ArevaEPRDCPEm Resource

From: WELLS Russell D (AREVA NP INC) [Russell.Wells@areva.com]
Sent: Friday, December 19, 2008 5:39 PM
To: Getachew Tesfaye
Cc: John Rycyna; Pederson Ronda M (AREVA US); BENNETT Kathy A (OFR) (AREVA US); DELANO Karen V (AREVA US)
Subject: Response to U.S. EPR Design Certification Application RAI No. 81, FSAR Ch 6, Supplement 1
Attachments: RAI 81 Supplement 1 Response US EPR DC.pdf

Getachew,

AREVA NP Inc. provided responses to 13 of the 20 questions of RAI No. 81 on November 3, 2008. The attached file, "RAI 81 Supplement 1 Response US EPR DC.pdf" provides technically correct and complete responses to the remaining 7 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 81 Questions 06.01.01–2, 06.01.01–6, 06.01.01–9, and 06.01.01–11.

The following table indicates the respective pages in the response document, "RAI 81 Supplement 1 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 81 — 06.01.01–1	2	2
RAI 81 — 06.01.01–2	3	3
RAI 81 — 06.01.01–5	4	5
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RAI 81 — 06.01.01–7	7	7
RAI 81 — 06.01.01–9	8	8
RAI 81 — 06.01.01–11	9	9

This concludes the formal AREVA NP response to RAI 81, and there are no questions from this RAI for which AREVA NP has not provided responses.

Sincerely,

(Russ Wells on behalf of)
Ronda Pederson
ronda.pederson@areva.com
Licensing Manager, U.S. EPR Design Certification
New Plants Deployment
AREVA NP, Inc.
An AREVA and Siemens company
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From: WELLS Russell D (AREVA NP INC)
Sent: Monday, November 03, 2008 7:23 PM
To: 'Getachew Tesfaye'

Cc: 'John Rycyna'; Pederson Ronda M (AREVA US); BENNETT Kathy A (OFR) (AREVA US); DELANO Karen V (AREVA US)
Subject: Response to U.S. EPR Design Certification Application RAI No. 81, FSAR Ch 6

Getachew,

Attached please find AREVA NP Inc.'s response to the subject request for additional information (RAI). The attached file, "RAI 81 Response US EPR DC.pdf" provides technically correct and complete responses to 13 of the 20 questions.

Appended to this file are affected pages of the U.S. EPR Final Safety Analysis Report in redline-strikeout format which support the response to RAI 81 Question 06.01.01-8.

The following table indicates the respective pages in the response document, "RAI 81 Response US EPR DC.pdf," that contain AREVA NP's response to the subject questions.

Question #	Start Page	End Page
RAI 81 — 06.01.01-1	2	2
RAI 81 — 06.01.01-2	3	3
RAI 81 — 06.01.01-3	4	4
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A complete answer is not provided for 7 of the 20 questions. The schedule for a technically correct and complete response to this question is provided below.

Question #	Response Date
RAI 81 — 06.01.01-1	December 19, 2008
RAI 81 — 06.01.01-2	December 19, 2008
RAI 81 — 06.01.01-5	December 19, 2008
RAI 81 — 06.01.01-6	December 19, 2008
RAI 81 — 06.01.01-7	December 19, 2008
RAI 81 — 06.01.01-9	December 19, 2008
RAI 81 — 06.01.01-11	December 19, 2008

Sincerely,

(Russ Wells on behalf of)

Ronda Pederson
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From: Getachew Tesfaye [mailto:Getachew.Tesfaye@nrc.gov]
Sent: Friday, October 03, 2008 5:42 PM
To: ZZ-DL-A-USEPR-DL
Cc: Robert Davis; Timothy Steingass; David Terao; Michael Miernicki; Joseph Colaccino; John Rycyna
Subject: U.S. EPR Design Certification Application RAI No. 81(960,1154,1046),, FSAR Ch 6

Attached please find the subject requests for additional information (RAI). A draft of the RAI was provided to you on September 15, 2008, and discussed with your staff on October 2, 2008. No changes were made to the Draft RAI Questions 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: 77

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Response to

Request for Additional Information No. 81 Supplement 1 (960, 1154, 1046), Revision 0

10/3/2008

U. S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 06.01.01 - Engineered Safety Features Materials
SRP Section: 06.01.02 - Protective Coating Systems (Paints) - Organic Materials
SRP Section: 06.06 - Inservice Inspection and Testing of Class 2 and 3 Components
Application Section: FSAR Ch. 6
CIB1 Branch

Question 06.01.01-1:

Emergency Feedwater System (EFWS) components materials specifications and grades are not listed in FSAR Table 6.1-1. The staff requests that the applicant modify FSAR Table 6.1-1 to include the material specifications and grades for EFWS components (piping, valves, fittings, etc.) including weld filler materials. In addition, the staff requests that the applicant discuss the compatibility of the materials of construction with the expected service conditions.

Response to Question 06.01.01-1:

Information for EFWS components is found in U.S. EPR FSAR Tier 2, Section 10.4.9, Table 10.4.9-1.

Austenitic stainless steel is chosen for the EFWS due to its workability, weldability, ductility, and general corrosion resistance along with extensive operating experience that demonstrates these materials perform well and are reliable in the expected service conditions. Operating experience has shown that reducing the allowable carbon content will lessen or may help to prevent the sensitivity to intergranular stress corrosion cracking caused by chromium depletion at the grain boundaries during welding and stress relieving operations. These materials are used in the solution annealed and water quenched (or rapidly cooled) condition. Unstabilized austenitic stainless steels are not heated above 800°F, other than locally by welding operations, or after the final heat treatment.

FSAR Impact:

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

Question 06.01.01-2:

The material types used for the ESF components are listed in FSAR, Tier 2, Table 6.1-1. The staff notes that the applicant has only listed material types such as austenitic stainless steel and ferritic steel for most components. In order for the staff to determine that the materials selected for ESF components meet GDC 1 and 10 CFR 50.55a, the staff requests that the applicant modify Table 6.1-1 to include material specifications and grades for each ESF component. In addition, the staff requests that the applicant include weld filler material specifications and classifications that will be used to weld each ESF component.

Response to Question 06.01.01-2:

U. S. EPR FSAR Tier 2, Chapter 6, Table 6.1-1 will be updated to include the material specifications and grades for emergency safety feature (ESF) components including weld filler materials.

FSAR Impact:

U. S. EPR FSAR Tier 2, Chapter 6, Table 6.1-1 will be revised as described in the response and indicated on the enclosed markup.

Question 06.01.01-5:

FSAR Section 6.1.1.1 states that the use of nickel-base alloys in primary pressure-retaining ESF applications is limited to Alloy 690 and its associated weld metals (Alloys 52, 52M, and 152). The staff notes that no Alloy 690 components or piping are listed in Table 6.1-1. Ni-Cr-Fe weld filler material specifications (for Alloys 52, 52M, and 152) are listed under safety injection system/residual heat removal system materials in Table 6.1-1. The staff requests the following information regarding the use of Alloy 690 materials and matching weld filler materials in ESF systems.

a. Identify any ESF components fabricated from Alloy 690 other than RCPB components listed in Table 5.2-2 and include them in Table 6.1-1.

b. For components containing dissimilar metal welds that use Alloys 52, 52M or 152 in ESF systems, provide a detailed description of how these welds are performed. The applicants detailed description should include the following:

   1. Provide base material combinations.

   2. Describe the welding processes used.

   3. 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 ESF and RCS fluids in order to minimize the susceptibility of components to stress corrosion cracking for the design life of the plant. In addition, provide the above information for austenitic stainless steel welds and include this information in FSAR Section 6.1.1

   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.

   5. Given the susceptibility of Alloys 52, 52M and 152 to ductility dip cracking and other types of welding flaws that have resulted in extensive repairs during repair and replacement activities for current operating PWRs, provide a description of special process controls used to minimize welding flaws.

Response to Question 06.01.01-5:

Answers to part a, b.1, b.2, and b.3 were submitted in the response to RAI 88 dated November 3, 2008.

b.4 Specific procedures for welding of ESF equipment will be developed later in the design process. It is recognized that primary water stress corrosion cracking resistance of high nickel alloys improves with higher chromium content.

AREVA NP's standard practice when welding on alloys that could reduce the as-deposited chromium content by dilution is to control welding parameters affecting heat input and power ratio. By controlling heat input and power ratio of welding parameters in Welding Procedures, the chromium content of the production weld deposits can be held within current industry standards. Vendors for safety-related ESF equipment will be required to meet these standards.

b.5 Specific procedures for welding of ESF equipment will be developed later in the design process. AREVA is aware of the susceptibility of Alloys 52, 52M and 152 to welding flaws.

All heats of Alloy 52 and Alloy 52M used for safety-related ESF equipment will undergo weldability testing prior to acceptance of the heat for production use. After welding, the test weldment is cross sectioned and metallography is performed to verify negligible microfissuring exists or other anomalies associated with weldability have not occurred.

Solidification cracking has been identified as a cracking mechanism in these alloys and is most evident with excessive sulfur and phosphorous levels. This problem commonly occurs when welding on austenitic stainless steel materials with high sulfur content. Limits on sulfur and phosphorus content will be used to minimize the potential for solidification cracking.

AREVA NP typically places limits on the number of repair/weld cycles on Ni-based alloys. Commonly the weld deposits are limited to one repair cycle in the same local area.

AREVA NP's experience when welding with Alloy 52 has shown that it is important to maintain interpass cleanliness to preclude the accumulation or buildup of oxides and nitrides, especially in thick multipass welds.

Alloy 52 contains significantly higher amounts of aluminum, (up to 1.10 percent) and titanium, (up to 1.0 percent, and up to 1.50 percent total for both aluminum and titanium) than does Alloy 82. Aluminum and titanium are added to the chemistry as deoxidizers. Due to the affinity for nitrogen and oxygen of these two elements, oxides and nitrides form readily and are not necessarily visually apparent to the welder or welding operator during his progressive inspections. In thick multipass welds that are not sufficiently clean, the accumulation of these nitrides and oxides may result. These non-metallic constituents have resulted in fine oxide stringers that have been revealed in the radiographic examinations.

Alloy 52M, with the addition of niobium, has resulted in improved performance associated with the excess nitride/oxide accumulation concern when compared to Alloy 52 and as a result is becoming widely used in the nuclear industry.

Interpass cleanliness is of primary importance and the welders/welding operators are instructed to be attentive during welding to maintain interpass cleanliness as an AREVA NP standard practice. This practice will be imposed on subcontractors as applicable, when production welding using these filler metals is performed on ESF safety-related components.

FSAR Impact:

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

Question 06.01.01-6:

FSAR Tier 2, Table 6.1-1 does not list reactor building liner or penetration materials. It does however provide a reference to FSAR Tier 2, Section 3.8.2. The staff reviewed Section 3.8.2 and could not locate specifications and grades for the reactor building liner or penetration sleeve materials. The staff did locate some limited information in Section 3.8.1.6.4. Section 3.8.1.6.4 states "The 0.25 inch thick liner plate is ASTM A516, Grade 55 material, which conforms to Subarticle CC-2500 of the ASME BPV Code, Section III, Division 2 (GDC 16)." The staff notes that Subarticle CC-2500 states that materials to be used for containment liners and attachments to liners are listed in Appendix I, Table I-2.2. Table I-2.2 does not list ASTM specifications for liner plate material. In addition, the staff was unable to locate the material specifications and grades for liner penetrations. In order for the staff to evaluate the acceptability of materials used in ESF systems, the staff requests that the applicant modify Table 6.1-1 to include all reactor building liner and penetration materials specifications and grades as well as verify that the materials selected are permissible in accordance with ASME Code for their intended use. The staff also requests that the applicant include weld filler metal specifications and classifications in Table 6.1-1.

Response to Question 06.01.01-6:

The reactor building liner plate material reference to the ASTM specification will be replaced by the equivalent ASME specification. U.S. EPR FSAR Tier 2, Section 3.8.1.6.4 will be revised to state that the liner plate is SA-516, Grade 55, 60, 65 or 70 material, which conforms to Subarticle CC-2500 of the ASME BPV Code, Section III, Division 2 (GDC 16).

U.S. EPR FSAR Tier 2, Table 6.1-1 will be revised to include the liner plate and penetration sleeve material specifications, grades and weld filler metal specifications and classifications.

U.S. EPR FSAR Tier 2, Section 3.8.1.6.4 will be revised to include the penetration sleeve materials that are listed in Table 6.1-1.

U.S. EPR FSAR Tier 2, Section 6.1.1.1 will be revised to remove the sentence about materials for the containment liner and penetrations that are identified in Section 3.8.2.

U.S. EPR FSAR Tier 2, Section 6.1.1.1 will be revised to add SFA 5.1 to the list of material specifications.

FSAR Impact:

U.S EPR FSAR Tier 2, Sections 3.8.1.6.4, 6.1.1.1 and Table 6.1-1 will be revised as described in the response and indicated on the enclosed markup.

Question 06.01.01-7:

For stainless steel components in the ESF systems, FSAR Tier 2, Section 6.1.1.1 states that unstabilized austenitic stainless steels used in ESF components is provided in the solution annealed and rapidly cooled condition to optimize the resistance to intergranular corrosion in accordance with RG 1.44. It is unclear to the staff if the EPR design follows all of the guidance provided in RG 1.44 for ESF systems. The staff requests that the applicant provide the same level of detail, regarding prevention of sensitization and intergranular corrosion of austenitic stainless steel, as that provided in FSAR Section 5.2.3.4.1. The staff suggests that the applicant provide a reference to Section 5.2.3.4.1 if this information also applies to ESF materials. In addition, the staff requests that the applicant identify if stabilized grades of stainless steels are used in ESF systems. If stabilized grades are used, provide a discussion similar to that in Section 5.2.3.4.1 or reference Section 5.2.3.4.1 if it applies.

Response to Question 06.01.01-7:

No stabilized stainless steel will be used in the engineered safety feature (ESF) systems.

Measures are taken to prevent the sensitization of the unstabilized austenitic stainless steels used in ESF components during fabrication. In addition to being solution annealed and rapidly cooled to avoid carbide formation at the grain boundaries, heat treatment parameters comply with ASME Section II. Non-sensitization of the materials can be verified by a corrosion test, in accordance with ASTM A-262, Practice A or E as required by RG 1.44. When testing of the weld heat affected zone (HAZ) is required, the tests are performed in accordance with ASTM A-262, Practice E. Austenitic stainless steel materials that are in contact with primary coolant, or are subjected to sensitizing temperatures subsequent to solution heat treatment, have a limited maximum carbon content of 0.03 percent by weight, as required by RG 1.44. No cold-worked austenitic stainless steels are used in the ESF systems.

FSAR Impact:

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

Question 06.01.01-9:

FSAR Section 6.1.1.4 states that portions of the ESF systems are insulated and portions within containment may be exposed to the insulation on the reactor coolant system (RCS) at their juncture with the RCPB, or other insulation if dislodged during an accident. The applicant further states that RCS insulation is primarily constructed of reflective stainless steel. The applicant did not provide a description of the insulation used on ESF systems other than to imply that non-metallic insulation is controlled in accordance with RG 1.36. The staff requests that the applicant modify FSAR Section 6.1.1.4 to include a description of the insulation used in ESF systems.

Response to Question 06.01.01-9:

U.S. EPR FSAR Tier 2, Section 6.1.1.4 will be revised to include a description of the insulation used in engineered safety feature (ESF) systems.

FSAR Impact:

U.S. EPR FSAR Tier 2, Section 6.1.1.4 will be revised as described in the response and indicated on the enclosed markup.

Question 06.01.01-11:

The staff was unable to locate ITAAC for the containment liner and containment liner penetrations relative to verifying compliance with ASME Codes (i.e. design, fabrication, welding and nondestructive examination). The staff requests that the applicant identify where the aforementioned information is addressed in FSAR Tier 1. If this is not addressed in Tier 1 information, modify the FSAR accordingly.

Response to Question 06.01.01-11:

U.S. EPR FSAR Tier 1, Section 2.1.1 addresses the Reactor Containment Building (RCB), including the liner plate.

- U.S. EPR FSAR Tier 1, Section 2.1.1.4.3 and associated ITAAC will be revised to provide additional details of the RCB liner plate.

- U.S. EPR FSAR Tier 1, Table 2.1.1-7, Item 4.3 will be revised to specify the 62 psig testing criteria for the RCB and liner plate.

The liner plate serves as a leak-tight membrane to prevent uncontrolled release of radioactive materials to the environment. U.S. EPR FSAR Tier 1, Table 3.3-1, Item 1.0 addresses the containment integrated leak rate test.

U.S. EPR FSAR Tier 1, Section 3.5 addresses containment isolation, including penetrations.

FSAR Impact:

U.S. EPR FSAR Tier 1, Section 2.1.1 will be revised as described in the response and indicated on the enclosed markup.

U.S. EPR Final Safety Analysis Report Markups

2.0 Arrangement

2.1 The as-installed basic configuration of the NI structures is as described in Section 2.1.1, 1.0 Description, and as shown on Figures 2.1.1-1, 2.1.1-3—Reactor Building, 2.1.1-4, and 2.1.1-5.

3.0 Key Design Features

3.1 The basic configuration of the NI structures includes: (a) an integrated contiguous barrier (b) decoupling of SBs 2 and 3 and the FB from their respective structures at their exterior walls along the entire wall length and at the SBs 2 and 3 upper ceiling and (c) SBs 2 and 3 decoupling from the RSB above elevation 0 feet, 0 inches as described in Section 2.1.1, and as shown on Figures 2.1.1-1, 2.1.1-2, 2.1.1-4, 2.1.1-6, 2.1.1-8 and 2.1.1-10—Fuel Building - View 2.

3.2 Six rib support structures, provided at the bottom of the reactor cavity, as shown on Figure 2.1.1-13—Concrete Barriers and Rib Support Structures, limit lower reactor pressure vessel head deformation due to thermal expansion and creep during severe accident mitigation.

3.3 As described in Table 2.1.1-3—Spreading Area Water Ingression Barrier a flooding wall is provided to prevent ingress of water into the core melt spreading area. This wall includes a watertight door that provides entry to the venting shaft of the spreading area.

3.4 Core melt cannot relocate to the upper containment due to the existence of concrete barriers as shown on Figure 2.1.1-13.

4.0 Mechanical Design Features, Seismic 1E Classifications

4.1 The NI site grade level is located at elevation 0 feet, 0 inches as indicated on Figures 2.1.1-7—SB 1, 2.1.1-8, 2.1.1-9—SB 4, and 2.1.1-10.

4.2 The NI as-installed basic configuration structural supports, including critical sections, are S~~s~~eismic Category I and are constructed to withstand design basis loads without loss of structural integrity and safety-related functions. The design basis loads are those loads associated with:

- Normal plant operation (including dead loads, live loads, lateral earth pressure loads, equipment loads, hydrostatic, hydrodynamic, and temperature loads).
- External events (including rain, snow, flood, tornado, tornado-generated missiles, earthquake, aircraft hazard, and explosion pressure wave).

06.01.01-11

4.3 The RCB, ~~is designed to retain its pressure boundary integrity associated with the design pressure~~ including the liner plate, maintains its pressure boundary integrity at the design pressure.

4.4 The as-installed basic configuration of the NI structures, as described in Section 2.1.1, 1.0 Description and as indicated in Table 2.1.1-1—Separation For Internal Hazards separates the four SBs and separates the FB from other NI structures so that the impact of internal

Table 2.1.1-7—Nuclear Island Inspections, Tests, Analyses, and Acceptance Criteria (~~5~~7 Sheets)

Commitment Wording		Inspection, Test or Analysis	Acceptance Criteria
4.1	The NI site grade level is located at elevation 0' 0" as indicated on Figures 2.1.1-7, 2.1.1-8, 2.1.1-9 and 2.1.1-10	An inspection of the as-installed NI site grade level will be performed.	The as-installed NI site grade level is located at elevation 0' 0" as indicated on Figures 2.1.1-7, 2.1.1-8, 2.1.1-9, and 2.1.1-10.
4.2	The NI structures are seismic Category I and are constructed to withstand design basis loads as specified in Section 2.1.1, without loss of structural integrity.	A verification inspection of the NI structures design analysis versus [illegible] records will be performed. 06.01.01-11	NI structures conform to the approved design and will withstand the design basis loads specified in Section 2.1.1, without loss of structural integrity.
4.3	The RCB, including the liner plate, maintains ~~as described in Section 2.1.1, and its penetrations as described in Section 3.5, Containment Isolation, retain their~~its pressure boundary integrity at~~associated with~~ the ~~RCB~~ design pressure	(a) Analysis of the RCB liner plate will be performed per ASME Code Section III design requirements. (b) Inspections will be conducted on the RCB liner plate to verify installation as specified on the construction drawings. (c) A Structural Integrity Test of the RCB, including the liner plate, will be performed. ~~A hydrostatic or pressure test will be performed on the components required by the ASME Code Section III to be tested.~~	(a) ASME Code Section III stress reports exist and conclude that the RCB liner plate meets ASME Code Section III design requirements. (b) The RCB liner plate has been installed as specified on the construction drawings. (c) The RCB, including the liner plate, maintains its integrity at the design pressure of at least 62 psig. ~~Components identified in Table 3.5.1-1 as ASME Code Section III, conform with the requirements of the ASME Code Section III, Division 2, Section CC-6410.~~
4.4	The as-installed basic configuration of the NI structures, as described in Section 2.1.1 and Table 2.1.1-1, separates the four	(a) An inspection of the as-installed basic configuration of the NI structures will be performed.	(a) The as-installed basic configuration of the NI structures provides separation as described in Table 2.1.1-1.

3.8.1.6.3 Tendon System Materials

Tendons

The post-tensioning tendon system consists of load-carrying and non-load-carrying components. The load-carrying components include the post-tensioning wires that make up the tendons, and anchorage components composed of bearing plates, anchor heads, wedges, and shims. Non-load-carrying components include the tendon sheathing (including sheaths, conduits, trumpet assemblies, couplers, vent and drain nipples, and other appurtenances) and corrosion prevention materials.

Materials used for the RCB post-tensioning system (including post-tensioning steel, anchorage components, and non-load-carrying and accessory components) meet the requirements of Subarticle CC-2400 of the ASME BPV Code, Section III, Division 2.

The Freyssinet C-range post-tensioning system has the following properties:

- ASTM A416 (Reference 36), Grade 270, low-relaxation tendon material.
- Tendon ultimate strength F_{pu} = 270 ksi
- Tendon minimum yield strength F_{py} = (0.9)(270) = 243 ksi
- Modulus of elasticity of tendon material E_{ps} = 28,000 ksi
- Number of strands per tendon $N_{strands}$ = 55
- Total area of each tendon A_p = 12.76 in^2

The materials used for the anchorage components are compatible with the tendon system. Tendon raceways consist of corrugated metal tubing, rigid conduit, or high-density polyethylene tubing. These components are non-structural and are sealed to prevent the intrusion of concrete during construction.

Grouting of Tendons

Cement grout for the grouted tendon system in the RCB is selected based on the testing and material requirements of the ASME BPV Code, Section III, Division 2, as amended by RG 1.136, which endorses the Regulatory Positions of RG 1.107, Qualifications for Cement Grouting for Prestressing Tendons in Containment Structures.

06.01.01-6

3.8.1.6.4 Liner Plate System and Penetration Sleeve Materials

The 0.25 inch thick liner plate is ASTM A516, Grade 55, 60, 65 or 70 material, which conforms to Subarticle CC-2500 of the ASME BPV Code, Section III, Division 2 (GDC

16). Thickened liner plates are used at penetrations, brackets, and embedded assemblies.

06.01.01-6

Penetration assemblies and appurtenances that are either not backed by concrete or are embedded in concrete and surrounded by a compressible material to provide local flexibility conform to the material requirements of Subsection NE of the ASME BPV Code, Section III, Division 1 (GDC 16). Penetration sleeve materials are listed in Table 6.1-1.

Welding materials conform to the requirements of ANSI/AWS D1.1 or ANSI/AWS D1.6 except as modified by ANSI/AISC N690, Sections Q1.17.1 and Q1.17.2.1. The compatibility of filler metal with base metal is specified in Table 3.1 of ANSI/AWS D1.1.

Materials used for the carbon steel liner plate, carbon steel and low alloy steel attachments, and appurtenances subject to ASME BPV Code Division 2 requirements, meet the fracture toughness requirements of Subsection CC-2520 of the ASME BPV Code, Section III, Division 2.

Materials used in ASME Division 1 attachments and appurtenances meet the fracture toughness requirements of Subsection 2300 of the ASME BPV Code, Section III, Division 1.

3.8.1.6.5 Steel Embedments

Steel embedment materials conform to the requirements of Subsection CC-2000 of the ASME BPV Code, Section III, Division 2.

3.8.1.6.6 Corrosion Retarding Compounds

Corrosion retarding compounds used for the RCB are described in Section 6.1.2.

3.8.1.6.7 Quality Control

In addition to the quality control measures addressed in Section 3.8.1.6, refer to Chapter 17 for a description of the quality assurance program for the U.S. EPR (GDC 1).

3.8.1.6.8 Special Construction Techniques

Special techniques are not used for construction of the RCB. Modular construction methods are used to the extent practical for prefabricating portions of the containment liner, equipment hatch, airlocks, penetrations, reinforcing steel, tendon conduits, and concrete formwork. Such methods have been used extensively in the construction industry. Rigging is pre-engineered for heavy lifts of modular sections. Permanent

accelerate aging, or increase susceptibility to stress corrosion cracking. Process controls during plant construction are covered under the appropriate quality assurance program (Section 17.2).

Section 3.2 identifies the quality groups assigned to ESF components. Materials for Quality Group A, Quality Group B, and Quality Group C components meet the requirements of Article NB-2000, Article NC-2000 and Article ND-2000 respectively, of Division 1 of Reference 1.

6.1.1.1 Materials Selection and Fabrication

Table 6.1-1—Pressure-Retaining Material Specifications for Engineered Safety Features lists the fabrication materials used in the principal pressure-retaining ESF components. Materials for the ~~containment liner and penetrations are identified in Section 3.8.2, and materials for the~~ main control room air conditioning system are identified in Section 9.4.1. Base and welding materials for the SIS/RHRS, in-containment refueling water storage tank system (IRWST), extra borating system (EBS), and annulus ventilation system are austenitic stainless steel and ferritic steel. Materials are selected for their compatibility with reactor coolant and borated water from the in-containment refueling water storage tank and the extra borating system as required by paragraph NX-2160 and subsubarticle NX-3120 as appropriate for the assigned ASME Code Class. Materials exposed to core coolant or borated water are corrosion resistant austenitic stainless steel materials; therefore, they have a corrosion allowance of 0.00 in. Materials that are not exposed to core coolant or borated water may be ferritic materials, which have a corrosion allowance of 1/16 in. Pressure-retaining ESF materials are selected from material specifications permitted by Division 1 of Reference 1 as identified in Parts A, B, and C of the ASME BPV Code Section II (Reference 2). Acceptable Code Cases described by RG 1.84 may be used with the above ASME specifications. Section 5.2.1.1 identifies the design baseline ASME Code edition and addenda.

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Unstabilized austenitic stainless steel used in ESF component fabrication is provided in the solution annealed and rapidly cooled condition to optimize the resistance to intergranular corrosion in accordance with RG 1.44. Sensitized austenitic stainless steel material is not used in the ESF components. The delta ferrite content of the weld filler material is controlled as required by RG 1.31. A COL applicant that references the U.S. EPR design certification will review the fabrication and welding procedures and other QA methods of ESF component vendors to verify conformance with RGs 1.44 and 1.31. Austenitic stainless steel base metal has a limited carbon content not exceeding 0.03 wt%.

Austenitic stainless steels are used extensively throughout ESF systems in current operating nuclear power plants, including locations that may be exposed to coolant during a LOCA with minimum degradation. These materials are chosen for their

As discussed above, ESF components are fabricated primarily from austenitic stainless steels, which are not susceptible to corrosion when exposed to these ESF fluids. For ferritic steel materials, protective coatings are applied inside containment, as addressed in Section 6.1.2.

The use of aluminum and zinc in components in containment that could be exposed to postaccident conditions is minimized to avoid hydrogen gas generation. Combustible gas control in containment through the use of passive autocatalytic recombiners is addressed in Section 6.2.5.

Materials used in the fabrication of ESF components are designed, qualified, and procured to withstand postulated accident environments.

6.1.1.3 Component and Systems Cleaning

To prevent stress corrosion cracking, austenitic stainless steel materials used in the fabrication, installation, and testing of ~~nuclear steam supply~~ESF components and systems are handled, protected, stored, and cleaned according to recognized and accepted methods, as identified in the applicable procedures and specifications. As applicable, these procedures and specifications supplement the equipment specifications and purchase order requirements of the individual austenitic stainless steel components or systems that are procured for the ~~nuclear steam supply~~ESF components and systems, regardless of the ASME Code classification. The procedures and specifications follow the guidance of RG 1.37 and RG 1.44.

Where minor leaks are anticipated (e.g., valve packing and pump seals), only materials compatible with the coolant are used. In these areas, the ferritic materials will show increased general corrosion rates. However, component integrity can be verified because this corrosion can be readily observed during the inservice visual or nondestructive inspection programs.

6.1.1.4 Thermal Insulation

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Portions of the ESF systems are insulated and portions within containment may be exposed to the insulation on the reactor coolant system (RCS) at their juncture with the RCPB, or other insulation if dislodged during an accident. The RCS insulation is primarily constructed of reflective stainless steel. Similarly, ESF systems insulation, from RCS to the first reactor coolant pressure boundary (RCPB) isolation valves, is primarily constructed of reflective stainless steel. Additional insulation for ESF systems inside containment, where required for plant personnel protection, is primarily constructed of reflective stainless steel. ESF systems insulation outside containment, where required for plant personnel protection, is primarily constructed of non-metallic insulation. The use of non-metallic insulation is controlled in accordance with RG 1.36. To prevent stress corrosion cracking, non-metallic insulation is designed with low leachable chloride and fluoride concentrations that do

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Table 6.1-1—Pressure-Retaining Material Specifications for Engineered Safety Features
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Component	Material
Reactor Building Liner and Penetrations	
All	Refer to Sections ~~3.8.2~~3.8.1.6.4 and 3.8.2
Safety Injection System/Residual Heat Removal System	
Piping	~~Austenitic Stainless Steel[1]~~ SA-312 Grade TP304L [1, 2, 4] SA-312 Grade TP316LN [1, 2, 4] SA-106 Grade B
Fittings	~~Austenitic Stainless Steel[1]~~ SA-403 Grade WP304L Class S [1, 2] SA-403 Grade WP316LN [1] SA-182 Grade F304L [1] SA-182 Grade F316L [1] SA-182 Grade F316LN [1]
Valves	~~Austenitic Stainless Steel[1]~~ SA-182 Grade F304 [1, 2] SA-182 Grade F304L [1] SA-182 Grade F316 [1, 2] SA-182 Grade F316L [1] SA-351 Grade CF3 SA-351 Grade CF3A SA-351 Grade CF3M SA-479 Type 304 [1, 2] SA-479 Type 304L [1] SA-479 Type 316 [1, 2] SA-479 Type 316L [1]
Accumulators	~~Austenitic Stainless Steel[1] - Type 304L~~ SA-182 Grade F304 [1, 2] SA-182 Grade F304L [1] SA-240 Type 304 [1, 2] SA-240 Type 304L [1] SA-336 Grade F304 [1, 2] SA-336 Grade F304L [1, 2] SA-479 Type 304 [1, 2] SA-479 Type 304L [1]

Table 6.1-1—Pressure-Retaining Material Specifications for Engineered Safety Features
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Component	Material
Low Head Safety Injection Heat Exchangers ~~Tube, t~~Tube ~~s~~Sheet, and ~~c~~Channel ~~h~~Head (primary side) ~~Shell (secondary side)~~	SA-182 Grade F304 [1, 2] SA-182 Grade F304L [1] SA-182 Grade F316 [1, 2] SA-182 Grade F316L [1] SA-240 Type 304 [1, 2] SA-240 Type 304L [1] SA-240 Type 316 [1, 2] SA-240 Type 316L [1] SA-336 Grade F304 [1, 2] SA-336 Grade F304L [1, 2] SA-336 Grade F316 [1, 2] SA-336 Grade F316L [1, 2] SA-479 Type 304 [1, 2] SA-479 Type 304L [1] SA-479 Type 316 [1, 2] SA-479 Type 316L [1] ~~Austenitic Stainless Steel[1]~~ ~~Ferritic Steel~~
Low Head Safety Injection ~~and Medium Head Safety Injection pumps~~Heat Exchangers Tube (primary side)	~~Austenitic Stainless Steel[1]~~ SA-213 Grade TP304 [1, 2] SA-213 Grade TP304L [1, 2]
Low Head Safety Injection Heat Exchangers Shell (secondary side)	SA-508 Grade 3 Class 1 or Class 2 SA-533 Type B Class 1 or Class 2 [3]

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Table 6.1-1—Pressure-Retaining Material Specifications for Engineered Safety Features
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Component	Material
Low Head Safety Injection Pump	SA-351 Grade CF3 SA-182 Grade F304 [1, 2] SA-182 Grade F304L [1] SA-336 Grade F304 [1, 2] SA-336 Grade F304L [1, 2] SA-564 Type 630 [3] SA-194 Grade 6 [3] SA-240 Type 304 [1, 2] SA-240 Type 304L [1] SA-240 Type 316 [1, 2] SA-240 Type 316L [1] SA-193 Grade B8 [1] SA-193 Grade B8M [1] SA-194 Grade 8 [1] SA-194 Grade 8M [1]
Medium Head Safety Injection Pump	SA-182 Grade F304 [1, 2] SA-182 Grade F304L [1] SA-336 Grade F304 [1, 2] SA-336 Grade F304L [1, 2] SA-453 Grade 660 SA-564 Type 630 [3] SA-194 Grade 6 [3] SA-240 Type 304 [1, 2] SA-240 Type 304L [1] SA-240 Type 316 [1, 2] SA-240 Type 316L [1] SA-193 Grade B8 [1] SA-193 Grade B8M [1] SA-194 Grade 8 [1] SA-194 Grade 8M [1]
Welding material	
• Ferritic	~~ASME~~ SFA 5.5, 5.17, 5.18, 5.20, 5.23, 5.28, and 5.29
• Austenitic Stainless Steel	~~ASME~~ SFA 5.4 E308, E309, E316 ~~,~~ SFA 5.9~~, and~~ ER308, ER309, ER316 SFA 5.22 E308, E309, E316

Table 6.1-1—Pressure-Retaining Material Specifications for Engineered Safety Features
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Component	Material
• Ni-Cr-Fe	~~ASME~~ SFA 5.11 ~~and~~ ENiCrFe-7 SFA5.14 ERNiCrFe-7, ERNiCrFe-7A
In-Containment Refueling Water Storage Tank System	
Liner	~~Austenitic Stainless Steel[1]~~ SA-182 Grade F304 [1, 2] SA-182 Grade F304L [1] SA-182 Grade F316 [1, 2] SA-182 Grade F316L [1] SA-240 Type 304 [1, 2] SA-240 Type 304L [1] SA-240 Type 316 [1, 2] SA-240 Type 316L [1] SA-479 Type 304 [1, 2] SA-479 Type 304L [1] SA-479 Type 316 [1, 2] SA-479 Type 316L [1]
Process piping	~~Austenitic Stainless Steel[1]~~ SA-312 Grade TP304L [1, 2, 4]
Fittings	~~Austenitic Stainless Steel[1]~~ SA-403 Grade WP304L Class S [1, 2] SA-182 Grade F304L [1]
Valves	~~Austenitic Stainless Steel[1]~~ SA-182 Grade F304 [1, 2] SA-182 Grade F304L [1] SA-182 Grade F316 [1, 2] SA-182 Grade F316L [1] SA-351 Grade CF3 SA-351 Grade CF3A SA-351 Grade CF3M SA-479 Type 304 [1, 2] SA-479 Type 304L [1] SA-479 Type 316 [1, 2] SA-479 Type 316L [1]

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Table 6.1-1—Pressure-Retaining Material Specifications for Engineered Safety Features
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Component	Material
Welding material (Austenitic Stainless Steel)	~~ASME SFA 5.4, 5.9, and 5.22~~ SFA 5.4 E308, E309, E316 SFA 5.9 ER308, ER309, ER316 SFA 5.22 E308, E309, E316
Extra Borating System	
Tanks	~~Austenitic Stainless Steel[1]~~ SA-182 Grade F304 [1, 2] SA-182 Grade F304L [1] SA-182 Grade F316 [1, 2] SA-182 Grade F316L [1] SA-240 Type 304 [1, 2] SA-240 Type 304L [1] SA-240 Type 316 [1, 2] SA-240 Type 316L [1] SA-479 Type 304 [1, 2] SA-479 Type 304L [1] SA-479 Type 316 [1, 2] SA-479 Type 316L [1]
Process piping	~~Austenitic Stainless Steel[1]~~ SA-312 Grade TP304L [1, 2, 4]
Fittings	~~Austenitic Stainless Steel[1]~~ SA-403 Grade WP304L Class S [1, 2] SA-182 Grade F304L [1]
Valves	~~Austenitic Stainless Steel[1]~~ SA-182 Grade F304 [1, 2] SA-182 Grade F304L [1] SA-182 Grade F316 [1, 2] SA-182 Grade F316L [1] SA-351 Grade CF3 SA-351 Grade CF3A SA-351 Grade CF3M SA-479 Type 304 [1, 2] SA-479 Type 304L [1] SA-479 Type 316 [1, 2] SA-479 Type 316L [1]

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Table 6.1-1—Pressure-Retaining Material Specifications for Engineered Safety Features
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Component	Material
Pumps	~~Austenitic Stainless Steel[1]~~ SA-182 Grade F304 [1, 2] SA-182 Grade F304L [1] SA-336 Grade F304 [1, 2] SA-336 Grade F304L [1, 2] SA-453 Grade 660 SA-193 Grade B6 SA-194 Grade 6 [3]
Welding material (Austenitic Stainless Steel)	~~ASME SFA 5.4, 5.9, and 5.22~~ SFA 5.4 E308, E309, E316 SFA 5.9 ER308, ER309, ER316 SFA 5.22 E308, E309, E316

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Table 6.1-1—Pressure-Retaining Material Specifications for Engineered Safety Features
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Component	Material
Annulus Ventilation System	
Ducts (accident trains)	~~Austenitic Stainless Steel[1]~~ ASTM A-240 Type 304 [1, 2]
Ducts (normal operation trains)	~~Ferritic Steel~~ ASTM A-36 ASTM A-653
Main control room air conditioning system	
All	Refer to Section 9.4.1
Reactor Building Liner and Penetration Sleeves	
Liner Plate	Carbon Steel SA-516 Grades 55, 60, 65 or 70 (ASME Section III, Division 2, Subsection CC)
Penetration Sleeves • Pipe Material	• Carbon Steel SA-333 Grade 6, SA-106 Grades A, B or C • Austenitic Stainless Steel SA-312 Grades TP304 or TP 304L (ASME Section III, Division 1, Subsection NE)
• Plate Material	• Carbon Steel SA-516, Gr. 55, 60, 65 or 70, and SA-537 Class 1 or 2 (ASME Section III, Division 1, Subsection NE)

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Table 6.1-1—Pressure-Retaining Material Specifications for Engineered Safety Features
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Component	Material
Welding Material	
• Carbon Steel	• E70XX (AWS D1.1, SFA-5.1) • ER70S-X or E70C-XC (AWS D1.1, SFA-5.18) • E7XT-X (AWS D1.1, SFA-5.20)
• Low Alloy Steel	• E80XX-X (AWS D1.1, SFA-5.5) • ER80S-XXX or E80C-XXX (AWS D1.1, SFA-5.28) • E8XTX-X (AWS D1.1, SFA-5.29)
• Stainless Steel	• E308L-XX, E309L-XX or E316L-XX (AWS D1.6, SFA-5.4) • ER308L, ER309L or ER316L (AWS D1.6, SFA-5.9) • E308LTX-X, E309LTX-X or E316LTX-X (AWS D1.6, SFA-5.22)

Notes:

1. Solution annealed and rapidly cooled.
2. Carbon not exceeding 0.03 wt%.
3. Quenched and tempered.
4. Piping should be seamless.

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