**Response to**

**Request for Additional Information No. 88 (1239, 1044), Revision 0**

**10/9/2008**

**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: FSAER Ch. 5**

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

**Question 05.02.03-1:**

The RCPB materials specified in Table 5.2-2 for the CRDM pressure housing lists martenstic stainless steel materials SA-182 Grade F6NM and SA-479 (UNS S41500). While SA-182 Grade F6NM is listed in ASME Code, Section II, Part D, Subpart I, Table 2A, for use in Class 1 systems in accordance with ASME Code Section III, NB-2121, “Permitted Material Specifications,” the staff notes that SA-479 UNS S41500 is not listed in Table 2A and therefore does not meet ASME Code, Section III, NB-2121 requirements and thus does not meet the requirements of 10 CFR50.55a. The staff requests that the applicant delete SA-479 UNS S41500 and if necessary provide an alternative material that meets ASME Code requirements. Alternatively, the applicant may choose to submit a code case to the ASME Code to include SA-479 UNS S41500 in Table 2A.

**Response to Question 05.02.03-1:**

In August 2008, AREVA NP submitted a request to ASME to extend the properties currently provided in Section II Part D for SA-182 Grade F6NM (UNS S41500) to SA-479 (UNS S41500). ASME assigned tracking number 08-1526 to this request. AREVA NP requested a response by December 2008 and expects a Code Case to be issued thereafter.

**FSAR Impact:**

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

**Question 05.02.03-2:**

The RCPB materials specified in Table 5.2-2 for the CRDM lists SA-312 Grade 347 as one of the materials used for the pressure housing. The staff notes that Grade 347 material is not listed in Section II material specification SA-312 although the staff notes that Grade TP347 is listed. In addition, under pressurizer components, the applicant has listed SA-213 Type 316L material. Material Type 316L does not appear in SA-213 although material Grade TP 316L is listed. The staff requests that the applicant modify Table 5.2-2 to list the appropriate material grades consistent with the applicable material specifications.

**Response to Question 05.02.03-2:**

A response to this question will be provided by December 17, 2008.

**Question 05.02.03-3:**

Table 5.2-2 lists several material specifications and grades for the RCPB piping, steam generator, pressurizer, reactor coolant pump and CRDM components. The applicant did not however identify the individual components that will be fabricated from each material specification. In order for the staff to complete its review of the RCPB materials, the staff requests that the applicant modify Table 5.2-2 to list the components fabricated with each material specification. For example, the specifications listed for the steam generators should identify which specification is used for the shell, heads, tubesheet, nozzles, etc. The Table 5.2-2 entry for the pressurizer safety relief valves should list all valve components that perform a pressure boundary function (valve bonnet, bolting etc.). In addition, the staff requests that the applicant identify weld filler materials used to weld the various material types and combinations.

**Response to Question 05.02.03-3:**

A response to this question will be provided by December 17, 2008.

**Question 05.02.03-4:**

The amount of specified preheat for the welding of ferritic steels should be in accordance with ASME Code, Section III, Appendix D, Article D-1000. Appendix D is supplemented by positions described in RG 1.50 for the control of preheat temperatures for low alloy steels. Although the applicant stated, in FSAR Section 5.2.3.3.2, that it will conform to the requirements of RG 1.50, it is unclear if the applicant intends to follow the minimum preheat requirements in Appendix D for all ferritic materials in the RCPB. The staff requests 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 ASME Code, Section III, Appendix D.

**Response to Question 05.02.03-4:**

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 meets the minimum preheat requirements of ASME Code, Section III, Appendix D ("Nonmandatory Preheat Procedures").

**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 05.02.03-5:**

FSAR Section 5.2.3.4.6 indicates that the ferrite content of the RCP casing is limited to 20 percent to reduce the susceptibility of thermal aging. The staff position regarding the susceptibility of cast austenitic stainless steels (CASS) to thermal aging embrittlement is documented in a letter from Christopher I. Grimes of the NRC to Douglas J. Walters of the Nuclear Energy Institute, dated May 19, 2000 (Agency wide Documents Access and Management System (ADAMS) Accession No. ML003717179). To be consistent with staff's position referenced above, ferrite should be calculated using Hull's equivalent factors as indicated in NUREG/CR-4513, "Estimation of Fracture Toughness of Cast Stainless Steels During Thermal Aging in LWR Systems," Revision 1, issued May 1994. The basis for using Hull's equivalent factors is that for ferrite content above 12 percent, other methods to calculate ferrite, such as ASTM A800, may produce nonconservative ferrite levels lower than those calculated using Hull's equivalent factors. Therefore, the staff requests that the applicant modify FSAR Section 5.2.3.4.6 to state that for all CASS 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). In addition, the staff requests that the applicant modify FSAR Section 5.2.3 to state that all CASS components in the RCPB will be limited to a ferrite content not to exceed 20 percent.

**Response to Question 05.02.03-5:**

U.S. EPR FSAR, Tier 2, Section 5.2.3.4.6 will be modified to state that for cast austenitic stainless steel material used in the reactor coolant pressure boundary (RCPB), the percent ferrite is calculated using Hull's equivalent factors as indicated in NUREG/CR-4513, "Estimation of Fracture Toughness of Cast Stainless Steels During Thermal Aging in LWR Systems," Revision 1, May 1994. This section will also be modified to state that cast austenitic stainless steel components in the RCPB are limited to a ferrite content of less than 20 percent.

**FSAR Impact:**

U.S. EPR FSAR, Tier 2, Section 5.2.3.4.6 will be revised as described in the response and indicated on the enclosed markup.

**Question 05.02.03-6:**

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 applicant further states that due to this stabilizing heat treatment, stabilized austenitic stainless steels are not expected to experience sensitization. Given that stabilizing heat treatments are supplementary requirements to the materials specifications for the stabilized grades listed in Table 5.2-2 and the specifications only stipulate that this heat treatment be carried out at a temperature lower than that used for the initial solution annealing heat treatment, the staff requests the following.

1. Modify FSAR Section 5.2.3.4.1 to include the stabilizing heat treatment temperature and a 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.
2. 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.

**Response to Question 05.02.03-6:**

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.

**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 05.02.03-7:**

FSAR Section 5.2.3.3.2 states that electroslag welding performed on RCPB components conforms to the requirements of RG 1.34. The staff requests that the applicant identify the components that will be fabricated using the electroslag weld process.

**Response to Question 05.02.03-7:**

None of the nuclear steam supply system (NSSS) components are fabricated using the electroslag weld process. Information for other reactor coolant pressure boundary components depend upon vendor selection. There will be a requirement that any electroslag welding will conform to RG 1.34.

**FSAR Impact:**

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

**Question 05.02.03-8:**

FSAR Section 3.3.4.2 and Table 5.2-2 indicate that MCL and 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 request 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.

**Response to Question 05.02.03-8:**

U.S. EPR FSAR, Tier 2, Section 5.2.3 will be modified 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 allows inspection by ultrasonic methods, while continuing to meet the specified mechanical properties of the ASME Code.

**FSAR Impact:**

U.S. EPR FSAR, Tier 2, Section 5.2.3 will be revised as described in the response and indicated on the enclosed markup.

**Question 05.02.03-9:**

FSAR Section 5.2.3.4.1 indicates that unstabilized austenitic stainless steels contain less than 0.03 wt% carbon but Table 5.2-2 does not limit carbon to less than 0.03% for all unstabilized carbon steels. For example, under RCPB piping in Table 5.2-2, the applicant has specified ASME SA-312 Grade TP304L but does not list Table 5.2-2 Note 3 which limits carbon to less than 0.03%. SA-312 Grade TP304L specifies a maximum carbon content of 0.035%. The staff requests that the applicant modify Table 5.2-2 to be consistent with FSAR Section 5.2.3.4.1.

**Response to Question 05.02.03-9:**

A response to this question will be provided by December 17, 2008.

**Question 05.02.03-10:**

FSAR Sections 5.3 and 3.6.3 indicate that dissimilar metal welds (DMWs) joining low alloy steel nozzles and stainless steel safe ends will use the GTAW process with a narrow groove weld joint design and no weld buttering of low alloy steel nozzles. The staff requests the following information in order for the staff to complete its review.

1. Discuss development and testing programs that AREVA has performed on narrow groove welding of nozzle to safe ends without first applying a buttering layer.
2. Discuss the PWHT procedures used in welding procedure qualification testing and those proposed to be used during fabrication. In addition, discuss any nontraditional PWHT regimes and discuss their adequacy.
3. Discuss typical HAZ impact test values (Charpy and mills lateral expansion) obtained during welding procedure qualification and discuss controls on welding to ensure that production welds will have similar fracture toughness to the fracture toughness testing results from welding procedure qualifications.
4. Discuss welding process controls employed to reduce weld metal dilution in order to retain the maximum percentage of Chromium possible in order to decrease the susceptibility of components to stress corrosion cracking for the life of the plant.

**Response to Question 05.02.03-10:**

A response to this question will be provided by December 17, 2008.

**Question 05.02.03-11:**

FSAR Section 5.3 indicates that Alloy 690 CRDM adapters are welded to the RPV head using Alloy 52/52M/152. The partial penetration j-groove joint design can be difficult to weld given the highly restrained nature of the joint design and the limited accessibility for the welder. The staff notes that recently fabricated RPV replacement heads have required extensive welding repairs during fabrication. In addition, large numbers of welding flaws have been identified during baseline UT examination of CRDM nozzles. Given the susceptibility of Alloys 52, 52M and 152 to ductility dip cracking and other types of welding flaws in partial penetration j-groove welds, the staff requests that the applicant discuss its welding process controls to minimize welding flaws in CRDM adapter to RPV head welds and any other partial penetration welds that involve dissimilar materials within the RCPB. In addition, discuss welding process controls employed to reduce weld metal dilution in order to retain the maximum percentage of Chromium possible in order to decrease the susceptibility of components to stress corrosion cracking for the life of the plant.

**Response to Question 05.02.03-11:**

A response to this question will be provided by December 17, 2008.

**Question 05.02.03-12:**

Table 5.2-2 indicates that Alloy 52/52M, Alloy 152 and Type 347 weld filler materials will be used in the fabrication of CRDM pressure housings. In reviewing the information provided in FSAR Sections 3.9.4, 4.5.1 and 5.2.3, the staff cannot identify where the CRDM pressure housing welds are located or what material/weld filler metal combinations are used. In order for the staff to continue its review, the staff requests that the applicant provide a description of the CRDM pressure housing welds including a detailed sketch that shows the locations of welds in the pressure housing and identifies the materials that are welded. In addition, provide a discussion of the weld joint designs, welding processes and heat treatment requirements that are used in the fabrication process.

**Response to Question 05.02.03-12:**

A weld development study is being performed for the U.S. EPR control rod drive mechanisms (CRDM) pressure housings. This design uses Alloy 52/52M filler metals and will be qualified to ASME Boiler and Pressure Vessel Code, Section III, Subsection NB.

The CRDM assembly is shown in Figure 05.02.03-12-1—CRDM Welds. The CRDM assembly has four welds, including two dissimilar welds using alloy 52/52M (ERNiCrFe-7/ERNiCrFe-7a) at locations CW 1/2 and CW 2/3, and two austenitic-austenitic welds (type ER347) at locations CW 3/4 and CW 4/5. As noted in Figure 05.02.03-12-1 and in U.S. EPR FSAR, Tier 2, Table 5.2-2, the pressure housing is fabricated as follows:

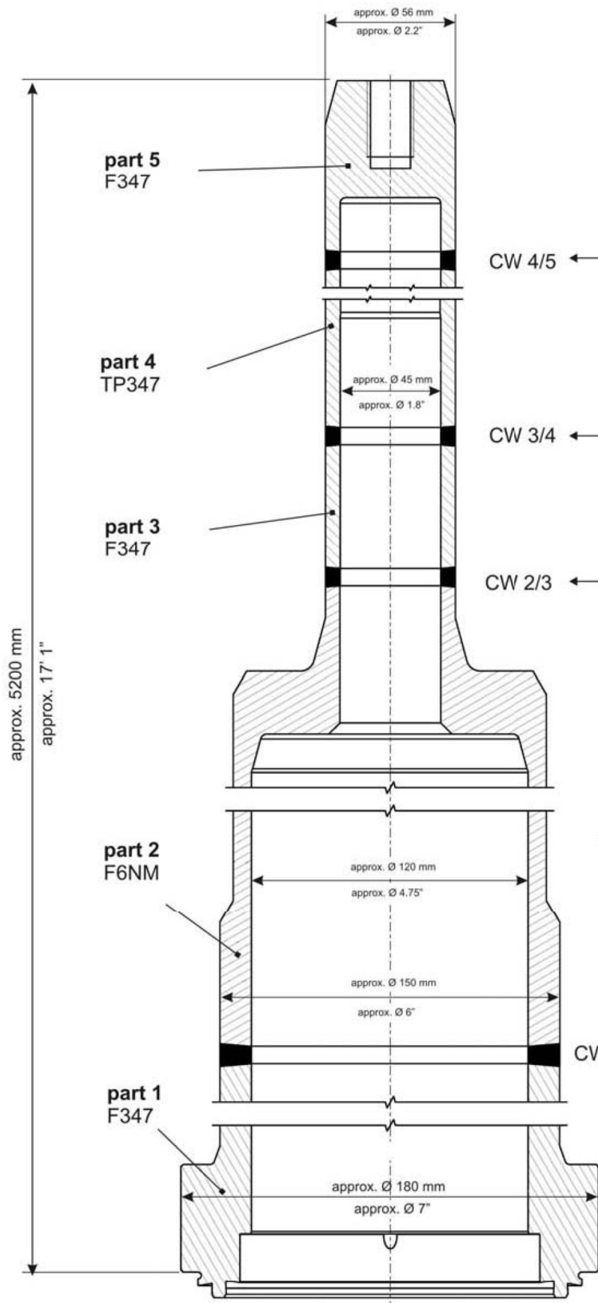
- The joints shown in Figure 05-02-03-12-1 are full penetration welds. The welds are made using the gas tungsten arc welding process.
- Joints CW 1/2 and CW 2/3 are full-penetration dissimilar metal welds that use Alloy 52/52M weld filler material and are welded with Alloy 690 backing rings. After welding, the backing rings are machined off when establishing the rough inside diameter bore dimensions.
- The lower pressure housing subassembly (part 1, part 2, and part 3) are heat treated in the lower-critical temperature regime of the F6NM alloy.
- The upper pressure housing consists of two austenitic stainless steel (F347/TP347) parts that are joined with a full penetration GTAW weld (CW 4/5) utilizing ER347 filler material. The upper and lower pressure housing subassemblies are joined with a full-penetration GTAW weld (CW 3/4) utilizing ER347 filler material. The joint (CW 3/4) is a similar metal joint between two austenitic stainless steels (F347/TP347).

The weld joint designs, welding processes, and heat treatment requirements for fabrication are developed later in the design process.

**FSAR Impact:**

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

**Figure 05.02.03-12-1—CRDM Welds**



**Question 05.02.03-13:**

Cold work and residual stress imparted on components fabricated from austenitic stainless steels and nickel based alloys has contributed to stress corrosion cracking in several currently operating PWRs and BWRs. The staff requests that the applicant describe special fabrication process requirements employed to limit the effects of cold work and residual stress, caused by grinding/repair or other fabrication processes on surfaces that come into contact with RCS fluids in order to minimize the susceptibility of components to stress corrosion cracking for the design life of the plant.

**Response to Question 05.02.03-13:**

A response to this question will be provided by December 17, 2008.

**Question 05.02.03-14:**

In FSAR Tier 1, Table 2.2.1-5 “RCS Inspections, Tests, Analyses, and Acceptance Criteria,” the applicant has listed ITAAC for fabrication, welding and welding inspection for RCS components. The staff noted some inconsistencies in the applicant’s ITAAC. For example, Table 2.2.1-5 line item 3.1 has a design commitment that states that components designated as ASME Section III in Table 2.2.1-1 are designed to ASME Code Section III requirements. The ITA for this line item states that inspections will be conducted of ASME design, NDE, and hydrostatic test reports. The ITAACs related to design should be separate from those related to fabrication, weld inspection and hydrostatic testing to provide clarity. Table 2.2.1-5, line item 3.4 is divided into two sections but is not consistent with the similar requirements for components in line item 3.1. The staff request that the applicant modify Table 2.2.1-5 to provide clear consistent ITAAC associated with the design, fabrication (including verification that welding was performed in accordance with ASME Code, Section III), weld inspection (NDE) and hydrostatic testing for ASME Code Section III piping and components. In addition, the type of report that is required under the acceptance criteria should be listed in Table 2.2.1-5 (i.e.; ASME N-5 data report or other type of report). The staff notes that this format should be applied to all Tier 1 ITAAC for ASME Code Section III, Class 1, 2, or 3 systems.

**Response to Question 05.02.03-14:**

A response to this question will be provided by January 15, 2009.

**Question 05.03.02-6:**

In Table 1.8-2, "U.S. EPR Combined License Information Items," the applicant did not provide an action for the COL applicant to provide its plant-specific pressurized thermal shock ($RT_{PTS}$) values for vessel beltline materials. Please add another item under Item No. 5.3-2 (Table 1.8-2) stating “A COL applicant that references the U.S. EPR design certification will provide plant-specific $RT_{PTS}$ values in accordance with 10 CFR 50.61 for vessel beltline materials.”

**Response to Question 05.03.02-6:**

A response to this question will be provided by December 17, 2008.

# U.S. EPR Final Safety Analysis Report Markups

05.02.03-4

Procedure Qualification Records and Welding Procedure Specifications performed to support welding of 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.

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."

Low-hydrogen covered arc welding electrodes are furnished in a sealed package. Upon opening, the electrodes are transferred to a heated holding oven to prevent moisture absorption.

#### 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 of chlorides and other contaminants into the system during fabrication, shipping, and storage. The use of hydrogen in the reactor coolant inhibits the presence of oxygen during operation. The effectiveness of these controls has been demonstrated by tests and operating experience.

Measures are taken to prevent sensitization of unstabilized austenitic stainless steel materials during component fabrication; the wrought products listed in Table 5.2-2 are used in the solution annealed condition and rapidly cooled. Heat treatment parameters comply with ASME Section II. The material is either cooled by water quenching or cooled quickly enough through the sensitization temperature range to avoid carbide formation at the grain boundaries and sensitization. Non-sensitization of the base materials can be verified by a corrosion test – in accordance with ASTM A-262 (Reference 4), Practice A or E – as required by RG 1.44. When testing of the weld heat affected zone (HAZ) of materials is required, the tests are performed in accordance with ASTM A-262, Practice E. Low carbon austenitic stainless steel materials and their welds in product forms which do not have inaccessible cavities or chambers that would preclude rapid cooling when water quenching need not be corrosion tested, provided that the solution heat treatment is followed by water quenching or rapid cooling so as to avoid chromium carbide precipitation.

All unstabilized austenitic stainless steel material, including weld material, has a carbon content of less than 0.03 wt%. RG 1.44 requires that any material subjected to sensitizing temperatures subsequent to solution heat treatment should be material with a carbon content of less than 0.03 wt%.

05.02.03-6

Stabilized austenitic stainless steels have a stabilizing heat treatment above 800°F where chromium carbides are prevented from precipitating after the stabilizing element combines with the carbon. Due to the stabilizing heat treatment, stabilized austenitic stainless steels are not expected to experience sensitization. The lack of sensitization in these alloys, in addition to the five points listed above, negates the concern of intergranular corrosion in stabilized austenitic stainless steels. 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.

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 of less than 0.03 wt% to prevent undue sensitization.

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 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.

05.02.03-8

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 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.

### 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.

specimen notch located at the weld center is used. The tests specified are applied to each of the welds. The austenitic stainless steel production welding is monitored to verify compliance with limits for the process variables specified in the procedure qualification. In the event that properties obtained from tests identified are not acceptable, additional procedures qualification is performed.

### 5.2.3.4.5 Nondestructive Examination for Wrought Austenitic Stainless Steel Tubular Products

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

### 5.2.3.4.6 Cast Austenitic Stainless Steel Materials used in the RCPB

05.02.03-5

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 ~~is restricted to 10-20 percent~~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).

### 5.2.3.5 Prevention of Primary Water Stress-Corrosion Cracking for Nickel-Base Alloys

Nickel-base alloy components in the RCS are protected from primary water stress-corrosion cracking (PWSCC) by:

- Using only Alloy 690 and Alloys 52/52M/152 weld metals in NiCrFe applications (Alloy 600 base metal and Alloys 82/182 weld metal is not used).
- Controlled chemistry, mechanical properties, and thermo-mechanical processing requirements that produce an optimum microstructure for resistance to intergranular corrosion for NiCrFe Alloy 690 base metal.
- Limiting the sulfur content of NiCrFe base metal in contact with RCS primary fluid to maximum 0.02 wt%.

The NiCrFe materials that are used in the RCPB, including weld materials, conform to the fabrication, construction, and testing requirements of ASME Section III. Material specifications comply with ASME Section II Parts B and C.

Inservice inspections follow the requirements of ASME Section XI, industry materials reliability programs, and NRC guidance to confirm PWSCC does not occur in Alloy 690 materials.