STICK-1T for the RBIS, STICK-3T for the RCB, and STICK-2T for the composite sticks representing the remaining structures on the NI Common Basemat. Frequencies and modal mass ratios of these three individual major sticksSTICK-1T are shown in :

- Table 3.7.2-1—Frequencies and Modal Mass Ratios for Balance of NI Common Basemat Structures STICK-2T with All Masses Included.
- Table 3.7.2-2—Frequencies and Modal Mass Ratios for Reactor Containment Building STICK-3T with Polar Crane Included.

- Table 3.7.2-3—Frequency and Modal Mass Ratios for Reactor Building Internal Structures STICK-1T with All Masses Included.

Table 3.7.2-6—Modal Frequencies of the Stick Model of NAB shows the frequencies and modal mass ratios computed by GTSTRUDL code for the first 25 modes of the NAB stick model. Table —Table 3.7.2-7—Modal Frequencies of 3D FEM of Emergency Power Generating Building, and shows the frequencies of the 3D FEM of the EPGB. Table 3.7.2-8—Modal Frequencies of 3D FEM of Emergency Service Water Building (EUR Motions), and Table 3.7.2-31—Modal Frequencies of 3D FEM of Essential Service Water Building (HF Motion) show the frequencies of the 3D FEMs of the EPGB and ESWB used in SSI analysis based on the EUR motions and HF motion, respectively.

Since the SSI analysis is performed using the complex frequency response method where the equation of motion is solved in the frequency domain, the modal frequencies and mass ratios presented in the tables above are for reference information only.

3.7.2.3 Procedures Used for Analytical Modeling

Seismic SSI analysis of the Seismic Category I structures is performed following the guidance in ASCE 4-98 (Reference 1) and SRP 3.7.2 (Reference 2). Methodology for development of the structural models is discussed below. Methodology for development of the SSI analysis model is discussed in Section 3.7.2.4.

3.7.2.3.1 Seismic Category I Structures – Nuclear Island Common Basemat

The NI Common Basemat is approximately 10 feet thick and transitions to a thickened section where the cylindrical walls of the RSB and the RCB intersect with the basemat. The basemat then steps down at the outer edge of the tendon gallery wall and continues out under the SBs, FB, and the SCTs (see Figure 3.7.2-3 and Figure 3.7.2-4).

The SBs basemat is approximately 10 feet thick from the intersection with the outer surface of the RSB wall to the internal wall dividing the radiological control area and nonradiological control area, where it thickens to approximately 13 feet and continues to the intersection with the exterior wall.

The FB basemat is approximately 10 feet thick throughout, with the exception of an area of the basemat that steps down to form a sump at the common wall with the RSB wall, and then steps up and continues out to the intersection with the exterior wall.

A total of twelveeight SSI analyses are performed for the NI and NAB for eightthe various soil and rock conditions. Five are encompassed by the EUR design spectra for the hard, medium, and soft soil conditions, and three are associated with the HF GMRS as described in Section 3.7.1. The purpose of the SSI analyses is to generate sets

3.7.2.3.1.4 Finite Element Model for NI Common Basemat Foundation

The 3D basemat FEM is used for the analysis and design of the NI Common Basemat foundation. The FE discretization is selected so that the elements representing elevations and varying thickness of the basemat are able to produce reliable forces and moments for design. The 3D basemat FEM consists of solid elements connected to the shell or beam element of the SASSI dynamic model described in Section 3.7.2.3.1.2 using the ANSYS code. Lumped masses representing the dead and live structural loads are applied to the model similar to the 3D FEMs for the Dynamic Analysis described in Section 3.7.2.3.1.2. Representations of the FEM are shown in Figure 3.7.2-151—Solid Element Basemat and Figure 3.7.2-152— Foundation Basemat Model with Solid Element Basemat.

The model has soil spring dashpot elements in the three translational directions at the bottom to idealize the soil column behavior and sidewall spring elements for the active, at-rest and passive states of earth pressure caused by the movement of the NI sidewalls against embedded soil mass. A parametric comparison of different soil spring formulations was performed for the seismic model. The Gazetas formulation produced displacements and base reactions similar to SASSI and, therefore, was selected and used in the model. The distribution for seismic and static vertical soil springs is elliptical in nature as described by the equation in Section 3.8.5.4.2. The model represents the sliding interface between the foundation concrete basemat and the underlying soil using sliding elements, and allows for basemat uplift through compression only vertical springs. The ANSYS model is loaded statically by accelerating the lumped and distributed masses described in Section 3.7.2.3.1.2 before a nonlinear time-history analysis is performed. The input motions are in-column ground motions obtained from SHAKE91 analysis runs at the bottom of the NI Common Basemat foundation level in the three translational directions derived using the NEI approach in Section 2.5.2.6.

The SSI analysis described in Section 3.7.2.4 does not capture the increase in loading due to sliding and uplift on the shear key. Capturing the increases in loading will be accomplished by tracking the pressures on the embedded structural members in the basemat model with time. When nonlinear responses in the basemat model are observed, a factor will be developed to increase SSI generated pressure results.

3.7.2.3.2 Seismic Category I Structures – Not on Nuclear Island Common Basemat

~~Unlike the stick model approach utilized for the NI Common Basemat Structures and NAB,~~ 3D FEM's for the EPGB and ESWB are developed with GTSTRUDL code, Version ~~27~~31, for use in both the equivalent static analysis and SSI analysis. For SSI analysis, the GTSTRUDL FEM's are translated to a format suitable for the ~~Bechtel~~computer code MTR/SASSI ~~2000~~, Version ~~3.1~~8.3.

The reinforced concrete base mat, floor slabs, and walls of both structures are modeled in GTSTRUDL using shell elements, SBHQ6 and SBHT6, to accurately represent the structure and calculate both in-plane and out-of-plane effects from applied loads. For the EPGB, modifications are made to the slab stiffness at elevation +51 ft, 6 inches to accurately represent the stiffness of composite beams. For the ESWB, two additional modeling features are used:

- Space frame elements are used to simulate the fill support beams and the distribution header supports.
- ~~Rigid~~In the lateral directions, the convective water mass is not included and only the rigid water mass, calculated in accordance with the procedure in ASCE 4-98, Reference 1 and ACI 350.3 (Reference 3), is lumped on the appropriate basin walls. The entire water mass is considered in the vertical direction. Both low water and high water level are separately considered.

Figure 3.7.2-57—Isometric View of GTSTRUDL FEM for Emergency Power Generating Building and Figure 3.7.2-58—Section View of GTSTRUDL FEM for Emergency Power Generating Building illustrate an isometric view and a section view of the 3D FEM of the EPGB. Figure 3.7.2-59—Isometric View of GTSTRUDL FEM for Essential Service Water Building (EUR Motions) and Figure 3.7.2-60—Section View of GTSTRUDL FEM for Essential Service Water Building (EUR Motions), depict the 3D FEM of the ESWB used in SSI analysis based on the EUR motions.

To bound the dynamic response in the SSI analysis considering the fully cracked and uncracked conditions for walls and slabs, and additional 3D FEM is developed for the EPGB and the ESWB. The wall and slab thicknesses for these models are reduced to a value corresponding to 0.5I (where I = moment of inertia of uncracked section) to simulate cracked section properties in the out-of-plane direction~~For walls and slabs, adjustment is made to account for cracked section properties. Specifically, a value of 0.5E$_c$ is typically used to determine out-of-plane stiffness of these concrete walls and floors. There remains the possibility that the wall stiffness may be between the fully cracked and uncracked conditions. To bound the dynamic response in the SSI analysis, SDOF out-of-plane oscillators based on uncracked section properties are included in the SASSI model at the center of selected slabs and walls~~.

The EPGB is a surface mounted structure and its stability determination is analytically performed in the same manner as for the NI Common Basemat structure. The same analytical tools are used for Seismic Category I structures. To increase the margin due to overturning, the side wall friction for the embedded portions (i.e., the basemat and the shear keys are used). The sidewall friction forces are calculated using a coefficient of friction, μ = tan 20 deg = 0.36, with the at-rest soil pressure. The sliding and overturning safety factor of 1.1 is met.

The ESWB is an embedded structure and its stability determination will be analytically performed in the same manner as for the NI Common Basemat structure. The ESWB basemat includes a horizontal extension to add foundation mass and engage the weight of the soil above the extension to meet the sliding and overturning safety factor of 1.1.

3.7.2.3.3 Seismic Category II Structures

Non-Seismic Category I structures with potential to impair the design basis safety function of a Seismic Category I SSC will be classified as Seismic Category II in accordance with the criteria identified in Section 3.2.1.2. [[Seismic Category II structures that are included in the U.S. EPR design are analyzed to SSE load conditions and designed to the codes and standards associated with Seismic Category I structures so that the margin of safety is equivalent to that of a Category I structure with the exception of sliding and overturning criteria.]] Because Category II structures do not have a safety function, they may slide or uplift provided that the gap between the Category II structure and any Category I structure is adequate to prevent interaction. Procurement, quality control, and QA requirements for Category II structures will be performed according to the guidance provided in Section 3.2.1.2. Site-specific Seismic Category II structures are addressed in Section 3.7.2.8.

3.7.2.3.4 Conventional Seismic (CS) Structures

The analysis and design of Conventional Seismic building structures will be in accordance with the applicable requirements of the International Building Code (IBC) (Reference 4) and other codes, as appropriate (see Section 3.2.1.4 for description of CS structures).

3.7.2.4 Soil-Structure Interaction

The SSI analysis of the NI Common Basemat Structures and NAB ~~are~~is performed using ~~the AREVA computer code~~ MTR/SASSI, Version ~~4.1B~~8.3, for the ~~generic~~ soil cases specified in Table 3.7.1-6. The free-field input motion to the SSI analysis is the certified seismic design response spectra (CSDRS) previously described in Section 3.7.1.1.1 for the seismic design of NI Common Basemat Structures.

~~For EPGB and ESWB, Bechtel computer code~~ MTR/SASSI ~~2000~~, Version ~~3.1~~8.3, is also used in the seismic SSI analysis of the EPGB and ESWB. Soil cases specified in Table 3.7.1-8 and Table 3.7.1-9 are considered for EPGB and ESWB, respectively. The free-field input motion to the SSI analysis is the modified CSDRS described in Section 3.7.1.1.1. The modified CSDRS accounts for the approximate structure-soil-structure interaction (SSSI) effect of the NI Common Basemat Structures on the free-field motions at the locations of these structures, and is developed based on the results of the SSI analysis of the NI Common Basemat Structures and NAB.

Methodology for the SSI analysis of the NI Common Basemat Structures and NAB, EPGB and ESWB is discussed in the following.

3.7.2.4.1 Step 1 - Selection of ~~Generic~~ Soil Profiles

The ~~ten generic~~ soil profiles previously specified in Table 3.7.1-6 are ~~considered~~ representative of potential sites in the central and eastern United States (CEUS). The~~y~~ soil profiles considered for SSI analysis of the NI Common Basemat Structures and NAB are Soil Cases ~~1u to 5u, 5a, 1n2u, 2sn4u, 2n3u, and 3r3u~~ 1n2ue, 2sn4ue, 4ue, 5ae, and 1n5ae, ranging from soft soil to medium soil to hard rock conditions, and hfub, hflb, and hfbe, representing soil conditions associated with high-frequency ground motion. Case 5ae ~~is intended to~~ simulates the hypothetical condition of a hard rock approaching a rigid foundation medium whereas Case 1n5ae simulates a soft backfill underlain by the same hard rock. Cases hfub, hflb and hfbe also contain a range of backfill soil layers. Table 3.7.2-8—Soil Properties Associated with Different ~~Generic~~ Shear Wave Velocities, lists the soil properties associated with the various shear wave velocities considered in the ~~generic~~ soil profiles. For U.S. EPR design certification, the ~~generic~~ soil properties are taken to be strain-compatible values during seismic events. Column 2 of Table 3.7.1-6 shows the free-field input motion associated with each of the ~~ten generic~~ soil cases considered in the SSI analysis of the NI Common Basemat Structures and NAB. Each ~~generic~~ soil case is associated with one of the ~~three~~ free-field input motions ~~except that Soil Cases 2u and 4u are associated with two different input motions~~, giving rise to a total of ~~twelve~~eight SSI analysis cases for the NI Common Basemat Structures and NAB. Figure 3.7.1-31 and Figure 3.7.1-32 illustrate the shear wave velocity profiles of the ~~ten generic~~ soil cases.

The ~~same ten generic~~ soil cases ~~are~~ considered in the SSI analysis of the EPGB and ESWB~~, and the modified CSDRS is the common free-field input motion in all soil cases.~~ are specified in Table 3.7.1-8 and Table 3.7.1-9, respectively. Figure 3.7.1-60 through Figure 3.7.1-62 provide the shear wave velocity profiles of the soil cases. Soil cases 1n2u, 2sn4u, 4u, and 5a shown in Table 3.7.1-8 and Table 3.7.1-9 are the same as the soil cases 1n2ue, 2sn4ue, 4ue, and 5ae shown in Table 3.7.1-6, respectively, except that the ones in Table 3.7.1-6 have backfill layers above elevation -38 ft, 10-1/2 inches. The soil case 1n5a in Table 3.7.1-8 and Table 3.7.1-9 is the same as the soil case 1n5ae in Table 3.7.1-6 except for the thickness of the backfill layer. The seismic input for the EPGB and ESWB is the modified CSDRS that accounts for the effects of structure-soil-structure interaction between these structures and the Nuclear Island Common Basemat Structures, as described in Section 3.7.1.1.1. Two modified CSDRS are developed, one based on the EUR motions and the other based on the HF motion. As in the analysis of the NI Structures and NAB, soil cases considered in the analysis of the EPGB and ESWB are associated with SSSI, the EUR-based modified CSDRS and SSSIHF, the HF-based modified CSDRS.

Layout Showing Basemat, Sidewalls, and Shear Key. Table 3.7.2-6 lists the frequencies and modal mass ratios calculated using the GTSTRUDL code for the first 25 modes of the fixed-base stick model of the NAB structure.

Structural damping values used in the SSI analysis are based on Table 3.7.1-1:

- Reinforced concrete (RBIS, balance-of-NI Common Basemat Structures and NAB) – 7 percent.
- Prestressed concrete (containment) – 5 percent.
- RCS components – 4 percent.
- Vent stack – 4 percent.

As an option noted previously in Section 3.7.2.3.1.1, the 3D FEM of the NI Common Basemat Structures or a dynamically compatible simplified 3D FEM may be used in lieu of the stick models in the SSI analysis.

(2) EPGB and ESWB

Section 3.7.2.3.2 describes the development of the GTSTRUDL code 3D FEM of the structure, the translation of the FEM to that suitable for the BechtelMTR/-SASSI 2000 code, and the development of the cracked FEM with reduced flexural stiffness in the out-of-plane direction of walls and slabsaddition of SDOF oscillators to the FEM to simulate out-of-plane flexibility of selected slabs and walls. Table , and Table 3.7.2-28 Table 3.7.2-7, and Table 3.7.2-31 show the frequencies computed by GTSTRUDL for the 3D FEM of the EPGB, ESWB (EUR motions), and ESWB (HF motion), respectively.

Both EPGB and ESWB are reinforced concrete structures. A structural damping equal to 4 percent is conservatively used in the SSI analysis.

3.7.2.4.3 Step 3 - Development of Soil Model

To develop the soil model for use in the SSI analysis with the SASSI code, each of the ten generic soil profiles is discretized into a sufficient number of sub-layers, followed by a uniform half space beneath the lowest sub-layer. The passing frequency f_p, which is the maximum frequency that can be represented by the soil model, is based on $f_p = V_s/(5L_e)$, where V_s is the soil shear wave velocity and L_e is the element size for discretizing the soil. Both the excavated soil element size and soil layer thickness are considered for L_e to assess the high-frequency transmission capability of the model in both the horizontal and vertical directions. The soil cases subjected to EUR soft input motions govern the design response spectra up to a frequency that is well below the calculated passing frequency of the subgrade. The medium and hard soil cases transmit frequencies up to the input motion frequency of interest. The upper bound HF (hfub)

Structures and the stick model for the NAB with the surface of each of the ten generic soil models described in Step 3, at all interface nodes on the rigid-beam grids at elevation -38 ft, 10-1/2 inches that represent the bottom faces of the NI Common Basemat Structures and NAB basemats and the lateral faces of the sidewalls. The interface nodes are shown in Figure 3.7.2-130—Nuclear Island and Nuclear Auxiliary Building Interface Nodes. The subtraction method provided by MTR/SASSI, Version 8.3, is used to account for the effects of seismic input and soil stiffness on the interface nodes. With consideration of the soil profile and control motion combinations of Table 3.7.1-6, this gives rise to a total of twelve SSI analysis models. Figure 3.7.2-62 shows a plan view of the SSI analysis model. The surrounding Seismic Category I structures, EPGB and ESWB, are much lighter than the NI Common Basemat Structures. It is expected that, through the soil, the SSI of the NI Common Basemat Structures will have some effects on the free-field seismic ground motions at these structures. To capture such effects, simple grids of massless rigid beams representing the footprints of these surrounding structures are placed at the respective plan locations on the soil surface of the SSI analysis model. Figure 3.7.2-124—SSI Analysis Model – Adjacent Structures Foundation Rigid Beam Elements, shows the layout of the rigid beam elements. The soil surface response motions at the footprints of the surrounding structure are extracted from the SSI analysis of the NI Common Basemat Structures and NAB to serve as the basis for developing the free-field input motion for the SSI analysis of the surrounding structures.

Exterior NI sidewalls below grade bear against soil except for those that are located next to the NAB and AB walls, as shown in Figure 3.7.2-132—Nuclear Island Foundation Layout Showing Basemat, Sidewalls, and Shear Key. The NAB and AB are embedded to approximately the same depth as the NI Common Basemat Structure. The NI sidewalls that are not bearing against soil are not connected to any soil interaction nodes except at the base of the wall and along the vertical edges common with other soil-bearing walls at which load transfer from soils onto those walls can occur.

Figure 3.7.2-63Figure 3.7.2-130 shows an elevationisometric view of the SSI model (NAB stick is not shown for clarity) in the X-Z plane, which includes a schematic soil model, to illustrate (a) the discretized sub-layering of the soil and the underlying half space in the soil model, (b) the interaction coupling between the soil model and NI Common Basemat Structures/NAB basemats, and (cb) the interaction coupling between the soil and the other rigid grids representing the massless footprints of the surrounding structures.

(2) EPGB and ESWB

Similarly, the SSI analysis models for EPGB and ESWB are established by coupling the 3D FEM of the structure with each of the soil models for the ten generic soil profiles. The EPGB is embedded with the ground surface modeled at elevation -1 ft, 0 inches

(-0.30 m) and the bottom of the basemat at elevation -6 ft, 0 inches (-1.83 m).The surface of the soil models is at grade (elevation 0 ft, 0 inches). The EPGB is surface founded, and the bottom face nodes of the FEM basemat are coupled to the soil model at the surface. For the ESWB, the exterior walls and basemat bottom of the 3D FEM are embedded in the soil model.

3.7.2.4.5 Step 5 - Performing SSI Analysis

The SSI analysis of the NI Common Basemat Structures and NAB is performed using the AREVA code, MTR/SASSI, Version 8.3. MTR/SASSI code performs the analysis in the frequency domain using the complex frequency response analysis method and then outputs the seismic responses in the time domain. One analysis is performed for each of the twelveeight SSI analysis cases resulting from the combination of the ten genericeight soil profiles and the threefour CSDRS design ground motions. The analysis cases combining each of the soil profiles with the corresponding ground motion are specified in Table 3.7.1-6 .

Similarly, the SSI analysis of the EPGB and ESWB is performed using the Bechtel code MTR/SASSI, Version 8.3 2000. One SSI analysis is performed for each of the ten generic soil profiles, and the modified CSDRS is the input motion at the surface of the soil model for the EPGB and at the basemat elevation of the soil model for the ESWB. The analysis cases are specified in Table 3.7.1-8 and Table 3.7.1-9.

3.7.2.4.6 Step 6 - Extracting Global Seismic SSI Responses

(1) NI Common Basemat Structures and NAB

The SSI analyses of the NI Common Basemat Structures generate the global seismic responses of the NI Common Basemat Structures of all of the twelveeight SSI analysis cases. In each analysis case, the analysis is performed for one component of the input motion at a time, and it outputs the time histories of the requested seismic responses (floor accelerations, member forces and moments, etc.) to the particular component of input motion. To account for the contributions from the three components of input motion to the floor acceleration response, the three output time histories for the floor acceleration in a given global direction and at a given location are algebraically summed to produce the total floor acceleration response time history in the corresponding global direction. The ZPA is the maximum amplitude of the total floor acceleration time history in the corresponding global direction. ZPAs at specified locations are computed using AREVA code SASSIEXT, Version 1.1.For global member forces and moments, only the maximum values are usually needed. In this case, the STRESS module of SASSI code is used to output the maximum global member force/moment due to each input motion component. The maximum collinear member forces/moments due to the three input motion components are then combined by the square-root-of-sum-of-squares (SRSS) rule to obtain the global maximum total member forces/moments. In addition, as discussed in Section 3.7.2.5 below, the in-structure response spectra (ISRS) for the floor acceleration time histories at specified locations are also computed using AREVA code RESPECSASSIEXT, Version 1.1A.

At each givenkey elevations of along the FEM for the individual stick modelstructure, the worstenvelope of ZPAs at the lumped mass location and building corners is taken to be the ZPA representative of the particular SSI analysis case. They ZPAs are shown in Table 3.7.2-9—NI Common Basemat Sttructures ZPAs, which presents the individual envelope of ZPAs from the sixteen cases (eight SSI analysis cases times two uncracked and cracked analysis models) as well as the envelope of all sixteen cases. to Table 3.7.2-17—Fuel Building Shield Structure ZPAs for the sticks for the NI Common Basemat Structures. Each table presents the individual worst ZPAs from the twelve SSI analysis cases as well as the envelope of the worst ZPAs. Table 3.7.2-18—Maximum Base Forces and Moments at Bottom of NI Common Basemat shows the maximum base forces and moments at the bottom face (elevation -38 ft, 10.53 inches) of the common basemat for the individual SSI analysis cases. Among the twelve SSI analysis cases, five cases are the most critical as far as ZPAs and base forces and moments for the NI Common Basemat Structures are concerned. These five cases are: 2n3um, 2sn4um, 3r3um, 4um, and 5ah. Figure 3.7.2-19—Worst Case Inter-Story Forces and Moments in Reactor Building Internal Structures to Table 3.7.2-25—Worst Case Inter-Story Forces and Moments in Safeguard Building 2/3 Shield Structure show the worst case inter-story forces and moments in the members of the individual sticks for the NI Common Basemat Structures.

The time history of the displacement at the NI Common Basemat relative to the input ground motion is determined by double integrating the acceleration response time history at the basemat Node 417, applying a linear baseline correction, and subtracting from it the displacement time history of the free field ground motion for each SSI analysis case. Table 3.7.2-26—Maximum NI Common Basemat Displacement Relative to Free Field Input Motion lists the peak relative displacement at Node 417 for all twelve SSI analysis cases. The maximum relative displacement at a given structural location in the NI Common Basemat Structures with respect to the basemat is conservatively taken from the equivalent static analysis of the FEM of the NI Common Basemat Structures described in Section 3.8.4.

(2) EPGB and ESWB

Similarly, the SSI analysis of the EPGB and ESWB generate total floor acceleration response time histories in the three global directions. ZPAs and ISRS at specified locations are computed using SASSIEXT, Version 1.0.

- From the nodal acceleration response time histories generated from the SSI analysis, maximum nodal accelerations in each given global direction and due to each of the three components of the input ground motion are extracted. For each of the ten generic soil cases, the extracted maximum nodal accelerations are used the un-cracked, or gross, moment of inertia, I_g. Thus the out-of-plane vibration frequency of the cracked slab or wall is equal to 0.707 times that of the uncracked slab or wall. Generation of response spectra for the flexible slabs and walls in the NI Common Basemat Structures are discussed in Section 3.7.2.5.

(2) EPGB and ESWB

TheSimilarly, the out-of-plane seismic responses of flexible slabs and walls are directly available from the 3D FEM of the EPGB and ESWB used in the SSI analyses.directly available from the SSI analysis because the meshing of the 3D FEM of the structure is sufficient to represent the flexible slabs and walls in cracked condition while the SDOF oscillators added to the 3D FEM simulate the un-cracked condition. Generation of response spectra for the flexible slabs and walls are discussed in Section 3.7.2.5.

3.7.2.5 Development of Floor Response Spectra

The ISRS for the U.S. EPR Seismic Category I structures are developed following the guidance in RG 1.122, Revision 1. They are calculated for 2 percent, 3 percent, 4 percent, 5 percent, 7 percent and 10 percent damping.

(1) NI Common Basemat Structures and NAB

For NI Common Basemat Structures and NAB, the floor acceleration response time histories in a given direction due to the three components of input motion are combined algebraically to produce the combined floor acceleration time history in the same direction, from which the ISRS in the corresponding direction is then computed. The ISRS are calculated using AREVA code RESPECSASSIEXT, Version 1.1A, at the following 7998 frequencies:

Frequency Range (Hz)	Frequency Increment (Hz)
0.21 to 3.0	0.10
3.0 to 3.6	0.15
3.6 to 5.0	0.20
5.0 to 8.0	0.25
8.0 to 15.0	0.50
15.0 to 18.0	1.00
18.0 to 22.0	2.00
22.0 to 50.0100	3.00
50 to 100	50.0

The above frequencies for ISRS generation comply with the guidelines set forth in Table 3.7.1-1 of SRP Section 3.7.1 in Reference 2. At each given structural elevation along the stick modelsFEM for the individual building, ISRS at the lumped mass point and building corner nodes (typically four corner nodes)key locations (nodes at wall-floor junctions) are calculated for each SSI analysis case. The key output nodes are shown in Figure 3.7.2-137—Location of Response

Output Nodes – NI Common Basemat, Figure 3.7.2-138—Location of Response Output Nodes – Reactor Building Internal Structure – Elev. +16 ft, 10-3/4 in (+5.15 m), Figure 3.7.2-139—Location of Response Output Nodes – Reactor Building Internal Structure – Elev. +63 ft, 11-3/4 in (+19.50 m), Figure 3.7.2-140—Location of Response Output Nodes – Safeguard Building 1 – Elev. +26 ft, 3 in (+8.10 m), Figure 3.7.2-141—Location of Response Output Nodes – Safeguard Building 1 – Elev. +68 ft, 10-3/4 in (+21.00 m), Figure 3.7.2-142—Location of Response Output Nodes – Safeguard Building 2 and 3 – Elev. +26 ft, 7 in (+8.10 m), Figure 3.7.2-143—Location of Response Output Nodes – Safeguard Building 2 & 3 – Elev. +50 ft, 6-1/4 in (+15.40 m), Figure 3.7.2-144—Location of Response Output Nodes – Safeguard Building 4 – Elev. +68 ft, 10-3/4 in (+21.00 m), and Figure 3.7.2-147—Location of Response Output Nodes, Fuel Building at Elev. +12 ft, 1-2/3 in (3.7 m). The envelope of the ISRS at these locations represents the ISRS at the particular structural elevation for the SSI particular SSI analysis case. The ISRS from the twelveeight SSI analysis cases, with each case considering both FEMs simulating cracked and uncracked section properties, are enveloped, and the spectrum envelope is broadened by ±15 percent and smoothed to account for uncertainty anticipated in the structural modeling and SSI analysis techniques.

(2) EPGB and ESWB

The ISRS for the EPGB and ESWB are calculated similarly using SASSIEXT, Version 1.0 at the same set of 98 frequencies.Response spectra are calculated using Bechtel computer code SASSI 2000, Version 3.1, at a total of 241 frequencies from 0.2 to 50 Hz, with 100 frequencies per decade that are uniformly spaced in the log scale. This is equivalent to a frequency increment of approximately 2.33 percent between all adjacent frequency points. At each given direction and location in the structural model, response spectra are first computed separately for the floor acceleration response time histories due to the three components of input ground motion. The three resulting response spectra are then combined using the SRSS method to produce the ISRS in the corresponding direction and at the given structural location. The ISRS from all ten genericthe analyzed soil cases are then enveloped, and the ISRS envelope is broadened by ±15 percent and smoothed to account for uncertainty anticipated in the structural modeling and SSI analysis techniques.

Results of the Response Spectrum Development

The results of the response spectrum development are presented below for the NI Common Basemat Structures, EPGB and ESWB separately:

(1) NI Common Basemat Structures

Figure 3.7.2-68—Response Spectra at NI Common Basemat Bottom Node 274 - 5% Damping, X-Direction, Figure 3.7.2-69—Response Spectra at NI Common Basemat Bottom Node 274 - 5% Damping, Y-Direction, and Figure 3.7.2-70—Response Spectra at NI Common Basemat Bottom Node 274 - 5% Damping, Z-Direction show the ISRS at Node 274417, the center bottom node of NI Common Basemat at elevation -38 ft, 10-1/2 inches, for five percent damping

3%, 4%, 5%, 7%, and 10% Damping, Y-Direction., and Figure 3.7.2-100—Spectrum Envelope of Containment Building - Elev. +190 ft, 3-1/2 in (+58.00m) 2%, 3%, 4%, 5%, 7%, and 10% Damping, Z-Direction.

- FB
  - Elevation +12 ft, 1-2/3 inches. See Figure 3.7.2-110—Spectrum Envelope of Fuel Building at Elev. +12 ft, 1-2/3 in (3.7 m) 2%, 3%, 4%, 5%, 7%, and 10% Damping, X-Direction, Figure 3.7.2-111—Spectrum Envelope of Fuel Building at Elev. +12 ft, 1-2/3 in (3.7 m) 2%, 3%, 4%, 5%, 7%, and 10% Damping, Y-Direction, and Figure 3.7.2-112—Spectrum Envelope of Fuel Building at Elev. +12 ft, 1-2/3 in (3.7 m) 2%, 3%, 4%, 5%, 7%, and 10% Damping, Z-Direction.

(2) EPGB and ESWB

Figure 3.7.2-101—Spectrum Envelope of EPGB at the Center of Basemat - 2%, 3%, 4%, 5%, 7%, and 10% Damping, X-Direction, Figure 3.7.2-102—Spectrum Envelope of EPGB at the Center of Basemat - 2%, 3%, 4%, 5%, 7%, and 10% Damping, Y-Direction, and Figure 3.7.2-103—Spectrum Envelope of EPGB at the Center of Basemat - 2%, 3%, 4%, 5%, 7%, and 10% Damping, Z-Direction show the peak-broadened and smoothed ISRS envelopes at Node 1172 on elevation +0 6 ft, 0 inches of the EPGB.

Figure 3.7.2-148—Spectrum Envelope of EPGB at Elev. +51 ft, 6 in - 2%, 3%, 4%, 5%, 7%, and 10% Damping, X-Direction, Figure 3.7.2-149—Spectrum Envelope of EPGB at Elev. +51 ft, 6 in - 2%, 3%, 4%, 5%, 7%, and 10% Damping, Y-Direction, and Figure 3.7.2-150—Spectrum Envelope of EPGB at Elev. +51 ft, 6 in - 2%, 3%, 4%, 5%, 7%, and 10% Damping, Z-Direction show the peak-broadened and smoothed ISRS envelopes on elevation +51 ft, 6 inches of the EPGB.

Figure 3.7.2-104—Spectrum Envelope of ESWB at Elev +63 ft, 0 in at Node 12733 - 2%, 3%, 4%, 5%, 7%, and 10% Damping, X-Direction, Figure 3.7.2-105—Spectrum Envelope of ESWB at Elev +63 ft, 0 in at Node 12733 - 2%, 3%, 4%, 5%, 7%, and 10% Damping, Y-Direction, Figure 3.7.2-106—Spectrum Envelope of ESWB at Elev +63 ft, 0 in at Node 12733 - 2%, 3%, 4%, 5%, 7%, and 10% Damping, Z-Direction, Figure 3.7.2-107—Spectrum Envelope of ESWB at Elev +14 ft, 0 in at Node 10385 - 2%, 3%, 4%, 5%, 7%, and 10% Damping, X-Direction, Figure 3.7.2-108—Spectrum Envelope of ESWB at Elev +14 ft, 0 in at Node 10385 - 2%, 3%, 4%, 5%, 7%, and 10% Damping, Y-Direction, and Figure 3.7.2-109—Spectrum Envelope of ESWB at Elev +14 ft, 0 in at Node 10385 - 2%, 3%, 4%, 5%, 7%, and 10% Damping, Z-Direction show the peak-broadened and smoothed ISRS envelopes at Node 12733 on elevation +63 ft, 0 inches and Node 10385 on elevation +14 ft, 0 inches of the ESWB.

As discussed in Section 3.8.4.4.3 and Section 3.8.4.4.4, subsequent analyses will incorporate certain design details for the EPGBs and ESWBs that are not reflected in the existing respective SASSI models used for the SSI analyses described in

Section 3.7.2. The subsequent analyses will determine the impact of these design details on the seismic responses and ISRS presented in Section 3.7.2.

3.7.2.6 Three Components of Earthquake Motion

(1) NI Common Basemat Structures and NAB

As previously stated in Section 3.7.2.4.6, the floor acceleration time history in a given direction is obtained by algebraically combining the three corresponding time histories due to the three earthquake components. Therefore, both the floor ZPA and the ISRS for the floor acceleration time history properly account for the contributions from the three components of earthquake motion. For member forces and moments in the stick models, the STRESS module of SASSI code outputs the maximum member force/moment in the stick model due to each earthquake motion component. The maximum member forces/moments due to the three earthquake motion components are then combined by the SRSS rule to obtain the maximum total member force/moment. The use of the SRSS rule is consistent with the guidelines specified in RG 1.92, Revision 2.

(2) EPGB and ESWB

Similarly, the floor acceleration time history in a given direction is obtained by algebraically combining the three corresponding time histories due to the three earthquake components. Therefore, both the ZPA and ISRS for the floor acceleration time history properly account for the contributions from the three components of earthquake motion.As previously stated in Section 3.7.2.4.6, the ZPA of the floor acceleration time histories in a given direction due to the three earthquake motion components are combined using the (1.0, 0.4, 0.4) rule. The response spectra for the floor acceleration time histories in a given direction due to the three earthquake motion components are combined using the SRSS rule to determine the combined ISRS. The (1.0, 0.4, 0.4) rule is also consistent with the guidelines specified in RG 1.92, Revision 2.

3.7.2.7 Combination of Modal Responses

When the response spectrum method of analysis is used, the maximum modal responses are combined using one of the methods specified in RG 1.92, Section C, Revision 2. Such combination methods include the grouping method, ten percent method and double sum methods, and they consider the effects of closely spaced modes having frequencies differing from each other by 10 percent or less of the lower frequency.

The effect of missing mass for modes not included in the analysis is accounted for by calculating the residual seismic load in accordance with AREVA NP Topical Report ANP-10264NP-A (Reference 11) and RG 1.92, Appendix A, Revision 2.

Table 3.7.2-7—Modal Frequencies of 3D FEM of Emergency Power Generating Building
Sheet 1 of 6

Mode No.	Frequency (Hz)	Modal Participating Mass Ratios		
		X	Y	Z
1	10.23	7.57E-14	7.35E+01	2.16E-15
2	10.77	6.88E+01	3.24E-14	1.74E-02
3	11.19	7.26E-12	6.50E-02	5.54E-17
4	11.67	3.35E-14	1.97E-02	8.92E-16
5	12.29	1.80E+00	3.31E-16	3.44E-01
6	12.93	4.13E-13	3.24E-03	2.87E-16
7	12.95	7.03E-01	1.39E-15	1.53E-04
8	13.24	3.25E+00	2.78E-15	1.69E-01
9	13.87	5.98E-14	3.20E-01	8.78E-14
10	14.08	1.92E-09	5.72E-14	3.95E+00
11	14.17	1.35E-15	2.28E-01	3.07E-15
12	14.57	1.09E-05	1.09E-13	4.25E-01
13	14.80	1.08E-13	4.82E-02	1.56E-13
14	14.94	3.71E-01	3.76E-15	8.21E-03
15	15.96	2.91E-13	3.76E+00	3.93E-11
16	16.59	1.37E-12	3.14E-01	3.93E-10
17	16.90	8.24E-02	3.30E-12	3.49E+01
18	17.34	3.67E-13	1.26E-01	1.13E-09
19	17.76	4.89E-13	1.75E-02	1.02E-10
20	18.45	3.09E-03	4.46E-14	3.45E-01
21	18.46	1.53E-13	1.09E-02	4.44E-13
22	18.89	1.93E+00	3.31E-14	2.80E+00
23	20.73	6.34E-15	1.25E-01	1.84E-13
24	21.12	8.29E-12	1.51E-03	5.59E-12
25	21.87	3.11E-01	2.55E-10	1.04E-01
26	22.00	1.70E-11	4.52E+00	5.71E-12
27	22.52	1.63E-13	1.41E-02	1.77E-12
28	22.58	1.73E-03	1.44E-12	3.95E-01
29	23.30	8.78E-16	1.59E-01	5.02E-14
30	23.35	3.47E-01	7.49E-15	4.22E-02
31	23.55	1.56E-13	4.88E-02	8.52E-13
32	23.93	1.00E-01	2.26E-15	6.83E-03
33	24.31	1.17E-14	4.27E-06	2.77E-12
34	24.90	1.57E-13	4.20E-02	2.60E-12
35	24.98	5.78E-13	1.82E-02	7.90E-12

**Table 3.7.2-7—Modal Frequencies of 3D FEM of Emergency Power Generating Building
Sheet 2 of 6**

Mode No.	Frequency (Hz)	Modal Participating Mass Ratios		
		X	Y	Z
36	24.99	1.38E-02	1.07E-11	1.45E-01
37	25.16	1.84E-01	3.27E-13	8.14E-02
38	25.34	3.23E-12	1.43E-01	2.74E-12
39	25.56	2.98E-02	3.15E-09	7.01E-02
40	25.59	2.03E-09	1.78E-01	3.62E-09
41	25.64	8.66E-02	9.45E-10	1.65E-01
42	26.04	1.43E-12	1.03E-02	5.90E-15
43	26.23	1.60E-12	2.27E-01	6.69E-12
44	26.36	3.75E-02	9.28E-11	1.20E-01
45	26.79	2.21E-03	1.43E-12	6.73E-02
46	27.03	5.98E-12	2.48E-02	8.79E-13
47	27.07	2.76E-01	3.42E-12	1.66E-04
48	27.23	3.77E-13	1.48E-01	2.90E-13
49	27.46	7.94E-01	9.71E-17	2.04E-03
50	27.82	2.08E-13	2.00E+00	1.69E-14
51	28.52	4.20E-14	5.72E-02	1.66E-11
52	28.54	1.85E-03	1.65E-11	4.65E-03
53	29.47	2.20E-01	4.11E-15	8.28E-01
54	29.71	6.00E-01	1.78E-15	1.85E-01
55	30.00	4.39E-14	1.32E-02	3.32E-12
56	30.12	1.26E-03	3.22E-15	8.21E-03
57	30.68	6.03E-14	8.55E-03	8.91E-11
58	31.08	2.53E-01	3.34E-11	8.03E-01
59	31.30	4.51E-10	2.17E-02	2.88E-10
60	31.54	1.19E-01	8.46E-13	2.26E+00
61	31.67	3.85E-12	5.56E-02	3.25E-11
62	31.97	7.45E-10	1.32E-02	1.59E-12
63	32.04	3.82E-01	5.36E-12	2.25E-02
64	32.09	2.49E-11	3.33E-02	1.29E-11
65	32.30	1.85E-04	1.39E-10	2.88E-02
66	32.42	6.24E-11	1.32E-02	1.15E-11
67	32.70	2.08E-01	2.49E-11	2.30E+00
68	32.89	6.10E-11	2.16E-05	2.91E-09
69	33.12	4.35E-02	2.95E-13	7.33E-02
70	33.65	2.24E-11	1.11E-01	1.12E-10

Table 3.7.2-7—Modal Frequencies of 3D FEM of Emergency Power Generating Building
Sheet 3 of 6

Mode No.	Frequency (Hz)	Modal Participating Mass Ratios		
		X	Y	Z
71	33.88	5.45E-01	7.42E-14	2.26E-01
72	34.27	5.55E-10	5.41E-02	1.68E-10
73	34.29	6.03E-01	6.57E-11	1.52E-03
74	34.84	3.87E-01	2.60E-12	3.97E-01
75	35.19	3.15E-12	6.22E-02	1.61E-11
76	35.65	1.89E-12	1.12E-01	2.33E-11
77	35.99	1.19E-02	9.58E-13	3.15E-02
78	36.12	9.04E-13	2.17E-03	1.22E-11
79	36.25	3.84E-02	7.10E-15	2.36E-03
80	36.26	8.50E-11	2.28E-05	3.07E-11
81	36.62	1.40E-11	4.43E-02	4.38E-14
82	37.17	5.35E-02	4.09E-09	1.54E-01
83	37.22	7.74E-10	3.26E-01	2.38E-09
84	37.48	2.15E-02	4.17E-11	2.47E-02
85	37.58	2.45E-12	3.02E-02	2.18E-11
86	37.66	3.14E-02	4.61E-10	1.98E-01
87	37.82	3.42E-01	1.56E-10	1.97E-01
88	37.92	3.42E-10	5.41E-02	1.78E-12
89	38.34	2.09E-12	1.80E-01	1.37E-12
90	38.53	1.01E-10	2.75E-02	5.35E-10
91	38.58	4.29E-02	1.11E-10	3.03E-01
92	38.87	1.78E-08	1.12E-01	2.18E-07
93	38.88	1.50E-01	1.84E-08	2.03E+00
94	38.97	5.47E-02	1.33E-09	2.15E+00
95	39.27	5.51E-12	1.43E-01	9.84E-10
96	39.50	9.25E-02	4.12E-11	5.49E+00
97	39.52	2.01E-10	2.93E-02	1.34E-08
98	39.89	8.71E-13	1.70E-02	1.87E-12
99	40.41	6.00E-03	1.86E-11	1.28E+00
100	40.59	4.00E-12	2.24E-01	3.84E-11
101	40.86	6.58E-12	6.15E-02	4.01E-10
102	41.06	1.53E-02	4.86E-12	2.18E+00
103	41.23	2.68E-12	4.61E-03	2.77E-10
104	41.63	1.21E-12	3.31E-02	4.37E-11
105	41.80	1.28E-02	3.69E-14	3.01E-03

Table 3.7.2-7—Modal Frequencies of 3D FEM of Emergency Power Generating Building
Sheet 4 of 6

Mode No.	Frequency (Hz)	Modal Participating Mass Ratios		
		X	Y	Z
106	42.16	6.40E-02	2.59E-10	2.07E-03
107	42.22	5.72E-11	3.00E-01	8.07E-12
108	42.32	3.08E-14	1.62E-01	1.92E-11
109	43.06	1.55E-02	3.63E-12	1.58E-04
110	44.19	3.34E-13	4.76E-02	3.38E-11
111	44.46	5.75E-03	4.16E-13	4.31E+00
112	44.95	2.12E-11	1.12E-01	1.55E-11
113	45.05	1.51E+00	1.05E-11	3.84E-01
114	45.28	3.43E-01	9.42E-11	1.93E-01
115	45.33	1.72E-09	6.88E-02	8.91E-10
116	45.70	6.77E-01	2.65E-12	1.29E+00
117	45.75	1.31E-11	8.29E-02	3.47E-11
118	46.31	2.71E-01	1.39E-12	1.02E-01
119	46.40	1.29E-10	3.91E-04	9.10E-13
120	46.43	2.31E-03	1.91E-12	1.13E-01
121	46.48	2.90E-13	3.41E-02	1.05E-15
122	46.60	4.90E-01	3.05E-13	2.55E-01
123	46.70	1.06E-11	2.09E-01	6.43E-11
124	46.84	7.89E-10	6.22E-03	3.08E-09
125	46.94	8.77E-02	5.89E-11	3.68E-01
126	47.48	2.69E-01	1.64E-10	9.11E-01
127	47.61	1.54E-09	3.47E-02	5.23E-09
128	48.03	2.76E-01	4.05E-15	6.64E-01
129	48.06	2.07E-01	1.87E-11	1.37E-01
130	48.32	3.99E-13	1.07E-01	8.01E-13
131	48.41	1.24E-02	1.66E-12	1.08E-01
132	48.53	2.01E-16	3.00E-02	7.75E-11
133	48.74	1.21E-01	1.86E-13	1.26E-02
134	48.85	1.88E-11	1.69E-05	1.85E-12
135	48.91	3.28E-01	9.71E-13	2.19E-02
136	48.98	1.23E-12	7.41E-03	2.01E-12
137	49.30	1.50E-11	4.59E-02	2.96E-12
138	49.39	5.93E-02	6.14E-13	3.70E-01
139	49.50	1.81E-03	2.71E-11	2.96E-02
140	49.51	7.61E-11	5.70E-03	7.16E-10

Table 3.7.2-7—Modal Frequencies of 3D FEM of Emergency Power Generating Building
Sheet 5 of 6

Mode No.	Frequency (Hz)	Modal Participating Mass Ratios		
		X	Y	Z
141	49.67	7.98E-12	2.15E-02	1.54E-11
142	49.72	1.63E-10	1.60E-01	2.21E-10
143	49.83	6.37E-02	2.83E-10	1.83E-02
144	49.98	1.19E-11	2.56E-01	3.51E-15
145	50.09	7.39E-03	1.09E-11	7.57E-01
146	50.14	5.88E-03	5.55E-12	8.00E-03
147	50.40	6.09E-11	1.90E-01	1.21E-08
148	50.42	2.73E-05	1.00E-08	2.11E-01
149	51.21	1.45E-09	6.44E-02	1.12E-08
150	51.27	7.97E-02	2.00E-09	7.48E-01
151	51.40	4.72E-12	2.81E-01	2.85E-11
152	51.55	1.84E-11	3.59E-01	3.92E-10
153	52.13	1.54E-02	7.65E-14	3.26E-02
154	52.36	6.26E-13	2.76E-01	8.23E-11
155	52.87	6.31E-02	9.20E-11	1.78E-01
156	52.92	2.39E-02	6.28E-10	6.17E-01
157	53.01	6.29E-11	6.76E-02	4.91E-09
158	53.38	7.41E-13	6.42E-02	8.75E-11
159	53.56	1.67E-01	9.01E-13	2.40E-01
160	53.89	4.17E-13	1.56E-02	1.04E-13
161	54.18	6.66E-01	8.24E-12	7.28E-02
162	54.45	5.83E-09	1.62E-02	5.38E-10
163	54.55	1.04E-11	7.45E-03	1.06E-14
164	54.60	8.03E-01	1.44E-11	1.26E-02
165	54.72	2.54E-01	2.67E-11	4.84E-02
166	55.29	7.86E-10	1.90E-02	1.99E-10
167	55.37	1.08E+00	2.39E-11	7.76E-02
168	55.45	1.93E-11	9.39E-03	8.15E-13
169	55.65	1.66E-10	8.19E-03	5.87E-11
170	55.73	1.98E-02	5.96E-12	9.20E-02
171	56.22	1.12E-01	8.00E-11	3.48E-02
172	56.27	8.83E-10	2.27E-02	1.13E-10
173	56.40	4.16E-11	7.98E-02	4.83E-13
174	56.95	1.46E-01	2.24E-11	3.64E-03
175	56.96	1.95E-11	3.91E-01	2.19E-11

Table 3.7.2-7—Modal Frequencies of 3D FEM of Emergency Power Generating Building Sheet 6 of 6

Mode No.	Frequency (Hz)	Modal Participating Mass Ratios		
		X	Y	Z
176	57.16	3.60E-02	7.44E-11	8.89E-03
177	57.31	4.60E-11	4.47E-02	1.48E-11
178	57.62	3.57E-11	4.55E-01	6.74E-11
179	57.79	1.44E-11	1.74E-01	2.44E-11
180	58.12	5.99E-02	9.23E-11	1.47E-01
181	58.37	1.81E-02	1.09E-10	2.79E-02
182	58.70	1.93E-01	9.51E-11	2.89E-03
183	58.81	3.47E-10	8.73E-02	1.18E-10
184	58.96	1.99E-11	1.53E-01	9.97E-10
185	59.08	4.74E-02	2.82E-11	2.76E-01
186	59.52	4.11E-08	2.44E-01	2.15E-08
187	59.54	2.22E-01	5.28E-08	1.19E-01
188	59.85	2.47E-09	5.75E-03	2.53E-09
189	59.93	3.39E-04	8.72E-14	4.48E-01
190	60.38	1.30E-11	7.73E-02	1.44E-10
191	60.86	1.36E-11	1.82E-04	4.57E-12
192	60.87	8.14E-03	8.16E-13	8.83E-02
193	60.99	3.89E-03	2.30E-12	4.17E-02
194	61.26	4.17E-10	8.14E-04	5.00E-08
195	61.26	2.62E-03	4.57E-09	1.75E-01
196	61.36	9.81E-12	2.65E-03	1.96E-09
197	61.63	9.16E-12	2.06E-04	2.70E-09
198	61.80	7.36E-10	3.14E-02	1.39E-09
199	61.90	2.06E-02	2.95E-07	2.82E-01
200	61.94	2.11E-04	4.18E-09	6.24E-01
Total MPF's in Each Direction:		92.222	92.789	80.029

Table 3.7.2-7—Modal Frequencies of 3D FEM of Emergency Power Generating Building
Sheet 6 of 6

Mode No.	Frequency (Hz)	Modal Participating Mass Ratios		
		X	Y	Z
176	57.16	3.60E-02	7.44E-11	8.89E-03
177	57.31	4.60E-11	4.47E-02	1.48E-11
178	57.62	3.57E-11	4.55E-01	6.74E-11
179	57.79	1.44E-11	1.74E-01	2.44E-11
180	58.12	5.99E-02	9.23E-11	1.47E-01
181	58.37	1.81E-02	1.09E-10	2.79E-02
182	58.70	1.93E-01	9.51E-11	2.89E-03
183	58.81	3.47E-10	8.73E-02	1.18E-10
184	58.96	1.99E-11	1.53E-01	9.97E-10
185	59.08	4.74E-02	2.82E-11	2.76E-01
186	59.52	4.11E-08	2.44E-01	2.15E-08
187	59.54	2.22E-01	5.28E-08	1.19E-01
188	59.85	2.47E-09	5.75E-03	2.53E-09
189	59.93	3.39E-04	8.72E-14	4.48E-01
190	60.38	1.30E-11	7.73E-02	1.44E-10
191	60.86	1.36E-11	1.82E-04	4.57E-12
192	60.87	8.14E-03	8.16E-13	8.83E-02
193	60.99	3.89E-03	2.30E-12	4.17E-02
194	61.26	4.17E-10	8.14E-04	5.00E-08
195	61.26	2.62E-03	4.57E-09	1.75E-01
196	61.36	9.81E-12	2.65E-03	1.96E-09
197	61.63	9.16E-12	2.06E-04	2.70E-09
198	61.80	7.36E-10	3.14E-02	1.39E-09
199	61.90	2.06E-02	2.95E-07	2.82E-01
200	61.94	2.11E-04	4.18E-09	6.24E-01
Total MPF's in Each Direction:		92.222	92.789	80.029

Note:

1. Y is in the vertical direction for GTSTRUDL FEM of EPGB.

Table 3.7.2-7—Modal Frequencies of 3D FEM of Emergency Power Generating Building
Sheet 1 of 6

Mode No.	Freq (Hz)	X % Participating Mass	Y % Participating Mass	Z % Participating Mass	Comments
1	10.72	0.00	0.00	74.99	Z Direction Global Mode
2	11.20	69.52	0.02	0.00	X Direction Global Mode
3	11.58	0.00	0.00	0.02	
4	12.24	0.00	0.00	0.01	
5	12.75	2.81	0.30	0.00	X Direction Global Drift
6	13.50	0.75	0.01	0.00	X Direction Global Drift
7	13.51	0.00	0.00	0.01	
8	13.84	2.64	0.21	0.00	X Direction Global Drift
9	14.47	0.00	0.00	0.17	
10	14.53	0.00	4.18	0.00	Local Response from Slabs
11	14.60	0.00	0.00	0.33	
12	15.14	0.00	0.18	0.00	
13	15.39	0.00	0.00	0.03	
14	15.57	0.38	0.01	0.00	
15	16.56	0.00	0.00	2.88	Local Response from Electrical Room & Walls
16	17.33	0.00	0.00	0.15	
17	17.58	0.05	35.91	0.00	Local Response from Slabs
18	18.20	0.00	0.00	0.09	
19	18.61	0.00	0.00	0.08	
20	19.17	0.00	0.34	0.00	
21	19.18	0.00	0.00	0.01	
22	19.64	1.82	2.20	0.00	Local Response from Wall & Slabs
23	21.12	0.00	0.00	0.07	

~~Table 3.7.2-7—Modal Frequencies of 3D FEM of Emergency Power Generating Building~~
~~Sheet 2 of 6~~

~~Mode No.~~	~~Freq (Hz)~~	~~X % Participating Mass~~	~~Y % Participating Mass~~	~~Z % Participating Mass~~	~~Comments~~
~~24~~	~~22.42~~	~~0.00~~	~~0.00~~	~~0.06~~	
~~25~~	~~23.06~~	~~0.44~~	~~0.24~~	~~0.00~~	
~~26~~	~~23.11~~	~~0.00~~	~~0.00~~	~~2.60~~	~~Local Response from Electrical Room & Walls~~
~~27~~	~~23.52~~	~~0.00~~	~~0.00~~	~~2.77~~	~~Local Response from Electrical Room & Walls~~
~~28~~	~~23.54~~	~~0.01~~	~~0.40~~	~~0.00~~	
~~29~~	~~24.09~~	~~0.00~~	~~0.00~~	~~0.02~~	
~~30~~	~~24.36~~	~~0.40~~	~~0.06~~	~~0.00~~	
~~31~~	~~24.57~~	~~0.00~~	~~0.00~~	~~0.09~~	
~~32~~	~~24.90~~	~~0.10~~	~~0.01~~	~~0.00~~	
~~33~~	~~25.36~~	~~0.00~~	~~0.00~~	~~0.02~~	
~~34~~	~~25.86~~	~~0.00~~	~~0.00~~	~~0.08~~	
~~35~~	~~25.97~~	~~0.14~~	~~0.28~~	~~0.00~~	
~~36~~	~~26.06~~	~~0.00~~	~~0.00~~	~~0.02~~	
~~37~~	~~26.26~~	~~0.10~~	~~0.00~~	~~0.00~~	
~~38~~	~~26.31~~	~~0.00~~	~~0.00~~	~~0.09~~	
~~39~~	~~26.74~~	~~0.00~~	~~0.00~~	~~0.35~~	
~~40~~	~~26.75~~	~~0.06~~	~~0.08~~	~~0.00~~	
~~41~~	~~26.93~~	~~0.02~~	~~0.06~~	~~0.00~~	
~~42~~	~~27.30~~	~~0.00~~	~~0.00~~	~~0.01~~	
~~43~~	~~27.52~~	~~0.00~~	~~0.00~~	~~0.27~~	
~~44~~	~~27.57~~	~~0.00~~	~~0.19~~	~~0.00~~	
~~45~~	~~28.17~~	~~0.11~~	~~0.00~~	~~0.00~~	
~~46~~	~~28.30~~	~~0.01~~	~~0.09~~	~~0.00~~	
~~47~~	~~28.31~~	~~0.00~~	~~0.00~~	~~0.28~~	
~~48~~	~~28.54~~	~~0.00~~	~~0.00~~	~~0.01~~	
~~49~~	~~28.59~~	~~0.87~~	~~0.01~~	~~0.00~~	~~Local Response from Walls~~

~~Table 3.7.2-7—Modal Frequencies of 3D FEM of Emergency Power Generating Building~~
~~Sheet 3 of 6~~

~~Mode No.~~	~~Freq (Hz)~~	~~X % Participating Mass~~	~~Y % Participating Mass~~	~~Z % Participating Mass~~	~~Comments~~
~~50~~	~~29.10~~	~~0.00~~	~~0.00~~	~~1.70~~	~~Local Response from Walls~~
~~51~~	~~29.69~~	~~0.00~~	~~0.00~~	~~0.05~~	
~~52~~	~~29.92~~	~~0.03~~	~~0.01~~	~~0.00~~	
~~53~~	~~30.66~~	~~0.51~~	~~0.52~~	~~0.00~~	~~Local Response from Walls & Slabs~~
~~54~~	~~30.83~~	~~0.35~~	~~0.35~~	~~0.00~~	
~~55~~	~~31.58~~	~~0.00~~	~~0.00~~	~~0.01~~	
~~56~~	~~31.65~~	~~0.00~~	~~0.09~~	~~0.00~~	
~~57~~	~~32.14~~	~~0.00~~	~~0.00~~	~~0.06~~	
~~58~~	~~32.28~~	~~0.46~~	~~0.91~~	~~0.00~~	~~Local Response from Slabs~~
~~59~~	~~32.73~~	~~0.00~~	~~0.00~~	~~0.02~~	
~~60~~	~~32.91~~	~~0.27~~	~~1.66~~	~~0.00~~	~~Local Response from Slabs~~
~~61~~	~~32.96~~	~~0.00~~	~~0.00~~	~~0.05~~	
~~62~~	~~33.19~~	~~0.00~~	~~0.00~~	~~0.08~~	
~~63~~	~~33.33~~	~~0.13~~	~~0.28~~	~~0.00~~	
~~64~~	~~33.51~~	~~0.24~~	~~0.13~~	~~0.00~~	
~~65~~	~~33.57~~	~~0.00~~	~~0.00~~	~~0.04~~	
~~66~~	~~33.97~~	~~0.00~~	~~0.00~~	~~0.01~~	
~~67~~	~~34.02~~	~~0.00~~	~~1.85~~	~~0.00~~	~~Local Response from Slabs~~
~~68~~	~~34.28~~	~~0.00~~	~~0.00~~	~~0.01~~	
~~69~~	~~34.57~~	~~0.05~~	~~1.56~~	~~0.00~~	~~Local Response from Slabs~~
~~70~~	~~34.60~~	~~0.00~~	~~0.00~~	~~0.08~~	
~~71~~	~~35.14~~	~~0.30~~	~~0.17~~	~~0.00~~	
~~72~~	~~35.72~~	~~0.43~~	~~0.91~~	~~0.00~~	~~Local Response from Slabs~~
~~73~~	~~35.75~~	~~0.00~~	~~0.00~~	~~0.05~~	

Table 3.7.2-7—Modal Frequencies of 3D FEM of Emergency Power Generating Building
Sheet 4 of 6

Mode No.	Freq (Hz)	X % Participating Mass	Y % Participating Mass	Z % Participating Mass	Comments
74	36.32	0.46	1.79	0.00	Local Response from Slabs
75	36.90	0.00	0.00	0.03	
76	37.04	0.00	0.00	0.15	
77	37.51	0.06	0.13	0.00	
78	37.57	0.00	0.00	0.00	
79	37.71	0.00	0.00	0.02	
80	37.82	0.00	0.00	0.03	
81	38.02	0.01	0.01	0.00	
82	38.60	0.00	0.00	0.05	
83	38.61	0.04	0.04	0.00	
84	38.72	0.00	0.03	0.00	
85	38.86	0.00	0.00	0.01	
86	39.01	0.01	0.03	0.00	
87	39.56	0.29	0.00	0.00	
88	39.69	0.00	0.00	0.14	
89	39.79	0.00	0.00	0.21	
90	40.02	0.07	0.05	0.00	
91	40.05	0.00	0.00	0.36	
92	40.25	0.00	0.00	0.07	
93	40.35	0.09	0.43	0.00	
94	40.58	0.03	0.01	0.00	
95	41.02	0.00	0.00	0.14	
96	41.06	016	0.85	0.00	Local Response from Slabs
97	41.54	0.00	0.00	0.00	
98	41.79	0.00	0.00	0.01	
99	42.24	0.02	7.67	0.00	Local Response from Slabs
100	42.32	0.00	0.00	0.13	
101	42.52	0.00	0.00	0.00	

Table 3.7.2-7—Modal Frequencies of 3D FEM of Emergency Power Generating Building
Sheet 5 of 6

Mode No.	Freq (Hz)	X % Participating Mass	Y % Participating Mass	Z % Participating Mass	Comments
102	42.71	0.01	0.26	0.00	
103	43.50	0.00	0.00	0.09	
104	43.51	0.05	0.11	0.00	
105	43.84	0.00	0.00	0.33	
106	44.96	0.00	0.00	0.13	
107	45.66	0.03	5.10	0.00	Local Response from Slabs
108	46.04	0.00	0.00	0.01	
109	46.50	0.84	1.08	0.00	Local Response from Wall & Slabs
110	46.75	1.27	0.02	0.00	Local Response from Walls
111	46.85	0.00	0.00	0.06	
112	47.02	0.00	0.00	0.01	
113	47.31	0.13	0.01	0.00	
114	47.37	0.00	0.00	0.01	
115	47.47	0.49	1.35	0.00	Local Response from Wall & Slabs
116	47.99	0.00	0.00	0.34	
117	48.04	0.04	0.00	0.00	
118	48.13	0.00	0.00	0.00	
119	48.53	0.13	0.18	0.00	
120	48.58	0.00	0.00	0.02	
121	48.85	0.10	1.13	0.00	Local Response from Wall & Slabs
122	48.88	0.00	0.00	0.00	
123	48.96	0.00	0.00	0.17	
124	49.01	0.09	0.54	0.00	Local Response from Wall & Slabs

Table 3.7.2-7—Modal Frequencies of 3D FEM of Emergency Power Generating Building
Sheet 6 of 6

Mode No.	Freq (Hz)	X % Participating Mass	Y % Participating Mass	Z % Participating Mass	Comments
125	49.24	0.00	0.45	0.00	
126	49.27	0.00	0.00	0.01	
127	49.98	0.33	0.99	0.00	Local Response from Wall & Slabs
128	50.20	0.04	0.13	0.00	
129	50.37	0.00	0.00	0.32	
130	50.46	0.09	0.14	0.00	
131	50.72	0.37	0.17	0.00	
132	50.73	0.00	0.00	0.00	
133	50.99	0.47	0.06	0.00	
134	51.17	0.00	0.00	0.06	
135	51.28	0.00	0.00	0.00	
136	51.49	0.00	0.00	0.00	
137	51.53	0.02	0.01	0.00	
138	51.56	0.06	0.09	0.00	
139	51.70	0.00	0.00	0.00	
140	51.82	0.01	0.01	0.00	

Note:

1. Y is in vertical direction for GTSTRUL FEM of EPGB.

Table 3.7.2-9—Soil Properties Associated with Different ~~Generic~~ Shear Wave Velocities

Applicable Soil Profiles	Shear Wave Velocity (ft/s)	Shear Wave Velocity (m/s)	Poisson's Ratio μ	Weight Density (pcf)	Weight Density (kN/m^3)	Shear Wave Damping Ratio (%)	Dynamic Shear Modulus (ksf)	Static Shear Modulus (ksf)
EUR	700	213	0.40	110	17.28	4.00 - 7.00	1,675	838
	820	250	0.40	110	17.28	7.00	2,299	1,150
	1,640	500	0.40	110	17.28	4.00	9,197	4,599
	3,937	1,200	0.40	120	18.85	1.00	57,790	28,900
	6,601	2,012	0.35	156	24.51	1.00	211,200	105,600
	13,123	4,000	0.35	156	24.51	1.00	834,900	417,500
HF	470	143	0.35	140	21.98	4.78	961	480
	578	176	0.35	140	21.98	3.58 - 4.65	1,454	727
	708	216	0.35	140	21.98	2.50	2,181	1,091
	719	219	0.48	140	21.98	4.49	2,251	1,125
	720	220	0.35	140	21.98	2.10	2,257	1,128
	908	277	0.48	140	21.98	3.35	3,585	1,793
	1,408	429	0.37	126	19.80	1.00	7,769	3,884
	2,817	859	0.44	126	19.80	1.00	31,080	15,540
	5,427	1,654	0.31	170	26.70	1.00	155,500	77,760
	6,647	2,026	0.31	170	26.70	0.75	233,300	116,700
	7,838	2,389	0.26	170	26.70	1.10	324,400	162,200
	8,143	2,482	0.31	170	26.70	0.51	350,200	175,100
	9,600	2,926	0.26	170	26.70	0.70	486,700	243,300
	10,960	3,341	0.26 - 0.31	170	26.70	0.50	634,400	317,200
	11,759	3,584	0.26	170	26.70	0.47	730,200	365,100

Notes:

1. P-wave damping is taken to be 1/3*S-wave damping.
2. When shear wave velocity varies linearly in a layer, other properties vary accordingly.
3. P-wave velocity = S-wave velocity*$[2(1-\mu)/(1-2\mu)]^{1/2}$.
4. Shear-wave velocities and S-wave damping values are strain compatible. Damping values do not exceed 15 percent.
5. Dynamic (best-estimate) shear modulus = mass density*$(\text{S-wave velocity})^2$.
6. Static shear modulus is taken as half of the dynamic shear modulus.

Shear Wave Velocity (ft/s)	Shear Wave Velocity (m/s)	Poisson's Ratio μ	Weight Density (pcf)	Weight Density (kN/m3)	S-Wave Damping (%)	Dynamic Shear Modulus (ksf)	Static Shear Modulus (ksf)
700	213	0.40	110	17.28	7	1668	834.2
820	250	0.40	110	17.28	7	2298	1149
1640	500	0.40	110	17.28	4	9193	4597
2625	800	0.40	115	18.07	2	24,610	12,310
3937	1200	0.40	120	18.85	1	57,760	28,880
5249	1600	0.40	125	19.64	1	107,000	53,500
13,123	4000	0.35	156	24.51	1	834,500	417,300

Notes:

1. P-wave damping is taken to be 1/3*S-wave damping.
2. When shear wave velocity varies linearly in a layer, other properties vary accordingly.
3. P-wave velocity = S-wave velocity*$[2(1-\mu)/(1-2\mu)]^{1/2}$.
4. Shear-wave velocities and S-wave damping values are strain compatible. Damping values do not exceed 15 percent.
5. Dynamic (best-estimate) shear modulus = mass density*S-wave velocity^2.
6. Static shear modulus is taken as half of the dynamic shear modulus.

Table 3.7.2-28—~~Worst Case~~ Maximum Accelerations in EPGB

Slab Elevation	X-Direction	Y-Direction	Z-Direction
+68 ft, 0 in	1.37 g ~~1.150g~~	1.58 g ~~1.364g~~	2.63 g ~~1.116g~~
+51 ft, 6 in	1.16 g ~~1.010g~~	1.22 g ~~1.089g~~	1.84 g ~~0.977g~~
+19 ft, 3 in	0.65 g ~~0.645g~~	1.00 g ~~0.756g~~	0.61 g ~~0.646g~~
0 ft, 0 in	0.46 g ~~0.499g~~	0.44 g ~~0.523g~~	0.58 g ~~0.633g~~

Table 3.7.2-29—~~Worst Case~~ Maximum Accelerations in ESWB

Will be provided later.			
~~Slab Elevation~~	~~X-Direction~~	~~Y-Direction~~	~~Z-Direction~~
~~+114 ft, 0 in~~	~~0.957g~~	~~1.018g~~	~~1.481g~~
~~+80 ft, 9 in~~	~~0.790g~~	~~0.754g~~	~~1.218g~~
~~+61 ft, 10 in~~	~~0.584g~~	~~1.087g~~	~~0.738g~~
~~+33 ft, 0 in~~	~~0.586g~~	~~0.561g~~	~~0.617g~~
~~0 ft, 0 in~~	~~0.447g~~	~~0.372g~~	~~0.568g~~

Table 3.7.2-31—Deleted

Figure 3.7.2-57—Isometric View of GTSTRUDL FEM for Emergency Power Generating Building