ArevaEPRDCPEm Resource

From: Pederson Ronda M (AREVA NP INC) [Ronda.Pederson@areva.com]
Sent: Thursday, April 23, 2009 3:42 PM
To: Getachew Tesfaye
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. 199, FSAR Ch. 5
Attachments: RAI 199 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 199 Response US EPR DC.pdf" provides a technically correct and complete response to 4 of the 6 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 199 Questions 05.02.03-15, 05.02.03-16, 05.02.03-18.

The following table indicates the respective pages in the response document, "RAI 199 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 199 — 05.02.01.02-2	2	2
RAI 199 — 05.02.03-15	3	3
RAI 199 — 05.02.03-16	4	4
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RAI 199 — 05.02.03-19	8	8

A complete answer is not provided for 2 of the 6 questions. The schedule for a technically correct and complete response to these questions is provided below.

Question #	Response Date
RAI 199 — 05.02.03-17	June 12, 2009.
RAI 199 — 05.02.03-19	June 12, 2009.

Sincerely,

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From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Tuesday, March 24, 2009 3:07 PM
To: ZZ-DL-A-USEPR-DL
Cc: Robert Davis; Jeffrey Poehler; David Terao; Tarun Roy; Joseph Colaccino; ArevaEPRDCPEm Resource
Subject: U.S. EPR Design Certification Application RAI No. 199 (794, 2243,2309), FSAR Ch. 5

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on March 6, 2009, and discussed with your staff on March 19, 2009. RAI Questions 05.02.01.02-2, 05.02.03-16, 05.02.03-18, and 05.02.03-19 were 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
(301) 415-3361

Hearing Identifier: AREVA_EPR_DC_RAIs
Email Number: 424

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Response to

Request for Additional Information No. 199 (749, 2243, 2309), Revision 0

3/24/2009

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 05.02.01.02 - Applicable Code Cases
SRP Section: 05.02.03 - Reactor Coolant Pressure Boundary Materials
Application Section: 5.2

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

Question 05.02.01.02-2:

FSAR Table 5.2-1, ASME Section III Code Cases, list Code Case N-71-18 as being used in the EPR design. The staff notes that N-71-18 lists a wide range of material specifications and grades. In order for the staff to evaluate the materials that will be used to fabricate supports for components in the EPR design, the staff requests that the applicant provide a list of all component supports that will be fabricated using N-71-18 and the materials specifications and grades that will be used to fabricate each component support.

Response to Question 05.02.01.02-2:

Code case N-71-18 is currently used for the following components: reactor pressure vessel support shell, gussets (both on the inside diameter and outside diameter of the shell), special gusset (i.e., modified gusset for load handling features), gusset for access plate, key connecting plate, and the access plate. These components use materials specification SA-572, grade 50 (plate).

FSAR Impact:

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

Question 05.02.03-15:

Previously, the staff requested, in RAI 05.02.03-4, that the applicant modify FSAR Section 5.2.3.3.2 to state that the minimum preheat requirements for all carbon steel and low-alloy steel components in the RCPB will meet the recommendations provided in ASME Code, Section III, Appendix D. The applicant responded on November 10, 2008 and stated that U.S. EPR FSAR, Tier 2, Section 5.2.3.3.2 will be revised to state that welding of carbon- and low-alloy-steel, reactor-coolant-pressure-boundary materials meet minimum preheat requirements of ASME Code, Section III, Appendix D ("Nonmandatory Preheat Procedures"). While the response is acceptable to the staff, the staff notes that the applicant's revision of FSAR Section 5.2.3.3.2, included in its November 10, 2008 response, does not mention carbon steels. In addition, FSAR Section 5.2.3.3.2 states that the typical preheat temperature for low-alloy steels in the RCPB is 200ºF. The staff notes that Appendix D recommends a minimum preheat of 250ºF for P3 (low alloy steel) materials over 5/8 in. thick. The staff requests that the applicant address the above discrepancies.

Response to Question 05.02.03-15:

U.S. EPR FSAR, Tier 2, Section 5.2.3.3.2 will be revised to add carbon steel and to delete the minimum preheat temperature, since it is specified in ASME Section III, Appendix D.

FSAR Impact:

U.S. EPR FSAR, Tier 2, Section 5.2.3.3.2 will be revised as described in the response and indicated on the enclosed markup.

Question 05.02.03-16:

FSAR Section 3.6.3.4.2 and Table 5.2-2 indicate that the main coolant loop (MCL) and pressurizer surge line (SL) piping will be fabricated from SA-336 F304LN or SA-182 F304LN forged austenitic stainless steel material. These specifications do not contain limitations on grain size. Given that grain size can affect the material properties of a material and the ability to perform ultrasonic examination, the staff requested, in RAI 05.02.03-8, that the applicant modify FSAR Section 5.2.3 to include the maximum grain size for forged stainless steel components within the entire RCPB and a basis for the grain size specified. The applicant responded on November 10, 2008 and stated that it would modify FSAR Section 5.2.3 to state that forged stainless steel components within the RCPB that are subject to ASME Code, Section XI volumetric examinations are specified to have a sufficiently large grain size to allow for inspection through ultrasonic methods, while continuing to meet the specified mechanical properties of the ASME Code. The staff considers the applicant's response insufficient for the following reasons:

a) The applicant did not specify the actual grain size number and provide a basis for its selection. The grain size number specified should be based on testing performed by the applicant that verifies that the grain size selected facilitates the performance of PDI-qualified UT exams.

b) The applicant's reference to "a sufficiently large grain size" is ambiguous because it implies that larger grains are more advantageous when performing ultrasonic examinations which is incorrect.

The staff requests that the applicant address the staff's comments above and modify the FSAR accordingly.

Response to Question 05.02.03-16:

a. U.S. EPR FSAR, Tier 2, Section 5.2.3.4.1 will be revised to state that forged stainless steel components within the reactor coolant pressure boundary that are subject to ASME Section XI volumetric examinations have a grain size that permits inspection by ultrasonic methods. Volumetric examinations required for the forging material in accordance with NB-2541 will be specified to be performed by ultrasonic methods (radiography not permitted). Since these examinations are performed in accordance with code requirements, a grain size does not need to be specified.

b. The above revision to U.S. EPR FSAR, Tier 2, Section 5.2.3.4.1 removes the reference to "a sufficiently large grain size."

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 05.02.03-17:

In RAI 05.02.03-6, the staff requested that the applicant modify FSAR Section 5.2.3.4.1 to include the stabilizing heat-treatment temperature for stabilized grades of stainless steels, and the basis for its selection including a discussion on verification testing that AREVA has performed to determine that its stabilizing heat treatment is adequate for material in the RCS environment to prevent stress-corrosion cracking. In addition, the staff requested that the applicant modify FSAR Section 5.2.3.4.1 to include corrosion-testing requirements for stabilized grades of stainless steels and a basis for the adequacy of the testing requirements selected.

The applicant responded on November 10, 2008 and provided the following response:

1. The material specifications for the U.S. EPR state that the designer must minimize the sensitization of austenitic stainless steels. The designer meets this specification by selecting the time and temperature for a stabilization heat treatment that reduces sensitization susceptibility for stabilized steels.
2. U.S. EPR FSAR, Tier 2, Section 5.2.3.4.1 will be modified to include the following sentences: Stabilized austenitic stainless steel is solution annealed and rapidly cooled so that the material is cooled through the sensitization temperature range rapidly to prevent sensitization. If means other than rapid cooling are used, the material is tested in accordance with Practice E of ASTM A262 to demonstrate the material is in the unsensitized condition.

   The applicant's response does not fully address the staff's question. The staff understands that stabilized austenitic stainless steel used in the RCPB will be solution annealed and rapidly cooled but the staff's RAI sought information related to the applicant's stabilizing heat-treatment temperature, including the adequacy of the stabilizing heat treatment. The only stabilized stainless steel material (Grade 347) identified by the staff that is part of the RCS pressure boundary is used to fabricate the CRDM pressure housing. The staff notes that some of the welding performed on Grade 347 material will involve dissimilar-metal welds-to-F6NM material as shown in the applicant's response to RAI 05.02.03-12, in which the applicant provided additional information to the staff on November 10, 2008. The staff also notes that the applicant has stated, in RAI responses, that the EPR CRDM is based on a proven German design with several years of operating experience. The staff requests that the applicant provide the following information:

1. Identify the stabilizing heat treatment temperature, for stabilized grades of stainless steels, and a basis for its selection including a discussion on verification testing that has been or will be performed to determine that the stabilizing heat treatment is adequate for material in the RCS environment to prevent stress corrosion cracking.
2. If the dissimilar-metal welds between F6NM and Grade 347 material will not be performed by first applying a buttering layer to the F6NM followed by PWHT before joining F6NM to Grade 347 material, provide a basis for performing a PWHT on the Grade 347 austenitic stainless steel. The staff notes that PWHT of Grade 347 after the stabilizing heat treatment is performed may degrade the material's resistance to degradation mechanisms such as stress-corrosion cracking. In addition, please include corrosion-testing requirements for weld-procedure qualifications involving stabilized grades of stainless steels that receive a subsequent PWHT.

3. Given that the applicant has stated that the EPR CRDM is based on a proven German design, the staff requests that the applicant describe any differences between the German and EPR design of the dissimilar-metal weld, including materials processing requirements and PWHT. Identify any service-related degradation issues that have occurred that were associated with the pressure housing in German plants. If degradation has occurred in German plants, describe what steps have been taken to address these issues in the EPR CRDM pressure housing design.

Response to Question 05.02.03-17:

A response to this question will be provided by June 12, 2009.

Question 05.02.03-18:

In RAI 05.02.03-3 the staff requested, in part, that the applicant list the material specifications for pressurizer safety-relief valves. The applicant responded by letter dated December 17, 2008 and stated that this information is not available because a vendor has not been selected for these components. In addition, the applicant's proposed revision to Table 5.2-2 does not list weld filler metal specifications and classifications used to weld various material types and combinations in the RCPB. The staff also notes that other valves, piping and components that are part of the reactor coolant pressure boundary such as, but not limited to, valves, piping and components in the safety injection system and residual heat removal system are also not listed.

In order for the staff to verify the applicant's compliance with GDC 1, GDC 30 and 10 CFR 50.55a, the staff requests that the applicant:

1. Modify Table 5.2-2 to include material specifications and grades for ALL valves, piping and fittings or other components that form part of the reactor coolant pressure boundary, or provide a reference in Table 5.2-2 to the location of this information in the FSAR. Material specifications for valves should include valve bodies, valve bonnets, closure bolting and valve disks.

2. In addition, the staff requests that the applicant modify Table 5.2-2 to list weld filler metal specifications and classifications used to weld various material types and combinations in the RCPB.

Response to Question 05.02.03-18:

1. U.S. EPR FSAR Tier 2, Table 5.2-2 will be modified to include material specifications and grades for valves that form part of the reactor coolant pressure boundary (RCPB). Material specifications for valves include valve bodies, valve bonnets, closure bolting, and valve disks. Consistent with the guidance in SRP 5.2.3 and past regulatory precedent (e.g., NUREG-1793, Section 5.2.3.1), U.S. EPR FSAR Tier 2, Section 5.2.3.1 will be revised to indicate that the materials listed in U.S. EPR FSAR Tier 2, Table 5.2-2 apply to Class 1 primary components that are part of the RCPB.

   The materials for the RCPB piping and fittings are in U.S. EPR FSAR Tier 2, Table 5.2-2 under the row titled "RCPB Piping." U.S. EPR FSAR Tier 2, Table 6.1-1 lists the pressure retaining material specifications for the safety injection system and residual heat removal system.

2. U.S. EPR FSAR Tier 2, Section 5.2.3.1 identifies the weld filler material specifications used to weld various material types and combinations in the RCPB. Therefore, no revision to U.S. EPR FSAR Tier 2, Table 5.2-2 is required.

FSAR Impact:

U.S. EPR FSAR, Tier 2, Section 5.2.3.1 and Table 5.2-2 will be revised as described in the response and indicated on the enclosed markup.

Question 05.02.03-19:

Background

The applicant is proposing to use SA-479 (UNS S41500) or SA 182 Grade F6NM (UNS S41500), in the quenched and tempered condition, for a portion of the control-rod-drive-mechanism pressure housing. UNS S41500 is a martensitic stainless steel. In operating reactors, there has been a history of environmentally induced cracking (stress-corrosion cracking or service-induced hydrogen embrittlement) in martensitic stainless steels (References 1-3), although not in control-rod-drive-mechanism applications. Many of these incidents have been attributed to improper heat treatment, specifically tempering at a lower-than-optimal temperature resulting in excessive strength and hardness, thereby rendering the material susceptible to environmentally induced cracking. In Reference 1, it was concluded based on several cracking incidents that the susceptibility of martensitic stainless steels to stress-corrosion cracking increased if the Rockwell hardness exceeded 26 HRC. For Grade F6NM, SA-182 imposes a maximum Brinell hardness of 295 HB, and SA-479 imposes a maximum hardness of 293 HB for UNS S41500 - both of which equate to a Rockwell hardness of approximately 31 HRC. Martensitic stainless steels with higher nickel content (> 2%) can also be susceptible to thermal aging embrittlement in the operating temperature range of PWR reactor coolant systems. (S41500 has a nickel content of 3.5-5.5 weight %)

Requested Information

1. Describe measures to be taken during manufacture of the UNS S41500 material and fabrication of the CRDM pressure housing to minimize the material susceptibility to environmentally induced cracking.

2. Describe the operating experience or other information used as the basis for concluding UNS S41500 stainless steel will be compatible with the reactor coolant system environment, particularly with regard to its resistance to environmentally induced cracking (either stress-corrosion cracking or service-induced hydrogen embrittlement) and its resistance to thermal aging embrittlement.

References

1. NRC Bulletin No. 89-02: Stress Corrosion Cracking of High-Hardness Type 410 Stainless steel Internal Preloaded Bolting in Anchor-Darling Model 350W Swing Check Valves or Valves of Similar Design, July 19, 1989
2. NRC Information Notice 94-055: Problems With Copes-Vulcan Pressurizer Power-Operated Relief Valves, August 4, 1994
3. NRC Information Notice 95-26: Defect in Safety-Related Pump Parts Due to Inadequate Heat Treatment, May 31, 1995

Response to Question 05.02.03-19:

A response to this question will be provided by June 12, 2009.

U.S. EPR Final Safety Analysis Report Markups

5.2.3.1 Material Specifications

05.02.03-18

Table 5.2-2 lists the materials for Class 1 primary components incorporated into the design of the RCPB (excluding the reactor pressure vessel), including grade or type and final metallurgical condition. Table 5.2-2 includes the materials specified for the steam generators, PZR, RCPs, RCPB piping, and control rod drive mechanism. ASME Boiler and Pressure Vessel Code, Section II material specifications are used for materials in the RCPB, including weld materials.

The weld filler materials used for joining the ferritic base materials of the RCPB conform to ASME Section II Part C material specifications SFA 5.5, 5.17, 5.18, 5.20, 5.23, 5.28, and 5.29. The weld filler materials used for joining the austenitic stainless steel base materials of the RCPB conform to ASME Section II Part C material specifications SFA 5.4, 5.9, and 5.22. The weld filler materials used for joining nickel-chromium-iron (NiFeCr) alloys in similar base material combination and in dissimilar ferritic or austenitic base material combination conform to ASME Section II Part C material specifications SFA 5.11 and 5.14.

Low alloy steel pressure boundary forgings have limited sulfur content not exceeding 0.008 wt%, (wt = weight). Clad low alloy steel pressure boundary materials have ASTM grain size 5 or finer.

Austenitic stainless steel base metal conforms to RG 1.44. Austenitic stainless steel base metal and weld metal have limited carbon content not exceeding 0.03 wt%. Austenitic stainless steel base metal and weld filler metal in contact with RCS primary coolant has limited cobalt content not exceeding 0.05 wt%. Austenitic stainless steel base metal in contact with RCS primary coolant has limited sulfur content not exceeding 0.02 wt%. When supplementary chemical analysis is performed which would be more complete than the analysis used to check the content of specific elements, the results will show that the sample contains no more than residual antimony. In addition, the carbon portion of the reactor coolant pump journal bearings will have no antimony.

Austenitic stainless steel welds in RCS piping, including surge line piping, have delta ferrite content limited to a ferrite number (FN) between 5 and 10, measured as determined by ASME Section III, NB-2433. Austenitic stainless steel weld materials for stainless steel welds joints in the balance of the RCPB system have delta content ferrite limited to an FN between 5 and 20, as determined by ASME Section III, NB-2433.

NiCrFe Alloy 600 base metal or Alloys 82/182 weld metal is not used in RCPB applications. NiCrFe Alloy 690 base metal has controlled chemistry, mechanical properties, and thermo-mechanical processing requirements that produce an optimum replacement components and new plant construction have been shown to easily meet this maximum -4°F RT_{NDT} requirement.

Calibration of temperature instruments and Charpy impact test machines are performed to meet the requirements of ASME Section III, NB-2360, NC-2360, and ND-2360 as appropriate. Impact test procedures comply with the requirements of ASME Section III, NB-2320, NC-2320, and ND-2320 as appropriate.

5.2.3.3.2 Control of Welding

Welding is conducted utilizing procedures qualified according to the rules of ASME Sections III and IX. Control of welding variables, as well as examination and testing during procedure qualification and production welding, is performed in accordance with ASME Code requirements.

Electroslag welding performed on RCPB components conforms to the requirements of RG 1.34, "Control of Electroslag Weld Properties." The procedure qualification for electroslag welding includes a requirement that the process variables selected will produce a solidification pattern with a joining angle of less than 90 degrees in the weld center. This procedure qualification includes a requirement for a macro-etch test to be performed in the longitudinal weld direction of the center plane across the weld from base metal to base metal, and a requirement that the test verify the desired solidification pattern has been obtained and that the weld is free of unacceptable fissures or cracks. The results of the tests are included in the certified qualification test report. For the longitudinal production welds of low alloy steel vessels, material containing base metal and weld metal taken from weld prolongations are tested as follows: tensile and impact tests similar to those required for the base metal by paragraph NB-3211(d) of Section III are made to determine the mechanical properties of the quenched and tempered weld metal. To verify that the specified weld solidification pattern has been obtained and that the weld center is sound, either a macro-etch test or an impact test with the specimen notch located at the weld center is used. The tests specified are applied to each of the welds. In the event that properties obtained from tests identified are not acceptable, additional procedures qualification is performed.

Stainless steel corrosion resistant weld overlay cladding of low alloy steel components conforms to the requirements of RG 1.43, "Control of Stainless Steel Weld Cladding of Low-Alloy Steel Components." Controls to limit underclad cracking of susceptible materials conform to the requirements of RG 1.43.

05.02.03-15

Procedure Qualification Records and Welding Procedure Specifications performed to support welding of carbon and low alloy steel welds in the RCPB conform to the requirements of RG 1.50, "Control of Preheat Temperature for Welding of Low-Alloy Steel" and the guidelines of ASME Section III, Division 1, Nonmandatory Appendix D.

05.02.03-15

Interpass temperatures to support welding of low alloy steel welds in the RCPB are qualified per ASME Sections III and IX. The typical minimum preheat temperature is 200°F and the typical maximum interpass temperature is 600°F.

Welders and welding operators are qualified in accordance with ASME Section IX and RG 1.71, "Welder Qualification for Areas of Limited Accessibility."

The practices for storing and handing welding electrodes and fluxes comply with ASME Code, Section III, Paragraphs NB-2400 and NB-4400.

5.2.3.3.3 Nondestructive Examination for Ferritic Steel Tubular Products

Nondestructive examinations performed on ferritic steel tubular products to detect unacceptable defects will comply with ASME Section III, NB-2550 through NB-2570, and ASME Section XI examination requirements.

5.2.3.4 Fabrication and Processing of Austenitic Stainless Steels

5.2.3.4.1 Prevention of Sensitization and Intergranular Corrosion of Austenitic Stainless Steels

Austenitic stainless steels are susceptible to different forms of intergranular corrosion in aggressive environments when sensitized. Grain boundary carbide sensitization occurs when metal carbides precipitate on the grain boundaries when the material is heated in the temperature range of 800°F to 1,500°F.

Avoidance of intergranular attack in austenitic stainless steels is accomplished by five main methods:

- Use of low carbon (less than 0.03 wt% carbon) unstabilized austenitic stainless steels.
- Monitoring of the ferrite number of weld filler metals to ensure correct ferrite content.
- Utilization of materials in the solution annealed plus rapid cooled condition and the prohibition of subsequent heat treatments in the 800°F and 1,500°F temperature range.
- Control of primary water chemistry to maintain an environment which does not promote intergranular attack.
- Control of welding processes and procedures to avoid heat affected zone sensitization as given in RG 1.44.

The water chemistry in the RCS is controlled to the ranges specified in Table 5.2-3 and by plant procedures to prevent the intrusion of aggressive species. Section 9.3.4 addresses RCS water chemistry control. Precautions are taken to prevent the intrusion

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.

05.02.03-16

Forged stainless steel components within the RCPB that are subject to ASME Section XI volumetric examinations ~~are specified to~~ have a ~~sufficiently large~~ grain size ~~to~~that allows ~~for~~ inspection ~~through~~by ultrasonic methods~~, while continuing to meet the specified mechanical properties of the ASME Code~~.

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 cleaned according to recognized and accepted methods that are designed to minimize contamination which could lead to stress corrosion cracking.

Procedures are developed to provide cleanliness controls during all phases of manufacture and installation including final flushing. As applicable, these procedures supplement the equipment specifications and purchase order requirements of individual austenitic stainless steel components procured for RCPB applications and follow the guidance of RG 1.37, Revision 1, “Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components of Water-Cooled Nuclear Power Plants.” Controls are established to minimize the introduction of potentially harmful contaminants including chlorides, fluorides, and low melting point alloys on the surface of austenitic stainless steel components. In accordance with RG 1.44, all cleaning solutions, processing equipment, degreasing agents, and other foreign materials are completely removed at any stage of processing prior to elevated temperature treatments. Pickling of austenitic stainless steel is avoided.

Tools for abrasive work such as grinding, polishing, or wire brushing do not contain, and are not contaminated by previous usage on, ferritic carbon steel or other materials that could contribute to intergranular cracking or stress-corrosion cracking.

Table 5.2-2—Material Specifications for RCPB Components
Sheet 3 of 5

Component	Material
Pressure boundary stud bolts & nuts	ASME SA-540M Grade B24 Class 1 (see Note 1)
Pressure boundary casing closure stud & nuts	ASME SA-540M Grade B24 Class 3 (see Note 1)
Shaft seal pressure boundary parts	ASME SA-705M Type 630 H1150 (see Note 7)
Pressure boundary welds	SFA 5.4 E308L SFA 5.4 E316L SFA 5.9 ER316L
Control Rod Drive Mechanism	
Flange, connection piece, head, loose flange	ASME SA-479 Grade 347 (see Note 3)
Latch housing	ASME SA-479/SA-182 Grade F6NM (see Note 1) (UNS S41500)
Seamless tube	ASME SA-312 Grade TP347 (Seamless) (see Note 3)
Bolt	ASME SA-453 Grade 660 (see Note 7)
Nut	ASME SA-437 Grade B4C (see Note 1)
Welding filler material	SFA 5.4 E347 SFA 5.9 ER347 SFA 5.14 ERNiCrFe-7 SFA 5.14 ERNiCrFe-7A
RCPB Valves~~Pressurizer Safety Relief Valves~~	
Bodies~~A vendor for the PSRV has not been chosen for the U.S. EPR~~	SA-182 Grade F304 (see Notes 3 & 4), Grade F304L (see Note 3), Grade F304LN (see Note 3), Grade F316 (see Notes 3 & 4), Grade F316L (see Note 3), Grade F316LN (see Note 3)
	SA-351 Grade CF3, Grade CF3A, Grade CF3M, Grade CF8 (see Note 4), Grade CF8A (see Note 4), Grade CF8M (see Note 4)
Bonnets	SA-182 Grade F304 (see Notes 3 & 4), Grade F304L (see Note 3), Grade F304LN (see Note 3), Grade F316 (see Notes 3 & 4), Grade F316L (see Note 3), Grade F316LN (see Note 3)
	SA-351 Grade CF3, Grade CF3A, Grade CF3M, Grade CF8 (see Note 4), Grade CF8A (see Note 4), Grade CF8M (see Note 4)
	SA-240 Type 304 (see Notes 3 & 4), Type 304L (see Note 3), Type 304LN (see Note 3), Type 316 (see Notes 3 & 4), Type 316L (see Note 3), 316LN (see Note 3)

05.02.03-18

05.02.03-18

Table 5.2-2—Material Specifications for RCPB Components
Sheet 4 of 5

Component	Material
Discs	SA-182 Grade F304 (see Notes 3 & 4), Grade F304L (see Note 3), Grade F304LN (see Note 3), Grade F316 (see Notes 3 & 4), Grade F316L (see Note 3), Grade F316LN (see Note 3)
	SA-351 Grade CF3, Grade CF3A, Grade CF3M, Grade CF8 (see Note 4), Grade CF8A (see Note 4), Grade CF8M (see Note 4)
	SA-479 Type 304 (see Notes 3 & 4), Type 304L (see Note 3), Type 304LN (see Note 3), Type 316 (see Notes 3 & 4), Type 316L (see Note 3), 316LN (see Note 3), XM-19 (see Note 3)
	SA-564 Type 630 (Conditions H1075, H1100, H1150)
	SB-637 UNS N07718 (see Note 8)
Stems	SA-479 Type 304 (see Notes 3 & 4), Type 304L (see Note 3), Type 304LN (see Note 3), Type 316 (see Notes 3 & 4), Type 316L (see Note 3), Type 316LN (see Note 3), Type XM-19 (see Notes 3 & 9)
	SA-564 Type 630
	SB-637 UNS N07718 (see Note 8)
Bolts	SA-193 Grade B7 (see Note 1), Grade B8 (see Note 3), Grade B16 (see Note 1)
	SA-453 Grade 660, Class A and Class B (see Note 7)
	SA-564 Type 630 (Condition H1100)
Nuts	SA-194 Grade 2, Grade 2H (see Note 1), Grade 6 (see Note 1), Grade 8 (see Note 3)
	SA-453 Grade 660, Class A and Class B (see Note 7)
Pressurizer Safety Relief Valve	
Bodies	SA-182 Grade F304 (see Notes 3 & 4), Grade F304L (see Note 3), Grade F304LN (see Note 3), Grade F316 (see Notes 3 & 4), Grade F316L (see Note 3), Grade F316LN (see Note 3)
Bonnets	SA-182 Grade F304 (see Notes 3 & 4), Grade F304L (see Note 3), Grade F304LN (see Note 3), Grade F316 (see Notes 3 & 4), Grade F316L (see Note 3), Grade F316LN (see Note 3)
	SA-240 Type 304 (see Notes 3 & 4), Type 304L (see Note 3), Type 304LN (see Note 3), Type 316 (see Notes 3 & 4), Type 316L (see Note 3), Type 316LN (see Note 3)

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Table 5.2-2—Material Specifications for RCPB Components
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Component	Material
Discs	SA-182 Grade F304 (see Notes 3 & 4), Grade F304L (see Note 3), Grade F304LN (see Note 3), Grade F316 (see Notes 3 & 4), Grade F316L (see Note 3), Grade F316LN (see Note 3)
	SA-479 Type 304 (see Notes 3 & 4), Type 304L (see Note 3), Type 304LN (see Note 3), Type 316 (see Notes 3 & 4), Type 316L (see Note 3), Type 316LN (see Note 3), Type XM-19 (see Note 3)
	SA-564 Type 630 (Conditions H1075, H1100, H1150)
	SB-637 UNS N07718 (see Note 8)
Stems	SA-479 Type 304 (see Notes 3 & 4), Type 304L (see Note 3), Type 304LN (see Note 3), Type 316 (see Notes 3 & 4), Type 316L (see Note 3), Type 316LN (see Note 3), Type XM-19 (see Notes 3 & 9)
	SA-564 Type 630
	SB-637 UNS N07718 (see Note 8)
Pressure Retaining Bolts	SA-193 Grade B7 (see Note 1), Grade B8 (see Note 3), Grade B16 (see Note 1)
	SA-453 Grade 660, Class A and Class B (see Note 7)
	SA-564 Type 630 (Condition H1100)
Pressure Retaining Nuts	SA-453 Grade 660, Class A and Class B (see Note 7)
	SA-194 Grade 2, Grade 2H (see Note 1), Grade 6 (see Note 1), Grade 8 (see Note 3)

Notes on Table 5.2-2

1. Quenched and tempered
2. Solution annealed and thermally treated
3. Solution annealed and rapidly cooled
4. Carbon content not exceeding 0.03 wt%
5. Silicon not greater than 1.5% and niobium restricted to trace elements
6. Annealed, normalized, normalized and tempered, or quenched and tempered.

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7. Solution t~~T~~reatment and h~~H~~ardening.
8. Solution treatment and precipitation hardening.
9. Hot rolled or strain hardened.