ArevaEPRDCPEm Resource

From: WILLIFORD Dennis (AREVA) [Dennis.Williford@areva.com]
Sent: Monday, April 29, 2013 5:24 PM
To: Snyder, Amy
Cc: Miernicki, Michael; ANDERSON Katherine (EXTERNAL AREVA); DELANO Karen (AREVA); LEIGHLITER John (AREVA); ROMINE Judy (AREVA); RYAN Tom (AREVA)
Subject: Response to U.S. EPR Design Certification Application RAI No. 547 (6499, 6359), FSAR Ch. 3 - NEW PHASE 4 RAI, Supplement 6 - Part 3 of 4
Attachments: RAI 547 Supplement 6 Response US EPR DC Part_3of4.pdf

Amy,
Attached is Part 3 of 4 of the response to RAI No. 547, Question 03.07.02-78.

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, April 29, 2013 5:22 PM
To: Amy.Snyder@nrc.gov
Cc: Michael.Miernicki@nrc.gov; ANDERSON Katherine (External AREVA NP INC.); DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 547 (6499, 6359), FSAR Ch. 3 - NEW PHASE 4 RAI, Supplement 6 - Part 2 of 4

Amy,
Attached is Part 2 of 4 of the response to RAI No. 547, Question 03.07.02-78.

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
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From: WILLIFORD Dennis (RS/NB)
Sent: Monday, April 29, 2013 5:18 PM
To: Amy.Snyder@nrc.gov
Cc: Michael.Miernicki@nrc.gov; ANDERSON Katherine (External AREVA NP INC.); DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 547 (6499, 6359), FSAR Ch. 3 - NEW PHASE 4 RAI, Supplement 6 - Part 1 of 4

Amy,

AREVA NP Inc. provided a schedule for a technically correct and complete response to the four questions in RAI No. 547 on July 11, 2012. On October 4, 2012, AREVA NP submitted Supplement 1 which provided a technically correct and complete final response to one (03.07.02-77) of the four remaining questions. On November 27, 2012, AREVA NP submitted Supplement 2 which changed the schedule for one of the three remaining questions. On November 29, 2012, AREVA NP submitted Supplement 3 which provided a technically correct and complete final response to one of the three remaining questions. On January 31, 2013, AREVA NP submitted Supplement 4 which provided a technically correct and complete final response to Question 03.06.01-14. On April 11, 2013, AREVA NP submitted Supplement 5 which provided a revised final response to Question 03.06.01-14 based on NRC staff feedback received during the ITAAC Public Meeting on April 4-5, 2013.

The attached file, "RAI 547 Supplement 6 Response US EPR DC – Part 1 of 4.pdf" provides a technically correct and complete final response to Question 03.07.02-78. Due to file size limitations, the remaining parts will be provided in three subsequent e-mails.

The following table indicates the respective pages in the response document, "RAI 547 Supplement 6 Response US EPR DC.pdf," that contain AREVA NP's response to the subject question. 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 547, Question 03.07.02-78.

Question #	Start Page	End Page
RAI 547 — 03.07.02-78	2	54

This concludes the formal AREVA NP response to RAI 547, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

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

From: WILLIFORD Dennis (RS/NB)
Sent: Thursday, April 11, 2013 6:44 PM
To: Amy.Snyder@nrc.gov
Cc: Michael.Miernicki@nrc.gov; DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WILLS Tiffany (CORP/QP); HONMA George (EXT); LENTZ Tony (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 547 (6499, 6359), FSAR Ch. 3 - NEW PHASE 4 RAI, Supplement 5

Amy,

AREVA NP Inc. provided a schedule for a technically correct and complete response to the four questions in RAI No. 547 on July 11, 2012. On October 4, 2012, AREVA NP submitted Supplement 1 which provided a technically correct and complete final response to one (03.07.02-77) of the four remaining questions. On November 27, 2012, AREVA NP submitted Supplement 2 which changed the schedule for one of the three remaining questions. On November 29, 2012, AREVA NP submitted Supplement 3 which provided a technically correct and complete final response to one of the three remaining questions. On January 31, 2013, AREVA NP submitted Supplement 4 which provided a technically correct and complete final response to Question 03.06.01-14.

The attached file, "RAI 547 Supplement 5 Response US EPR DC.pdf" provides a revised final response to Question 03.06.01-14 based on NRC staff feedback received during the ITAAC Public Meeting on April 4-5, 2013.

The following table indicates the respective pages in the response document, "RAI 547 Supplement 5 Response US EPR DC.pdf," that contain AREVA NP's response to the subject question. 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 547, Question 03.06.01-14.

Question #	Start Page	End Page
RAI 547 — 03.06.01-14	2	18

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

Question #	Response Date
RAI 547 — 03.07.02-78	April 30, 2013

Sincerely,

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

From: WILLIFORD Dennis (RS/NB)
Sent: Thursday, January 31, 2013 8:26 PM
To: Amy.Snyder@nrc.gov
Cc: Michael.Miernicki@nrc.gov; DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WILLS Tiffany (CORP/QP); WELLS Russell (RS/NB); VANCE Brian (RS/NB); GUCWA Len (External RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 547 (6499, 6359), FSAR Ch. 3 - NEW PHASE 4 RAI, Supplement 4

Amy,

AREVA NP Inc. provided a schedule for a technically correct and complete response to the four questions in RAI No. 547 on July 11, 2012. On October 4, 2012, AREVA NP submitted Supplement 1 which provided a technically correct and complete final response to one (03.07.02-77) of the four remaining questions. On November 27, 2012, AREVA NP submitted Supplement 2 which changed the schedule for one of the three remaining questions. On November 29, 2012, AREVA NP submitted Supplement 3 which provided a technically correct and complete final response to one of the three remaining questions.

The attached file, "RAI 547 Supplement 4 Response US EPR DC.pdf" provides a technically correct and complete final response to one of the two remaining questions.

The following table indicates the respective pages in the response document, "RAI 547 Supplement 4 Response US EPR DC.pdf," that contain AREVA NP's response to the subject question. 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 547, Question 03.06.01-14.

Question #	**Start Page**	**End Page**
RAI 547 — 03.06.01-14	2	22

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

Question #	**Response Date**
RAI 547 — 03.07.02-78	April 30, 2013

Sincerely,

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

From: WILLIFORD Dennis (RS/NB)
Sent: Thursday, November 29, 2012 12:10 PM
To: Amy.Snyder@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 547 (6499, 6359), FSAR Ch. 3 - NEW PHASE 4 RAI, Supplement 3

Amy,

AREVA NP Inc. provided a schedule for a technically correct and complete response to the four questions in RAI No. 547 on July 11, 2012. On October 4, 2012, AREVA NP submitted Supplement 1 which provided a technically correct and complete final response to one (03.07.02-77) of the four remaining questions. On

November 27, 2012, AREVA NP submitted Supplement 2 which changed the schedule for one of the three remaining questions.

The attached file, "RAI 547 Supplement 3 Response US EPR DC.pdf" provides a technically correct and complete final response to one of the three remaining questions.

The following table indicates the respective pages in the response document, "RAI 547 Supplement 3 Response US EPR DC.pdf," that contain AREVA NP's response to the subject question. 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 547, Question 03.07.02-76.

Question #	Start Page	End Page
RAI 547 — 03.07.02-76	2	14

The schedule for a technically correct and complete response to the remaining 2 questions is unchanged and is provided below.

Question #	Response Date
RAI 547 — 03.06.01-14	January 31, 2013
RAI 547 — 03.07.02-78	April 30, 2013

Sincerely,

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

From: WILLIFORD Dennis (RS/NB)
Sent: Tuesday, November 27, 2012 12:40 PM
To: Amy.Snyder@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); WELLS Russell (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 547 (6499, 6359), FSAR Ch. 3 - NEW PHASE 4 RAI, Supplement 2

Amy,

AREVA NP Inc. provided a schedule for a technically correct and complete response to the four questions in RAI No. 547 on July 11, 2012. On October 4, 2012, AREVA NP submitted Supplement 1 which provided a technically correct and complete final response to one (03.07.02-77) of the four remaining questions.

The schedule for a technically correct and complete response to the 1 of the remaining 3 questions has been changed as provided below.

Question #	Response Date
RAI 547 — 03.06.01-14	**January 31, 2013**
RAI 547 — 03.07.02-76	November 29, 2012
RAI 547 — 03.07.02-78	April 30, 2013

Sincerely,

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

From: WILLIFORD Dennis (RS/NB)
Sent: Wednesday, October 17, 2012 2:07 PM
To: Amy.Snyder@nrc.gov
Cc: Michael.Miernicki@nrc.gov; BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); GARDNER Darrell (RS/NB) (Darrell.Gardner@areva.com); VANCE Brian (RS/NB); WELLS Russell (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 547 (6499, 6359), FSAR Ch. 3 - NEW PHASE 4 RAI, Question 03.06.01-14 - STATUS

Amy,
AREVA appreciates the initial comments received from NRC staff during our telecon on September 25th, the e-mail with additional comments received on September 27th, and the additional comments and status update on the review status of the DRAFT RAI 547 Question 03.06.01-14 response (submitted on August 17, 2012) which were provided by Mike Miernicki on October 15th. We understand that the NRC staff needs additional time to complete their review and provide final comments on the Draft response. AREVA will provide a revised schedule for submittal of the final response to this question after receipt and evaluation of all NRC staff comments.

The schedule for a technically correct and complete final response to the other 2 questions remains unchanged as shown below.

Question #	Response Date
RAI 547 — 03.06.01-14	**TBD**
RAI 547 — 03.07.02-76	November 29, 2012
RAI 547 — 03.07.02-78	April 30, 2013

Sincerely,

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

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

From: RYAN Tom (RS/NB)
Sent: Thursday, October 04, 2012 1:33 PM
To: Tesfaye, Getachew
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); LEIGHLITER John (RS/NB); ROMINE Judy (RS/NB); WILLIFORD Dennis (RS/NB); ABAYAN Victor (EP/PE)
Subject: Response to U.S. EPR Design Certification Application RAI No. 547 (6499, 6359), FSAR Ch. 3 - NEW PHASE 4 RAI, Supplement 1

Getachew,

AREVA NP Inc. provided a schedule for a technically correct and complete response to the four questions in RAI No. 547 on July 11, 2012.

The attached file, "RAI 547 Supplement 1 Response US EPR DC.pdf" provides a technically correct and complete final response to one of the four remaining questions.

The following table indicates the respective pages in the response document, "RAI 547 Supplement 1 Response US EPR DC.pdf," that contain AREVA NP's response to the subject question. Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the responses to RAI 547 Question 03.07.02-77.

Question #	Start Page	End Page
RAI 547 — 03.07.02-77	2	2

The schedule for a technically correct and complete response to the remaining 3 questions is unchanged and is provided below.

Question #	Response Date
RAI 547 — 03.06.01-14	**October 17, 2012**
RAI 547 — 03.07.02-76	**November 29, 2012**
RAI 547 — 03.07.02-78	**April 30, 2013**

Sincerely,

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

From: WILLIFORD Dennis (RS/NB)
Sent: Wednesday, July 11, 2012 2:52 PM
To: Getachew.Tesfaye@nrc.gov
Cc: BENNETT Kathy (RS/NB); DELANO Karen (RS/NB); ROMINE Judy (RS/NB); RYAN Tom (RS/NB); Michael.Miernicki@nrc.gov; WELLS Russell (RS/NB)
Subject: Response to U.S. EPR Design Certification Application RAI No. 547 (6499, 6359), FSAR Ch. 3 - NEW PHASE 4 RAI

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 547 Response US EPR DC.pdf," provides a schedule since a technically correct and complete response to the four questions cannot be provided at this time.

The following table indicates the respective pages in the response document, "RAI 547 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 547 — 03.06.01-14	2	2
RAI 547 — 03.07.02-76	3	4
RAI 547 — 03.07.02-77	5	5
RAI 547 — 03.07.02-78	6	12

The schedule for a technically correct and complete response to these 4 questions is provided below.

Question #	Response Date
RAI 547 — 03.06.01-14	**October 17, 2012**
RAI 547 — 03.07.02-76	**November 29, 2012**
RAI 547 — 03.07.02-77	**November 14, 2012**
RAI 547 — 03.07.02-78	**April 30, 2013**

Sincerely,

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

From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Friday, June 15, 2012 2:45 AM
To: ZZ-DL-A-USEPR-DL

Cc: Xu, Jim; Thomas, Brian; Miernicki, Michael; Clark, Phyllis; Segala, John; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 547 (6499, 6359), FSAR Ch. 3 - NEW PHASE 4 RAI

Attached please find the subject request for additional information (RAI). A draft of the RAI was provided to you on May 17, 2012, and June 12, 2012, 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/LB1
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 4353

Mail Envelope Properties (554210743EFE354B8D5741BEB695E65612C04E)

Subject: Response to U.S. EPR Design Certification Application RAI No. 547 (6499, 6359), FSAR Ch. 3 - NEW PHASE 4 RAI, Supplement 6 - Part 3 of 4
Sent Date: 4/29/2013 5:24:28 PM
Received Date: 4/29/2013 5:25:35 PM
From: WILLIFORD Dennis (AREVA)

Created By: Dennis.Williford@areva.com

Recipients:
"Miernicki, Michael" <Michael.Miernicki@nrc.gov>
Tracking Status: None
"ANDERSON Katherine (EXTERNAL AREVA)" <katherine.anderson.ext@areva.com>
Tracking Status: None
"DELANO Karen (AREVA)" <Karen.Delano@areva.com>
Tracking Status: None
"LEIGHLITER John (AREVA)" <John.Leighliter@areva.com>
Tracking Status: None
"ROMINE Judy (AREVA)" <Judy.Romine@areva.com>
Tracking Status: None
"RYAN Tom (AREVA)" <Tom.Ryan@areva.com>
Tracking Status: None
"Snyder, Amy" <Amy.Snyder@nrc.gov>
Tracking Status: None

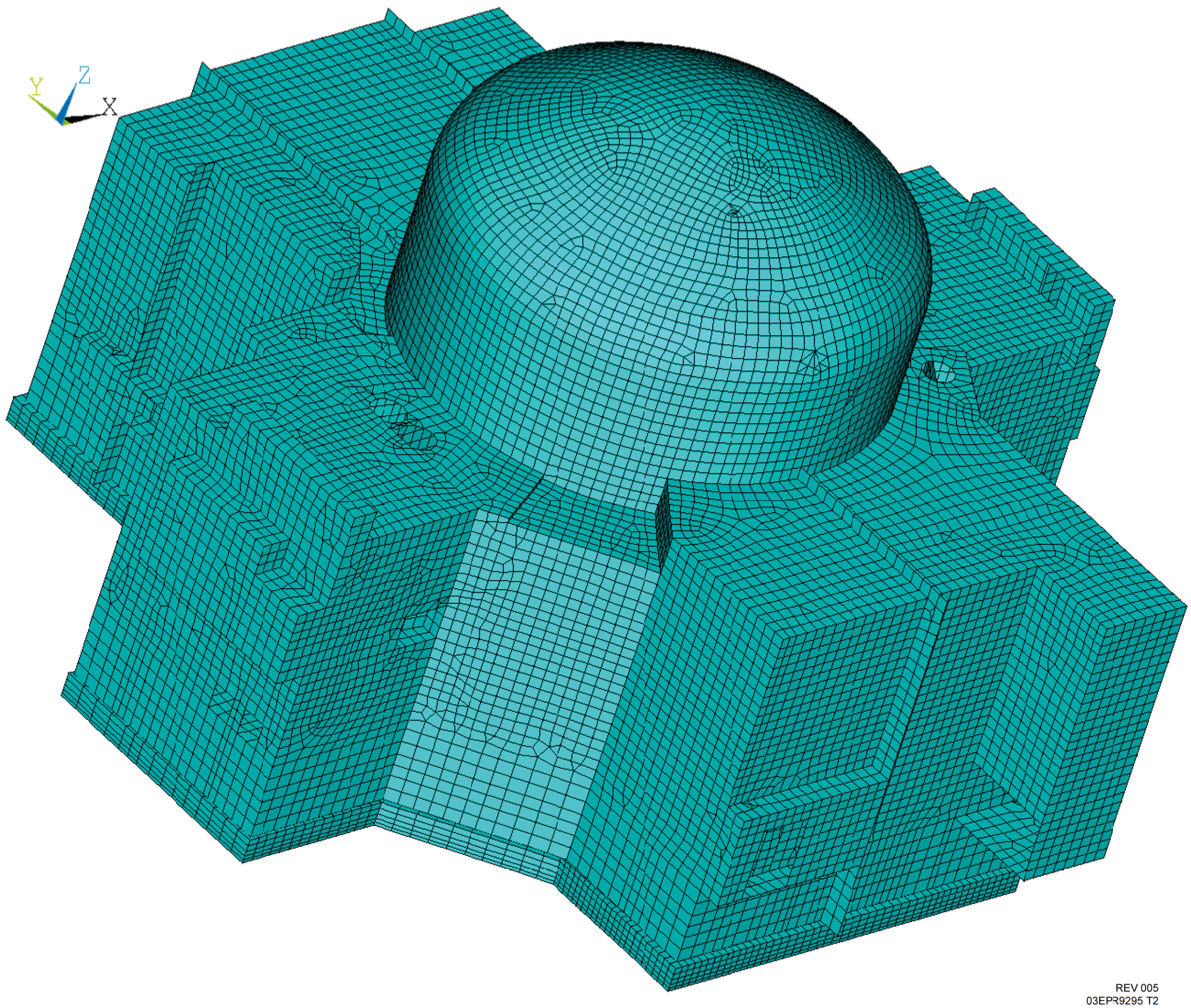
Post Office: FUSLYNCMX03.fdom.ad.corp

Files	**Size**	**Date & Time**
MESSAGE	18479	4/29/2013 5:25:35 PM
RAI 547 Supplement 6 Response US EPR DC Part_3of4.pdf		5372037

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

RAI 547
Q. 03.07.02-78

Figure 3.7.2-152—Foundation Basemat Model with Solid Element Basemat



Next File

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

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

RAI 547
Q. 03.07.02-78

3.8.5.4.2 Nuclear Island Common Basemat Structure Foundation Basemat

Model

The details of the ~~seismic design loads for the NI Common Basemat are obtained using the~~ 3D FEM ~~for~~ NI Common Basemat Foundation Models (dynamic and static) including the types of finite elements used are described in Section 3.7.2.3.1.4. ~~The NI Common Basemat Structure foundation basemat is analyzed and designed using the ANSYS V10.0 SP1 finite element overall computer model (a static model) for NI Common Basemat Structure Seismic Category I structures, which is described in Sections 3.8.1.4.1 and 3.8.5.3.~~ The NI Common Basemat Structure Foundation M~~m~~odel includes the RCB, RB internal structures, RSB, FB, and SBs, as well as the NI Common Basemat Structure foundation basemat and subgrade.

Figure 3.7.2-151—Solid Element Basemat shows the basemat portion of the full model, and Figure 3.7.2-152—Foundation Basemat Model with Solid Element Basemat shows the full model, including the NI superstructure.~~ANSYS SOLID45 solid elements are used to model the concrete basemat foundation in the NI Common Basemat Structure static analysis. SOLID45 is a three-dimensional, eight-node element that is suitable for moderately thick structures. Depending on the thickness of the basemat, between three to five layers of SOLID45 elements are used in the model, with an average of four elements in the typical 10 feet thick basemat areas. Figure 3.8-103—DeletedNuclear Island Common Basemat Structure Foundation Basemat ANSYS Model illustrates the model used for design of the basemat.~~

Springs are used to represent soil that provides support for the concrete foundation basemat in the ANSYS model. These springs represent the compressibility of the soil and were developed to reflect the pressure distribution under the NI Common Basemat Structure. Springs values vary for each soil case and are based on the soil properties delineated in Section 2.5 and Table 3.7.1-6. The distribution used is elliptical in nature and takes the form of:

$$K(x,y) = K_o[A - B^*(1 - x^2/2l^2 - y^2/2b^2)^{1/2}]$$

where:

K(x, y) is the subgrade modulus at x, y corrected for mat stiffness (pounds/ft^2 per foot)

K_o is the weighted average subgrade modulus (pounds/ft^2 per foot)

A & B are constants for a soil type based on its properties, bearing pressure distribution and shape of the foundation.

x = is the coordinate in the length direction of the Foundation Mat (feet)

y = is the coordinate in the width direction of the Foundation Mat (feet)

b = half width of foundation

l = half length of foundation.

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The Gazetas equation (Reference 57) was used to evaluate the total soil spring (K_o) for the design of the foundation basemat of the NI Common Basemat Structure. Although Gazetas addresses the dynamic stiffness of the foundation basemat, the use of one-half the dynamic shear modulus in the equation approximates the total stiffness of the supporting soil medium under static conditions. Table 3.8-13—Static Spring Distribution ~~Table 3.8-12—Deleted.~~ provides the distribution equations and K_o values for each soil case.

The pressure on the buried outer walls that are in contact with soil/rock is a function of the relative movement between the structure and the surrounding soil. The sidewall pressures are idealized by nonlinear sidewall soil/rock springs that represent the following three states: active, passive and at-rest. In ANSYS, the sidewall springs are modeled using a combination of two elements: a linear 3-D truss element (LINK8) and a non-linear spring element (COMBIN39). The at-rest earth pressure is applied as a preload to the 3-D truss element and the forces developed due to the wall movement (towards and away from the soil mass) are modeled using the nonlinear spring element which is capable of idealizing the different force-deflection curves on the active and passive side. The pressures at a sidewall node are multiplied by the tributary area of the sidewall node to define the sidewall force versus the deflection behavior of a

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particular sidewall spring.The high frequency soil cases (i.e., hfub, hfbe and hflb) static distributions are based on a site-specific rock site distribution where a foundation modulus is determined for each NI common basemat structure (see Figure 3.8-145).

Linear bi-directional static springs that have a stiffness of one-half the dynamic springs as specified in Table 3.8-13 are applied to the base of the NI Common Basemat Structure. Sliding and uplift are not modeled in the static analysis. Soil stiffness springs are modeled through the use of contact elements applied to the base of the NI Common Basemat Structure. These elements do not allow tension force transfer between the soil and the foundation. Sliding is not modeled in the static analysis. Figure 3.8-106—DeletedElastic Displacement for Soil Case 1u, Figure 3.8-107—Deleted.Elastic Displacement for Soil Case 2u, Figure 3.8-108—Elastic Displacement for Soil Case 1n2u, Figure 3.8-109—DeletedElastic Displacement for Soil Case 3u, Figure 3.8-110—Elastic Displacement for Soil Case 4u, Figure 3.8-111—Elastic Displacement for Soil Case 5aeFigure 3.8-111—Elastic Displacement for Soil Case 5ae, Figure 3.8-112—Elastic Displacement for Soil Case 1n5a, Figure 3.8-112—Elastic Displacement for Soil Case 1n5a, and Figure 3.8-113—Elastic Displacement for Soil Case 2sn4u, Figure 3.8-114—DeletedElastic Displacement for Soil Case 2n3u, and Figure 3.8-115—DeletedElastic Displacement for Soil Case 3r3u illustrate elastic displacements, from loading, and dead load + 0.25* live load + 0.75* precipitation load + hydrostatic forces and at-rest earth pressure, equipment load using the springs listed in Table 3.8-13Table 3.8-12.

The results of the soil spring analyses are used in determining forces and moments in the basemat for concrete design and for determining the acceptability of the supporting soil media under static loading conditions.

Analysis

The ANSYS basemat 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 initial conditions (dead load, 25% live load, 75% precipitation load, hydrostatic forces and at-rest earth pressures) to the basemat foundation model (nonlinear) are input by performing multiple static analysis load steps prior to the start of the dynamic load. Static load steps are performed in a transient analysis by turning off the transient time integration effects. The static analysis time-steps are performed at solution times less than 0.005sec. The transient itself is started by turning on the time integration effects at time = 0.005sec to the end of the acceleration time-history input.

The seismic 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 seismic time-history analysis starts from time = 0.005 sec. Thus, effects of the seismic loads are obtained by subtracting the results at time-history data points with the static analysis baseline results. The maximum seismic loads are obtained by determining the maximum/minimum design load values for basemat and tendon gallery for each of the elements/nodes over all time points of the transient analysis.

In addition to the seismic load, the basemat foundation model is analyzed (with static soil springs) for various static load cases: normal loads (e.g., dead, live, soil/lateral earth pressure, thermal load, pipe reaction, post-tension loads, relief valve loads), construction loads, test loads for reactor containment building, severe environmental loads (e.g., wind), extreme environmental loads (e.g., tornado), abnormal loads (e.g., internal flood, buoyant pressure, accident pressure).

SSI analysis is performed using SASSI and a linear elastic 3D FEM model. The resulting soil loadings on the embedded walls and the tendon gallery are used as the basis for the design of these structural elements. The SSI analysis does not capture the nonlinear response of sliding and uplift. Any increases in loading due to sliding and uplift from the 3D basemat FEM is added to the SSI results. The analytical methodology is described in Section 3.7.2.3.1.4.

Design Considerations

The NI stability analysis using seismic reaction forces from the SSI model addressed in Section 3.7.2 considers the soil cases in Table 3.7.1-6.

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

The SSI analysis, described in Section 3.7.2.4, is a frequency domain linear seismic analysis. The additional loads due to the nonlinearities of basemat uplift and sliding obtained in the 3D basemat FEM is considered for the design of the tendon gallery and NI embedded walls. The additional (delta) loads, generated on the tendon gallery walls due to sliding, are calculated by performing additional analyses without allowing for sliding and uplift behavior and comparing the results (sidewall pressures and design forces and moments) to the analysis that includes the nonlinear effects. When nonlinear responses are observed in the model, the increase in loading is added to the SSI results described in Section 3.7.2.4 for the design of tendon gallery and NI embedded walls.

In the design of the NI embedded walls and tendon gallery, the static soil pressure (earth pressure at rest) and effects of surcharge due to the weight of adjacent buildings

(NI for the case of the tendon gallery) are applied as a separate load case. The dynamic load case corresponds to the passive pressures generated on the walls during the SSE condition.

The passive soil pressures on the NI embedded walls (excluding the tendon gallery) are calculated using the results from the SSI analysis (see Section 3.7.2.4). The SSE wall pressures are scaled up such that the maximum pressure on each wall is, at least, equal to the passive earth pressure obtained with $K_p = 3$. The dynamic load case corresponding to scaled SSI pressures and delta pressures due to uplift and sliding of the basemat is applied as a separate load case. The static and dynamic load cases are then combined in the appropriate load combinations to arrive at the design forces and moments of the walls. The above procedure is used for all soil cases except 5ae. For 5ae (rock case), the nodes in contact with the excavation are laterally constrained to obtain design forces and moments of the walls.

The passive soil pressures and seismic design loads on the tendon gallery walls for all cases including the 5ae case are directly obtained from the nonlinear analysis of finite element model for NI Common Basemat Foundation described in Section 3.7.2.3.1.4. These loads include the sidewall and delta pressures due to uplifting and sliding of the basemat. The seismic loads are combined with other static analysis load cases as described in Section 3.8.1 through Section 3.8.4 to obtain the design forces and moments for the tendon gallery.

Based on the results (shears and moments) from the static and dynamic analysis of the basemat foundation model described above, the basemat is designed for the combined effect of the various load cases. Section 3.8.1 through Section 3.8.4 list the appropriate load combinations to be used for the Seismic Category I structures.

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A differential settlement evaluation is performed for the NI common basemat structure considering both short term (elastic) and long term (heave and consolidation) effects. The evaluation accounts for the construction sequence, building stiffness, and time duration for loading the NI common basemat structure. The evaluation considers a soft soil site consistent with the soft soil case, 1n2ue, addressed in Table 3.7.1-6. A comparison of the angular distortion (measure of curvature) of the basemat for various soil cases demonstrates that the soft soil site will control the design for settlement.

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

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

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

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

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

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

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

Two sets of soil springs are developed using Plaxis 3D. The first set of soil springs is developed with the geometry and loading of the basemat only. The second set of soil springs is developed with the geometry and loading of the full NI superstructure. Each set of soil springs is developed by iterating on settlement results between a full 3D finite element structural model of the NI common basemat structure with Winkler springs and results from the Plaxis 3D model. The Plaxis 3D model plate thicknesses are adjusted and soil springs are developed for each iteration as previously described. The distribution of the soil springs matches the distribution with the stiffness of the NI common basemat completed structure considering the full concrete elastic modulus, Ec. The soil springs are applied to the 3D finite element structural model until a good fit (less than 10 percent difference) is observed between settlements generated by both the 3D finite element structural model and Plaxis 3D model.

The Plaxis 3D model assumes a sandy material with laterally uniform soil stiffness. The effects from the adjacent structures are considered in the development of the second set of soil springs. The Plaxis 3D analysis also includes the settlement effects due to consolidation. Beyond construction, the long term settlements due to rewatering, creep, and dissipation of any excess remaining pore pressure is assumed to be negligible.

The 11 steps in the construction sequence are evaluated for each set of soil springs. At each construction step in the 3D FEM structural evaluation, 100 percent of the dead load, 25 percent of the live load, and 75 percent of the precipitation loads are applied to determine locked-in forces and moments for structural elements.

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

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

The basemat and superstructure forces and moments are captured at each construction step and an enveloping settlement load file is developed. A comparison is made of the enveloping settlement load file results from each set of soil springs. The set of soil springs which control the design of forces and moments due to settlement are used on the design.

The NI superstructure design is performed with fixed base models. The additional forces and moments due to settlement are added to each of the design soil cases. The fixed base models already include the results from dead weight, live load, and precipitation loads. To capture the effects of only the differential settlement, a comparison is made between the settlement load results and the fixed base results with the same load combination (i.e., 100 percent of the dead load, 25 percent of the live load, and 75 percent of the precipitation loads). A single and separate load file is developed and added to each NI superstructure fixed base static model analyses in the load combinations with a dead load (i.e., the load factor used corresponds to the dead load factor).

The forces and moments due to settlement in the basemat model are determined similar to the approach used for the NI superstructure. The basemat model node numbering and meshing is different from the NI superstructure model. The settlement analysis is performed with the basemat model to allow mapping results directly to the model using the same nodal and element geometry. The basemat model settlement analysis is performed by applying the settlement soil springs to the basemat model for each of the 11 construction sequence steps. The basemat model settlement analysis is then performed for each of the 11 construction steps applying the elastic soil springs developed for each generic FSAR soil case.

For a given soil case, a comparison is made with the basemat forces and moments from the elastic soil spring case, and the forces and moments from the settlement springs at each of the 11 construction steps to develop a differential set of forces and moments in the basemat for each step. An enveloping differential load file is created which consists of the maximum differential forces and moments in each basemat element from each construction steps.

Following this same approach, an enveloping differential load file is created for each soil case and added to the elastic soil spring analysis results in the load combinations with a dead load (i.e., the load factor used corresponds to the dead load factor).

The basemat design includes symmetrical main reinforcing steel in each direction and on each face to control development of any large cracks in the basemat.

Relative differential settlement contours are developed for each construction step using the second set of soil springs. The contours are relative to the minimum settlement value determined under the NI common basemat structure, and are shown in Figure 3.8-124 through Figure 3.8-134.

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

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

Stability Evaluation

The NI stability analysis using seismic reaction forces from the SSI model addressed in Section 3.7.2 considers the soil cases in Table 3.7.1-6. The soil bearing pressures directly beneath the foundation basemat are based on the SASSI analysis described in Section 3.7.2.4 and reported in Appendix 3E Table 3E.1-40.

Table 3.8-13—Static Spring Distribution

Soil Case	K_o (k/ft^3) Static	Dynamic	Recommended Springs and Distribution Distribution (b = l = ~52.4m)	Min/Max Spring
1n2ue		55.8	$K(x,y)=K_o [3.74 - 3.12*sqrt(1 - x^2/2l^2 - y^2/2b^2)]$	$0.62 K_o, 1.88 K_o$
4ue		390	$K(x,y)=K_o [3.12 - 2.42*sqrt(1 - x^2/2l^2 - y^2/2b^2)]$	$0.70 K_o, 1.68 K_o$
5ae		5190	$K(x,y)=K_o [2.01 - 1.15*sqrt(1 - x^2/2l^2 - y^2/2b^2)]$	$0.86 K_o, 1.33 K_o$
2sn4ue		260	$K(x,y)=K_o [3.33 - 2.65*sqrt(1 - x^2/2l^2 - y^2/2b^2)]$	$0.68 K_o, 1.75 K_o$
1n5ae		1324	$K(x,y)=K_o [2.48 - 1.69*sqrt(1 - x^2/2l^2 - y^2/2b^2)]$	$0.79 K_o, 1.48 K_o$
1n2ue	36	72	$K(x,y)=K_o [3.74 - 3.12*sqrt(1 - x^2/2l^2 - y^2/2b^2)]$	$0.62 K_o, 1.99 K_o$
4ue	372	743	$K(x,y)=K_o [3.12 - 2.42*sqrt(1 - x^2/2l^2 - y^2/2b^2)]$	$0.70 K_o, 1.77 K_o$
5ae	5402	10804	$K(x,y)=K_o [2.01 - 1.15*sqrt(1 - x^2/2l^2 - y^2/2b^2)]$	$0.86 K_o, 1.37 K_o$
2sn4ue	162	324	$K(x,y)=K_o [3.33 - 2.65*sqrt(1 - x^2/2l^2 - y^2/2b^2)]$	$0.68 K_o, 1.85 K_o$
1n5ae	918	1837	$K(x,y)=K_o [2.48 - 1.69*sqrt(1 - x^2/2l^2 - y^2/2b^2)]$	$0.79 K_o, 1.53 K_o$
hf-lb	1578	3157	$K(x,y)=K_o [2.53 - 1.75*sqrt(1 - x^2/2l^2 - y^2/2b^2)]$	$0.78 K_o, 1.55 K_o$
hf-be	2341	4682	$K(x,y)=K_o [2.44 - 1.64*sqrt(1 - x^2/2l^2 - y^2/2b^2)]$	$0.80 K_o, 1.52 K_o$
hf-ub	3634	7267	$K(x,y)=K_o [2.32 - 1.50*sqrt(1 - x^2/2l^2 - y^2/2b^2)]$	$0.82 K_o, 1.48 K_o$

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Table 3.8-14—Deleted

Table 3.8-15—Deleted

Table 3.8-16—Deleted

Figure 3.8-103—Deleted~~Nuclear Island Common Basemat Structure Foundation Basemat ANSYS Model~~

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Figure 3.8-105—Essential Service Water Building Foundation Basemat Model

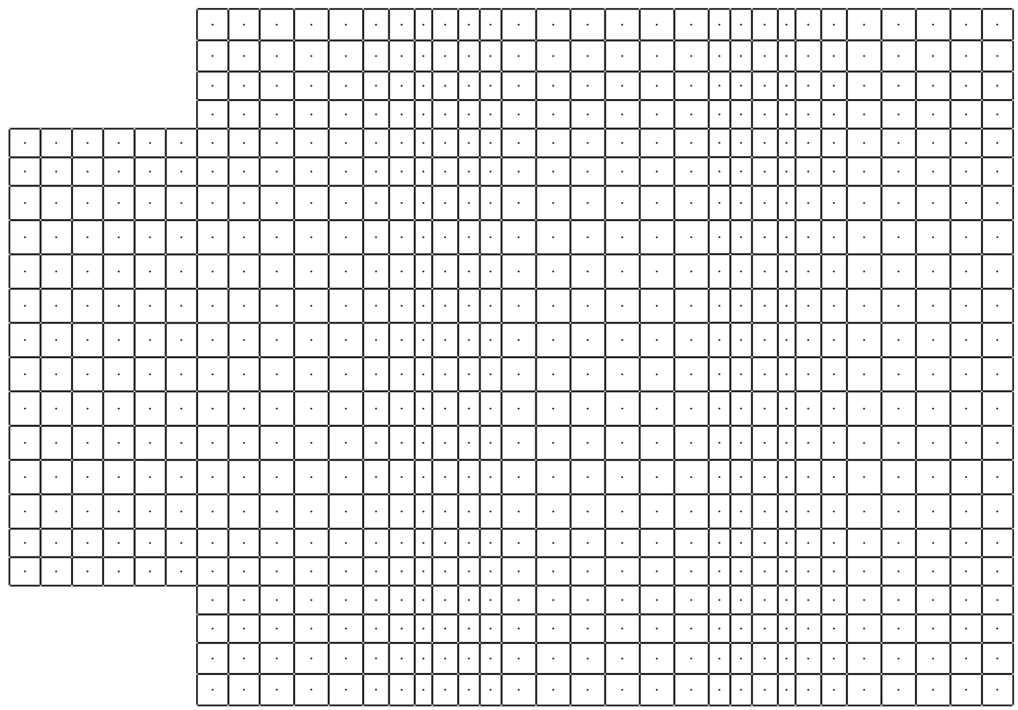

Figure 3.8-106—Deleted~~Elastic Displacement for Soil Case 1u~~

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Figure 3.8-107—Deleted.~~Elastic Displacement for Soil Case 2u~~

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Figure 3.8-108—Elastic Displacement for Soil Case 1n2u

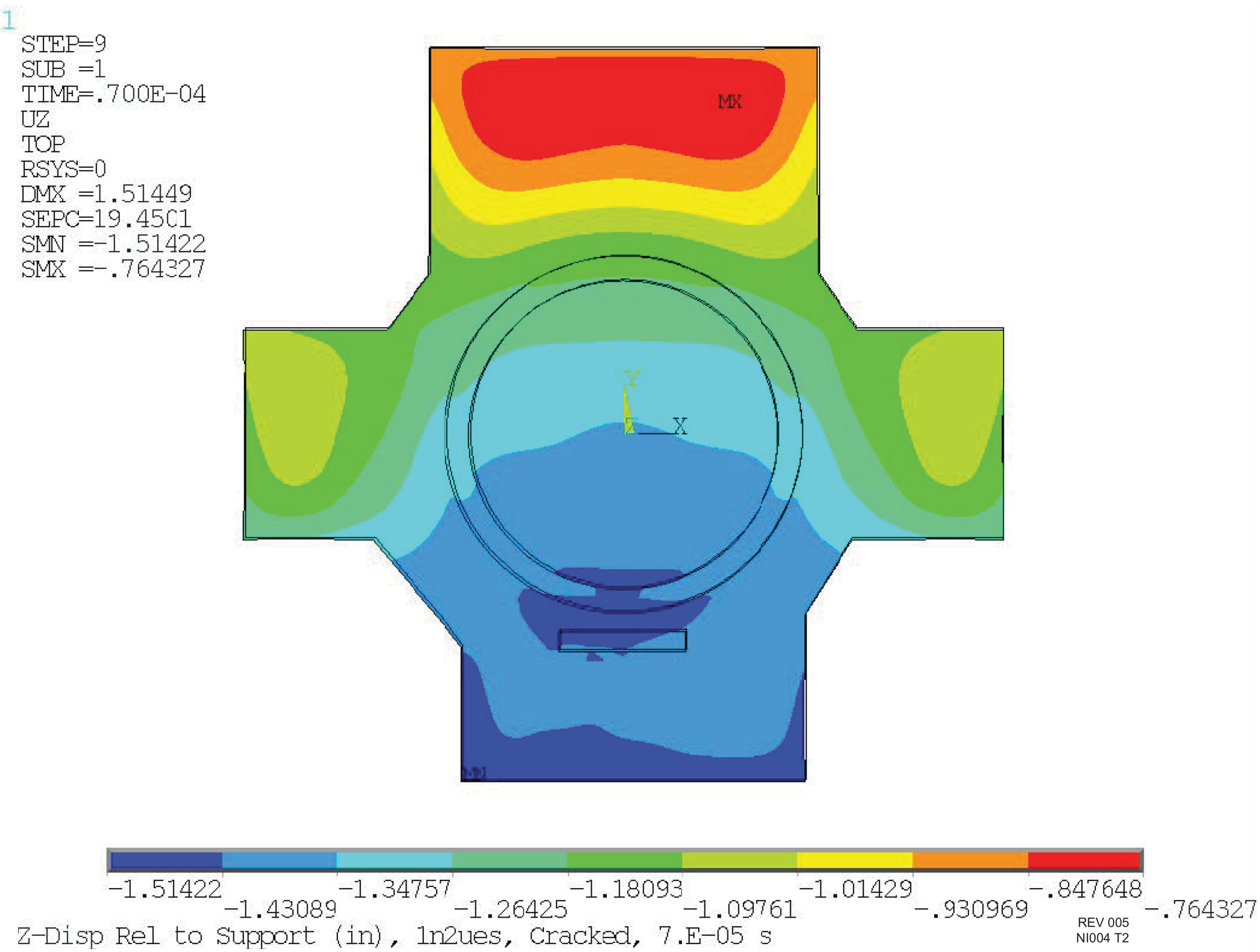

Figure 3.8-109—Deleted~~Elastic Displacement for Soil Case 3u~~

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