AreveEPRDCPEm Resource

From:	Pederson Ronda M (AREVA NP INC) [Ronda.Pederson@areva.com]
Sent:	Tuesday, July 07, 2009 6:09 PM
To:	Tesfaye, Getachew
Cc:	BENNETT Kathy A (OFR) (AREVA NP INC); DELANO Karen V (AREVA NP INC); WELLS Russell D (AREVA NP INC)
Subject:	Response to U.S. EPR Design Certification Application RAI No. 232, FSARCh. 5
Attachments:	RAI 232 Response US EPR DC.pdf

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 232 Response US EPR DC.pdf" provides a technically correct and complete response to the 2 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 232 Question 05.03.01-10 and 05.03.01-11.

The following table indicates the respective pages in the response document, "RAI 232 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 232 — 05.03.01-10	2	3
RAI 232 — 05.03.01-11	4	5

This concludes the formal AREVA NP response to RAI 232 and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

Ronda Pederson
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From: Tesfaye, Getachew [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Friday, June 05, 2009 6:53 PM
To: ZZ-DL-A-USEPR-DL
Cc: Jenkins, Joel; Terao, David; Roy, Tarun; Colaccino, Joseph; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 232 (2761), FSARCh. 5

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on May 19, 2009, and discussed with your staff on June 5, 2009. Draft RAI Question 05.03.01-10 (b)(2) was modified as a result of that discussion. 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
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Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 626

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Response to

Request for Additional Information No. 232 (2761), Revision 0

6/05/2009

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 05.03.01 - Reactor Vessel Materials
Application Section: 5.3.1

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

Question 05.03.01-10:

In response to RAI No. 64, Question 05.03.01-2, the applicant clarified that the surfaces of the SA-508 alloy steel reactor vessel in contact with the reactor coolant are clad with stainless steel and NiCrFe. The cladding is deposited by weld overlay. The applicant's response to RAI No. 202, Question 05.03.01-7 further clarified that Type (Alloy) 308L/309L stainless steel is used for cladding, except that in areas of the Alloy 690 radial key attachments, the weld overlay cladding of the reactor vessel is made using Alloy 52/52M/152. The staff notes that Alloy 308L/309L welded over Alloy 52/52M/152 may introduce defects, and therefore proper sequencing of the weld overlay can affect the integrity of the reactor vessel, cladding and the structural attachment weld (i.e., radial keys). Therefore, because two different materials are used to clad the reactor vessel, describe and include in the FSAR additional information to clarify the following areas:

a) Identify the specific areas of the reactor vessel that are clad with Alloy 308L/309L, and the areas that are clad with Alloy 52/52M/152. Information similar to your response to RAI No. 202, Question 05.03.01-7 should also be included in the FSAR.

b) Discuss the sequencing of the Alloy 308L/309L and Alloy 52/52M/152 weld overlay cladding to ensure that defects are not introduced in the weld overlay cladding or adjacent reactor vessel material. The discussion should include the following:

    1) Is Alloy 308L/309L applied first to the reactor vessel, except for at the radial key locations, and then Alloy 52/52M/152 is applied directly to the RPV material (SA-508 alloy steel) at the radial key locations?

    2) Is Alloy 308L/309L applied first to the entire reactor vessel, and then Alloy 52/52M/152 is applied to the Alloy 308L/309L cladding at the radial key locations?

c) Clarify how the cladding thickness of 0.295 inches in the applicant's response to RAI 64, Question 05.03.01-2 applies to the Alloy 308L/309L cladding, the Alloy 52/52M/152 cladding, or to the combined cladding (if Alloy 52/52M/152 cladding is deposited on top of the 308L/309L cladding).

Response to Question 05.03.01-10:

a) The internal surfaces of the reactor pressure vessel (RPV) are clad with stainless steel (309L/308L), except for the areas where the Alloy 690 radial keys are welded (see U.S. EPR FSAR, Tier 2, Figure 5.3-4). As stated in the response to RAI 202, Question 05.03.01-7, Alloy 52/52M/152 weld filler materials are used to minimize dissimilar materials in the overall RPV pressure boundary, clad, attachment configuration. As stainless steel has a higher coefficient of thermal expansion than both the low alloy steel pressure boundary material and the Alloy 690 attachment material, the use of Alloy 52/52M/152 in this application is considered the better alternative to minimize thermal stresses. U.S. EPR FSAR, Tier 2, Section 5.3.1.2 will be revised accordingly.

   The RPVs that have been fabricated for the EPRs used two different approaches regarding weld filler cladding. In one case, the 52/52M/152 weld filler material was deposited only at the individual radial key locations. For the other case, the weld filler material was deposited in a complete circumferential band enveloping the radial keys. Since this process is a matter of fabrication preference at the vessel manufacturing facility it may not reflect the process to be utilized for the U.S. EPR depending on the specific fabrication facility and its associated machining/tooling/fabrication equipment and fabrication techniques as well as meeting the requirements of the ASME Code.

b) Cladding is deposited using either 309L/308L stainless steel or Alloy 52/52M/152 for the full cladding thickness. For the areas clad using Alloy 52/52M/152 filler material, the cladding is applied directly to the low alloy steel base metal, not over previously deposited 309L/308L stainless steel. The specific sequencing of weld deposited cladding is again specific depending upon the facility at which the vessel is manufactured; that is, not all stainless steel cladding must be completed prior to cladding with Alloy 52/52M/152. However, the cladding at interfaces between the 309L/308L stainless steel and the Alloy 52/52M/152 cladding is deposited using Alloy 52/52M/152 weld filler material. U.S. EPR FSAR, Tier 2, Section 5.3.1.2 will be revised accordingly.

c) As stated in the response to Question 05.03.01-10b, either 309L/308L stainless steel or Alloy 52/52M/152 is deposited for the full clad thickness. The nominal cladding thickness of 0.295 inches applies to the total cladding thickness regardless of cladding material. This thickness applies only to cladding. Where the cladding is also required to be qualified as weld buttering, additional thickness requirements may apply, as addressed in the response to Question 05.03.01-11b.

FSAR Impact:

U.S. EPR FSAR, Tier 2, Section 5.3.1.2 will be revised as described in the response and indicated on the enclosed markup.

Question 05.03.01-11:

The Alloy 52/52M/152 weld overlay on the SA-508 alloy steel reactor vessel provides both corrosion resistance for the reactor vessel in contact with the reactor coolant, and structurally attaches the radial keys to the reactor vessel via the radial key attachment weld. The radial keys carry the structural load for the core support (i.e., radial key inserts). Discuss and incorporate into the FSAR additional information to address the following areas:

a) Confirm that the weld procedure and welders for the Alloy 52/52M/152 weld overlay are qualified for both corrosion resistance cladding and a structural weld in accordance with the ASME Code, Section IX.

b) Concerning the attachment weld of the radial key to the Alloy 52/52M/152 weld overlay cladding, confirm that a low heat input weld process will be used to prevent embrittlement of the SA-508 alloy steel reactor vessel. This commitment is necessary to ensure that the integrity of the reactor vessel is not adversely affected, since your response to RAI No. 50, Question 04.05.02-6 states that the reactor vessel will not be post weld heat-treated after the attachment weld of the radial key to the Alloy 52/52M/152 weld overlay cladding. Also, include in the FSAR how the reactor vessel is heat-treated, similar to your response to RAI No. 50, Question 04.05.02-6.

c) Provide the joint design for the attachment weld of the radial key to the Alloy 52/52M/152 weld overlay cladding specifically addressing whether it is a full-penetration weld joint and the welding processes to be used.

Response to Question 05.03.01-11:

a) The radial keys perform a structural function supporting the reactor vessel internals. Accordingly, the Alloy 52/52M/152 weld deposits directly below the radial keys are considered part of the structural weld, and are qualified in accordance with ASME Sections III and IX. U.S. EPR FSAR, Tier 2, Section 5.3.1.2 of the U.S. EPR FSAR will be revised accordingly.

   U.S. EPR FSAR, Tier 2, Section 5.3.1.2 specifies that the reactor pressure vessel (RPV) is fabricated in accordance with ASME Section III, NB-4000, which requires welding procedures and welders / weld operators to be qualified in accordance with ASME Section IX. Therefore, in the areas where the cladding is qualified as a structural weld, the weld procedures and welders / welding operators are qualified accordingly.

b) The welds between the radial keys and the RPV are specified to meet the requirements of ASME Section III, Subsection NB. The alloy 52/52M/152 cladding and the weld between the radial keys and the cladding are deposited using weld procedures qualified in accordance with ASME Section III and Section IX. As stated in the response to Question 05.03.01-11a, the alloy 52/52M/152 cladding of the RPV low alloy steel directly below the radial key attachment is considered as part of the structural weld and qualified as such in accordance with ASME Sections III and IX.

   The alloy 52/52M/152 cladding may be qualified as weld buttering in accordance ASME Sections III and IX such that the remainder of the radial key structural weld may be completed without requiring post weld heat treatment. In accordance with QW-283 of ASME Section IX, the minimum qualified buttering thickness is specified in the qualified welding procedure. The welding parameters for performing the remaining weld that may be completed without post weld heat treatment are also controlled by welding procedures qualified in accordance with ASME Sections III and IX. Alternatively, both the Ni-Cr-Fe cladding and the weld between the radial key and the cladding may be subjected to a post weld heat treatment (either concurrently or separately at different stages of the fabrication sequence).

For either of the fabrication methods and sequences above, qualification of the welding procedures and processes in accordance with ASME Sections III and IX provides acceptable controls to ensure integrity of the RPV low alloy steel base metal is not adversely affected by the welding of the radial keys. In both instances, weld procedure qualifications will require testing of the low alloy steel base metal heat affected zone to verify acceptable mechanical strength and toughness are maintained following welding. Since either of these approaches meet the specified requirements, it is not considered necessary to specify a singular approach. U.S. EPR FSAR Tier 2, Section 5.3.1.2 will be revised to reflect that the cladding within the structural radial key welds is qualified as weld buttering in accordance with ASME Sections III and IX when the radial keys are to be welded to the cladding without subsequent post weld heat treatment. This response provides clarification to the previous response to RAI No. 50, Question 04.05.02-6.

As further information, for an EPR RPV under fabrication, the Ni-Cr-Fe cladding is deposited for the full circumferential band enveloping the location of the radial key attachments. The Ni-Cr-Fe cladding at the individual radial key locations is qualified as a weld buttering with a minimum thickness of 0.39 inches. The cladding / buttering is then subjected to the required post weld heat treatment. The radial keys are then welding to the cladding / buttering. As part of the final fabrication sequence for the RPV lower vessel, the complete assembly is subjected to a post weld heat treatment. Although the radial keys are welded to the cladding / buttering prior to final assembly of the lower vessel, this is due only to limitations of machining / tooling required for their installation. The radial key structural welds are subjected to the final post weld heat treatment temperatures, but this heat treatment is provided for the vessel low alloy steel circumferential welds and would not be required for the radial key welds if necessary machining / tooling were available to allow their installation after final vessel assembly. This sequence is specific for this particular RPV, and may not reflect the sequence to be utilized for the U.S. EPR.

c) As stated in U.S. EPR FSAR Tier 2, Section 5.3.1, the RPV is required to be fabricated and constructed to meet the requirements of ASME Section III for Class 1 components (Subsection NB). In accordance with NB-4433 of ASME Section III, structural attachments to the internal surface of reactor vessels are required to be full penetration welds. The specific welding process to be employed is based on qualifications as discussed in the response to Question 05.03.01-11b.

FSAR Impact:

U.S. EPR FSAR, Tier 2, Section 5.3.1.2 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

used for their corrosion resistance, acceptable mechanical properties, and fabricability. The RPV surfaces normally in contact with the reactor coolant are either austenitic stainless steel or Ni-Cr-Fe alloy. A listing of material specifications for the RPV and its appurtenances is provided in Table 5.3-1—Reactor Pressure Vessel Material Specifications and Table 5.3-2—Reactor Pressure Vessel Weld Material Specifications. The RPV materials meet the requirements of the ASME Section III and comply with fracture toughness requirements of 10 CFR Part 50, Appendix G as addressed in Section 5.3.1.5.

The weld filler materials used for the reactor vessel conform to ASME Section II Part C material specifications SFA 5.4, 5.9, 5.11, 5.14, 5.22, 5.23, 5.28, 5.29, and 5.30.

The shell forgings of the RPV beltline are restricted to the maximum composition limits shown in Table 5.3-3—Maximum Limits for RPV and Appurtenances Material Composition. The phosphorous, nickel, and copper content is limited to reduce sensitivity to radiation embrittlement of the vessel. The weld filler metals used in the beltline region of the RPV are restricted to the limits shown in Table 5.3-3.

Stainless steel normally in contact with the reactor coolant has a maximum cobalt content of 0.05 wt percent. Stainless steel base and weld filler materials have a limited carbon content not exceeding 0.03 wt percent and are supplied in accordance with RG 1.44. Stainless steel base and weld filler metal in contact with the reactor coolant has a limited sulfur content, as shown in Table 5.3-3.

The Ni-Cr-Fe Alloy 600 base metal and Alloy 82/182 weld filler metal are not used in Ni-Cr-Fe applications. Alloy 690 base metal and Alloy 52/52M/152 weld filler metal are used in Ni-Cr-Fe applications. The Ni-Cr-Fe base metal in contact with the reactor coolant has a limited sulfur content not exceeding 0.02 percent.

5.3.1.2 Special Processes Used for Manufacturing and Fabrication

05.03.01-10, 05.03.01-11

The RPV is a vertically mounted cylindrical vessel consisting of forged shells, heads, and nozzles joined by circumferential welds. ~~The surfaces of the RPV low alloy steel that come into contact with the reactor coolant are clad in stainless steel or Ni-Cr-Fe alloy using weld metal overlay.~~ The design of the RPV is addressed in Section 5.3.3.

The RPV is fabricated in accordance with ASME Section III, NB-4000 and RPV materials comply with the requirements of ASME Section III, NB-2000.

The internal surfaces of the RPV low alloy steel that could come into contact with the reactor coolant are clad using weld metal overlay primarily with stainless steel, with the exception of the areas where Alloy 690 radial keys are to be welded, as shown on Figure 5.3-4. For these areas, Ni-Cr-Fe weld filler materials are used to clad the low alloy steel to minimize dissimilar materials in the overall RPV pressure boundary, clad, 05.03.01-10, 05.03.01-11

attachment configuration. The cladding at all interfaces between the stainless steel and Ni-Cr-Fe cladding is deposited with Ni-Cr-Fe weld filler material.

As the radial keys perform a structural function in support of the reactor vessel internals, the Ni-Cr-Fe cladding directly below the radial key attachment is qualified as part of the radial key structural weld in accordance with ASME Sections III and IX. Where the radial keys are welded to the cladding without subsequent post-weld heat treatment, the cladding is qualified as weld buttering in accordance with ASME Sections III and IX.

5.3.1.3 Special Methods for Nondestructive Examination

The non-destructive examination (NDE) of the RPV and its appurtenances is conducted in accordance with ASME Section III requirements. Full penetration weld preparations for pressure retaining materials are examined in accordance with ASME Section III, NB-5130, prior to welding.

The cladding on the sealing surfaces and load-bearing surfaces of the RPV flange and the closure head flange are ultrasonically examined for the complete volume for both bond and defects. All cladding is ultrasonically examined for bond. Surfaces to be clad are examined using magnetic particle or liquid penetrant techniques in accordance with ASME Section III NB-2545 or NB-2546, respectively, prior to cladding.

5.3.1.4 Special Controls for Ferritic and Austenitic Stainless Steels

Welding of ferritic and austenitic stainless steels is addressed in Section 5.2.3, which addresses conformance to the guidance of RG 1.31, RG 1.34, RG 1.37, RG 1.43, RG 1.44, RG 1.50, and RG 1.71 regarding welding, composition, heat treatments, and similar processes. In addition, RG 1.99 is addressed in Section 5.3.1.5 and RG 1.190 is addressed in Section 5.3.1.6.

5.3.1.5 Fracture Toughness

RCPB ferritic materials provide adequate fracture toughness in accordance with ASME Section III, NB-2300 and 10 CFR Part 50, Appendix G.

The initial Charpy V-notch minimum upper-shelf fracture energy levels for the RPV beltline materials (in the transverse direction for base materials), including welds (along the weld), is 75 ft-lbs, as required by 10 CFR Part 50, Appendix G. The maximum initial nil-ductility reference temperature, $RT_{NDT,}$ of the RPV is -4°F. Materials are evaluated with regard to the effects of chemistry (copper content), initial upper shelf energy, and neutron fluence to assure that 50 ft-lbs upper-shelf energy, as required by 10 CFR Part 50, Appendix G, is maintained throughout the life of the vessel. The vessel fracture toughness data is calculated in accordance with RG 1.99,