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December 31, 2009

Subject: AP1000 Response to Request for Additional Information (SRP 5)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 5. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in this response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

Enclosure 1 provides the response for the following RAI(s):

RAI-SRP5.2.3-CIB1-01 R1

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

Robert Sisk, Manager
Licensing and Customer Interface
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/Enclosure

1. Response to Request for Additional Information on SRP Section 5

D063
NRO

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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 5

RAI Response Number: RAI-SRP5.2.3-CIB1-01
Revision: 1

Questions (Revision 0):

Revision 17 revised Section 5.2.3.1 of the AP1000 DCD, Tier 2, to include ASME Code Filler Metal Specifications SFA 5.1 and 5.17 for carbon steel, ASME Code Filler Metal Specification SFA 5.22 for stainless steel, and ASME Code Filler Metal Specification SFA 5.30 for consumable inserts. The staff has the following concerns regarding the addition of these filler metal specifications:

1) ASME Code Filler Metal Specifications SFA 5.1 and 5.17 is proposed to be used for welding AP1000 carbon steel reactor coolant pressure boundary components listed in Table 5.2-1 of the AP1000 DCD, Tier 2. In reviewing Table 5.2-1, the pressure forgings (including nozzles and tubesheets for the steam generator) has an option to use carbon steel (SA-508, Class 1A) instead of alloy steel (SA-508, Grade 3, Class 2) and the pressure forgings for the reactor coolant pump has an option to use carbon steel (SA-508, Grade 1) instead of stainless steel (SA-336, Grades F304, F304L, F304LN, F316, F316L and F316LN).

    a. The ASME Code Filler Metal Specifications SFA 5.1 and 5.17 and the associated carbon steel base materials are not typical for this application due to the incompatibility of these materials with the reactor coolant. In addition, the reactor coolant pump flywheel analysis (Curtiss-Wright Electro-Mechanical Corporation Report AP1000 RCP-06-009-P) assumed the reactor coolant pump pressure boundary material to be stainless steel. The flywheel analysis does not include a carbon steel reactor coolant pump pressure boundary, and therefore a flywheel analysis using a carbon steel pressure boundary would be required to be performed.

    b. ASME Code Filler Metal Specifications SFA 5.22 allows the use of fluxed cored filler metal to be used for welding the root pass in all stainless steel reactor coolant pressure boundary components. Using flux cored filler metal in the root pass may introduce slag inclusion in the root weld layer in contact with the reactor coolant, providing a crack initiation site based on current operating experience.

    c. The staff notes that Table 5.2-1 in Chapter 5 of the AP1000 DCD, Tier 2 should also include ASME Code Filler Metal Specification SFA 5.30 under welding consumables.

Therefore, the NRC staff requests that Westinghouse delete the proposed addition of these materials from the AP1000.or provide further justification addressing the acceptability of the proposed addition of ASME Code Filler Metal Specifications SFA 5.1, 5.17, and 5.22. As currently proposed, the staff finds the proposed addition of the materials does not meet NRC regulations on the basis that the changes (1) unacceptability decrease the overall safety and reliability of the facility design and (2) contribute to a decreased standardization of the certification information contrary to 10 CFR 52.63(a)(1)(vi) and (vii).

Questions (Revision 1):

1) In Table 5.2-1 of the FSAR, provide a list for each part of the reactor coolant pump (RCP) that will be stainless steel and which will be carbon steel. Otherwise, delete the option to use carbon steel material for the reactor coolant pressure boundary of the RCP.

2) Provide justification and operating experience to use carbon steel as an option for stainless steel reactor coolant pressure boundary parts (i.e., pressure forgings for the reactor coolant pump). In addition, provide justification and operating experience to use carbon steel as an option for low alloy steel reactor coolant pressure boundary parts (i.e., pressure forgings, including nozzles and tubesheets of the steam generator). Otherwise, delete the option to use carbon steel material for the reactor coolant pressure boundary.

3) Your response stated that carbon steel filler metal specifications and the associated base materials are used for welding the stator shell. Discuss the types of welds to be performed on the stator shell, since there appears to be no welding on the stator shell other than the welds joining the stator shell to the stator main flange and the stator lower flange. Include how the stator shell will be welded to the stator main flange and the stator lower flange.

4) What material is the stator can? How is it attached to the pump?

5) Discuss why the stator can and rotor can are not designed as a pressure boundary part since its primary function is to contain the reactor coolant. Discuss which areas of the pump are wetted and non-wetted and how the design (stator can and rotor can) will prevent reactor coolant from contacting the carbon steel portions. Since the motor will stop working if the stator becomes wet, discuss what amount of leakage would be needed to stop the motor and the reliability of the stator can and rotor can.

6) Explain why AP1000 will not use Inconel (Alloy 690) consumable inserts (SFA 5.30) since Inconel (Alloy 690) safe ends will be used for some components (i.e., pressurizer and steam generator).

7) Explain how carbon steel filler metals using flux (SFA 5.1 and 5.17) will be used and for which reactor coolant pressure boundary welds. Otherwise, delete the option to use carbon steel material for the reactor coolant pressure boundary.
8) Proposed Note 4 for Table 5.2-1 only limits use of carbon steel for welds that are not exposed to reactor coolant. Provide justification why this limitation does not apply to base material.

9) Clarify whether proposed Note 3 to Table 5.2-1 implies that this note only applies to gas shielded FCAW electrodes, or that only gas shielded FCAW electrodes with the FCAW process are to be used. In addition, the allowance of using FCAW rod per SFA 5.22 with the GTAW process for welding the root layer should be prohibited. Provide justification and nuclear operating experience for using FCAW on stainless steel reactor coolant pressure boundary material.

10) Table 5.2-1 of the FSAR was changed in Revision 17 to replace material specifications SA-312 and SA-376 for seamless pipe with material specification SA-479 for hot or cold-rolled bar stock. Provide justification and operating experience for using cold-rolled bar stock in lieu of seamless pipe. In addition, the UNS designation S21800 for material specification SA-479 has higher carbon, phosphorus and silicon composition than Types 304 and 316, along with a low chromium content with no molybdenum additions. Discuss how this material is similar to Types 304 and 316 stainless steels, and justify the compatibility with the reactor coolant, along with operating experience. Otherwise, remove the UNS designation S21800 from Table 5.2-1. Which of these materials are used for the Quickloc?

Westinghouse Responses to Revision 0 Questions:

a. The ASME Code Filler Metal Specifications SFA 5.1 and 5.17 and the associated carbon steel base materials (SA-508, Grade 1) are used for welding of the stator shell of the reactor coolant pump. Although part of the pressure boundary, the stator shell is not normally exposed to the reactor coolant because the stator "can" separates the reactor coolant from the stator and the stator shell pressure boundary. The only time the stator shell would be exposed to reactor coolant is if the stator can fails. If this occurs the pump would not longer operate and would have to be replaced/repaired.

   A note will be added to Table 5.2-1, as shown in the DCD markup given below, to identify that these weld filler materials will not be exposed to reactor coolant.

   In the analysis of a reactor coolant pump flywheel failure, a stainless steel pressure boundary is considered because it is assumed that any flywheel fragments would impact the pressure boundary components immediately adjacent (radially) to the flywheel. These components are the casing, thermal barrier, and stator closure ring for the upper flywheel, and the stator lower flange for the lower flywheel.

b. Westinghouse prohibits the use of flux bearing weld processes for root welds in which the back side is exposed to fluid, unless the backside is first back gouged and back welded. This requirement is included in APP-GW-VLR-010, " AP1000 Supplemental Fabrication and Inspection Requirements" in Section 4.1.2 which states:

"Welding processes that use flux, such as FCAW, SMAW, or SAW shall not be used on the root pass except for joints welded from two sides where the root is back gouged to sound metal as evidenced by magnetic particle or liquid penetrant testing."

A note will be added to DCD Table 5.2-1, as shown in the DCD markup given below, to identify this restriction.

c. Westinghouse will include ASME Code Filler Metal Specifications SFA 5.1, 5.17, 5.22, and 5.30 under Welding Consumables in DCD Table 5.2-1 as shown in the DCD markup given below.

Westinghouse Responses to Revision 1 Questions:

1) The stainless, alloy, and carbon steel Class 1components of the reactor coolant pump are listed in the table below.

Pressure Boundary Class 1 Wetted		Pressure Boundary Class 1 Non-wetted	
Part	Material	Part	Material
Casing	Stainless steel	Stator main flange	Carbon steel
Upper and lower seal rings (canopy seals)	Stainless steel	Stator shell	Carbon steel
Stator closure ring	Stainless steel	Stator vent flange	Stainless steel
Stator closure	Stainless steel	External heat exchanger supports	Carbon steel
Shell lower flange	Stainless steel	Terminal gland, adapter, adapter nut	Stainless steel
Stator cap	Stainless steel	Stator RTD receptacle	Stainless steel
External heat exchanger primary side	Stainless steel	RTD nut	Stainless steel
External heat exchanger piping & flanges	Stainless steel	Main Flange Stud	Alloy steel
Fill & drain nozzle	Stainless steel	Main Flange Nut	Alloy steel
Bearing water RTD thermowell	Stainless steel	End closure bolt	Alloy steel
Speed sensor well	Stainless steel		
Phase reference sensor well	Stainless steel		
Thrust bearing sleeve	Stainless steel		
Upper basealign ring (for lower radial bearing and upper thrust bearing)	Stainless steel		
Lower base ring (for lower thrust bearing)	Stainless steel		

A note will be added to DCD Table 5.2-1 to indicate which reactor coolant pump pressure boundary components are carbon steel. This note is shown in the markup of Table 5.2-1 in the DCD Revision Section at the end of the responses.

2) Carbon steel is used only for those pressure boundary components which are not normally exposed to the reactor coolant. Carbon steel has a higher yield stress than 304 stainless steel and provides higher margins against nut to main flange bearing stresses. For a 304 stainless steel main flange there is a potential for the main flange stud load to increase significantly at operating conditions due to the relative thermal expansion between the stud and main flange.

   All large canned pumps designed by Curtiss-Wright EMD have carbon steel in the locations of interest.

   The only CL 1A pressure forgings on the steam generator are for the small nozzles on the generator – blowdown, sampling, and level tap nozzles. These smaller nozzles are typically from SA-508 CL 1A and do not represent a departure from recent replacement steam generator designs. All of the large, major forgings, such as the tubesheet, upper and lower shells, elliptical head, and transition cone, are SA-508 Gr 3 Cl 2.

   DCD Table 5.2-1 will be modified to clarify the steam generator small nozzle and tube sheet materials. The markup of Table 5.2-1 is included in the DCD Revision Section at the end of the responses.

3) The stator shell is welded to the main flange using the submerged arc welding (SAW) process. This joint is full penetration, approximately 4.5" thick and is welded from one side, the outside diameter. Both base materials are SA-508 Grade 1 which is classified as P No. 1 in the ASME code. The weld filler material is per SFA 5.17, classification EH11K. Once this weld is completed the shell/flange is stood upright with the main flange down and several layers of weld buttering are deposited on the end of the shell. This is done using the SAW process and the weld filler material is per SFA 5.9, classification ER309. After the completion of weld buttering, post weld heat treatment is performed. Machining is then performed on the inside and outside diameters of the shell/ flange weld and the buttering is machined in order to provide a weld prep for the shell to lower flange weld. The shell/flange weld is inspected via radiography and magnetic particle testing is performed on the inside and outside diameter surfaces. The buttered and machined weld prep on the shell is liquid penetrant inspected. The lower flange is then welded to the buttered portion of the shell/flange. The lower flange material is per SA-336, Grade F304, classified as P No. 8. The SAW process is used for this weld also and the joint design is essentially the same as for the shell to main flange joint. The weld filler material is per SFA 5.9, classification ER308. Following welding and machining, radiography is performed along with liquid penetrant inspection of both the inside and outside diameter surfaces.

4) The base material for the stator can is Hastelloy C276. (ASTM B-575, UNS N10276). It is welded to portions of the stator pressure boundary that are stainless steel.

5) The primary function of the rotor and stator cans is to retain primary fluid and keep it from contacting electrical windings. The primary function does NOT include keeping primary fluid from escaping to the atmosphere. In addition, the rotor can is not in the load path to the atmosphere.

   If the cans were designed as primary pressure boundary parts they would be prohibitively thick and the motor could not function electrically.

   The stator windings and laminations and associated structure (end winding supports, core mechanical structure and power terminals) and the rotor laminations and squirrel cage are considered to be the non-wetted portions of the pump. Other parts internal to the pump are considered wetted.

   As stated above the rotor can is not in the load path to the atmosphere, and will not be discussed further in this response.

   The stator can retains primary fluid. As described above it is welded to portions of the stator pressure boundary that are stainless steel. The can is supported in a radial direction (to resist internal primary fluid pressure) by the stator laminations and a series of short cylinders that bridge the gap between the stator winding and the SST pressure boundary. This pressure force is in the load path that ends at the primary pressure boundary components. The stator can provides a hermetically sealed barrier between the primary fluid and the carbon steel pressure boundary parts.

   The motor will stop working if the power terminals become wetted sufficiently to short between 2 of the 3 phase connections. This could happen if approximately 2 gallons of water were to accumulate in the bottom end of the stator region that is normally non-wetted. The motor will operate successfully, of course, if there is no moisture present. It is unknown at exactly what point between those two quantities that the motor might otherwise become wet enough to fail.

   There are no known failures of EMD-designed and manufactured canned motors of this general size due to a stator can failure.

6) The code year of construction for the AP1000 is 1999 with 2000 addenda. This year of the code does not have a consumable insert classification for alloy 160 (IN-52). Since Westinghouse sub-contracts the construction of most of the equipment containing reactor coolant, it is the vendor's choice to use consumable inserts or not. Most of the vendors do not choose to use consumable inserts since the primary use of consumable inserts is for manual GTAW, and most safe ends are welded with automatic GTAW. So even if consumable inserts could be added, it is not likely they

would be used in lieu of the filler metal already listed.

7) The use of SFA 5.17 weld filler material for reactor coolant pump pressure boundary welds is described in the response to Question 3 above. As for the use of SFA 5.1, the reactor coolant pump vendor is currently qualifying a welding procedure using filler metal classification E7018 to be used for making weld repairs of the shell/main flange joint. This procedure would also be usable for base material repairs on the shell or main flange.

   Using welding processes containing flux is only a concern when doing single sided welding where the root of the weld is exposed to reactor coolant. The DCD paragraph 5.2.3.2.2 states that any carbon steel that is exposed to reactor coolant will be clad. So any weld on carbon or low alloy steel will not be exposed to reactor coolant whether the weld was performed with a process using flux or a process that does not use flux.

8) The original intent of adding Note 4 to Table 5.2-1 was to address a previous NRC comment. Since it is basically redundant with regards to paragraph 5.2.3.2.2, Westinghouse recommends that the note be deleted as shown in the markup of Table 5.2-1 which is included in the DCD Revision Section at the end of the responses. DCD paragraph 5.2.3.2.2 states:

   "Ferritic low-alloy and carbon steels used in principal pressure-retaining applications have corrosion-resistant cladding on surfaces exposed to the reactor coolant."

9) The purpose of the note is to limit the use of filler metals listed in SFA-5.22 to only those used for gas shielded FCAW.

   Using GTAW with flux-cored rod is prohibited since the SFA-5.22 filler metals are limited to gas-shielded FCAW applications (see proposed Note 3 of DCD Table 5.2-1 in the Revision 0 response to RAI SRP 5.2.3-CIB1-01). Any GTAW rod would start with an R instead of an E, and as shown in Table 5.2-1 only E rods are permitted.

10) The SA-312 and SA-376 material for seamless pipe changed to SA-479 for hot or cold-rolled bar stock because of the AP1000 design change to incorporate the Quickloc design. On the previous design there were forty-two (42) individual penetrations for the Incore Instrument Thimble Assemblies (IITAs) and with the Quickloc design there are eight (8) Quickloc Instrument Nozzle (QIN) penetrations with up to six (6) IITAs in each for a total of eight (8) QINs. Hot or cold-rolled bar stock has been used in previous Quickloc installations.

   The operating experience for SA-479, S21800 (Nitronic 60) Quickloc pressure boundary parts are as follows:

Table 10-1: Quickloc Plants and Installation Date

Quickloc Plants	Installation Date
Waterford Unit 3	Fall 1995
St. Lucie Unit 2	Spring 1997
St. Lucie Unit 1	Fall 1997
Calvert Cliffs Unit 2	Spring 2001
Calvert Cliffs Unit 1	Spring 2006

In addition, SA-479, S21800 has been used for Core Exit Nozzle Assembly (CETNA) pressure boundary parts on various plants since the Fall of 1988. CETNAs have been installed on approximately 50 plants (domestic and international).

SA-479 or SA-240 plate Grade S21800 has been used in the construction of a number of parts for reactor vessel internals (RVI) for Combustion Engineering (C-E) NSSS plants. Domestic and international plants which have been in service beginning in the mid-1980's through current plants have utilized this grade of austenitic stainless steel. Table 10-2 lists the S21800 parts used in the RVI for these plants. The identified items were included in the original specification of the RVI for these units and were fabricated and installed during the original construction of the plants.

Table 10-2: UNS S21800 Parts in Reactor Vessel Internals

Component	Specification
Bushing	SA-479
Upper connector	SA-479
Pin	SA-479 or SA-240
Concave Spherical Washer	SA-479
Convex Spherical Washer	SA-479
Connector	SA-479
Guide Tube	SA-479
Guide Tube Reducer	SA-479
Nose	SA-479

Older C-E NSSS have also utilized S21800 as original parts, such as the instrument guide block and for modifications and repairs. One modification utilized S21800 as part of the reactor level monitoring system (RVLMS) probe guide path. This consisted of welded construction of two S21800 items welded to a Type 304 stainless steel tube. A repair was also made to the thermal shield in on plant, replacing the thermal shield positioning pins that support the thermal shield on the core barrel in the RVI. These pins were hardfaced to provide additional wear resistance of the face of the pin against the core barrel. The pins are threaded and torqued into the thermal shield to provide structural stability between the thermal shield and core barrel.

The S21800 austenitic stainless steel was specified with the same requirements used for Type 304 bar material used in the RVI. Requirements included limits on carbon and cobalt content, corrosion testing in accordance with ASTM A 262 for welded construction of austenitic stainless steels and NDE performed according to Subsection NG requirements for bar. There have been no reported problems are issues with the S21800 material used in any of the above applications, some which have accumulated over 20 years of operating history.

The chemical compositions of Nitronic 60, type 304 stainless steel, and type 316 stainless steel from the material specification SA-479 are provided in Table 10-3. The SA-479 cold-rolled bar austenitic stainless steels are all solution-annealed, which recrystallizes the grain structure of the steel.

Table 10-3: Chemical Composition of Nitronic 60, Type 304 Stainless Steel, and Type 316 Stainless Steel

Type	Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Nitrogen	Molybdenum
Nitronic 60	0.10	7.0-9.0	0.060	0.030	3.5-4.5	16.0-18.0	8.0-9.0	0.08-0.18	...
304	0.08	2.00	0.045	0.030	1.00	18.0-20.0	8.0-10.5	...	...
316	0.08	2.00	0.045	0.030	1.00	16.0-18.0	10.0-14.0	...	2.00-3.00

Nitronic 60 is an austenitic stainless steel, similar to types 304 and 316. The chromium content of Nitronic 60 is comparable to type 316, and therefore has the same general corrosion resistance. The nickel content is comparable to type 304. The additions of silicon and manganese help to prevent wear, galling, and fretting. Molybdenum in type 316 resists pitting corrosion. Because the Nitronic 60 will not be welded, the sensitization concerns from higher carbon content are not applicable.

The minimum yield and tensile strengths of the materials are listed in Table 10-4. Nitronic 60 has higher yield and tensile strengths than types 304 and 316 stainless steel.

Table 10-4: Minimum Yield and Tensile Strengths of Nitronic 60, Type 304 Stainless Steel, and Type 316 Stainless Steel

Type	Yield Strength	Tensile Strength
Nitronic 60	50	95
304	30	75
316	30	75

Design Control Document (DCD) Revision Associated with Revision 0 Questions:

Markup of DCD Table 5.2-1 Sheet 5:

Table 5.2-1 (Sheet 5 of 5)

REACTOR COOLANT PRESSURE BOUNDARY MATERIALS SPECIFICATIONS

Component	Material	Class, Grade, or Type
Pressure retaining nuts	SA-453 or SA-194	GR 660 or GR 6 or 8
Core Makeup Tank		
Pressure plates	SA-533 or SA-240	Type B, CL 1 or 304, 304L, 304LN, 316, 316L, 316LN
Pressure forgings	SA-508 or SA-182 SA-336	GR 3 CL 1 or F304, F304L, F316, F316L F304, F304L, F316, F316L
Passive Residual Heat Removal Heat Exchanger		

Pressure plates	SA-533 or SA-240	Type B CL1 or 304, 304L, 304LN
Pressure forgings	SA-508 or SA-336	GR 3 CL 2 or F304, F304L, F304LN
Tubing	SB-163	N06690
Welding Consumables		
Corrosion resistant cladding, buttering, and welds	SFA 5.4 and 5.9 SFA 5.11 SFA 5.14 5.22(3) SFA 5.30	E308, E308L, E309, E309L, E316, E316L, ER308, ER308L, ER309, ER309L, ER316, ER316L ENiCrFe-7 ERNiCrFe-7/A E308LTX-Y, E308TX-Y, E309LTX-Y, E309TX-Y, E316LTX-Y, E316TX-Y IN308, IN308L, IN316, IN316L
Carbon steel pressure boundary welds(4)	SFA 5.1, 5.17, 5.30	To be compatible with base material
Low alloy pressure boundary welds	SFA 5.5, 5.23, 5.28	To be compatible with base material

Notes:
1. Limited to seamless form only
2. Subject to manufacturing sequence and final finish condition review
3. Gas Shielded FCAW electrodes only. These electrodes shall not be used for root passes except for joints welded from two sides where the root is back-gouged to sound metal as evidenced by magnetic particle or liquid penetrant testing.
   X=Position, acceptable values 0 (flat and horizontal) and 1 (all positions)
   Y=Shield Gas, acceptable values 1 (100% CO_2) and 4 (75-80% Argon, remainder CO_2)
4. Limited to applications in which the welds are not exposed to reactor coolant.

Design Control Document (DCD) Revision Associated with Revision 1 Questions:

In response to the Revision 1 questions, the markups of the DCD Table 5.2-1 Sheets 2, 3, and 5 are given below. The basis for the markup of Sheet 5 is the proposed table in the Revision 0 response. Only the changes on Sheet 5 resulting from the Revision 1 responses are indicated. The markups are in response to Revision 1 Questions 1, 2, and 8.

Table 5.2-1 (Sheet 2 of 5)

REACTOR COOLANT PRESSURE BOUNDARY MATERIALS SPECIFICATIONS

Component	Material	Class, Grade, or Type
Vent pipe	SB-166 SB-167 or SA-312[1] SA-376	N06690 N06690 TP304, TP304L, TP304LN, TP316, TP316L, TP316LN TP304, TP304LN, TP316, TP316LN
Steam Generator Components		
Pressure plates	SA-533	Type B, CL 1 or CL 2
Pressure forgings Small nozzles[5] Other Pressure Boundary Forgings and Tubesheet	 SA-508 SA-508	 CL 1A GR 3, CL 2
Nozzle safe ends	SA-182 SA-336 or SB-564	F316, F316L, F316LN F316LN N06690
Channel heads	SA-508	GR 3, CL 2
Tubes	SB-163	N06690
Manway studs/ Nuts	SA-193 SA-194	GR B7 GR 7
Pressurizer Components		
Pressure plates	SA-533	Type B, CL 1
Pressure forgings	SA-508	GR 3, CL 2
Nozzle safe ends	SA-182 SA-338 or SB-163	F316, F316L, F316LN F316, F316L, F316LN N06690
Manway studs/ Nuts	SA-193 SA-194	GR B7 GR 7

Table 5.2-1 (Sheet 3 of 5)

REACTOR COOLANT PRESSURE BOUNDARY MATERIALS SPECIFICATIONS

Component	Material	Class, Grade, or Type
Reactor Coolant Pump		
Pressure forgings	SA-182 SA-508 or SA-336	F304, F304L, F304LN, F316, F316L, F316LN GR1[(4)] F304, F304L, F304LN, F316, F316L, F316LN
Pressure casting	SA-351	CF3A or CF8A
Tube and pipe	SA-213 SA-376 or SA-312[(1)]	TP304, TP304L, TP304LN, TP316, TP316L, TP316LN TP304, TP304LN, TP316, TP316LN TP304, TP304L, TP304LN, TP316, TP316L, TP316LN
Pressure plates	SA-240	304, 304L, 304LN, 316, 316L, 316LN
Closure bolting	SA-193 or SA-540	GR B7 or GR B24, CL 2 & CL 4, or GR B23, CL2, CL 3 & 4
Reactor Coolant Piping		
Reactor coolant pipe	SA-376 SA-182[(2)]	TP304, TP304LN, TP316, TP316LN F304, F304L, F304LN, F316, F316L, F316LN
Reactor coolant fittings, branch nozzles	SA-376 SA-182	TP304, TP304LN, TP316, TP316LN F304, F304L, 304LN, F316, F316L, F316LN
Surge line	SA-376 or	TP304, TP304LN, TP316, TP316LN

	SA-312[1]	TP304, TP304L, TP304LN, TP316, TP316L, TP316LN

Table 5.2-1 (Sheet 5 of 5)

REACTOR COOLANT PRESSURE BOUNDARY MATERIALS SPECIFICATIONS

Component	Material	Class, Grade, or Type
Pressure retaining nuts	SA-453 or SA-194	GR 660 or GR 6 or 8
Core Makeup Tank		
Pressure plates	SA-533 or SA-240	Type B, CL 1 or 304, 304L, 304LN, 316, 316L, 316LN
Pressure forgings	SA-508 or SA-182 SA-336	GR 3 CL 1 or F304, F304L, F316, F316L F304, F304L, F316, F316L
Passive Residual Heat Removal Heat Exchanger		
Pressure plates	SA-533 or SA-240	Type B CL1 or 304, 304L, 304LN
Pressure forgings	SA-508 or SA-336	GR 3 CL 2 or F304, F304L, F304LN
Tubing	SB-163	N06690
Welding Consumables		
Corrosion resistant cladding, buttering, and welds	SFA 5.4 and 5.9 SFA 5.11 SFA 5.14 5.22[3]	E308, E308L, E309, E309L, E316, E316L, ER308, ER308L, ER309, ER309L, ER316, ER316L ENiCrFe-7 ERNiCrFe-7/A E308LTX-Y, E308TX-Y, E309LTX-Y, E309TX-Y, E316LTX-Y, E316TX-Y

	SFA 5.30	IN308, IN308L, IN316, IN316L
Carbon steel pressure boundary welds	SFA 5.1, 5.17, 5.30	To be compatible with base material
Low alloy pressure boundary welds	SFA 5.5, 5.23, 5.28	To be compatible with base material

Notes:

1. Limited to seamless form only
2. Subject to manufacturing sequence and final finish condition review
3. Gas Shielded FCAW electrodes only. These electrodes shall not be used for root passes except for joints welded from two sides where the root is back-gouged to sound metal as evidenced by magnetic particle or liquid penetrant testing.
   X=Position, acceptable values 0 (flat and horizontal) and 1 (all positions)
   Y=Shield Gas, acceptable values 1 (100% CO_2) and 4 (75-80% Argon, remainder CO_2)
4. GR1 material (carbon steel) is used only for reactor coolant pump components which are not exposed to the reactor coolant. These components are limited to the stator main flange, stator shell, and external heat exchanger supports.
5. The small steam generator nozzles are limited to the blowdown, sampling, and level tap nozzles.

PRA Revision: None.

Technical Report (TR) Revision: None.