ArevaEPRDCPEm Resource

From:	BRYAN Martin (EXTERNAL AREVA) [Martin.Bryan.ext@areva.com]
Sent:	Friday, August 27, 2010 11:09 AM
To:	Tesfaye, Getachew
Cc:	DELANO Karen (AREVA); ROMINE Judy (AREVA); BENNETT Kathy (AREVA); KOWALSKI David (AREVA)
Subject:	Response to U.S. EPR Design Certification Application RAI No. 278, FSAR Ch. 5, Supplement 6
Attachments:	RAI 278 Supplement 6 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. provided a schedule for technically correct and complete responses to the eight questions in RAI No. 278 on February 27, 2010. Supplement 1, Supplement 2, Supplement 3, Supplement 4 and Supplement 5 responses to RAI No. 278 were sent on April 9, 2010, April 30, 2010, May 26, 2010, June 23, 2010 and July 27, 2010, respectively, to provide a revised schedule.

On June 23, 2010, a DRAFT response to RAI No. 278 was submitted and on August 13, 2010, AREVA NP received feedback from the NRC staff.

The attached file, "RAI 278 Supplement 6 Response US EPR DC.pdf" provides a technically correct and complete response to seven of the eight questions. Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which supports the response to RAI 278 Questions 05.02.03-22 and 05.02.03-23.

The following table indicates the respective pages in the response document, "RAI 278 Supplement 6 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 278 — 05.02.03-21	2	3
RAI 278 — 05.02.03-22	4	5
RAI 278 — 05.02.03-23	6	7
RAI 278 — 05.03.02-7	8	10
RAI 278 — 05.03.02-8	11	11
RAI 278 — 05.03.02-9	12	13
RAI 278 — 05.03.02-10	14	14

A complete answer is not provided for one of the questions. The schedule for a technically correct and complete response to this question remains the same and is provided below.

Question #	Response Date
RAI 278 — 05.02.03-20	September 9, 2010

Sincerely,

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

From: BRYAN Martin (EXT)
Sent: Tuesday, July 27, 2010 3:53 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); KOWALSKI David J (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 278, FSAR Ch. 5, Supplement 5

Getachew,

AREVA NP Inc. provided a schedule for technically correct and complete responses to the eight questions in RAI No. 278 on February 27, 2010. Supplement 1, Supplement 2, Supplement 3 and Supplement 4 responses to RAI No. 278 were sent on April 9, 2010, April 30, 2010, May 26, 2010 and June 23, 2010, respectively, to provide a revised schedule.

To allow time for interaction between AREVA and the NRC staff, a revised schedule is provided in this e-mail.

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

Question #	Response Date
RAI 278 — 05.02.03-20	September 09, 2010
RAI 278 — 05.02.03-21	August 27, 2010
RAI 278 — 05.02.03-22	August 27, 2010
RAI 278 — 05.02.03-23	August 27, 2010
RAI 278 — 05.03.02-7	August 27, 2010
RAI 278 — 05.03.02-8	August 27, 2010
RAI 278 — 05.03.02-9	August 27, 2010
RAI 278 — 05.03.02-10	August 27, 2010

Sincerely,

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

From: BRYAN Martin (EXT)
Sent: Wednesday, June 23, 2010 11:20 AM
To: Tesfaye, Getachew
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); KOWALSKI David J (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 278, FSAR Ch. 5, Supplement 4

Getachew,

AREVA NP Inc. provided a schedule for technically correct and complete responses to the eight questions in RAI No. 278 on February 27, 2010. Supplement 1, Supplement 2 and Supplement 3 responses to RAI No. 278 were sent on April 9, 2010, April 30, 2010 and May 26, 2010, respectively, to provide a revised schedule.

To allow time for interaction between AREVA and the NRC staff, a revised schedule is provided in this e-mail.

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

Question #	Response Date
RAI 278 — 05.02.03-20	July 27, 2010
RAI 278 — 05.02.03-21	July 27, 2010
RAI 278 — 05.02.03-22	July 27, 2010
RAI 278 — 05.02.03-23	July 27, 2010
RAI 278 — 05.03.02-7	July 27, 2010
RAI 278 — 05.03.02-8	July 27, 2010
RAI 278 — 05.03.02-9	July 27, 2010
RAI 278 — 05.03.02-10	July 27, 2010

Sincerely,

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From: BRYAN Martin (EXT)
Sent: Wednesday, May 26, 2010 5:29 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); KOWALSKI David J (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 278, FSAR Ch. 5, Supplement 3

Getachew,

AREVA NP Inc. provided a schedule for technically correct and complete responses to the eight questions in RAI No. 278 on February 27, 2010. Supplement 1 and Supplement 2 responses to RAI No. 278 were sent on April 9, 2010 and April 30, 2010, respectively, to provide a revised schedule. Since additional time is needed for AREVA to discuss the responses to the questions with the NRC, an updated schedule is provided in this e-mail.

The schedule for technically correct and complete responses to the questions has been revised as provided below.

Question #	Response Date
RAI 278 — 05.02.03-20	June 24, 2010
RAI 278 — 05.02.03-21	June 24, 2010
RAI 278 — 05.02.03-22	June 24, 2010
RAI 278 — 05.02.03-23	June 24, 2010
RAI 278 — 05.03.02-7	June 24, 2010
RAI 278 — 05.03.02-8	June 24, 2010
RAI 278 — 05.03.02-9	June 24, 2010
RAI 278 — 05.03.02-10	June 24, 2010

Sincerely,

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

From: BRYAN Martin (EXT)
Sent: Friday, April 30, 2010 4:27 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); KOWALSKI David J (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 278, FSAR Ch. 5, Supplement 2

Getachew,

AREVA NP Inc. provided a schedule for technically correct and complete responses to the eight questions in RAI No. 278 on February 27, 2010. A revised schedule for technically correct and complete responses was provided on April 9, 2010. Since additional time is needed for AREVA to have an opportunity to interact with NRC on the response, an updated schedule is provided in this e-mail.

The schedule for technically correct and complete responses to the questions has been revised as provided below.

Question #	Response Date
RAI 278 — 05.02.03-20	May 26, 2010
RAI 278 — 05.02.03-21	May 26, 2010
RAI 278 — 05.02.03-22	May 26, 2010
RAI 278 — 05.02.03-23	May 26, 2010
RAI 278 — 05.03.02-7	May 26, 2010
RAI 278 — 05.03.02-8	May 26, 2010
RAI 278 — 05.03.02-9	May 26, 2010
RAI 278 — 05.03.02-10	May 26, 2010

Sincerely,

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

From: BRYAN Martin (EXT)
Sent: Friday, April 09, 2010 4:04 PM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); ROMINE Judy (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); KOWALSKI David J (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 278, FSAR Ch. 5, Supplement 1

Getachew,

AREVA NP Inc. provided a schedule for technically correct and complete responses to the eight questions in RAI No. 278 on February 27, 2010. To allow time for AREVA to discuss the responses with the NRC, a revised schedule is provided in this e-mail.

The schedule for technically correct and complete responses to the questions has been revised as provided below.

Question #	Response Date
RAI 278 — 05.02.03-20	April 30, 2010
RAI 278 — 05.02.03-21	April 30, 2010
RAI 278 — 05.02.03-22	April 30, 2010
RAI 278 — 05.02.03-23	April 30, 2010
RAI 278 — 05.03.02-7	April 30, 2010
RAI 278 — 05.03.02-8	April 30, 2010
RAI 278 — 05.03.02-9	April 30, 2010
RAI 278 — 05.03.02-10	April 30, 2010

Sincerely

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

From: BRYAN Martin (EXT)
Sent: Saturday, February 27, 2010 10:48 AM
To: 'Tesfaye, Getachew'
Cc: DELANO Karen V (AREVA NP INC); BENNETT Kathy A (OFR) (AREVA NP INC); ROMINE Judy (AREVA NP INC); KOWALSKI David J (AREVA NP INC)
Subject: Response to U.S. EPR Design Certification Application RAI No. 278, FSAR Ch. 5

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 278 Response US EPR DC" states that complete answers cannot be currently provided for the eight questions.

The following table provides the page(s) in the response document, "RAI 278 Response US EPR DC" containing the response to each question.

Question #	Start Page	End Page
RAI 278 — 05.02.03-20	2	2
RAI 278 — 05.02.03-21	3	3
RAI 278 — 05.02.03-22	4	4
RAI 278 — 05.02.03-23	5	5
RAI 278 — 05.03.02-7	6	6
RAI 278 — 05.03.02-8	7	7
RAI 278 — 05.03.02-9	8	8
RAI 278 — 05.03.02-10	9	9

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

Question #	Response Date
RAI 278 — 05.02.03-20	April 9, 2010
RAI 278 — 05.02.03-21	April 9, 2010
RAI 278 — 05.02.03-22	April 9, 2010
RAI 278 — 05.02.03-23	April 9, 2010
RAI 278 — 05.03.02-7	April 9, 2010
RAI 278 — 05.03.02-8	April 9, 2010
RAI 278 — 05.03.02-9	April 9, 2010
RAI 278 — 05.03.02-10	April 9, 2010

Sincerely,

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

From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Monday, September 14, 2009 3:37 PM
To: ZZ-DL-A-USEPR-DL
Cc: Davis, Robert; Downey, Steven; Terao, David; Roy, Tarun; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 278 (3466, 3506),FSAR Ch. 5

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on August 17, 2009, and discussed with your staff on September 14, 2009. Draft RAI Question 05.03.02-8 was modified as a result of that discussion. The questions in this RAI are considered potential open items for Phases 2 and 3 reviews. As such, the schedule we have established for your application assumes technically correct and complete responses prior to the start of Phase 4 review. For any RAI question that cannot be answered prior to the start of Phase 4 review, it is expected that a date for receipt of this information will be provided 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: 1911

Mail Envelope Properties (BC417D9255991046A37DD56CF597DB71075A88DF)

Subject: Response to U.S. EPR Design Certification Application RAI No. 278, FSAR Ch. 5, Supplement 6
Sent Date: 8/27/2010 11:08:32 AM
Received Date: 8/27/2010 11:08:35 AM
From: BRYAN Martin (EXTERNAL AREVA)

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

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"Tesfaye, Getachew" <Getachew.Tesfaye@nrc.gov>
Tracking Status: None

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Files	**Size**	**Date & Time**
MESSAGE	12100	8/27/2010 11:08:35 AM
RAI 278 Supplement 6 Response US EPR DC.pdf		219316

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

Response to

Request for Additional Information No. 278, Supplement 6
9/14/2009

U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 05.02.03 - Reactor Coolant Pressure Boundary Materials
SRP Section: 05.03.02 - Pressure-Temperature Limits, Upper-Shelf Energy, and Pressurized Thermal Shock

Application Section: FSAR Ch. 5

QUESTIONS for Component Integrity, Performance, and Testing Branch 1 (AP1000/EPR Projects) (CIB1)

Question 05.02.03-21:

POTENTIAL OPEN ITEM

FSAR Section 5.2.3.4.6 states:

The RCP casing is made from ASME SA-351 Grade CF3 material with additional restrictions on silicon (1.5% maximum) and niobium (restricted to trace elements). In addition, the ferrite content of cast austenitic stainless components in the RCPB will be limited to a ferrite content of less than 20 percent. These restrictions reduce susceptibility to thermal aging (Section 3.6.3.3.6). For cast austenitic stainless steel material used in the RCPB, the percent ferrite is calculated using Hull's equivalent factors as indicated in NUREG/CR-4513 Rev. 1 (May 1994).

The FSAR statement above is acceptable for CASS materials currently listed in Table 5.2-2 which contain a maximum of 0.5 % molybdenum. However, in response to RAI 05.02.03-18, the applicant provided a proposed modification to Table 5.2-2. The applicant's proposed modified Table 5.2-2 includes RCPB valve specifications and grades as requested by the staff in RAI 05.02.03-18. The staff notes that the applicant's proposed revised Table now includes CASS grades CF3M and CF8M for the fabrication of RCPB valves. These two materials contain molybdenum ranging between 2.0-3.0% which increases their susceptibility to thermal aging embrittlement. To be consistent with staff guidance, these materials should have a ferrite content of ≤14% to be considered not susceptible to thermal aging embrittlement. The staff requests that the applicant modify the FSAR to limit the ferrite content of high Molybdenum RCPB CASS components, such as CF3M and CF8M, to ≤14%.

Response to Question 05.02.03-21:

For cast austenitic stainless steel components that will experience service temperatures greater than 482°F, the delta ferrite content is limited as described in the following changes to the U.S. EPR FSAR.

U.S. EPR FSAR Tier 2, Section 5.2.3.4.6 was revised in U.S. EPR FSAR, Rev. 2 to include the following:

> "For cast austenitic stainless steel components that experience service temperatures greater than 482°F, the delta ferrite content is limited to less than or equal to 20 percent for low molybdenum content statically cast materials, less than or equal to 14 percent for high molybdenum content statically cast materials, and less than or equal to 20 percent for high molybdenum content centrifugally cast materials. Low molybdenum content is defined as 0.5 wt% maximum and high molybdenum content is defined as 2.0-3.0 wt%."

U.S. EPR FSAR Tier 2, Table 5.2-2—Material Specifications for RCPB Components was revised in U.S. EPR, Rev. 2 to include a new Note 10 that explains the classification of cast austenitic stainless steel materials.

U.S. EPR FSAR Tier 2, Section 3.6.3.3.6 was revised in U.S. EPR FSAR, Rev. 2 to include the following:

> "Ferrite limitations for CASS RCPB materials are described in Section 5.2.3.4.6."

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 05.02.03-22:

POTENTIAL OPEN ITEM

In FSAR Section 5.2.3.4.1, the applicant states that stabilized grades of austenitic stainless steels have a stabilizing heat treatment above 800°F. The only stabilized stainless steel material (Grade 347), identified by the staff, used to fabricate components in the RCS pressure boundary, is used to fabricate the CRDM pressure housing. In response to RAI 05.02.03-17, dated June 5, 2009, the applicant stated that no stabilizing heat treatment will be performed for Grade 347 used for the CRDM pressure housing. There appears to be an inconsistency between the FSAR, which references stabilizing heat treatments and the applicant's response to RAI 05.02.03-17 which indicates that Grade 347 used to fabricate the CRDM will not receive a stabilizing heat treatment. The staff requests that the applicant address this inconsistency and modify the FSAR accordingly.

Response to Question 05.02.03-22:

The control rod drive mechanism (CRDM) pressure housings are the only reactor coolant system pressure boundary components that will be fabricated of stabilized austenitic stainless steel. Stabilizing heat treatment will not be performed on the stabilized austenitic stainless steel used for the CRDM pressure housing.

U.S. EPR FSAR Tier 2, Section 5.2.3.2.2 and Section 5.2.3.4.1 were revised in U.S. EPR FSAR, Rev. 2 to be consistent with the Response to RAI 199, Supplement 1, Question 05.02.03-17.

U.S. EPR FSAR Tier 2, Section 5.2.3.4.1 was modified in U.S. EPR FSAR, Rev. 2 to include the following:

> "Stabilizing heat treatment is not performed for the stabilized austenitic stainless steels. The only heat treatment performed in the course of steel manufacturing is solution annealing with a maximum temperature not to exceed 2012°F, followed by quenching in water or equivalent rapid cooling in air to prevent grain boundary carbide precipitation.
>
> Postweld heat treatment (PWHT) is performed on CRDM pressure housing components joined by welding. The sensitization concern in the stabilized austenitic stainless steel is eliminated by the compositional requirement and additional testing during welding procedure qualification. Welding procedure qualification is based on ASME Section III and Section IX with additional test requirements. During procedure qualification, tests and examinations are performed in the as-welded and PWHT condition. Corrosion testing per ASTM A 262 Practice E is performed to the qualification weld, which is identical to the actual welded joint including the stabilized austenitic stainless steel base metal.
>
> The carbon content of the sensitized material is limited to a maximum of 0.04 percent. The minimum stabilization ratio of niobium to carbon (Nb/C) is specified as 13 for the stabilized austenitic stainless steel component that receives PWHT. Additionally, the minimum allowable chromium content is increased to 18 percent. As required by the material specification, stabilized austenitic stainless steel is corrosion tested according to ASTM A 262 Practice E after being subjected to sensitizing heat treatment. In any ASTM A 262 test, intergranular attack is not permitted regardless of depth."

U.S. EPR FSAR Tier 2, Section 5.2.3.4.1 will be revised to include the following modified sentence:

> "The carbon content of the stabilized material is limited to a maximum of 0.04 percent."

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 5.2.3.4.1 will be revised as described in the response and indicated on the enclosed markup.

Question 05.02.03-23:

POTENTIAL OPEN ITEM

FSAR Section 5.2.3.2.2 states that unstabilized austenitic stainless steels are not heated above 800°F, other than locally by welding operations, after the final heat treatment. FSAR Section 5.2.3.4.1 states that utilization of materials in the solution annealed plus rapidly cooled condition and the prohibition of subsequent heat treatments in the 800°F to 1500°F temperature range is one of five methods used to avoid intergranular attack in austenitic stainless steel. These statements appear to be inconsistent with the applicant's process for joining low alloy steel nozzles to austenitic stainless steel safe-ends which requires that safe-ends be subject to post weld heat treatment.

The staff requests that the applicant modify the FSAR to address these inconsistencies by discussing those components used in the solution annealed and rapidly cooled condition and those that will be used in the solution annealed and rapidly cooled condition followed by post weld heat treatment after welding.

In addition, in order to make the FSAR clear as to the requirements for testing of post weld heat treated stainless steel safe-ends, the staff requests that the applicant modify FSAR Section 5.2.3 to state that for post weld heat treated austenitic stainless steel safe-ends, non-sensitization of the safe-ends will be verified in accordance with RG 1.44.

Response to Question 05.02.03-23:

To the extent possible, fabrication sequences are selected to avoid subjecting austenitic stainless steel materials to post weld heat treatments. However, where this is not possible, as is the case of welding the austenitic stainless steel safe ends directly to the component low alloy steel nozzles, the materials are subjected to additional requirements to verify that they will not be sensitized during the heat treatments in accordance with RG 1.44. Specifically, the unstabilized austenitic stainless steels heated in the sensitization range of 800˚F - 1500˚F for ≥ 60 minutes will be tested in accordance with ASTM A-262 as required by RG 1.44. Additionally, low carbon (not exceeding 0.03wt% carbon) unstabilized austenitic stainless steel materials are used, as required by RG 1.44.

The welds between the low alloy steel nozzles and stainless steel safe ends of the reactor pressure vessel, steam generator and pressurizer nozzles are performed with NiCrFe alloy weld filler material and subjected to a post weld heat treatment. However, these may not be the only stainless steel materials in the reactor coolant system pressure boundary equipment (for which procurement has not been performed) that may be subjected to postweld heat treatment. The austenitic stainless steel safe ends are an example of when additional testing is required, but may not be the only components subjected to further testing.

U.S. EPR FSAR Tier 2, Section 5.2.3.4.1 was revised in U.S. EPR FSAR, Rev. 2 to reflect this information.

U.S. EPR FSAR Tier 2, Section 5.2.3.2.2 will be revised to reflect this information.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 5.2.3.2.2 will be revised as described in the response and indicated on the enclosed markup.

Question 05.03.02-7:

POTENTIAL OPEN ITEM

Provide a table of the data points (reactor coolant temperature vs. pressure) for each P-T curve displayed in Technical Report ANP-10283, Revision 1.

Response to Question 05.03.02-7:

Table 05.03.02-7-1—RCS Heatup Limits at 60 EFPY and Table 05.03.02-7-2—RCS Cooldown Limits at 60 EFPY contain the data points for Figure 6-1—U.S. EPR RCS P-T Limits – Normal Heatup with ISLH and Criticality Limit Curves Applicable to 60 EFPY and Figure 6-2—U.S. EPR RCS P-T Limits – Normal Cooldown Applicable to 60 EFPY in Technical Report ANP-10283P, “U.S. EPR Pressure-Temperature Limits Methodology for RCS Heatup and Cooldown,” respectively.

Technical Report ANP-10283P has been revised to include Table 05.03.02-7-1 and Table 05.03.02-7-2.

While preparing the response to this question, an error was identified in the criticality limit on Figure 6-1 in Technical Report ANP-10283P. This figure has been revised to eliminate the error. Table 05.03.02-7-1 contains the correct data points for the criticality limit.

U.S. EPR FSAR Tier 2, Figure 5.3-1—Reactor Coolant System Heatup Pressure-Temperature Curve was also affected by the error identified in Figure 6-1. U.S. EPR FSAR Tier 2, Figure 5.3-1 was revised in U.S. EPR FSAR, Rev. 2 to eliminate the error.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Technical Report Impact:

ANP-10283P, “U.S. EPR Pressure-Temperature Limits Methodology for RCS Heatup and Cooldown,” Revision 2 incorporates the changes as described in the response.

Table 05.03.02-7-1—RCS Heatup Limits at 60 EFPY

(Does not include margin for instrument uncertainty)

Normal Heatup		Criticality Limit		Inservice Leak and Hydrostatic Test Limit	
Fluid Temp. (°F)	**Hot Leg Press. (psig)**	**Fluid Temp. (°F)**	**Hot Leg Press. (psig)**	**Fluid Temp. (°F)**	**Hot Leg Press. (psig)**
50	0	221	0	200	1457
50	611	221	807	205	1705
55	611	225	868	210	1953
60	611	230	943	215	2202
65	611	235	1019	217	2301
70	611	240	1095	220	2400
75	611	245	1170	220.53	2476
80	611	250	1246		
85	611	251	1261		
90	611	255	1459		
95	611	260	1707		
100	611	265	1954		
105	611	270	2202		
110	611	272	2301		
115	611	275	2457		
120	611	275.37	2476		
125	611				
130	611				
135	611				
140	611				
145	611				
150	611				
155	611				
160	611				
165	611				
168	611				
170	641				
175	717				
180	792				
185	868				
190	943				
195	1019				
200	1095				
205	1170				
210	1246				
211	1261				
215	1459				
220	1707				
225	1954				
230	2202				
232	2301				
235	2457				
235.37	2476				

Table 05.03.02-7-2—RCS Cooldown Limits at 60 EFPY

(Does not include margin for instrument uncertainty)

Fluid Temp. (°F)	Hot Leg Press. (psig)
50	0
50	611
52	611
57	611
62	611
67	611
72	611
77	611
82	611
87	611
91	611
96	611
101	611
106	611
111	611
116	611
116	1468
121	1527
122	1680
123	1704
128	1830
133	1970
138	2099
143	2200
148	2312
153	2435
158	2572

Question 05.03.02-8:

POTENTIAL OPEN ITEM

Clarify the thickness value (including vessel thickness and cladding thickness) used to calculate the fluence at the 1/4t and 3/4t locations for all materials provided in Technical Report ANP-10283, Rev.1.

Response to Question 05.03.02-8:

Note 3 of Table 6-1—Chemical Composition and Projected Fluence for the U.S. EPR Reactor Vessel Materials through 60 EFPY in Technical Report ANP-10283P, "U.S. EPR Pressure-Temperature Limits Methodology for RCS Heatup and Cooldown," states that the neutron fluence at the 1/4T and 3/4T locations are calculated using Equation 3 of RG 1.99, Revision 2 using a vessel thickness of 9.84 inches with a cladding thickness of 0.20 inches (the cladding thickness value used in the calculation is a minimum value). The vessel and cladding thickness values were used to calculate the neutron fluence.

In RG 1.99, Revision 2, Equation 3, variable x is the depth into the vessel wall measured from the vessel inner (wetted) surface. The 1/4t and 3/4t locations are 1/4 and 3/4 through the vessel thickness (9.84 inches). Therefore, variable x is calculated as follows:

1/4t location: $x = [9.84 \times 0.25] + 0.20 = 2.66\ inches$

3/4t location: $x = [9.84 \times 0.75] + 0.20 = 7.58\ inches$

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Question 05.03.02-9:

POTENTIAL OPEN ITEM

Provide all values (i.e., chemistry factors, fluence factors, margins, ΔRT_{NDT}, etc.) used to calculate the ART at the 1/4t and 3/4t locations for all applicable materials provided in Technical Report ANP-10283, Rev. 1.

Response to Question 05.03.02-9:

The values used to calculate the 1/4T and 3/4T adjusted reference temperature (ART) values are provided in Table 05.03.02-9-1—Factors Used to Calculate the US EPR ART Values.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Table 05.03.02-9-1—Factors Used to Calculate the US EPR ART Values

Reactor Vessel Location	Initial RT_{NDT}, °F	60 EFPY Fluence, n/cm^2			Fluence Factor		Chemistry Factor, °F	ΔRT_{NDT}, °F at 60 EFPY		Margin, °F	
		Inner wetted surface (f_{surf})	1/4T Location	3/4T Location	¼T Location	¾T Location		¼T Location	¾T Location	¼T Location	3/4T Location
ANP-10283P Reference	Table 6-2	Table 6-1	Table 6-1 (1)	Table 6-1 (1)	Equation 3-3	Equation 3-3	Table 6-1	Equation 3-2	Equation 3-2	Table 6-2 Note 1	Table 6-2 Note 1
Nozzle Shell	-4	2.103E+17	1.111E+17	3.410E+16	0.118	0.050	51.0	6.0	2.6	6.0	2.6
Upper Core Shell	-4	1.375E+19	7.262E+18	2.230E+18	0.910	0.596	37.0	33.7	22.1	33.7	22.1
Lower Core Shell	-4	1.375E+19	7.262E+18	2.230E+18	0.910	0.596	37.0	33.7	22.1	33.7	22.1
Transition Ring	-4	4.406E+18	2.327E+18	7.145E+17	0.606	0.353	51.0	30.9	18.0	30.9	18.0
Weld #1	-4	2.103E+17	1.111E+17	3.410E+16	0.118	0.050	82.0	9.7	4.1	9.7	4.1
Weld #2	-4	1.368E+19	7.225E+18	2.218E+18	0.909	0.594	82.0	74.5	48.7	56.0	48.7
Weld #3	-4	4.406E+18	2.327E+18	7.145E+17	0.606	0.353	82.0	49.7	28.9	49.7	28.9

Note 1: See the response to Question 05.03.02-8 for the calculation of neutron fluence at depths of 1/4T and 3/4T.

Question 05.03.02-10:

POTENTIAL OPEN ITEM

To address PTLR Criterion 4(GL 96-03), clearly identify both the limiting adjusted reference temperature (ART) values and limiting materials at the 1/4t and 3/4 t locations (t= vessel thickness) used in the development of the P-T limits.

Response to Question 05.03.02-10:

The limiting adjusted reference temperature (ART) values were 126.5ºF at ¼ t and 93.4ºF at ¾ t for the circumferential seam weld and 63.4ºF at ¼ t and 40.2ºF at ¾ t for the base metal forging (generic bounding value considered for both upper and lower shell forging). The limiting circumferential seam weld is the upper shell to lower shell weld in the reactor pressure vessel beltline region. The limiting forging material is the reactor pressure vessel beltline upper and lower shell forging. The pressure-temperature limits were developed based on the above limiting circumferential seam weld and forging materials.

Technical Report ANP-10283P has been revised to reflect the limiting ART values and limiting materials.

FSAR Impact:

The U.S. EPR FSAR will not be changed as a result of this question.

Technical Report Impact:

ANP-10283P, “U.S. EPR Pressure-Temperature Limits Methodology for RCS Heatup and Cooldown,” Revision 2 incorporates the changes as described in the response.

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(2) hydrogen immediately prior to and following criticality. Dissolved hydrogen is added to maintain a reducing environment by scavenging oxidizing molecular products formed by the radiolysis of water and with any oxygen introduced into the RCS with makeup water.

Suspended solids (corrosion product particulates) in the reactor coolant are minimized by the coordinated boron-lithium chemistry program and by filtration during shutdown operations. Other impurity concentrations are maintained below specified limits through the control of the chemical quality of makeup water and chemical additives and by purification of the reactor coolant through the mixed bed ion exchangers. Section 9.3.4 addresses RCS water chemistry control.

5.2.3.2.2 Compatibility of Construction Materials with Reactor Coolant

Ferritic low alloy and carbon steels used in principal pressure retaining applications have either austenitic stainless steel or nickel-base alloy corrosion resistant cladding on all surfaces that are exposed to the reactor coolant. The cladding of ferritic type base material receives a post-weld heat treatment, as required by ASME Section III.

Unstabilized austenitic stainless steel base materials with primary pressure retaining applications are used in the solution annealed and water quenched (or rapidly cooled) condition in accordance with RG 1.44. To the extent possible, ~~U~~unstabilized austenitic stainless steels are not heated above 800°F, other than locally by welding operations, after the final heat treatment.

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Due to the control of oxygen, chlorides, and fluorides in the reactor coolant, any unstabilized stainless steel locally sensitized at the high temperatures used during fabrication are not expected to experience stress corrosion cracking during normal plant operation. Precipitation hardenable stainless steel (SA-453 Grade 660) is used as a necked-down bolt for the control rod drive mechanism; because of its location it will not have contact with reactor coolant. The RCP bolting is external to the wetted pressure boundary. Alloy 690 base materials with primary pressure retaining applications are used in the solution annealed and thermally treated condition to optimize resistance to intergranular corrosion. Alloy 600 base and weld filler materials are not used in the RCS including any RCPB applications.

5.2.3.3 Fabrication and Processing of Ferritic Materials

5.2.3.3.1 Fracture Toughness

The fracture toughness properties of the RCPB components including pumps, piping, and valves comply with the requirements of 10 CFR 50, Appendix G and ASME Section III, NB-2300, NC-2300, and ND-2300 as appropriate. Section 5.3.1 provides a specific description of the reactor vessel materials and Section 5.4.1 provides a specific description of the RCP flywheel. The maximum reference temperature RT_{NDT} for qualification weld, which is identical to the actual welded joint including the stabilized austenitic stainless steel base metal.

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The carbon content of the ~~sensitized~~stabilized material is limited to a maximum of 0.04 percent. The minimum stabilization ratio of niobium to carbon (Nb/C) is specified as 13 for the stabilized austenitic stainless steel component that receives PWHT. Additionally, the minimum allowable chromium content is increased to 18 percent. As required by the material specification, stabilized austenitic stainless steel is corrosion tested according to ASTM A 262 Practice E after being subjected to sensitizing heat treatment. In any ASTM A 262 test, intergranular attack is not permitted regardless of depth.

Due to necessary welding, the unstabilized austenitic stainless steel in the HAZ is heated in the sensitized temperatures range (800°F to 1500°F) during fabrication. Welding practices and material composition are controlled to manage the sensitization while the material is in this temperature range and all weld metals have a carbon content not exceeding 0.03 wt% to prevent undue sensitization. In addition, where unstabilized austenitic stainless steel materials are subjected to sensitizing temperatures for greater than 60 minutes during a post weld heat treatment, as is the case for welding the austenitic stainless steel safe ends directly to the low alloy steel nozzles of the reactor pressure vessel, steam generator and pressurizer, non-sensitization of the materials is verified by testing in accordance with Practice A or E of ASTM A-262, as required by RG 1.44.

The unstabilized austenitic stainless steel casting material used in the RCP is used for the RCP casing. The maximum carbon content of this material, as with other austenitic stainless steel materials, is 0.03 wt%.

No cold-worked grade austenitic stainless steels are used for manufacture of the RCPB components. Inservice inspections follow the requirements of ASME Section XI, industry materials reliability programs, and NRC guidance to check for intergranular corrosion from sensitization.

Actual yield strength values for austenitic stainless steel materials are supplied on material test reports for each component at the time of shipment.

Forged stainless steel components within the RCPB that are subject to ASME Section XI volumetric examinations have a grain size that allows inspection by ultrasonic methods.

5.2.3.4.2 Cleaning and Contamination Protection Procedures

Austenitic stainless steel materials used in the fabrication, installation, and testing of nuclear steam supply components and systems are handled, protected, stored, and

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The lowest allowable pressure at each time point yields a single lower bound P-T limit curve for normal heatup or normal cooldown. The P-T curves for normal plant heatup and cooldown are presented in Figure 6-1 and Figure 6-2, respectively, and are tabulated in Table 6-6 and Table 6-7, respectively. 05.03.02-7

The P-T limit curve for the closure head region is calculated separately. The allowable pressure from plant startup is maintained as a constant value of 635 psig (20 percent of preservice hydrostatic test pressure) from the bolt preload temperature condition until the coolant temperature reaches the temperature where a calculated crack-tip metal temperature exceeds the minimum temperature requirement of Reference 1 and Table 2-1. The minimum required temperatures are subsequently determined at 1285 psig and at 2325 psig (full power, steady-state condition). The resulting closure head limit curves are included in Figure 6-1 and Figure 6-2 for heatup and cooldown, respectively.

For plant heatup, the closure head limit curve lower bounds both the beltline region and the nozzle corner limit curves. As noted, the closure head limit does not change throughout the lifetime of the plant. In the case of normal cooldown from steady-state conditions, as shown in Figure 6-2, the beltline P-T limit is controlling until it intersects with the closure head limit curve. At 635 psig, which corresponds to 20 percent of the preservice hydrostatic test pressure, the allowable temperature corresponds to the minimum temperature requirement of RT_{NDT} +120°F per item 2.b of Table 2-1. The P-T limit curve for the (inlet and outlet) nozzle corner region is not a controlling P-T limit region at any time during normal plant heatup or cooldown.

The P-T limits thus calculated are “uncorrected P-T limits,” meaning that measurement uncertainty due to instrument error or sensor location adjustment is not included. The sensor location adjustment is necessary due to the difference in sensor readings (pressure and temperature) at the measurement location compared to the corresponding pressures and temperatures at the controlling P-T limit region. Sensor location adjustment includes the effect of pump operation. These corrections are made to the uncorrected P-T limits and the resultant corrected P-T limits are presented in

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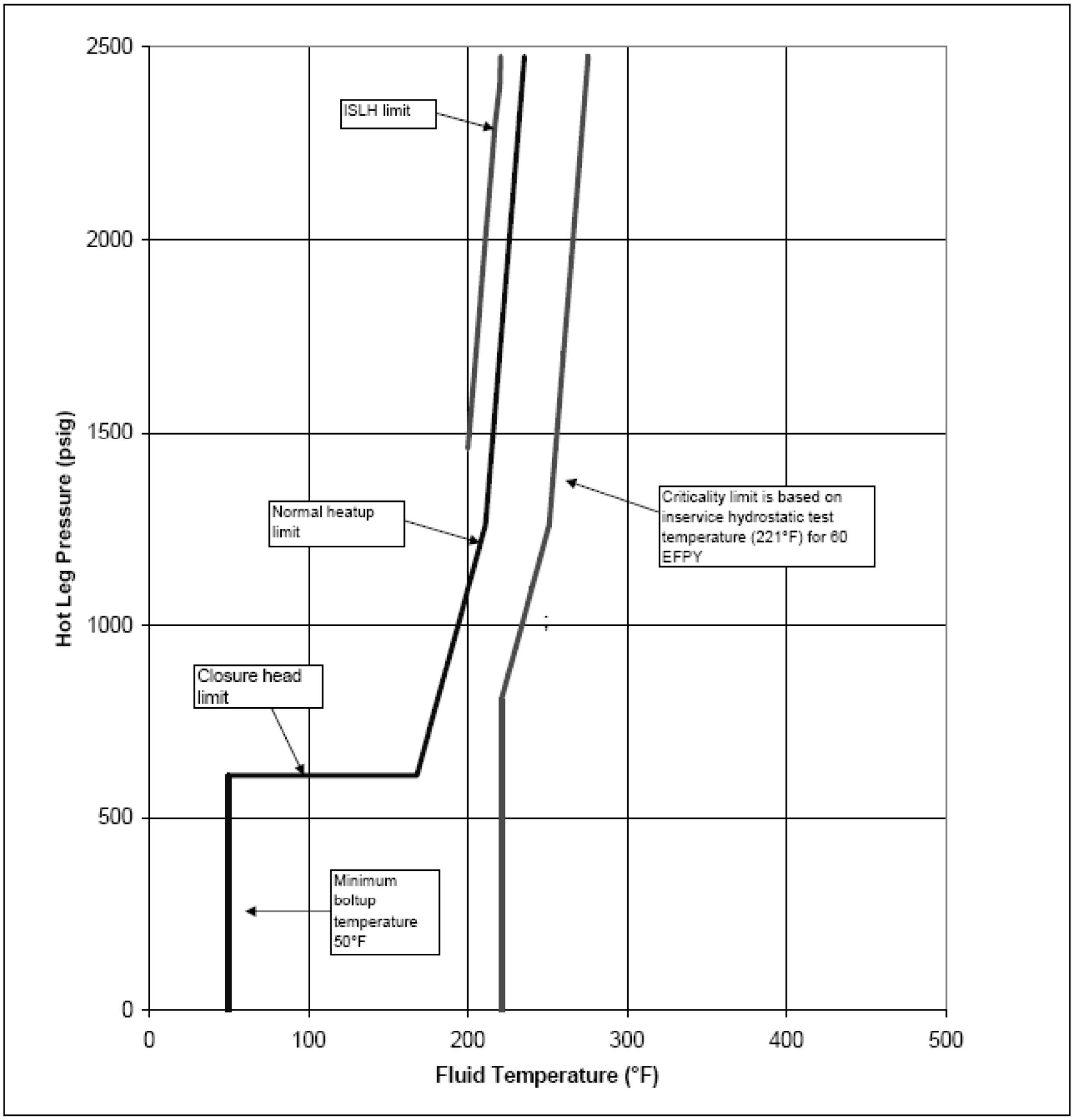
Figure 6–1 U.S. EPR RCS P-T Limits – Normal Heatup with ISLH and Criticality Limit Curves Applicable to 60 EFPY



Note:

1. P-T limit curves do not include margin for instrument uncertainty.

Note:

1. P-T limit curves do not include margin for instrument uncertainty.

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Table 6–2 Adjusted Reference Temperature for the U.S. EPR Reactor Vessel Materials through 60 EFPY

Material Description		Initial RT_{NDT} (°F)	ART, °F at 60 EFPY[1]	
Reactor Vessel	Type		1/4t Location	3/4t Location
Nozzle Shell	SA-508, Grade 3, Class 1	-4	8.0	1.2
Upper Core Shell	SA-508, Grade 3, Class 1	-4	63.4[3]	40.2[3]
Lower Core Shell	SA-508, Grade 3, Class 1	-4	63.4[3]	40.2[3]
Transition Ring	SA-508, Grade 3, Class 1	-4	57.8	32.0
Weld #1	Low Alloy Steel Weld	-4	15.4	4.2
Weld #2	Low Alloy Steel Weld	-4	126.5[3]	93.4[3]
Weld #3	Low Alloy Steel Weld	-4	95.4	53.8
Closure Head	SA-508, Grade 3, Class 1	-4	-4[2]	N/A
Closure Head	Closure Head Weld	-4	-4[2]	N/A

Notes:

1. The margin term in the RG 1.99 Revision 2 expression for adjusted reference temperature is calculated according to RG 1.99 Revision 2, Equation 4. The standard deviation for initial RTNDT is 0°F because the initial RTNDT is specified as a maximum limit for vessel manufacture. The standard deviation for ΔRTNDT is the lesser of 28°F for welds and 17°F for base metals and 0.50 times the mean value of ΔRTNDT calculated from the chemistry factors and fluences in Table 6-1.
2. The projected fluence to the RPV head is insufficient to cause any measurable shift in RTNDT.
3. Limiting beltline ART values and materials used in the generation of the P-T Limits.

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Table 6–6 RCS Heatup Limits at 60 EFPY

Normal Heatup		Criticality Limit		ISLH Test Limit	
Fluid Temp. (°F)	Hot Leg Press. (psig)	Fluid Temp. (°F)	Hot Leg Press. (psig)	Fluid Temp. (°F)	Hot Leg Press. (psig)
50	0	221	0	200	1457
50	611	221	807	205	1705
55	611	225	868	210	1953
60	611	230	943	215	2202
65	611	235	1019	217	2301
70	611	240	1095	220	2400
75	611	245	1170	220.53	2476
80	611	250	1246		
85	611	251	1261		
90	611	255	1459		
95	611	260	1707		
100	611	265	1954		
105	611	270	2202		
110	611	272	2301		
115	611	275	2457		
120	611	275.37	2476		
125	611				
130	611				
135	611				
140	611				
145	611				
150	611				
155	611				

Table 6–6 RCS Heatup Limits at 60 EFPY

160	611				
165	611				
168	611				
170	641				
175	717				
180	792				
185	868				
190	943				
195	1019				
200	1095				
205	1170				
210	1246				
211	1261				
215	1459				
220	1707				
225	1954				
230	2202				
232	2301				
235	2457				
235.37	2476				

Note:

The tabulated heatup limits do not include margin for instrument uncertainty.

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Table 6–7 RCS Cooldown Limits at 60 EFPY

Fluid Temperature (°F)	Hot Leg Pressure (psig)
50	0
50	611
52	611
57	611
62	611
67	611
72	611
77	611
82	611
87	611
91	611
96	611
101	611
106	611
111	611
116	611
116	1468
121	1527
122	1680
123	1704
128	1830
133	1970
138	2099
143	2200

Table 6–7 RCS Cooldown Limits at 60 EFPY

148	2312
153	2435
158	2572

Note:
The tabulated cooldown limits do not include margin for instrument uncertainty.

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