MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #1 (AI 6-14.1)

In FSAR Section 6.1.1, page 6.1-1, the applicant states:

> ESF pressure-retaining materials meet the applicable material requirements of ASME Section III (Reference 1) and conform to the applicable ASME Section II (Reference 2) material specifications. The material specifications for ESF pressure-retaining materials meet the requirements of ASME Section III, Class 2; Article NC-2000 for Quality Group B, ASME Section III, Class 3; Article ND-2000 for Quality Group C; and ASME Section III for containment pressure boundary components. The materials used in containment penetrations meet the requirements of ASME Section III, Division 1, Articles NC-2000 or NE-2000.

The staff understands this paragraph to state the material will meet the requirements of Section III of the ASME Code. Conformance to the general provisions and methodology of the ASME Code should be consistent between all Quality Class A, B, and C components. As such, the discussion on conformance should be relocated to one centralized location, FSAR Section 5.2.1, “Conformance with 10 CFR 50.55a” and should be cited by other applicable sections.

Please delete the passage above and replace with the following:

> The ESF materials meet the requirements of the ASME Code as described in FSAR Section 5.2.1.

The staff will also address this in its Issue List for FSAR Section 5.2.1.

Response

DCD Tier 2, Section 6.1.1 will be revised to eliminate the cited statement, and replace the wording with a pointer to Section 5.2.1 of DCD Tier 2, as shown in the attachment associated with this response.

Impact on DCD

The DCD will be revised as shown in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

AI 6-14_6.1.1_#1 Attachment(1/1)

6.1 Engineered Safety Features Materials

Material selection and fabrication of ESF components are described in this section. The materials used in ESF systems are selected for compatibility with core cooling coolants and containment spray solution.

6.1.1 Metallic Materials

The ASME Code that applies to the design and fabrication of the piping and components is specified in Chapter 3. For materials, later editions or addenda of the ASME Code are used as permitted by the ASME Code if the edition or addenda are approved by 10 CFR 50.55a.

6.1.1.1 Materials Selection and Fabrication

ESF materials are selected for compatibility with core cooling coolants and containment spray solution.

The ESF materials meet the requirements of the ASME Code as described in Section 5.2.1.

Issue#1

Principal ESF pressure-retaining materials are listed in Table 6.1-1. ~~ESF pressure-retaining materials meet the applicable material requirements of ASME Section III (Reference 1) and conform to the applicable ASME Section II (Reference 2) material specifications. The material specifications for ESF pressure-retaining materials meet the requirements of ASME Section III, Class 2; Article NC-2000 for Quality Group B, ASME Section III, Class 3; Article ND-2000 for Quality Group C; and ASME Section III for containment pressure boundary components. The materials used in containment penetrations meet the requirements of ASME Section III, Division 1, Articles NC-2000 or NE-2000.~~

Principal ESF materials inside the containment that are exposed to the containment spray solution are listed in Table 6.1-2. These materials are chosen to be compatible with the chemical solutions in the containment spray. The materials used in ESF component construction are reviewed for acceptability prior to release for material procurement. Corrosion of materials in the containment is minimized in accordance with the recommendations of U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide (RG)

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #2 (AI 6-14.2)

In FSAR Section 6.1.1, on pages 6.1-1 and 6.1-2, the applicant states:

> Corrosion of materials in the containment is minimized in accordance with the recommendations of U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide (RG) 1.7 (Reference 3) by restricting the use of zinc and aluminum and prohibiting the use of mercury.

(A) The staff believes that this statement relates to hydrogen generation. Hydrogen generation is addressed in FSAR Section 6.2.5, "Combustible Gas Control in Containment." Confirm if this topic is addressed in depth in FSAR Section 6.2.5 or revise FSAR Section 6.1.1 to describe the scope of what this paragraph addresses.

(B) Regarding the statement "prohibiting the use of mercury," it is unclear to the staff what statement has to do with either limiting corrosion and/or hydrogen generation. Revise FSAR Section 6.1.1 to explain why a prohibition on the use of mercury is noted.

(C) Regarding the statement, "restricting the use of zinc," FSAR Section 5.2.3.2.1 states, "A soluble zinc compound (Zn-64 < 1.0 wt%) may be added to the reactor coolant for the purpose of radiation field reduction and mitigation of PWSCC initiation." Revise FSAR Section 6.1.1 to clarify the "restricting the use of zinc" statement in light the apparent plan to specifically add zinc to the reactor coolant loop. Note that other design certification (DC) applications have removed generic restrictions on zinc due to its use in reactor coolant chemistry.

Response

(A) DCD Tier 2 Section 6.1.1.1 will be revised to clarity the cited statement, as shown in the attachment associated with this response.

(B) Mercury could react with aluminum, stainless steel, NiCrFe alloy 690, and alloys containing copper. DCD Tier 2 Section 6.1.1.1 will be revised to clarify the cited statement, as shown in the attachment associated with this response.

(C) APR1400 does not have a zinc addition program. So, the relevant description of zinc injection will be deleted in Section 5.2.3.2.1. Please refer to the answer to Issue #3 regarding Section 5.2.3.

Impact on DCD

The DCD will be revised as shown in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

6.1 Engineered Safety Features Materials

Material selection and fabrication of ESF components are described in this section. The materials used in ESF systems are selected for compatibility with core cooling coolants and containment spray solution.

6.1.1 Metallic Materials

The ASME Code that applies to the design and fabrication of the piping and components is specified in Chapter 3. For materials, later editions or addenda of the ASME Code are used as permitted by the ASME Code if the edition or addenda are approved by 10 CFR 50.55a.

6.1.1.1 Materials Selection and Fabrication

ESF materials are selected for compatibility with core cooling coolants and containment spray solution.

Principal ESF pressure-retaining materials are listed in Table 6.1-1. ESF pressure-retaining materials meet the applicable material requirements of ASME Section III (Reference 1) and conform to the applicable ASME Section II (Reference 2) material specifications. The material specifications for ESF pressure-retaining materials meet the requirements of ASME Section III, Class 2; Article NC-2000 for Quality Group B, ASME Section III, Class 3; Article ND-2000 for Quality Group C; and ASME Section III for containment pressure boundary components. The materials used in containment penetrations meet the requirements of ASME Section III, Division 1, Articles NC-2000 or NE-2000.

Principal ESF materials inside the containment that are exposed to the containment spray solution are listed in Table 6.1-2. These materials are chosen to be compatible with the chemical solutions in the containment spray. The materials used in ESF component construction are reviewed for acceptability prior to release for material procurement. ~~Corrosion of materials~~ in the containment is minimized in accordance with the recommendations of U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide (RG)

Hydrogen gas generation

1.7 (Reference 3) by restricting the use of zinc and aluminum. ~~and prohibiting the use of mercury.~~ The use of mercury shall be prohibited inside containment to prevent reactions with aluminum, stainless steel, NiCrFe alloy 690, and alloys containing copper.

The integrity of the safety-related components of the ESF systems is maintained during all stages of component manufacture and reactor construction as follows:

a. Significant sensitization during fabrication and assembly of austenitic stainless steel components of ESF systems is avoided as follows:

1) All raw austenitic stainless steel, both wrought and cast, used to fabricate pressure-retaining components of the ESF is supplied in the annealed condition as specified in ASME Section II. ESF systems do not use furnace-sensitized materials.

2) Duplex, austenitic stainless steels containing certain quantity of delta ferrite (weld metal, cast metal, weld deposit overlay) are not considered unstabilized because these alloys do not sensitize (i.e., form a continuous network of chromium-iron carbides). Alloys in this category are:

CF3, CF3M, CF8, CF8M	Cast stainless steels (delta ferrite) are controlled to 8 % to 30 %, 8 % to 20 % for normal operating temperatures above 260 °C (500 °F) or 8 % to 14 % for high molybdenum content (not less than 2 %) statically cast stainless steels with normal operating temperatures above 260 °C (500 °F)
308, 309, 312, 316	Singly and combined stainless steel weld filler metals (control of weld filler metal delta ferrite content is described in Subsection 5.2.3.4)

3) In duplex austenitic/ferritic alloys, chromium-iron carbides are precipitated preferentially at the ferrite/austenite interface during exposure to temperatures ranging from 427 to 816 °C (800 to 1,500 °F). This precipitate morphology precludes intergranular penetrations associated with sensitized Type 300 series stainless steels exposed to oxygenated or otherwise faulted environments.

Response to Action Item 5-9 Sections 5.2.3 and 9.3.4

MCB Issue List Regarding APR-1400, FSAR Sections 5.2.3 and 9.3.4

Issue #3 (AI 5-9.3)

APR1400 FSAR Section 5.2.3.2.1 states "A soluble zinc compound (Zn-64 < 1.0 wt%) may be added to the reactor coolant for the purpose of radiation field reduction and mitigation of PWSCC initiation." However, no explanation is provided on the limit, or the sampling and surveillance program for this addition. Industry experience with zinc addition in PWRs shows that, depending on the core duty, zinc addition typically leads to thinner, more evenly distributed crud on fuel.

Revise FSAR Section 5.2.3.2.1 to include a description of the zinc addition, its impact on fuel (High Duty Core Index), operating experience considered, and the fuel surveillance program to be implemented to monitor the effects of the zinc addition.

Response

APR1400 does not have a zinc addition program. So, the relevant description of zinc injection will be deleted in FSAR Section 5.2.3.2.1 as follow:

Delete

"A soluble zinc compound (Zn-64 < 1.0 wt%) may be added to the reactor coolant for the purpose of radiation field reduction and mitigation of PWSCC initiation" in FSAR Section 5.2.3.2.1."

Impact on DCD

DCD 5.2.3.2.1 will be revised as indicated on the attached markup.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specification.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical or Environmental Reports.

Two chemicals (hydrazine and hydrogen) are added to the reactor coolant to control dissolved oxygen (DO). Hydrazine is maintained in the reactor coolant at 1.5 times of DO concentration whenever the reactor coolant temperature is below 65.6 °C (150 °F). At power operation, DO concentration is limited by maintaining the excess dissolved hydrogen in the coolant. To minimize the effect of crud deposition on the reactor core heat transfer surfaces, lithium-7 hydroxide is added. Lithium-7 hydroxide produces pH conditions within the reactor coolant at operating temperatures that reduce the corrosion product solubility and hence the dissolved crud inventory in the circulating reactor coolant. The lithium concentration is maintained as shown in Tables 9.3.4-1B and 9.3.4-1C. Subsection 9.3.4 provides additional information on the water chemistry limits applicable to the RCS. For example, information on the control of suspended solid and demineralizer performance is described in Subsections 9.3.4.2.8.5 and 9.3.4.2.7, respectively.

A soluble zinc compound (Zn-64 < 1.0 wt%) may be added to the reactor coolant for the purpose of radiation field reduction and mitigation of PWSCC initiation.

Delete

5.2.3.2.2 Materials of Construction Compatibility with Reactor Coolant

The construction materials used in the RCPB that are in contact with the reactor coolant are designated in Table 5.2-2. These materials are selected to minimize corrosion and have demonstrated satisfactory performance in existing operating reactor plants. The materials used for the RCPB conform with the requirements of GDC 4 of 10 CFR Part 50, Appendix A. Conformance of the fabrication and processing of austenitic stainless steels with NRC RG 1.44 (Reference 21) is shown in Subsection 5.2.3.4.1. Stainless steel or nickel-chromium-iron cladding is applied for corrosion resistance to all ferritic low-alloy and carbon steel surfaces that come into contact with the reactor coolant.

The joints between the austenitic safe ends and low alloy or carbon steel nozzles are made by welding with Alloy 690 equivalent weld materials. Austenitic stainless steel and A690 base materials that are used for primary pressure-retaining applications are supplied in the solution-annealed and thermally treated condition, respectively.

Cobalt content is restricted to as low a level as practicable in metallic materials that are in contact with reactor coolant and that are in stainless steel or nickel-based alloy components

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #3 (AI 6-14.3)

In FSAR Section 6.1.1, on pages 6.1-2, 6.1-3, and 6.1-4, the DC application discusses strategies for preventing sensitization of austenitic stainless steels. The discussion is similar but has less detail than is provided in FSAR, Section 5.2.3, “Reactor Coolant Pressure Boundary Materials.”

The staff would expect that the controls used for preventing the sensitization of austenitic stainless steels would be the same whether they are being used for reactor coolant pressure boundary (RCPB) or ESF materials. If so, revise FSAR Section 6.1.1 to delete specific discussion of controls to prevent austenitic stainless steel sensitization and state:

> “Sensitization shall be avoided as described in FSAR Section 5.2.3.”

The staff will also address this in its Issue List for FSAR Section 5.2.3.

Response

DCD Tier 2, Section 6.1.1 will be revised to cite Section 5.2.3 regarding the sensitization of austenitic stainless steels, as shown in the attachment associated with this response.

Impact on DCD

The DCD will be revised as shown in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

AI 6-14_6.1.1_#3

Attachment(1/2)

1.7 (Reference 3) by restricting the use of zinc and aluminum and prohibiting the use of mercury.

The integrity of the safety-related components of the ESF systems is maintained during all stages of component manufacture and reactor construction as follows:

~~a. Significant sensitization during fabrication and assembly of austenitic stainless steel components of ESF systems is avoided as follows:~~

~~1) All raw austenitic stainless steel, both wrought and cast, used to fabricate pressure-retaining components of the ESF is supplied in the annealed condition as specified in ASME Section II. ESF systems do not use furnace-sensitized materials.~~

~~2) Duplex, austenitic stainless steels containing certain quantity of delta ferrite (weld metal, cast metal, weld deposit overlay) are not considered unstabilized because these alloys do not sensitize (i.e., form a continuous network of chromium-iron carbides). Alloys in this category are:~~

~~CF3, CF3M, CF8, CF8M~~	~~Cast stainless steels (delta ferrite) are controlled to 8 % to 30 %, 8 % to 20 % for normal operating temperatures above 260 °C (500 °F) or 8 % to 14 % for high molybdenum content (not less than 2 %) statically cast stainless steels with normal operating temperatures above 260 °C (500 °F)~~
~~308, 309, 312, 316~~	~~Singly and combined stainless steel weld filler metals (control of weld filler metal delta ferrite content is described in Subsection 5.2.3.4)~~

~~3) In duplex austenitic/ferritic alloys, chromium-iron carbides are precipitated preferentially at the ferrite/austenite interface during exposure to temperatures ranging from 427 to 816 °C (800 to 1,500 °F). This precipitate morphology precludes intergranular penetrations associated with sensitized Type 300 series stainless steels exposed to oxygenated or otherwise faulted environments.~~

a. Sensitization of austenitic stainless steel shall be avoided as described in Section 5.2.3.

Issue#3 and Issue#5, Item 1

Issue#3

4) ~~The delta ferrite content of austenitic stainless steel weld metal is controlled in accordance with the recommendations of NRC RG 1.31 (Reference 4), as described in Subsection 5.2.3.4. Austenitic stainless steel materials subjected to sensitizing conditions are tested in accordance with NRC RG 1.44. Non-sensitization of austenitic stainless steel materials are verified in accordance with ASTM A262 (Reference 5), Practices A or E. The sensitization of heat-affected zone (HAZ) for austenitic stainless steels is avoided by careful control of the following conditions:~~

  a) ~~Maximum heat input: 23.6 kJ/cm (60 kJ/in)~~

  b) ~~Maximum interpass temperature: 177 °C (350 °F)~~

  d) ~~Maximum carbon content: 0.065 percent~~

b. Contaminants that are capable of causing stress corrosion cracking are controlled as follows:

1) Cleanliness and contamination protection is provided for components that are controlled for contamination during fabrication, shipment, and storage as recommended in ASME NQA-1 (Reference 6).

2) Contamination of Type 300 series austenitic stainless steels by compounds that can alter the physical or metallurgical structure and properties of the material is avoided during all stages of fabrication. Painting of Type 300 series stainless steels is prohibited. Internal surfaces of completed components are cleaned to the extent that grit, scale, corrosion products, grease, oil, wax, gum, adhered or embedded dirt, and extraneous material are not visible to the unaided eye. Degreasing solvents such as acetone, isopropyl alcohol, and trisodium phosphate (TSP) are used on metallic surfaces. Water used for cleaning is inhibited with 30 to 100 ppm hydrazine. The specification for water quality is in accordance with Table 3.4.1 of ASME NQA-1 (Reference 6), Subpart 2.1. To prevent halide-induced intergranular corrosion that can occur in an aqueous environment with significant quantities of dissolved oxygen, flushing water is inhibited through

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #4 (AI 6-14.4)

FSAR Section 6.1.1 does not address whether the CF3/CF3M/CF8/CF8M stainless steel castings used in ESF systems are susceptible to thermal embrittlement.

10 CFR Part 50, Appendix A, General Design Criteria 4 requires SSCs to be designed and fabricated to accommodate the effects of environmental conditions during normal, off normal, and accident conditions. The staff seeks clarification of the operating conditions of the ESF system to determine whether thermal embrittlement has been addressed for ESF system materials.

Revise FSAR Section 6.1.1 to address the potential for thermal embrittlement of cast austenitic stainless steel materials or why it is not a concern based on ESF system service temperatures.

Response

FSAR 6.1.1 will be revised to refer FSAR Section 5.2.3 for avoidance of sensitization. Please refer to answers in Issue#3 for Section 6.1.1 and Issue #9 for Section 5.2.3.

Impact on DCD

The DCD will be revised as shown in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA

Impact on Technical Specifications

There is no impact on the Technical Specification

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Reports

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #5 (AI 6-14.5)

In FSAR Section 6.1.1, starting on page 6.1-2 and ending on 6.1-4, the applicant states:

> The integrity of safety related components of the ESF systems is maintained during all stages of component manufacture and reactor construction as follows:
>
> a. Significant sensitization during fabrication…
>
> b. Contaminates that are capable of causing…
>
> c. Cold-worked austenitic stainless steel is not…
>
> d. All non-metallic insulation materials …
>
> e. When nickel-chromium-iron alloys…
>
> f. Fracture toughness properties of…
>
> g. Grinding is performed with resin…

The staff notes several items:

1. Item A should be removed and replaced with a citation to Section 5.2.3 (as discussed in Issue 3).

2. Items B and G relate to controls on materials. These should be moved to FSAR Section 6.1.1.2.2.

3. Item F should be deleted for the reasons stated in Issue 1.

4. The items on the list should follow the topic of, “Maintaining [integrity] during all stages of manufacture and construction.” Items C, D, and E relate to design decisions. As such they should not be in the list and should have their own paragraphs.

Attached is a document showing a clearer format for this section. The document will also addresses Issue 6. Revise FSAR 6.1.1 in accordance with the attached document.

Response

Item 1: Paragraph a. will be revised to refer to Section 5.2.3, as shown in the attachment associated with this response.

Item 2: Section 6.1.1.2.2 Controls for Ferritic Steel and Stainless Steel is a subsection of Section 6.1.1.2, “Composition and Compatibility of Core Cooling Coolants and Containment Sprays”. Paragraphs B and G relate to control of materials that are described in Section 6.1.1.1. “Materials Selection and Fabrication” as general requirements for ESF components. Therefore, KHNP does not wish to move paragraphs B and G from Section 6.1.1.1 to 6.1.1.2.2.

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Item 3: Paragraph f. will be removed as shown in the attachment associated with this response.

Item 4: Material selection and fabrication of ESF components are described in Section 6.1.1.1, as stated in Section 6.1, and material selection is a design decision. Therefore, paragraphs c, d, and e, related to design decisions, need not to be moved to their own paragraphs.

Impact on DCD
The DCD will be revised as shown in the attachment associated with this response.

Impact on PRA
There is no impact on the PRA.

Impact on Technical Specifications
There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical, or Environmental Report.

1.7 (Reference 3) by restricting the use of zinc and aluminum and prohibiting the use of mercury.

The integrity of the safety-related components of the ESF systems is maintained during all stages of component manufacture and reactor construction as follows:

~~a. Significant sensitization during fabrication and assembly of austenitic stainless steel components of ESF systems is avoided as follows:~~

~~1) All raw austenitic stainless steel, both wrought and cast, used to fabricate pressure-retaining components of the ESF is supplied in the annealed condition as specified in ASME Section II. ESF systems do not use furnace-sensitized materials.~~

~~2) Duplex, austenitic stainless steels containing certain quantity of delta ferrite (weld metal, cast metal, weld deposit overlay) are not considered unstabilized because these alloys do not sensitize (i.e., form a continuous network of chromium-iron carbides). Alloys in this category are:~~

~~CF3, CF3M, CF8, CF8M~~	~~Cast stainless steels (delta ferrite) are controlled to 8 % to 30 %, 8 % to 20 % for normal operating temperatures above 260 °C (500 °F) or 8 % to 14 % for high molybdenum content (not less than 2 %) statically cast stainless steels with normal operating temperatures above 260 °C (500 °F)~~
~~308, 309, 312, 316~~	~~Singly and combined stainless steel weld filler metals (control of weld filler metal delta ferrite content is described in Subsection 5.2.3.4)~~

~~3) In duplex austenitic/ferritic alloys, chromium-iron carbides are precipitated preferentially at the ferrite/austenite interface during exposure to temperatures ranging from 427 to 816 °C (800 to 1,500 °F). This precipitate morphology precludes intergranular penetrations associated with sensitized Type 300 series stainless steels exposed to oxygenated or otherwise faulted environments.~~

a. Sensitization of austenitic stainless steel shall be avoided as described in Section 5.2.3.

Issue#3 and Issue#5, Item 1

additions of hydrazine. Onsite and pre-operational cleaning of ESF components is in accordance with the recommendations of ASME NQA-1.

c. Cold-worked austenitic stainless steel is not normally used for pressure boundary applications. However, if it is necessary to use cold-worked austenitic stainless steel, such cold-work is processed and documented during each fabrication process. Reasonable assurance of the integrity of the steel structure is provided by conducting an augmented in-service inspection. Cold-worked austenitic stainless steels have a maximum 0.2 percent offset yield strength of 620 MPa (90,000 psi) to reduce the probability of stress corrosion cracking in ESF systems.

d. All non-metallic insulation materials installed on stainless steel ESFs conform to NRC RG 1.36 (Reference 7).

e. When nickel-chromium-iron alloys are used as ESF materials, only Alloy 690 is selected. Alloy 690 has improved stress-corrosion cracking resistance.

~~f. Fracture toughness properties of ESF materials meet the requirements of ASME Section III, Subarticles NC/ND/NE-2300.~~

Issue#5, Item 3

~~g.~~ f. Grinding is performed with resin or rubber bonded aluminum oxide or silicon carbide wheels that have not previously been used on any materials other than Type 300 series stainless alloys. Grinding wheels bonded with rubber compositions that include halides or sulfur are not used on austenitic stainless steels.

The ESF system is designed with a consideration of the deterioration of materials in service from pipe wall thinning by corrosion, erosion, mechanical abrasion, or other environmental effects.

The recommendations of NRC RG 1.50 (Reference 8) and ASME Section III Appendix D are applied to weld fabrication. The minimum preheat temperature meets ASME Section III, Appendix D, Article D-1000. The maximum interpass temperature used for the low alloy steels that require impact testing is 260 °C (500 °F).

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #6 (AI 6-14.6)

In FSAR Section 6.1.1, on page 6.1-3 the applicant states:

Per RG 1.28, “Quality Assurance Program Criteria (Design and Construction,” the implementation of a quality assurance (QA) program during design and construction of a nuclear power plant provides adequate basis for complying with 10 CFR Part 50, Appendix B as long as the program also meets the additional terms and conditions stated in RG 1.28.

APR-1400 FSAR Section 6.1.1 describes provisions concerning the types of cleaning and contamination protection for austenitic stainless steel nuclear steam supply system (NSSS) components as part of a QA program. Specifically it is noted that,

> Contamination of austenitic stainless steels of Type 300 series by compounds that can alter the physical or metallurgical structure and/or properties of the material is avoided during all stages of fabrication. Type 300 series stainless steels are not painted. Grinding is accomplished with resin or rubber-bounded aluminum oxide or silicon carbide wheels that were not previously used on materials other than austenitic alloys that could contribute to intergranular corrosion or SCC.
>
> Outside storage of partially fabricated components is avoided and in most cases prohibited. Exceptions are made for certain components provided they are dry, completely covered with a waterproof material, and kept above ground.
>
> Internal surfaces of completed components are cleaned to produce an item that is clean to the extent that grit, scale, corrosion products, grease oil, wax, gum, adhered or embedded dust, or extraneous materials are not visible to the unaided eye…

In the preceding paragraphs the applicant committed to meeting the requirements of ASME NQA-1 “Quality Assurance Program Requirements for Nuclear Power Plants,” consistent with the recommendation of RG 1.28. As such, conforming to NQA-1 is part of the licensing basis presented in the FSAR.

Within NQA-1, Subpart 2.1 “Quality Assurance Requirements for Cleaning of Fluid Systems and Associated Components for Nuclear Power Plants” describes provisions to fulfill the corresponding requirements of 10 CFR Part 50, Appendix B, Criterion XIII “Handling, Storage, and Shipping” (there are no conditions in RG 1.28 associated with this criterion). NQA-1 describes a cleanness classification of SSCs that is graded based upon the safety function and operational environment of the SSCs. Guidance on classification is discussed in NQA-1, Part III, Subpart 3.2, Appendix 2.1. The FSAR Section 6.1.1 is not consistent with this guidance.

Revise the quoted text above to read as follows:

> Contamination of austenitic stainless steels series by compounds that can alter the physical or metallurgical structure and/or properties of the material is avoided during all stages of fabrication. Type 300 series stainless steels are not painted. Grinding is accomplished with

> resin or rubber-bounded aluminum oxide or silicon carbide wheels that were not previously used on materials other than austenitic alloys that could contribute to intergranular corrosion or SCC.
>
> Outside storage of partially fabricated components is avoided and in most cases prohibited. Exceptions are made for certain components provided they are dry, completely covered with a waterproof material, and kept above ground…

Additionally, revise FSAR Section 6.1.1 to comply with the NQA-1 nonmandatory guidance for establishing NQA-1 programs, or provide an otherwise acceptable methodology to implement NQA-1 mandatory requirements.

Response

DCD Tier 2, Section 6.1.1, page 6.1-3 will be revised as suggested and state compliance with the NQA-1 nonmandatory guidance, as shown in the attachment associated with this response.

Impact on DCD

The DCD will be revised as shown in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

4) The delta ferrite content of austenitic stainless steel weld metal is controlled in accordance with the recommendations of NRC RG 1.31 (Reference 4), as described in Subsection 5.2.3.4. Austenitic stainless steel materials subjected to sensitizing conditions are tested in accordance with NRC RG 1.44. Non-sensitization of austenitic stainless steel materials are verified in accordance with ASTM A262 (Reference 5), Practices A or E. The sensitization of heat-affected zone (HAZ) for austenitic stainless steels is avoided by careful control of the following conditions:

   a) Maximum heat input: 23.6 kJ/cm (60 kJ/in)

   b) Maximum interpass temperature: 177 °C (350 °F)

   d) Maximum carbon content: 0.065 percent

b. Contaminants that are capable of causing stress corrosion cracking are controlled as follows:

1) Cleanliness and contamination protection is provided for components that are controlled for contamination during fabrication, shipment, and storage as recommended in ASME NQA-1 (Reference 6).

2) Contamination of ~~Type 300 series~~ austenitic stainless steels by compounds that can alter the physical or metallurgical structure and properties of the material is avoided during all stages of fabrication. Painting of Type 300 series stainless steels is prohibited. Internal surfaces of completed components are cleaned to the extent that grit, scale, corrosion products, grease, oil, wax, gum, adhered or embedded dirt, and extraneous material are not visible to the unaided eye. Degreasing solvents such as acetone, isopropyl alcohol, and trisodium phosphate (TSP) are used on metallic surfaces. Water used for cleaning is inhibited with 30 to 100 ppm hydrazine. The specification for water quality is in accordance with Table 3.4.1 of ASME NQA-1 (Reference 6), Subpart 2.1. To prevent halide-induced intergranular corrosion that can occur in an aqueous environment with significant quantities of dissolved oxygen, flushing water is inhibited through

Issue#6

, Subpart 2.1 with nonmandatory Appendix 2.1 in Subpart 3.2 and Subpart 2.2.

Issue#6

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #7 (AI 6-14.7)

In FSAR Section 6.1.1, on page 6.1-4 the applicant states:

> c. “Cold-worked austenitic stainless steel is not normally used for pressure boundary applications. However, if it is necessary to use cold-worked austenitic stainless steel, such cold-work is processed and documented during each fabrication process. Reasonable assurance of the integrity of the steel structure is provided by conducting an augmented in-service inspection.

GDC 1 requires SCCs to be designed and fabricated to quality standards commensurate with the importance of the performed safety function. Acceptable standards of meeting GDC 1 are contained in 10 CFR 50.55a which includes acceptable editions and addendums of the ASME Code, Section XI. Revise this statement as follows to document a connection between the ISI program described in Section 6.6 and the fabrication requirement specified in this paragraph:

> c. “Cold-worked austenitic stainless steel is not normally used for pressure boundary applications. However, if it is necessary to use cold-worked austenitic stainless steel, such cold-work is processed and documented during each fabrication process. Reasonable assurance of the integrity of the steel structure is provided by conducting an augmented in-service inspection in accordance with FSAR Section 6.6.”

Response

DCD Tier 2, Section 6.1.1, page 6.1-4 will be revised to state that an augmented in-service inspection will be conducted in accordance with DCD Tier 2, Section 6.6, as shown in the attachment associated with this response.

Impact on DCD

The DCD will be revised, as shown in in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

AI 6-14_6.1.1_#7 Attachment(1/1)

additions of hydrazine. Onsite and pre-operational cleaning of ESF components is in accordance with the recommendations of ASME NQA-1.

c. Cold-worked austenitic stainless steel is not normally used for pressure boundary applications. However, if it is necessary to use cold-worked austenitic stainless steel, such cold-work is processed and documented during each fabrication process. Reasonable assurance of the integrity of the steel structure is provided by conducting an augmented in-service inspection. Cold-worked austenitic stainless steels have a maximum 0.2 percent offset yield strength of 620 MPa (90,000 psi) to reduce the probability of stress corrosion cracking in ESF systems.

d. All non-metallic insulation materials installed on stainless steel ESFs conform to NRC RG 1.36 (Reference 7).

in accordance with Section 6.6

Issue#7

e. When nickel-chromium-iron alloys are used as ESF materials, only Alloy 690 is selected. Alloy 690 has improved stress-corrosion cracking resistance.

f. Fracture toughness properties of ESF materials meet the requirements of ASME Section III, Subarticles NC/ND/NE-2300.

g. Grinding is performed with resin or rubber bonded aluminum oxide or silicon carbide wheels that have not previously been used on any materials other than Type 300 series stainless alloys. Grinding wheels bonded with rubber compositions that include halides or sulfur are not used on austenitic stainless steels.

The ESF system is designed with a consideration of the deterioration of materials in service from pipe wall thinning by corrosion, erosion, mechanical abrasion, or other environmental effects.

The recommendations of NRC RG 1.50 (Reference 8) and ASME Section III Appendix D are applied to weld fabrication. The minimum preheat temperature meets ASME Section III, Appendix D, Article D-1000. The maximum interpass temperature used for the low alloy steels that require impact testing is 260 °C (500 °F).

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #8 (AI 6-14.8)

In FSAR Section 6.1.1, on page 6.1-4, the applicant states:

> e. “When nickel-chromium-iron alloys are used as ESF materials, only Alloy 690 is selected. Alloy 690 has improved stress-corrosion cracking resistance.”

Table 6.1-1 implies that this material will be welded with ERNiCrFe-7 material (alloy 52/152). Industry experience has shown significant issues with stress corrosion cracking (SCC) of the nickel-based Alloy 600 and the corresponding weld material Alloy 82/182. Alloy 690 and the corresponding weld material Alloy 52/152 has been proposed as an alternative which has better resistance to SCC.

However, Alloy 52 welds are not completely immune to (PWSCC). Contributing factors which could increase an Alloy 52 butt welds susceptibility to PWSCC include factors, for example dilution effects on dissimilar metal welds, weld residual stresses, etc., which may be controlled by the implementation of specific welding processes/parameters (e.g., heat input).

This issue is also addressed in the Issue List for FSAR Section 3.6.3.

Revise APR1400 FSAR Section 6.1.1 to state that welding procedures (including those for repairs) will be qualified to minimize tensile stresses on the internal diameters, dilution effects, etc., and to state that weld repairs that will be in contact with the fluid will be made such that there will be compressive stress conditions on the wetted surface. Alternatively, revise FSAR 6.1.1 to reference where the same statement may be found elsewhere in the FSAR (e.g., Section 3.6.3).

Response

Welding condition for Alloy 690 will be described in DCD Tier2, Section 3.6.3. DCD Tier 2, Section FSAR 6.1.1, page 6.1-4 will be revised to state “Welding of Alloy 690 meets the requirements of Section 3.6.3.” as shown in the attachment associated with this response.

Impact on DCD

The DCD will be revised, as shown in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

AI 6-14_6.1.1._#8 Attachment(1/1)

additions of hydrazine. Onsite and pre-operational cleaning of ESF components is in accordance with the recommendations of ASME NQA-1.

c. Cold-worked austenitic stainless steel is not normally used for pressure boundary applications. However, if it is necessary to use cold-worked austenitic stainless steel, such cold-work is processed and documented during each fabrication process. Reasonable assurance of the integrity of the steel structure is provided by conducting an augmented in-service inspection. Cold-worked austenitic stainless steels have a maximum 0.2 percent offset yield strength of 620 MPa (90,000 psi) to reduce the probability of stress corrosion cracking in ESF systems.

d. All non-metallic insulation materials installed on stainless steel ESFs conform to NRC RG 1.36 (Reference 7).

e. When nickel-chromium-iron alloys are used as ESF materials, only Alloy 690 is selected. Alloy 690 has improved stress-corrosion cracking resistance.

f. Fracture toughness properties of ESF materials meet the requirements of ASME Section III, Subarticles NC/ND/NE-2300.

g. Grinding is performed with resin or rubber bonded aluminum oxide or silicon carbide wheels that have not previously been used on any materials other than Type 300 series stainless alloys. Grinding wheels bonded with rubber compositions that include halides or sulfur are not used on austenitic stainless steels.

The ESF system is designed with a consideration of the deterioration of materials in service from pipe wall thinning by corrosion, erosion, mechanical abrasion, or other environmental effects.

The recommendations of NRC RG 1.50 (Reference 8) and ASME Section III Appendix D are applied to weld fabrication. The minimum preheat temperature meets ASME Section III, Appendix D, Article D-1000. The maximum interpass temperature used for the low alloy steels that require impact testing is 260 °C (500 °F).

Welding of Alloy 690 meets the requirements of Section 3.6.3.

Issue#8

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #9 (AI 6-14.9)

In FSAR Section 6.1.1, on page 6.1-4 the applicant states:

> The ESF system is designed with a consideration of the deterioration of materials in service from pipe wall thinning by corrosion, erosion, mechanical abrasion, or other environmental effects.

Provide addition information regarding the allowances for wall thinning. For example, does the APR1400 ESF system design incorporate a specific amount of material that can be lost due to wall thinning without impacting the functionality of systems, structures, and components (SSCs)? If so, are those allowances dependent on material, application, etc.?

The FSAR statement specifically states that the thinning is for pipe walls. Provide additional information to clarify whether other ESF SSCs (e.g., valves) are designed for erosion/corrosion/abrasion/other environmental effects?

Response

Valves and Piping in the CS, ECC, and IW systems, and all components which come into contact with the reactor coolant are fabricated with austenitic stainless steel. There is no allowance for wall thinning considered in the design of these systems and components.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

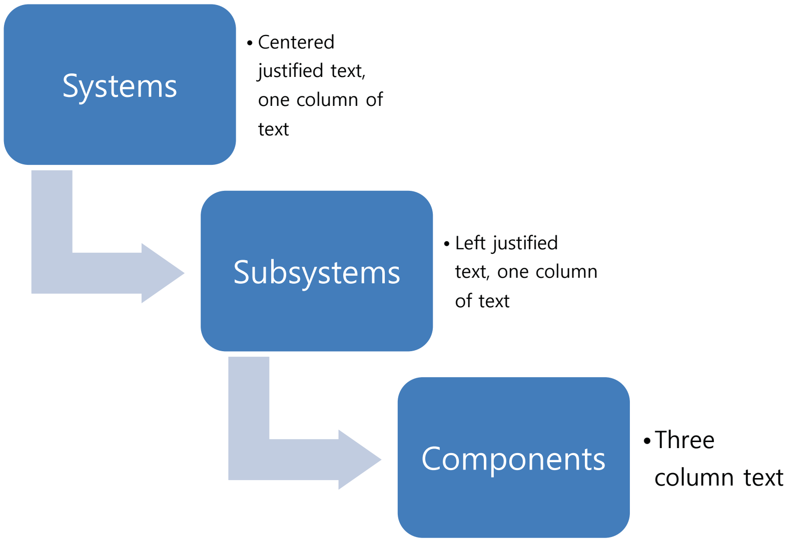
There is no impact on any Technical, Topical, or Environmental Report.

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

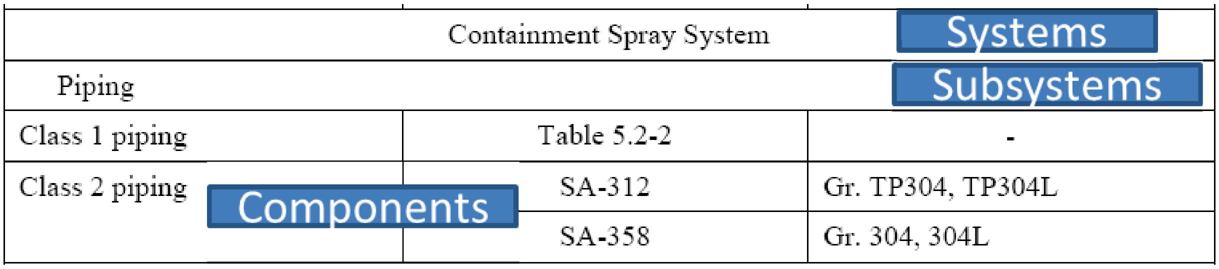
Issue #10 (AI 6-14.10)

In FSAR Section 6.1.1, the applicant has provided Tables 6.1-1 and 6.1-2. Table 6.1-1 is confusing because the table does not have clear formatting.

Based on Table 6.1-2 and elements from Table 6.1-1, the staff interprets the table formatting as such:



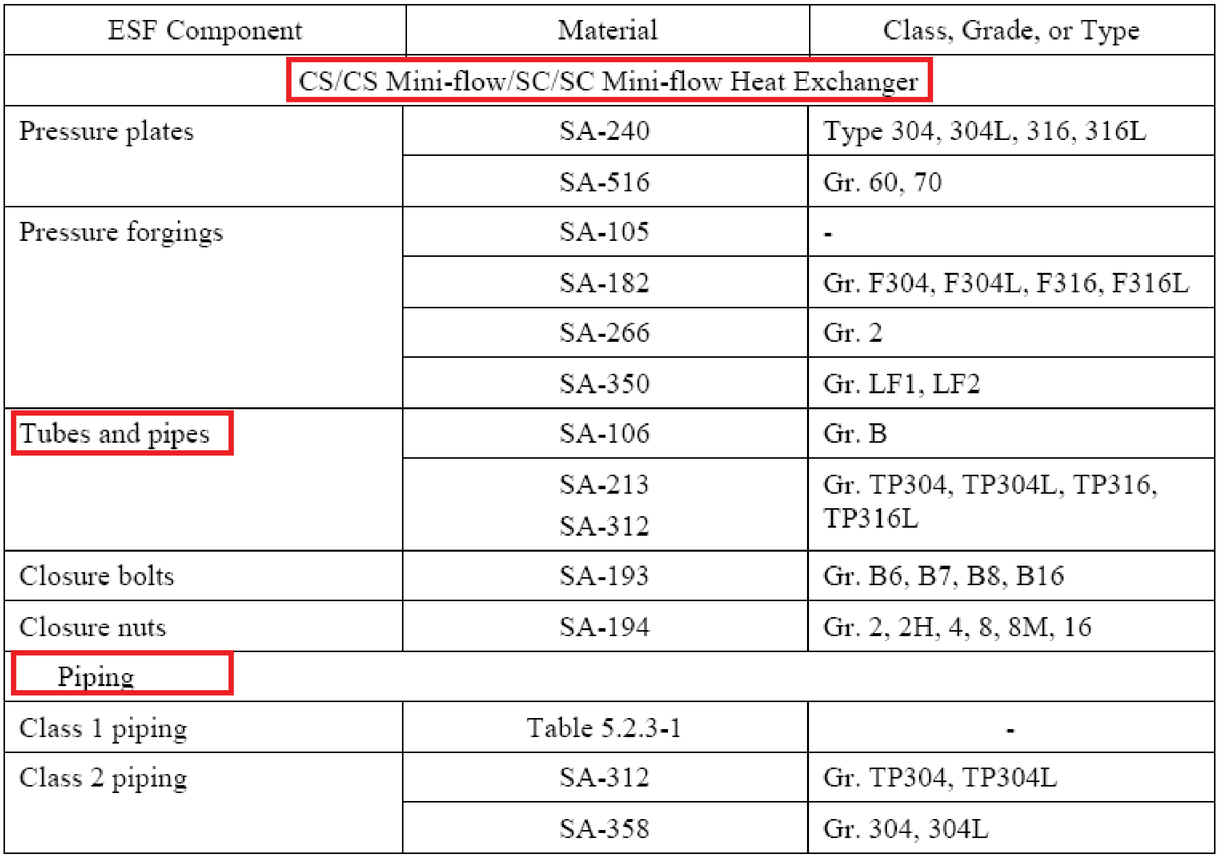
An example of this interpretation from FSAR page 6.1-16 is show below:



Containment Spray System		
Piping		
Class 1 piping	Table 5.2-2	-
Class 2 piping	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L

However, the staff notes that the applicant is not consistent in this formatting in Table 6.1-1:

MCB Issue List Regarding APR1400 FSAR Section 6.1.1



ESF Component	Material	Class, Grade, or Type
CS/CS Mini-flow/SC/SC Mini-flow Heat Exchanger		
Pressure plates	SA-240	Type 304, 304L, 316, 316L
	SA-516	Gr. 60, 70
Pressure forgings	SA-105	-
	SA-182	Gr. F304, F304L, F316, F316L
	SA-266	Gr. 2
	SA-350	Gr. LF1, LF2
Tubes and pipes	SA-106	Gr. B
	SA-213 SA-312	Gr. TP304, TP304L, TP316, TP316L
Closure bolts	SA-193	Gr. B6, B7, B8, B16
Closure nuts	SA-194	Gr. 2, 2H, 4, 8, 8M, 16
Piping		
Class 1 piping	Table 5.2.3-1	-
Class 2 piping	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L

In this example it is unclear what the difference is between the “Tubes and pipes” and the “Piping.”

Revise Table 6.1-1 to ensure that the formatting of the table is clear and consistent with the formatting of other, similar tables.

Response

DCD Tier 2, Table 6.1-1, 6.1-2 will be revised, as shown in the attachment associated with this response.

Impact on DCD

The DCD will be revised, as shown in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

Issue#10 Revise Table 6.1−1 table format.

Table 6.1-1 (1 of 5)

Principal Engineered Safety Feature Pressure Retaining Material Specifications

ESF Component	Material	Class, Grade, or Type
Containment		
Containment liner plate	SA-516 SA-240	Gr. 60 or 70 Type 304
Penetrations		
Head Fitting	SA-182 SA-350 SA-516 SA-240	Gr. F22 Class 3 Gr. LF2 Gr. 60 Type 304
Pipe	SA-106 SA-312	Gr. B, C Gr. TP304, TP304L, Gr. TP316L
Sleeve	SA-516	Gr. 70
	SA-333	Gr. 6
Containment Spray System		
Containment Spray (CS) / Shutdown Cooling (SC) Pump		
Pressure casting	SA-351	Gr. CF3 or CF3M Gr. CF8 or CF8M
Pressure forgings	SA-182	Gr. F304 or F304L/LN Gr. F316 or F316L/LN
Tubes and pipes	SA-213 SA-312	Gr. TP304 or TP304L Gr. TP316 or TP316L
Closure stud bolts	SA-193	Gr. B7 or B8
	SA-638	Gr. 660
	SA-564	Type 630 COND. H1100
Closure stud nuts	SA-194	Gr. 7 or 8
	SA-638	Gr. 660
	SA-564	Type 630 COND. H1100

Issue#10 Revise Table 6.1-1 table format.

Table 6.1-1 (2 of 5)

ESF Component	Material	Class, Grade, or Type
CS/CS Mini-flow/SC/SC Mini-flow Heat Exchanger		
Pressure plates	SA-240	Type 304, 304L, 316, 316L
	SA-516	Gr. 60, 70
Pressure forgings	SA-105	-
	SA-182	Gr. F304, F304L, F316, F316L
	SA-266	Gr. 2
	SA-350	Gr. LF1, LF2
Tubes and pipes	SA-106	Gr. B
	SA-213 SA-312	Gr. TP304, TP304L, TP316 TP316L
Closure bolts	SA-193	Gr. B6, B7, B8, B16
Closure nuts	SA-194	Gr. 2, 2H, 4, 8, 8M, 16
Piping		
Class 1 piping	Table 5.2.3-1	
Class 2 piping	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L

Issue#10

Revise Table 6.1−1 table format.

Table 6.1-1 (3 of 5)

ESF Component	Material	Class, Grade, or Type
Valves		
Class 1 valves	Table 5.2-2	
Class 2 valves	Material for Class 2 valves are the same as for Class 1 (Table 5.2-2)	-
Fitting / flange	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
	SA-182	Gr. F304, F304L
	SA-479	Type 304, 304L
Emergency Core Cooling System		
Safety Injection Pump		
Pressure casting	SA-351	Gr. CF3 or CF3M Gr. CF8 or CF8M
Pressure forgings	SA-182	Gr. F304 or F304L/LN Gr. F316 or F316 L/LN
Tubes and pipes	SA-213 SA-312	Gr. TP304 or TP304L Gr. TP316 or TP316L
Closure stud bolts	SA-193	Gr. B6 or B7
	SA-638	Gr. 660
Closure stud nuts	SA-194	Gr. 6 or 7
	SA-638	Gr. 660
Cladding, buttering	Type 308L/309L stainless steel strip electrode	-

Issue#10 Revise Table 6.1−1 table format.

Table 6.1-1 (4 of 5)

ESF Component	Material	Class, Grade, or Type
Accumulator (SIT)		
Pressure plates	SA-516	Gr. 60 or 70
Pressure forgings	SA-105	-
	SA-182	Gr. F304, F304L, F316, or F316L
	SA-350	Gr. LF1 or LF2
Pipes	SA-312	Gr. TP304, TP304L, TP316, and TP316L
Closure bolts	SA-193	Gr. B6, B7, B8, B16
Closure nuts	SA-194	Gr. 2, 2H, 4, 8, 8M or 16
Clad	Austenitic stainless steel	
Piping		
Class 1 piping	Table 5.2-2	-
Class 2 piping	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
Valves		
Class 1 valves	Table 5.2-2	
Class 2 valves	Material for Class 2 valves are the same as for Class 1 (Table 5.2-2)	-
Fitting / flange	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
	SA-182	Gr. F304, F304L
	SA-479	Type 304, 304L

Issue#10 Revise Table 6.1-1 table format.

Table 6.1-1 (5 of 5)

ESF Component	Material	Class, Grade, or Type
ESF Filter System		
	Subsection 6.5.1	
In-Containment Water Storage System		
Class 2 piping	SA-312	Gr. TP304
	SA-358	Gr. TP304
Class 2 valves	SA-182	Gr. F316
	SA-351	Gr. CF8M
Fitting / flange	SA-182	F304
	SA-193	Gr. B7
	SA-194	Gr. 2H
	SA-403	Gr. WP304
Weld Filler Material		
	SFA-5.1	E7016, E7018
	SFA-5.4	E308-15, E308-16, E308L-15, E308L-16 E309L-16
	SFA-5.5	E9018-B3
	SFA-5.9	ER308, ER309, ER308L ER309L
	SFA-5.11	ENiCrFe-7
	SFA-5.14	ERNiCrFe-7, ERNiCrFe-7A
	SFA-5.18	ER70S-2, ER70S-6
	SFA-5.28	ER90S-B3

Issue#10 Revise Table 6.1−2 table format.

Table 6.1-2 (1 of 3)

Principal Engineered Safety Features Materials
Exposed to Core Coolant and Containment Spray

ESF Component	Material	Class, Grade, or Type
Containment		
Containment liner plate	SA-516 SA-240	Gr. 60 or 70 Type 304
Penetrations		
Head Fitting	SA-182 SA-350 SA-516 SA-240	Gr. F 22 Class 3 Gr. LF2 Gr. 60 Type 304
Pipe	SA-106 SA-312	Gr. B, C Gr. TP304, TP304L, Gr.
Sleeve	SA-516	Gr. 70
	SA-333	Gr. 6
Containment Spray System		
Piping		
Class 1 piping	Table 5.2-2	
Class 2 piping	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
Valves		
Class 1 valves	Table 5.2-2	
Class 2 valves	Material for Class 2 valves are the same as for Class 1 (Table 5.2-2)	-
Fitting / flange	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
	SA-182	Gr. F304, F304L
	SA-479	Type 304, 304L

Issue#10 Revise Table 6.1-2 table format.

Table 6.1-2 (2 of 3)

ESF Component	Material	Class, Grade, or Type
Emergency Core Cooling System		
Accumulator (SIT)		
Pressure plates	SA-516	Gr. 60, 70
Pressure forgings	SA-105	-
	SA-182	Gr. F304, F304L, F316, F316L
	SA-350	Gr. LF1, LF2
Internal parts	SA-240	Type 304, 304L, 316, 316L
	SA-182	Gr. F304, F304L, F316, F316L
Pipes	SA-312	Gr. TP304, TP304L, TP316, TP316L
Closure bolts	SA-193	Gr. B6, B7, B8, B16
Closure nuts	SA-194	Gr. 2, 2H, 4, 8, 8M, 16
Clad	Austenitic stainless steel	
Piping		
Class 1 piping	Table 5.2-2	-
Class 2 piping	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
Valves		
Class 1 valves	Table 5.2-2	
Class 2 valves	Material for Class 2 valves are the same as for Class 1 (Table 5.2-2)	
Fitting / flange	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
	SA-182	Gr. F304, F304L
	SA-479	Type 304, 304L

Issue#10 Revise Table 6.1−2 table format.

Table 6.1-2 (3 of 3)

ESF Component	Material	Class, Grade, or Type
ESF Filter System		
	Subsection 6.5.1	
In-Containment Water Storage System		
IRWST	A 240	Type 304
HVT	A 240	Type 304
IRWST Sump strainer	A 240	Type 304
Class 2 piping	SA-312	Gr. TP304
	SA-358	Gr. TP304
Class 2 valves	SA-182	Gr. F316
	SA-351	Gr. CF8M
Fitting / flange	SA-182	F304
	SA-193	Gr. B7
	SA-194	Gr. 2H
	SA-403	Gr. WP304
Weld Filler Material		
	SFA-5.1	E7016, E7018
	SFA-5.4	E308-15, E308-16, E308L-15, E308L-16 E309L-16
	SFA-5.5	E9018-B3
	SFA-5.9	ER308, ER309, ER308L, ER309L
	SFA-5.11	ENiCrFe-7
	SFA-5.14	ERNiCrFe-7, ERNiCrFe-7A
	SFA-5.18	ER70S-2, ER70S-6
	SFA-5.28	ER90S-B3

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #11 (AI 6-14.11)

In FSAR, Section 6.1.1, Tables 6.1-1 and 6.1-2 use language that is not consistent with the rest of the application and is sometimes confusing. In general, continuity of the document needs to be reviewed.

As an example:

On page 6.1-12, Table 6.1-1 includes the system “CS/CS Mini-flow/SC/SC Mini-flow Heat Exchanger.”

Consistency:

> The term “CS mini-flow heat exchanger” is used interchangeability with “containment spray mini-flow heat exchanger” (pg. 40, 726 for CS mini-flow heat exchanger and pg. 94, 98, and 483 for Containment spray mini-flow heat exchanger). The term “SC heat exchanger is first mentioned on page 736 and is mentioned multiple times. However on page 727 the “shutdown cooling heat exchangers” are defined as the acronym SCHXs.

The staff requests Section 6 to be reviewed for consistency especially with regard to acronyms.

Response

DCD Tier 2, Chapter 6 will be revised to consistently use the acronyms CS, CSP, CSS, CSHX, as shown in the attachment associated with this response.

Impact on DCD

The DCD will be revised, as shown in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

containment, containment boundary, and containment isolation system. Removal processes include various aerosol removal processes that remove airborne particulates and iodine from the containment atmosphere following a postulated DBA. The containment boundary and isolation systems control the release of radioactivity from the containment to provide reasonable assurance that the leakage fraction that may reach the environment is below limits. The APR1400 fission product removal and control system consists of the following:

a. Control room emergency makeup air cleaning system (CREACS)

b. Auxiliary building controlled area emergency exhaust system (ABCAEES)

c. Fuel handling area emergency exhaust system (FHAEES)

d. Containment spray system

e. Containment vessel

The CREACS is a part of the control room heating, ventilation, and air conditioning (HVAC) system and is described in Section 6.4 and Subsection 9.4.1. The ABCAEES is part of the auxiliary building controlled area HVAC system and is described in Subsection 9.4.5. The FHAEES is part of the fuel handling area HVAC system and is described in Subsection 9.4.2. The ~~containment spray system~~ CSS is described in Subsection 6.2.2.

6.0.6 In-service Inspection of Class 2 and 3 Components

The in-service inspection of ASME Section III Class 2 and 3 components is described in Section 6.6 and meets the requirements of 10 CFR 50.55a(g) (Reference 1).

6.0.7 In-containment Water Storage System

The in-containment water storage system (IWSS), described in Section 6.8, provides the water collection, delivery, storage, and heat sink functions inside the containment during normal operation and accident conditions. The IWSS comprises the IRWST, holdup volume tank (HVT), and cavity flooding system (CFS).

The IRWST is a safety-related source of borated water for emergency core cooling in the event of a LOCA and is a source of water for containment cooling and for core melt cooling in the event of a severe accident. The HVT serves as a low-collection point in the containment and receives water from pipe breaks and ~~containment spray~~ CS during accident conditions. The CFS floods the reactor cavity in the event of a severe accident and covers core debris in the reactor cavity with water.

6.0.8 References

1. 10 CFR 50.55a, “Codes and Standards”, U.S Nuclear Regulatory Commission.
2. 10 CFR Part 50, Appendix A, “General Design Criteria for Nuclear Power Plants”, U.S. Nuclear Regulatory Commission.
3. ASME Boiler and Pressure Vessel Code, Section III, “Rules for Construction of Nuclear Facility Components,” The American Society of Mechanical Engineers, the 2007 Edition with the 2008 Addenda.
4. ASME Boiler and Pressure Vessel Code, Section III, Division 2, “Code for Concrete Containments,” The American Society of Mechanical Engineers, the 2007 Edition with the 2008 Addenda.
5. Regulatory Guide 1.84, “Design, Fabrication, and Material Code Case Acceptability ASME Section III,” Rev. 36, U.S. Nuclear Regulatory Commission, August 2014.

6.1 Engineered Safety Features Materials

Material selection and fabrication of ESF components are described in this section. The materials used in ESF systems are selected for compatibility with core cooling coolants and ~~containment spray~~ solution.

6.1.1 Metallic Materials

The ASME Code that applies to the design and fabrication of the piping and components is specified in Chapter 3. For materials, later editions or addenda of the ASME Code are used as permitted by the ASME Code if the edition or addenda are approved by 10 CFR 50.55a.

6.1.1.1 Materials Selection and Fabrication

CS

ESF materials are selected for compatibility with core cooling coolants and ~~containment spray~~ solution.

Principal ESF pressure-retaining materials are listed in Table 6.1-1. ESF pressure-retaining materials meet the applicable material requirements of ASME Section III (Reference 1) and conform to the applicable ASME Section II (Reference 2) material specifications. The material specifications for ESF pressure-retaining materials meet the requirements of ASME Section III, Class 2; Article NC-2000 for Quality Group B, ASME Section III, Class 3; Article ND-2000 for Quality Group C; and ASME Section III for containment pressure boundary components. The materials used in containment penetrations meet the requirements of ASME Section III, Division 1, Articles NC-2000 or NE-2000.

Principal ESF materials inside the containment that are exposed to the ~~containment spray~~ solution are listed in Table 6.1-2. These materials are chosen to be compatible with the chemical solutions in the ~~containment spray~~. The materials used in ESF component construction are reviewed for acceptability prior to release for material procurement. Corrosion of materials in the containment is minimized in accordance with the recommendations of U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide (RG)

Moisture control on low hydrogen welding materials conforms to the requirements of ASME Section III.

Welder performance qualification for areas with limited accessibility conforms with the recommendations of NRC RG 1.71 (Reference 9).

6.1.1.2 Composition and Compatibility of Core Cooling Coolants and Containment Sprays

Controlled water chemistry is maintained within the RCS. RCS water chemistry is specified to minimize corrosion. RCS water chemistry specification is shown in Table 5.2-5. Water chemistry limits are determined at a level comparable to the guidelines in the Electric Power Research Institute (EPRI), "PWR primary water chemistry guidelines" (Reference 10). Control of the reactor coolant chemistry is the function of the chemical and volume control system (CVCS), which is described in Subsection 9.3.4.

Water from the in-containment refueling water storage tank (IRWST), which serves as the long-term water source for ~~containment spray system,~~ is controlled to maintain a pH range during a loss-of-coolant accident (LOCA).

CSS

6.1.1.2.1 Compatibility of Construction Materials with Core Cooling Coolants and Containment Sprays

To minimize the corrosion of the stainless steel in the containment during a LOCA, long-term post-LOCA pH control of IRWST water is provided by granular TSP, which is stored in baskets in the holdup volume tank (HVT). The stainless steel baskets have a solid top and bottom with mesh sides to provide reasonable assurance of dissolution when submerged in water. The pH control is described in Subsection 6.5.2.3.2. Surfaces in the IRWST that are in direct contact with borated water are lined with stainless steel.

The materials used in the fabrication of mechanical and structural components inside the containment are selected to minimize corrosion and hydrogen generation resulting from contact with spray solutions. The use of aluminum and zinc is minimized in the containment to minimize the yield of hydrogen gas through the chemical reaction with the emergency core cooling or ~~containment spray~~ solutions used in the containment.

CS

Located at the bottom of the containment, at El. 81 ft., the IRWST is a reinforced concrete structure with a stainless steel inside liner. The IRWST provides continuous subcooled water for the SI and CS to cool the containment in the event of abnormal events such as a LOCA or secondary system piping rupture. Section 6.8 describes the in-containment water storage system (IWSS).

6.2.1.1.2.1 Protection against External Pressure Loads

Inadvertent operation of the CS system, containment purge, and containment fan cooler systems could potentially result in a significant containment external pressure loading. The APR1400 containment is designed to withstand an external pressure loading of 0.28 kg/cm2G (4.0 psig) relative to ambient pressure. An evaluation and associated analyses demonstrate that the containment structure integrity is maintained under maximum external pressure-loading conditions; see Subsection 6.2.1.1.3.5.

6.2.1.1.2.2 Potential Water Traps Inside Containment

The evaluation of the IRWST upstream effect is a review of the flow paths leading to the IRWST to identify flow paths that could result in blocking the return water that could challenge the IRWST minimum water level. The evaluation also includes identifying holdup volumes, such as recessed areas and enclosed rooms where trapped water volumes do not return to the IRWST. All of the hold-up volumes were taken into account in the minimum water level evaluation of the IRWST.

Holdup volumes are divided into two groups: Hold-up water on the way to the IRWST and the inactive pool volume. Detail holdup volume capacities are listed in Table 6.8-2 and the schematic of potential water traps in containment is shown in Figure 6.2.1-20. The groups are defined as follows:

a. Hold-up volume on the way to the IRWST

   In a LOCA, the IRWST water returns from the ~~containment spray~~ CS nozzles and broken pipe. The water on the way to the IRWST decreases the initial IRWST water level. The following are the source of hold-up water on the way to the IRWST:

6.2.1.3.6 Description of Decay Heat Phase Model

The final phase of the large break LOCA is a relatively stable period characterized by decay heat release. This period extends from the EOPR and the M&E release rate is calculated based on the thermal conditions from the EOPR for the cold leg breaks or the EOB for the hot leg break.

LOCA M&E are released to the containment using a flow boundary condition in the GOTHIC containment model until the EOPR (or EOB for hot leg break). Thereafter, GOTHIC directly calculates the break flow from the RCS until the end of transient.

The constituent energy sources that are considered in the decay heat phase are as follows:

a. Core decay heat

b. RCS and SGs fluid stored energy

c. RCS and SGs metal sensible energy

The M&E release rates during the decay heat phase for all of the analyses cases are presented in Tables 6.2.1-4 through 6.2.1-8. The detailed description of the analysis methods used for M&E release calculation during the decay heat phase is provided in Reference 3.

6.2.1.3.7 Single Active Failure Analysis

Two potential failures are considered as a single failure in the LOCA M&E analysis: the failure of one SI pump or the failure of one EDG. The potential failures result in a decrease in the safety injection flow and eventually degrade the emergency core cooling system (ECCS) performance to cool down the core. In the LOCA mass and energy analysis, the single failure is assumed for the minimum safety injection flow and no failure is assumed for the maximum safety injection flow.

Another failure in containment system is considered as single failure, the failure of one train of ~~containment spray.~~ The failure reduces the capability to suppress the containment

CS

6.2.2.1.2 Reliability Design Bases

The CSS is automatically actuated on the receipt of the containment spray actuation signal (CSAS). The active components of the CSS are normally powered from separate Class 1E buses, which can be energized from the EDG. Each emergency power source is capable of driving all components and instruments associated with one division of the CSS. The onsite Class 1E emergency electric power suppliers are described in Chapter 8.

The CSS is seismic Category I and designed to remain functional in the event of a safe shutdown earthquake (SSE). The CSS is designed with sufficient redundancy to provide reasonable assurance of reliable system operation, assuming a single component failure coincident with a DBA, as shown in Table 6.2.2-3.

Environmental envelopes are specified for system components to provide reasonable assurance of acceptable performance in normal and accidental environments.

The CSS is protected from the dynamic effects of pipe rupture as described in Subsection 3.6.1. The CSS is protected from missiles as described in Section 3.5. The CSS components are capable of functioning in the event of the maximum probable flood or other natural phenomena defined in GDC 2.

Inspection and testing requirements for the CSS are given in Chapter 16 and Subsection 6.2.2.4.

6.2.2.2 System Design

The CSS schematic diagram is shown in Figure 6.2.2-1. Design parameters and applicable codes for the major components are given in Table 6.2.2-2.

The safety-related components of the CSS receive electrical power for their operation from physically and electrically independent and redundant emergency power supply systems as well as normal offsite power supplies. For the unlikely event of a LOCA or MSLB, the CSPs are automatically started by an SIAS or a CSAS. ~~Containment spray~~ flow to the containment does not occur until a CSAS opens the ~~containment spray~~ header isolation valves. The setpoints of SIAS and CSAS are tabulated in Table 7.3-5A.

CS

CS

The CSS is designed to be manually operated from the MCR and the remote shutdown room (RSR). Once the CSPs are started and the valves are opened, the spray water flows into the ~~containment spray~~ headers. These headers contain spray nozzles that break the flow into small droplets, thus enhancing the water's cooling effect on the containment atmosphere. As these droplets fall to the containment floor, they absorb heat until they approach thermal equilibrium with the containment. When the water reaches the containment floor, it drains to the HVT and subsequently back to the IRWST.

Following a LOCA or MSLB, the containment pressure reduces near the atmospheric pressure with the CSS operation. When the containment pressure is reduced sufficiently, the CSS is not required for iodine removal, and the operator determines that the ~~containment spray~~ is no longer required, the operator terminates the CSS operation.

The CSS is designed so that the CSPs and the shutdown cooling pumps (SCPs) are functionally interchangeable when not required to perform their requisite design basis function, assuming a loss of offsite power and single failure. The SCPs are designed to be aligned from the MCR to provide the ~~containment spray.~~ When used in a ~~containment spray~~ configuration, the SCPs are capable of being automatically started by an SIAS or a CSAS.

The CSS is designed to provide a backup to the shutdown cooling system (SCS) for residual heat removal and for cooling of the IRWST during post-accident feed-and-bleed operations using the safety injection system and pressurizer POSRVs.

The CSS is designed to perform its heat removal function without adverse effects on the safety injection system performance.

The emergency containment spray backup subsystem (ECSBS) for severe accident management is provided in the APR1400. The ECSBS is used as an alternate means of providing ~~containment spray~~ in the event of a beyond a DBA in which both CSPs, both SCPs, and/or the IRWST are unavailable. The ECSBS is to be placed in service 24 hours after a severe accident to prevent a catastrophic failure of the containment. The fire engine truck as ECSBS pumping devices is used to deliver water from external water sources to the ECSBS ~~containment spray~~ header after the initiation of a severe accident. Further details of ECSBS are provided in Section 19.2.

6.2.2.2.1 Containment Spray Pumps

CS

The function of the CSPs is to provide flow through the ~~containment spray~~ headers and CSHXs to remove fission product and control containment atmosphere temperature and pressure resulting from a plant accident.

One CSP is provided for each of two 100 percent capacity divisions. The CSPs are vertical, single stage, centrifugal pumps driven by induction motors. The pumps are sized to deliver 20,535.86 L/min (5,425 gpm) at a discharge head of 140.21 m (460 ft). The pump rated flow consists of 100 percent cooling capacity of 18,927.06 L/min (5000 gpm) and pump minimum flow of 1,608.8 L/min (425 gpm). The 100 percent capacity design flow rate is based on 57.54 L/min (15.2 gpm) per main spray of 307 nozzles and 11.36 L/min (3.0 gpm) per auxiliary of 111 nozzles. The CSP discharge head is based on a static head of 72.85 m (239 ft) and pressure losses equivalent to 63.09 m (207 ft) including a margin of 4.27 m (14 ft). The CSP data are provided in Table 6.2.2-2.

Minimum flow orifices are installed in the lines running from the pump discharge, returning back to the pump suction. These paths include a mini-flow heat exchanger and provide reasonable assurance that the pumps will not be deadheaded if they are inadvertently run against a closed system.

Cooling water is provided to the ~~containment spray~~ mini-flow heat exchangers by the component cooling water system. The component cooling water system is described in Subsection 9.2.2.

The CSPs are designed to the same specifications as the SCPs. This makes the CSPs and the SCPs functionally interchangeable and allows each pump to provide a backup when the required function of the pumps is not needed. Alignment of the SCPs to the CSS and alignment of the CSPs to the SCS are accomplished by repositioning several remotely actuated valves located in the pump suction and discharge piping. The alignments permit the SCPs to back up the CSPs during long-term post-LOCA operations when the SCPs are not required for shutdown cooling.

For refueling operation, the CSP is used as an alternate method of filling the refueling pool.

A flow restrictor is provided to minimize the loss of fluid in the event of a gross seal failure. Vent and drain connections are provided. An internal drain to the pump suction is provided in the pump casing. The pump is designed to be completely drained and flushed prior to maintenance, thus reducing radiation levels and doses to plant personnel.

The pressure-retaining portions of the pumps are stainless steel, meeting ASME Section III, Class 2 requirements. The material for all other parts is reviewed for compatibility with its intended service and is approved prior to release for manufacture.

CS

Two CSPs automatically start on a SIAS or a CSAS, and the ~~containment spray~~ header isolation valves automatically open on a CSAS, thus initiating flow to the CSS spray nozzle headers. Initiating signals and controls is described in Chapter 7. Electric power supplies are discussed in Chapter 8.

6.2.2.2.2 Containment Spray Heat Exchangers

The CSHXs are used to remove heat from the containment atmosphere during and after an accident. The units are designed to reduce the containment atmosphere pressure in 24 hours after an accident to half of the calculated peak pressure. The CSHX parameters are given in Table 6.2.2-2.

The CSHXs are used as a backup to the shutdown cooling heat exchangers for IRWST cooling during post-accident operations when the SIS and the pressurizer POSRVs are used for feed-and-bleed cooling of the RCS.

6.2.2.2.3 Containment Spray Piping

Each IRWST suction valve is normally open to provide a reliable water source to the CSPs and to provide reasonable assurance of water full suction piping.

During normal power operation, the CSS piping is water solid up to the IRWST 100 percent water level at elevation 28.3 m (93 ft). A 110-second delay is conservatively assumed between the system initiation and the spray flow through the spray nozzles. The delay time is described further in Subsection 6.2.1.1.3.

6.2.2.2.5 In-containment Refueling Water Storage Tank

The IRWST is a protected, reliable, and safety-related source of borated water for the CS and SI. Section 6.3 describes the SI function for the APR1400 ECCS. The IRWST is also used to fill the refueling pool in support of refueling operations.

The IRWST is also equipped with spargers, which are designed to effectively condense the steam and minimize the loads on the structure.

Section 6.8.2.2.1 describes the IRWST in detail.

6.2.2.2.6 IRWST Sump Strainers

The four independent sets of strainers are located in the IRWST and each strainer is for one of the four SI pumps and for one of two SCPs and two CSPs. These strainers prevent debris from entering the reactor and causing inadequate core or containment cooling.

The IRWST sump strainers are described in Section 6.8.

6.2.2.2.7 Valves

The location of the valves that are used in the containment heat removal systems, along with their type, type of operator, position during the normal operating mode of the plant, type of position indication, and failure position are shown on Figure 6.2.2-1.

6.2.2.2.7.1 Containment Spray Pump Suction Isolation Valves

The ~~containment spray pump~~ suction isolation valves (SI-347, SI-348) are included in the SIS. The valves are normally open motor-operated valves in the CSP suction lines from the IRWST. They are operated from the MCR and RSR and are maintained open during normal and accident conditions. These valves are closed manually if a CSP performs the backup function to a SCP during shutdown cooling operation or a CSS division is isolated from the IRWST to terminate a leak or maintain a CSP or a valve.

CSP

6.2.2.2.7.2 Containment Spray Header Isolation Valve

The spray header isolation valves (CS-003, CS-004) are normally closed motor-operated valves that open fully upon receipt of a CSAS. These valves are operated from the MCR and RSR. They are closed if containment isolation is required or when a CSP backups a SCP for shutdown cooling operation, or when the ~~containment spray~~ isolation is required.

6.2.2.2.7.3 Containment Spray Header Block Valve

The spray header block valves (CS-001, CS-002) are normally open motor-operated valves located upstream of the ~~containment spray~~ header isolation valves. The valves are closed to provide double valve isolation of the ~~containment spray~~ headers whenever the CSPs are used in test, shutdown cooling, or IRWST cooling modes of operation.

CS

6.2.2.2.7.4 IRWST Return Line Flow Control Valve

The IRWST return line control valves (CS-005, CS-006) are normally closed motor-operated globe valves located in the CSP test return line back to the IRWST. These valves are used during CSP testing to throttle CSP flow to the design flow rate. When the CSPs are used for shutdown cooling, these valves are used to isolate the RCS pressure boundary. The valves are designed to be opened from the MCR and the RSR to align the CSS for IRWST cooling.

6.2.2.3 Design Evaluation

All components, including CSPs with mechanical seals, piping, valves, orifices, and ~~containment spray~~ nozzles are qualified to operate with the post-LOCA fluids for at least 30 days using the qualification guidance of ASME QME-1, 2007, as endorsed by NRC RG 1.100, "Seismic Qualification of Electrical and Active Mechanical Equipment and Functional Qualification of Active Mechanical Equipment for Nuclear Power Plants," Revision 3.

The spray nozzle test program is performed per ASTM E799. Sauter mean diameters of the main spray nozzle sprays and auxiliary spray nozzle sprays are 294 microns and 146 microns, respectively, at the design pressure drop of 2.81 kg/cm^{2}D (40 psid). The Sauter mean diameter of 1,000 microns is conservatively assumed for the containment pressure and temperature analysis using GOTHIC code. The droplet of 1,000 microns has 100% effectiveness before it falls to about 12.19 m (40 ft) from the level of spray nozzles, which is shorter than the minimum spray fall height of 32.13 m (105.4 ft) (from the nozzles to the top of the PZR wall).

~~Containment spray~~ elevation and plane drawings are provided in Figures 6.2.2-4 and 6.2.2-5, respectively. These drawings show spray coverage and overlap. The volume of the containment covered by the sprays is described in Table 6.5-3.

The IRWST sump strainer performance evaluation related to Generic Safety Issue (GSI) - 191 is described Reference 1 and Subsection 6.8.4.5.

The IRWST is the suction source for the SI pumps and CSPs during short-term injection and long-term cooling modes of post-accident operation. As described in Section 6.8, the HVT performs water collection services after an accident. Spillways allow accumulated water in the HVT to spill back into the IRWST, thereby replenishing IRWST water volume during accident operations. The determination of the minimum available NPSHs for the SI pumps and the CSPs are based on the minimum water level in the IRWST during accident conditions. In addition, the following conservative assumptions are made:

a. Fluid conditions in the IRWST are saturated; no credit is taken for an increase in containment pressure.

CS

b. The contribution of the volume of water spillage from the RCS and one safety injection tank is conservatively neglected.

c. With the CSS actuated, the reactor cavity is assumed to be flooded, and the HVT is assumed to be full to just above the level at which water begins to return to the IRWST through the spillways.

d. Spray water is held up on surfaces throughout the containment. Locations of the accumulation of water inside the containment include water held up on horizontal surfaces, clogged floor drains, water held up in ~~containment spray~~ piping, water in

6.2.2.5 Instrumentation Requirements

CSP

~~Containment spray pump~~ operation is automatically initiated by either an SIAS or a CSAS. ~~Containment spray~~ flow to the containment is not provided until a CSAS opens the ~~containment spray~~ header isolation valves. The SIAS and CSAS are part of the engineered safety features actuation system and are described in Section 7.3. An SIAS is automatically generated upon the occurrence of either a low pressurizer pressure signal or a high containment pressure signal. A CSAS is automatically generated upon the occurrence of a high-high containment pressure signal. The CS system operation can also be initiated in the control room by manually initiating a CSAS.

CSS

Display instrumentation is available to the operator to allow him to adequately monitor conditions in the ~~containment spray system~~ and to perform any required manual safety functions. The information provided is sufficient to allow the operator to accurately assess the conditions within the ~~containment spray system~~ and in a timely manner perform those actions to maintain appropriate system conditions. In addition, the information provides reasonable assurance of a positive indication that the pumps and valves have actuated and that flows have been established.

The CS system instrumentation is listed in Table 6.2.2-4. Instrumentation identified by Note (2) in the table is provided for post-accident monitoring of system operation.

CS

The following instrumentation is provided:

a. CSP suction and discharge pressure indication is provided in the MCR to allow the operator to monitor CSP operation. An alarm is provided in the MCR to alert the operator to low pump discharge pressure conditions that occur during pump operation. An alarm is also provided in the MCR to alert the operator to low pump suction pressure conditions that occur when the CSP is used for shutdown cooling during reduced RCS inventory operations.

b. CSP flow indication is provided in the MCR to allow the operator to monitor CSP flow during ~~containment spray~~ operation and during shutdown cooling operation using the CSPs. A low-flow alarm is provided to alert the operator when the pump flow rate falls below the flow rate required for shutdown cooling operation.

This alarm allows the operator to take corrective actions to prevent a loss of shutdown cooling flow. The alarm receives a pump status input signal to prevent nuisance alarms.

c. Valve open/close position indication is provided for spray header isolation valves (CS-0003 and CS-0004). The valves are normally closed and receive a signal to open on a CSAS.

d. Valve open/close position indication is provided for spray header block valves (CS-0001 and CS-0002). The valves are administratively controlled in the open position from the control room.

e. Valve open/close position indication and full range 0 to 100 percent position indication is provided for IRWST return line flow control valves (CS-0005 and CS-0006). The valves are normally closed to provide reasonable assurance that the CSPs are aligned to the CS header. During CSP testing, the valve position is throttled to establish the flow rate at the CSP design flow rate.

f. CSP on/off indication is provided in the MCR to identify pump status. A pump status signal is provided to the shutdown cooling low-flow alarm to prevent nuisance alarms when a CSP is used for shutdown cooling.

g. CSP motor current indication is provided in the MCR to allow the operator to monitor pump operation. A low indicated current when the CSPs are aligned for shutdown cooling operation may indicate air entrainment in the pump suction line and the potential loss of shutdown cooling.

h. CS heat exchanger outlet temperature indication is provided in the MCR to monitor heat exchanger performance during ~~containment spray~~ CS operation.

i. Open/closed position indication is provided in the MCR for the CSP discharge manual isolation valves (CS-1003 and CS-1004). An alarm is provided to alert the operator when a valve is not fully open.

a. The four safety injection and ~~containment spray pump~~ CSP suction isolation valves in the IRWST penetration lines outside containment are located in the auxiliary building valve rooms.

b. The high volume and low volume containment purge system containment isolation valves, which are outside containment, are located in the containment high/low volume supply AHU room.

c. The four main steam lines and four main feedwater lines, due to the nature of their service, have all of their containment isolation valves located within the main steam isolation valve house, with the exception of the main feedwater inside-containment check valves.

d. The four component cooling water (CCW) containment isolation valves outside containment are located in the pipe chases, which are located in quadrant A of the auxiliary building.

The isolation arrangement of the fuel transfer tube consists of a transfer tube closure and a blind flange, enclosing the transfer tube. The fuel transfer tube blind flange is Type-B leak-rate tested in accordance with ANSI/ANS 56.8-1994. The blind flange contains two O-ring grooves and a pressure tap that runs through the blind flange to the annulus between the two O-rings. When assembled prior to reactor operation, the blind flange is bolted to the transfer tube closure and the annulus between the seals is pressurized to provide reasonable assurance that both seals are functioning. The seal is further tested when test pressure is introduced into the containment.

When these tests have been satisfactorily completed, the fuel transfer tube is isolated from the containment. The transfer tube closure and the blind flange are considered to be part of the containment boundary and, therefore, GDC 56 does not apply to the transfer tube penetration and an isolation valve is not required.

A normally locked-closed manual valve is provided on the transfer tube outside the containment. However, its basic function is not to provide containment isolation. At the beginning of refueling, during filling of the refueling pool, this valve is maintained closed

Test connections, drains, vents, and pressurizing facility are provided to test each Type C containment isolation valve or barrier for leak-tightness in the accident direction (out of containment), unless it is more conservative to pressurize in the non-accident direction. Air or nitrogen is used as the pressurizing medium.

6.2.5 Combustible Gas Control in Containment

The containment hydrogen control system is designed to control combustible gas, primarily hydrogen gas (H_2), inside the containment within the acceptable limits. Combustible gas is controlled by passive autocatalytic recombiners (PARs) or hydrogen igniters (HIs) with consideration of hydrogen generation during a severe accident.

The containment hydrogen control system consists of 30 PARs and 8 HIs. The PARs and HIs installed within the containment as shown in Figure 6.2.5-1 are designed to control beyond DBA hydrogen concentration in the containment and the IRWST below 10 percent by volume. Table 6.2.5-1 shows the location of the PARs and HIs. The use of hydrogen-generating materials such as aluminum and zinc within containment is minimized to the extent practicable. The 30 PARs and 8 HIs are enough to cover the hydrogen gas due to corrosion from the emergency cooling or ~~containment spray~~ solutions.

CS

6.2.5.1 Design Bases

During a degraded core accident, hydrogen is generated at a greater rate than in a design-basis LOCA. The PARs and HIs are designed to accommodate the hydrogen generation from 100 percent fuel clad metal-water reaction and to limit the uniformly distributed hydrogen concentration in the containment and IRWST below 10 percent by volume, assuming the representative severe accident sequences. These limits are imposed to preclude local detonations in the containment that could jeopardize containment integrity or damage essential equipment.

The containment hydrogen control system is designed in accordance with 10 CFR 50.34(f)(2)(ix), 10 CFR 50.44, GDC 41, GDC 42, GDC 43, and NRC RG 1.7.

The PARs and HIs are installed throughout the containment. HIs as supplementary to the PARs provide an effective means of controlling local hydrogen concentration in compartments where the hydrogen release rate is greater than the depletion capability of PARs during a certain period of severe accident progression.

The failure modes and effects analyses (FMEA) of containment hydrogen monitoring system (CHMS) are presented in Table 6.2.5-2.

6.2.5.2 System Design

6.2.5.2.1 Provision against Severe Accidents

The PARs and HIs are designed to control or allow adiabatic controlled burning of hydrogen at fairly low concentrations to preclude hydrogen concentration buildup to detonable levels. The system is designed to prevent the global and local hydrogen concentration in the containment and the IRWST from exceeding 10 percent by volume during a degraded core accident with 100 percent fuel clad metal-water reaction in accordance with 10 CFR 50.44(c). The PARs in the containment and IRWST and the HIs in the containment are installed.

The PAR assemblies consist of structures for device and a stainless steel enclosure in which the catalyst is installed. The enclosure is open on the bottom and top and extends above the catalyst elevation to provide a chimney to yield additional lift to enhance the efficiency and ventilation capability of the device. Cartridge type devices are coated with catalytic material and supported by the enclosure. The function of the bores or spaces inside the cartridge is air pass-through. Covers are installed over the chimney to protect the cartridge from ~~containment spray or~~ stagnant water.

CS

For the PARs, provisions are not required because they can operate automatically and their function can be confirmed by technical performance specification. PARs do not need to be grouped because they work independently.

The HIs are ac-powered glow plugs and are powered directly from a step down transformer. Each HI assembly consists of a thick steel enclosure that contains the transformer and all electrical connections and partially encloses the HI. The enclosure satisfies the U.S. National Electrical Manufacturers Association (NEMA) Type 4 specifications for water-tight integrity under various environmental conditions including exposure to water jets.

maintaining a safe shutdown of the plant and containment integrity are capable of performing their functions during and after their exposure to hydrogen burning.

The PARs and HIs are located throughout the containment open volumes and compartments. The following location criteria are used:

a. Flow path requirements

b. Consideration of enclosed spaces

c. Equipment performance efficiency

d. Installation and maintenance

e. Consideration of dynamic effect

For the surveillance test of PARs, a sample of the PAR cartridges or plates is selected and removed from each PAR. Surveillance bench tests are performed on the removed specimens to confirm continued satisfactory performance. The HIs are capable of attaining the surface temperature that is sufficient for igniting hydrogen gases under any environmental conditions including ~~containment spray~~ CS actuation. The HI configuration, including possible spray shields, is supported by combustion test data.

Because the PAR is self-actuated and does not need a power supply, operator action for the PAR is not needed. The HIs are actuated by manual actuation in the MCR or RSR on indication that the hydrogen concentration exceeds a predetermined setpoint of volume percent or an indication of the beyond DBA. The HIs are capable of a manual trip. Restart of the system on restoration of power is performed by manual actuation.

The PAR is designed to provide reasonable assurance that the gas mixture flows into PAR inlets and thus augments the circulation of gas mixture within the containment to eliminate stagnant pockets of air where hydrogen could accumulate.

The PAR in the IRWST is provided to remove hydrogen produced by sump radiolysis in the IRWST.

Table 6.2.2-3 (2 of 5)

CSHX

CS

No	Name	Failure Mode	Cause	Symptoms and Local Effects including Dependent Failures	Method of Detection	Inherent Compensating Provision	Remarks and Other Effects
5	~~Containment spray heat exchanger~~ 1, 2	a) Loss of cooling	• Insufficient component cooling water flow • Excessive fouling	Diminished ability of subsystem to provide temperature and pressure suppression within the containment during recirculation mode of operation	High temperature indication from T-071C, T-072D	Parallel redundant ~~containment spray~~ path	-
6	~~Containment spray~~ header block valve CS-0001, CS-0002	a) Fails closed	• Corrosion • Mechanical binding • Operator error • Electrical failure	Effective loss of one ~~containment spray~~ path	• Valve position indicator • Periodic testing	Parallel redundant ~~containment spray~~ path	Valves normally locked open
		b) Fails open	Mechanical failure	No effect during CSS operation	Periodic testing	None required	-
7	~~Containment spray~~ header isolation valve CS-0003, CS-0004	a) Fails closed	• Corrosion • Mechanical binding • Electrical failure	Effective loss of one ~~containment spray~~ path	• Valve position indicator • Periodic testing	Parallel redundant ~~containment spray~~ path	-
		b) Fails open	• Mechanical failure • Electrical failure	No effect during CSS operation	• Valve position indicator • Periodic testing	None required	Valve normally locked closed

Table 6.2.2-3 (3 of 5)

CS

No	Name	Failure Mode	Cause	Symptoms and Local Effects including Dependent Failures	Method of Detection	Inherent Compensating Provision	Remarks and Other Effects
8	~~Containment spray~~ nozzles	a) Nozzle blockage	• Foreign objects in ~~containment spray~~ lines • Corrosion	No ~~containment spray~~ flow to affected nozzle	• Low flow indication F-338C, F-348D • Periodic testing	Parallel redundant CSS train	The main and auxiliary spray nozzles have 1.31 cm (0.516 in) and 0.559 cm (0.220) in orifices, respectively, and are not subject to clogging by particles less than 0.299 cm (0.09 in) maximum dimension. Solution is completely stable and soluble at all temperatures of interest in the containment and therefore does not precipitate or otherwise interfere with nozzle performance.

Table 6.2.2-3 (4 of 5)

No	Name	Failure Mode	Cause	Symptoms and Local Effects Including Dependent Failures	Method of Detection	Inherent Compensating Provision	Remarks and Other Effects
9	~~Containment spray~~ mini-flow heat exchanger 1, 2	a) Loss of cooling	• Insufficient component cooling water flow • Excessive fouling	Possibly damage to one CSP	Periodic testing	Parallel redundant ~~containment spray~~ train	
10	~~Containment spray~~ IRWST return line flow control valves CS-0005, CS-0006	a) Fails open	• Corrosion • Mechanical binding • Operator error • Electrical failure	Diversion of flow from ~~containment spray~~ header	• Valve position indicator • Periodic testing	Parallel redundant ~~containment spray~~ train, series isolation valve	Valves normally locked closed
		b) Fails closed	• Corrosion • Mechanical binding	No effect during CSS operation	Periodic testing	None required	
11	IRWST isolation valves SI-308, SI-309	a) Fails closed	• Corrosion • Mechanical binding • Operator error • Electrical failure	Effective loss of one CSP	• Low flow indication F-338C, F-348D • Periodic testing	Parallel redundant ~~containment spray~~ path	Valves normally locked open
		b) Fails open	Corrosion	No effect on CSS operation	Periodic testing	None required	

CS

and then into the containment atmosphere. Spray flow to the CS nozzle headers is not provided until a CSAS automatically opens the ~~containment spray~~ header isolation valves. The main spray nozzle headers are located in the upper part of the containment building to provide the falling spray droplets to approach thermal equilibrium with the steam-air atmosphere. Condensation of the steam by the falling spray reduces the containment pressure and temperature.

By reducing the containment pressure, the CSS diminishes the pressure differential between the containment atmosphere and the external environment atmosphere, thus reducing the leakage of fission products to the external environment.

CS

Performance requirements are set to conform with the dose limit specified in 10 CFR 50.34.

Following a LOCA or an MSLB, the containment pressure is reduced to near atmospheric pressure. When the containment pressure is reduced sufficiently, the CSS is not required for iodine removal. The operator determines that ~~containment spray~~ is no longer required, and the operator terminates the CSS operation. When the containment temperature and pressure do not stabilize or continue reducing, the operator restarts the CSS manually.

The CSPs are designed to be functionally interchangeable with the shutdown cooling pumps (SCPs) when not required to perform their requisite design basis function, assuming a loss of offsite power and single failure. The CSPs can be used as a backup to the SCPs to provide residual heat removal, and the CSPs and the CSHXs can be used as a backup to the SCPs and the shutdown cooling heat exchangers (SCHXs) to provide cooling of the IRWST.

6.5.2.2 System Design (for Fission Product Removal)

The IRWST contains 2,457 m^3 (649,000 gal) of borated water to at least 4,000 ppm concentration. TSP is stored in baskets at the HVT. The TSP is fully dissolved in the return flow from the sprayed water or break flow.

As discussed in Subsection 6.2.2, there are 296 containment main spray nozzles for each division, arranged in four spray nozzle headers at high locations in the containment. Figure 6.2.2-4 shows the sectional view of the containment providing the main spray nozzle header elevations. Figure 6.2.2-5 shows the plan view of the locations and types of nozzles on each spray nozzle header. Figure 6.2.2-5 also shows the spray coverage on the operating floor of the containment.

The mass mean drop size produced at the nozzle design condition of 2.81 kg/cm^{2}D (40 psid) is assumed to be 295 microns for the main spray nozzles.

Table 6.5-3 presents a tabulation of the sprayed and unsprayed volumes in the containment. ~~Containment spray~~ CS coverage is approximately 75 percent of the containment net free volume. Unsprayed volume includes covered regions such as pressurizer and steam generator compartments.

There is no safety grade forced ventilation inside the containment. Air mixing is accomplished by flows due to the density difference between the regions resulting from the effect of the spray.

Operation of the CSS to remove fission products from the containment is described in Subsection 15.6.5.5.1.1. The time of spray initiation is also shown in Subsection 15.6.5.5.1.1.

CSS components including pumps, piping, and valves are described in Subsection 6.2.2.

6.5.2.2.1 Design Features for Minimization of Contamination

The CSS is designed with specific features to meet the requirements of 10 CFR 20.1406 (Reference 8) and NRC RG 4.21 (Reference 9). The basic principles of NRC RG 4.21 and the methods of control suggested in the regulations are specifically delineated into four design objectives and two operational objectives discussed in Subsection 12.4.2. The following evaluation summarizes the primary features to address the design and operational objectives for the CSS.

The CSS has been evaluated for leakage identification from the SSCs that contain radioactive or potentially radioactive materials, the areas and pathways where probable leakage may occur, and the methods of leakage control incorporated in the design of the system. The leak identification evaluation indicated that the CSS is designed to facilitate

b. Shell and tube type heat exchangers are used to transfer heat from the CSS side to the component cooling water system side. The heat exchangers are designed with stainless steel tubes to minimize the potential for cross-contamination between ~~containment spray~~ and component cooling water. The leakage from the heat exchangers is collected in the local floor drain and sumps.

c. Process sampling connections are provided to determine levels of contamination and determine treatment requirements.

CS

Decommissioning Planning

a. The SSCs are designed for the full service life and fabricated as individual assemblies for easy removal.

b. The SSCs are designed with decontamination capabilities. Design features (e.g., utilized welding technique, surface finishes) are included to minimize the need for decontamination and the resultant waste generation.

c. The CSS is designed without any embedded or buried piping for contaminated or potentially contaminated fluid, which minimizes the potential for unintended contamination of the environment.

Operations and documentation

a. The COL applicant is to provide the operational procedures and maintenance program as related to leak detection and contamination control (COL 6.5(1)).

b. The COL applicant is to maintain the complete documentation of system design, construction, design modifications, field changes, and operations (COL 6.5(2)).

Site Radiological Environmental Monitoring

The CSS is on standby mode during normal power operation and designed to have only low levels of contamination. Through monitoring, in-service inspection, and lessons learned from industry experiences, the integrity of the CSS is well maintained, resulting in a very

6.5.2.3.2 Containment Spray pH Control

The pH of IRWST water is evaluated to provide reasonable assurance that the calculated minimum and maximum pH values under any possible water chemistry conditions caused by a LOCA are between 7.0 and 8.5.

After a LOCA, the spray water from the spray nozzles removes the fission product from the containment atmosphere drops to the floor of the containment. The spray water that drops to the containment floor accumulates in the HVT. During a LOCA, TSP stored in baskets in the HVT becomes immersed in water, and the resulting solution overflows into the IRWST. If the pH of IRWST water during the post-accident is maintained above 7.0, the radioactive iodine dissolved into IRWST water does not re-evaporate into the containment atmosphere.

Stainless steel baskets, which are attached to the walls of the HVT, have a solid top and bottom with mesh sides to permit submergence of the TSP. The elevation of the baskets is below the IRWST spillway.

The principal water sources that contribute to the pH control are from the IRWST, the RCS including the pressurizer, the safety injection tanks (SITs), safety injection system piping, and CSS piping.

The volume of TSP required to establish a minimum pH of 7.0 in the recirculated ~~containment spray~~ CS solution is calculated using the following conservative assumptions:

a. Maximum boron concentration for each water source

b. Maximum water sources

c. Minimum IRWST water temperature

For this analysis, it is assumed that one CS pump is running.

On the other hand, the maximum pH is conservatively calculated using the previously determined TSP volume and the following initial conditions:

a. Minimum boron concentrations for each water source

b. Minimum water sources

c. Maximum IRWST water temperature

The major parameters used in pH calculations are presented in Table 6.5-4. The results of the calculations show that the time required to reach a pH of 7.0 for the minimum pH condition is estimated to be 157 minutes after the onset of a LOCA. The maximum pH value is calculated not to exceed 8.5 for the maximum pH condition. Therefore, the pH of IRWST water is maintained between 7.0 and 8.5 after 157 minutes.

6.5.2.3.3 Airborne Fission Product Removal Coefficient

The fission products are released from the RCS into the containment atmosphere following a DBA through the three steps: coolant activity release, gap activity release, and early in-vessel release according to NUREG-1465 (Reference 11). Fission products are divided into eight radionuclide groups on the basis of chemical behavior. Of the radioiodine released from the RCS to the containment atmosphere, 95 percent is particulate iodine, 4.85 percent is elemental iodine, and 0.15 percent is organic iodine. With the exception of elemental and organic iodine and noble gases, fission products are assumed to be in a particulate form.

The removal of airborne radioactivity in the containment by natural deposition is credited by acceptable models for elimination of iodine and aerosols in SRP 6.5.2 and in NUREG/CR-6189 (Reference 12). The removal of airborne radioactivity in the containment by CSS is credited by acceptance models in SRP 6.5.2.

The removal rates of elemental and particulate iodine by natural deposition (process) or by ~~containment spray~~ CS are used based on the above regulations and as described below.

Elemental Iodine Removal by Containment Spray

The elemental iodine removal coefficients are estimated using the following equation:

6.5.3 Fission Product Control System

The primary fission product control system following a DBA is the CSS and the containment. The fission product leakage to the environment is reduced below the release limit by the fission product removal function of the ~~containment spray~~ CS and the leaktight pressure boundary of the containment. Chapter 15 describes the radiological consequences following the DBAs. The in-service leakage testing program monitors the containment leakage rate as detailed in Subsection 6.2.6.

6.5.3.1 Primary Containment

The containment is a pre-stressed, post-tensioned concrete structure with stainless steel liner plates that form a leaktight pressure boundary. The containment serves as a defense-in-depth boundary of fission product with the containment isolation system. Details of the containment structural design characteristics are described in Subsection 3.8.1. The containment design characteristics for containment integrity and fission product release after DBAs are described in Section 6.2. The containment isolation system is described in Subsection 6.2.4.

Containment purge system operation is not required during a DBA. The heat and fission product released into the containment during a DBA, such as a LOCA or an MSLB, is removed by the CSS, which is described in Subsection 6.5.2. The APR1400 design does not include a containment hydrogen purge system.

6.5.3.2 Secondary Containment

The secondary containment is not applicable to the APR1400.

6.5.4 Ice Condenser as a Fission Product Cleanup System

This subsection is not applicable to the APR1400.

6.5.5 Pressure Suppression Pool as a Fission Product Cleanup System

This subsection is not applicable to the APR1400.

The swing panels are also actuated by a vacuum in the IRWST, which prevents a vacuum from being drawn in the IRWST during SI actuation, CS actuation, and normal drain down from the IRWST to the refueling pool.

The swing panels are located to minimize impact on maintenance laydown space on the 100 ft elevation. They are also located to prevent jetting from the spargers in the IRWST during POSRV actuation. The IRWST vent stacks and swing panels locations are shown in Figure 6.8-4.

The swing panels are arranged to prevent water from entering the IRWST through the swing panels during normal operation or after an accident. This arrangement provides reasonable assurance that the water enters the IRWST from the holdup volume and that the TSP baskets are used for pH control during DBAs. This is accomplished by swing panels that are installed at the vent stack above the maximum flood elevation and by providing covers above the swing panels.

6.8.2.2.6 IRWST Strainer

The four independent sets of strainers are located in the IRWST and each strainer is for one of the four SI pumps, and for one of two SC pumps and two CS pumps. Each strainer has enough surface area of 55.74 m^2 (600 ft^2) and perforated plate hole size of 2.38 mm (3/32 in). These strainers prevent debris from entering the reactor and causing inadequate core or containment cooling. The strainers are designed to be fully submerged during all postulated events requiring the actuation of the ECC or CS ~~containment spray~~, which minimizes the effects of floating or buoyant debris on the integrity of strainer and on subsequent head loss. The strainers are design to meet safety Class 2 and seismic Category I requirements.

Additional design features are described further in Reference 4 and Subsection 6.8.4.5.

6.8.3 Instrumentation

IWSS instrumentation is designed in accordance with the applicable portions of the IEEE standards and NRC RGs that are identified in Subsection 7.1.2.

Surrogate suspensions of chemical precipitates representing this chemical debris can be included as an additional debris source to the strainer testing program to qualify the strainer for "chemical effects". The quantities of chemical precipitates are based on reactive material surface areas and quantities, temperature, water level, pH and other parameters related to the plant specific environment and postaccident evolution. The calculated result based on the WCAP-16530-NP (Reference 9) methodology referenced in RG 1.82 (Reference 3) is provided in Table 6.8-3.

6.8.4.5.8 Upstream Effects

The evaluation of upstream effect is a review of the flow paths leading to the IRWST, identifying those flow paths which could result in blocking the return water that could challenge the IRWST minimum water level evaluation. The evaluation also includes identifying the hold-up volumes, such as recessed areas and enclosed rooms, for which trapped water will not return to the IRWST. All of the hold-up volumes were taken account of in the minimum water level calculation. Detail holdup volume is provided in Table 6.8-2.

Figure 6.2.1-20 show a schematic of ~~containment spray~~ and blowdown return pathways, and the schematic of potential water traps in containment. During long-term cooling subsequent to a RCS pipe break, borated water is drawn from the IRWST by the SIPs and injected into the RV for core cooling. This water is ejected to the bottom floor of the containment within the secondary shield wall through the horizontal platforms which are constructed of open grating within the SG compartments. The CSPs also draw water from the IRWST sumps to cool the containment building. This water rains down on all containment surfaces, and then drains to the bottom floor of containment within secondary shield wall and annulus via the stairway and a ring of deck grating around much of the circumference of the building.

CS

Water spilled from RCS break and the uniformly distributed ~~containment spray~~ water drain back to the HVT, and then drains to the IRWST via spillways. Since there are four pathways on the bottom floor of the containment, the debris will not clog these pathways. As a result of evaluation, no choke points that may block the flow paths of return water are identified. Therefore, only the hold-up volumes may challenge the minimum water level of the IRWST.

This result also verifies that inadequate core or containment cooling does not occur because of debris blockage at flow restrictions, plugging or excessive wear of close-tolerance component (e.g., pumps, heat exchangers, piping, valves, spray nozzles) in the flow path. The component design parameter used in the evaluation of ex-vessel downstream effect is listed in Table 6.2.2-2, 6.3.2-1, and 6.8-4.

As a result of strainer bypass test, the amount of bypass fiber per fuel assembly (FA) is less than the 15 gram limit. Based on this information, the evaluation result of in-vessel downstream effect is that the maximum total deposit thickness and the peak cladding temperature are maintained within the WCAP-16793-NP (Reference 10) LTCC criteria with enough margin, and the LTCC can be maintained.

6.8.4.5.10 Potential Debris Source Control

Programmatic controls are established to ensure that potential sources of debris introduced into containment (e.g., insulation, coatings, foreign material, aluminum), and plant modifications do not adversely impact the SI and CS/SC recirculation function.

Programmatic controls are established consistent with the guidance in NRC RG 1.82, Rev. 4 (Reference 3), which provides reasonable assurance that (1) potential quantities of post-accident debris are maintained within the bounds of the analyses and design bases that support the safety injection (SI), ~~containment spray (CS)~~ CS, and shutdown cooling (SC) recirculation functions and (2) the long-term core cooling requirements of 10 CFR 50.46 (Reference 11) are met.

The following is a summary of the programmatic controls that are implemented to provide reasonable assurance of the proper operation of IRWST sump strainer and limits the quantities of latent debris (e,g., unintended dirt, dust, paint chips, fibers) and miscellaneous debris (e.g., tape, tags, stickers) are limited inside containment:

a. Preparation of a cleanliness, housekeeping, and foreign materials exclusion program. This program addresses latent and miscellaneous debris inside containment. An acceptance criterion below the conservative assumption of 90.72 kg (200 lb) for latent debris inside containment is consistent with Reference 4. The programs also ensure that the quantity of miscellaneous debris, such as signs, placards, tags or stickers in the containment is limited so that the 9.29 m^3

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #12 (AI 6-14.12)

FSAR Section 6.0 describes several components that are not listed in FSAR Table 6.1-1 or 6.1-2:

- In-containment Refueling Water Storage Tank
- Hold-up Volume Tank
- Shutdown Cooling Pump
- Shutdown Cooling Heat Exchanger
- Containment Spray Heat Exchanger
- Safety Injection Filling Tank
- Class 3 systems

The text of the application suggests that these components are part of the ESF system. Revise Tables 6.1-1 and 6.1-2, or add a new table to the section, to address the components listed above. The staff needs this information to evaluate all ESF materials, including information on specification, grade, class, and type to make an adequate assurance finding.

In addition, review Tables 6.1-1 and 6.1.-2 to ensure that no other ESF system components have been left out.

Response

The Tables 6.1-1 and 6.1-2 have been reviewed for completeness, and will be revised, to as shown in the attachment associated with this response.

Impact on DCD

The DCD will be revised, as shown in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

Table 6.1-1 (5 of 5)

Issue#12

ESF Component	Material	Class, Grade, or Type
ESF Filter System		
	Subsection 6.5.1	
In-Containment Water Storage System		
Class 2 piping	SA-312	Gr. TP304
	SA-358	Gr. TP304
Class 2 valves	SA-182	Gr. F316
	SA-351	Gr. CF8M
Fitting / flange	SA-182	F304
	SA-193	Gr. B7
	SA-194	Gr. 2H
	SA-403	Gr. WP304
Weld Filler Material		
	SFA-5.1	E7016, E7018
	SFA-5.4	E308-15, E308-16, E308L-15, E308L-16 E309L-16
	SFA-5.5	E9018-B3
	SFA-5.9	ER308, ER309, ER308L ER309L
	SFA-5.11	ENiCrFe-7
	SFA-5.14	ERNiCrFe-7, ERNiCrFe-7A
	SFA-5.18	ER70S-2, ER70S-6
	SFA-5.28	ER90S-B3

Table 6.1-2 (3 of 3)

Issue#12

ESF Component	Material	Class, Grade, or Type
ESF Filter System		
	Subsection 6.5.1	
In-Containment Water Storage System		
IRWST	A 240	Type 304
HVT	A 240	Type 304
IRWST Sump strainer	A 240	Type 304
Class 2 piping	SA-312	Gr. TP304
	SA-358	Gr. TP304
Class 2 valves	SA-182	Gr. F316
	SA-351	Gr. CF8M
Fitting / flange	SA-182	F304
	SA-193	Gr. B7
	SA-194	Gr. 2H
	SA-403	Gr. WP304
Weld Filler Material		
	SFA-5.1	E7016, E7018
	SFA-5.4	E308-15, E308-16, E308L-15, E308L-16 E309L-16
	SFA-5.5	E9018-B3
	SFA-5.9	ER308, ER309, ER308L, ER309L
	SFA-5.11	ENiCrFe-7
	SFA-5.14	ERNiCrFe-7, ERNiCrFe-7A
	SFA-5.18	ER70S-2, ER70S-6
	SFA-5.28	ER90S-B3

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #13 (AI 6-14.13)

APR-1400 FSAR Section 6.0 states that:

> Weld-heat-affected-zone sensitized austenitic stainless steels are avoided by carefully controlling:
>
> 1) Weld heat input to less than 23.6 kJ/cm (60 kJ/in)
>
> 2) Interpass temperature to 176.7 °C (350 °F) maximum
>
> 3) Carbon content to 0.065 percent maximum

It is not clear to the staff what specifying a maximum carbon content of 0.065 does with regards to sensitization. RG 1.44, "Control of the Processing and Use of Stainless Steel," states that low carbon grade stainless steel (i.e., 304L and 316L, which the staff understands to be limited to a maximum carbon content of 0.03 percent) should be used where the material comes in contact with the reactor coolant. Specifying 0.065 percent carbon maximum does not appear consistent with this.

Revise FSAR Section 6.0 to delete item (3) from the list and to remove all non-L grade 304 and 316 grades from Tables 6.1-1 and 6.1-2. Alternatively revise FSAR Section 6.0 to justify why requiring a maximum carbon content of 0.065 helps prevent sensitization and justify the use of non-L grade 304 and 316.

Response

Please refer to the answer to Issue #14 regarding Section 5.2.3

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

Response to Action Item 5-8 Section 5.2.3

MCB Issue List Regarding APR-1400, FSAR Section 5.2.3

Issue #14 (AI 5-8.14)

APR-1400 FSAR Section 5.2.3.4.1.d states that:

> Weld-heat-affected-zone sensitized austenitic stainless steels are avoided by carefully controlling:
>
> 1) Weld heat input to less than 23.6 kJ/cm (60 kJ/in)
>
> 2) Interpass temperature to 176.7 °C (350 °F) maximum
>
> 3) Carbon content to 0.065 percent maximum

It is not clear to the staff what specifying a maximum carbon content of 0.065 does with regards to sensitization. RG 1.44, “Control of the Processing and Use of Stainless Steel,” states that low carbon grade stainless steel (i.e., 304L and 316L, which the staff understands to be limited to a maximum carbon content of 0.03 percent) should be used where the material comes in contact with the reactor coolant. Specifying 0.065 percent carbon maximum does not appear consistent with this.

Revise FSAR Section 5.2.3.4.1.d to delete item (3) from the list and to remove all non-L grade 304 and 316 grades from Table 5.2-2. Alternatively revise FSAR Section 5.2.3.4.1.d to justify why requiring a maximum carbon content of 0.065 helps prevent sensitization and justify the use of non-L grade 304 and 316.

Response

1) FSAR Section 5.2.3.4.1.d will be revised to read as follows:

> Weld-heat-affected-zone sensitized austenitic stainless steels are minimized by carefully controlling:
>
> 1) Weld heat input to less than 23.6 kJ/cm (60 kJ/in)
> 2) Interpass temperature to 176.7 °C (350 °F) maximum
> 3) Carbon content to 0.065 percent maximum

2) Usage of non-L-grade stainless steel

> Avoiding the occurrence of SCC in non-L-grade stainless steels is obtained through the controls on welding, fabrication, and water chemistry during reactor operation and by limitation of the carbon content of austenitic stainless steels to 0.065 % as follows:

AI 6-14_6.1.1_#13

Attachment(2/4)

AI 5-8.14_5.2.3_#14

Response to Action Item 5-8 Section 5.2.3

a) The RG 1.44 C.4 requires that low carbon grade stainless steel (i.e., 304L and 316L) should be used where the material comes in contact with the reactor coolant with the exceptions. One of the exceptions is that the material can have carbon content higher than 0.03%C provided that a limiting value of 0.10 ppm dissolved oxygen during normal operation is maintained.

For APR1400, the dissolved oxygen content of reactor coolant will be less than 0.10 ppm during normal operation. In addition to the dissolved oxygen control, contents of chloride and fluoride will be managed to equal to or less than 0.05 ppm. According to B. M. Gordon[note 1], SCC will not occur for non-sensitized stainless steels at this low chloride content even though dissolved oxygen content is about 5 ppm. For the allowable contents of dissolved oxygen, chloride and fluoride in reactor coolant during power operation, please see Table 5.2-8, “Reactor Coolant Detailed Power Operation Specifications” included in the response to Issue #1 of the MCB Issue List Regarding Chemical Engineering Issues Related to APR1400 FSAR Sections 5.2.3 and 9.3.4.

Note 1: B. M. Gordon, “The Effect of Chloride and Oxygen on the Stress Corrosion Cracking of Stainless Steels: Review of Literature.” Materials Performance, Vol. 19, No. 4, pp. 29-38, 1980.

b) Appropriate venting activities for RCS are performed through the venting nozzles at the top of the components such as CEDM, RV, PZR, RCP, shutdown cooling piping, safety injection piping, where dead leg conditions may occur. For CEDM venting, please see the response to Issue #2 of MCB Issue List Regarding APR1400, FSAR Section 4.5.1. Other components which do not have venting nozzle, such as SG tubes, RCS piping are vented by operating RCPs for a short time.

c) Cold-worked or strain hardened austenitic stainless steel is not used for components of the RCPB. Please see FSAR 5.2.3.4.3.

d) Unsensitized materials which succeed to pass ASTM A262 practice A or E and the procedures and/or practices which are demonstrated not to produce a sensitized structure are only used for the RCPB components. Please see FSAR 5.2.3.4.1.

e) Contamination control is imposed to prevent the presence of detrimental impurities that could lead to SCC during the fabrication of austenitic stainless steels for the CEDMs. Please see FSAR 5.2.3.4.2.

f) Only qualified welding processes to avoid sensitization at heat affected zone are applied. Also, interpass temperature and weld heat input are carefully controlled. Please see FSAR 5.2.3.4.1.

Response to Action Item 5-8 Section 5.2.3

g) Carbon content to 0.065 percent maximum is imposed to austenitic stainless steels to enhance the resistance to sensitization of heat affected zone by welding.

These mitigating actions have been proved successfully for more than 30 years in the operating plants, such as Arkansas nuclear unit 2, Palo Verde nuclear unit 1, which design is similar to the OPR1000 plants. Therefore, they would give reasonable assurance that SCC can be controlled and the integrity of the components composing RCPB can be maintained.

Impact on DCD
DCD 5.2.3.4.1.d will be revised as indicated on the attached markup.

Impact on PRA
There is no impact on the PRA.

Impact on Technical Specifications
There is no impact on the Technical Specification.

Impact on Technical/Topical/Environmental Reports
There is no impact on any Technical, Topical or Environmental Reports.

In duplex, austenitic/ferritic alloys, chromium-iron carbides are precipitated preferentially at the ferrite/austenitic interfaces during exposure to temperatures ranging from 427 to 816 °C (800 to 1,500 °F). This precipitate morphology precludes intergranular penetrations associated with sensitized Type 300 series stainless steels exposed to oxygenated or fluoride environments.

d. Avoidance of sensitization

Exposure of unstabilized austenitic Type 300 series stainless steels to temperatures ranging from 427 to 816 °C (800 to 1,500 °F) results in carbide precipitation. The degree of carbide precipitation, or sensitization, depends on the temperature, the amount of time at that temperature, and the carbon content. Severe sensitization is defined as a continuous grain boundary chromium-iron carbide network. This condition induces susceptibility to intergranular corrosion in oxygenated aqueous environments, as well as those containing fluorides. Such a metallurgical structure rapidly fails the ASTM A262 Practice A or E Test. Discontinuous precipitates (i.e., an intermittent grain boundary carbide network) are not susceptible to intergranular corrosion in a PWR environment.

Weld-heat-affected-zone sensitized austenitic stainless steels are avoided by carefully controlling:

1) Weld heat input to less than 23.6 kJ/cm (60 kJ/in)

2) Interpass temperature to 176.7 °C (350 °F) maximum

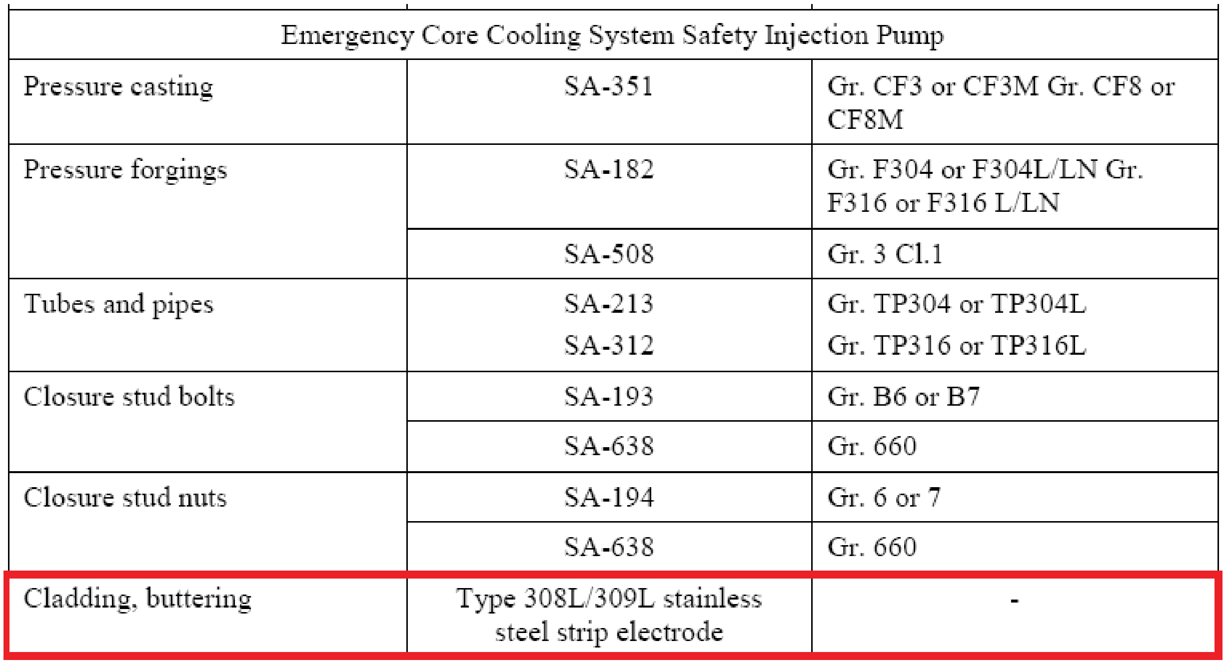
3) ~~Carbon~~ content to 0.065 percent maximum

Homogeneous or localized heat treatment in the temperature range from 427 to 816 °C (800 to 1,500 °F) is prohibited for unstabilized austenitic stainless steel with a carbon content greater than 0.03 percent used in components of the RCPB. When stainless steel safe ends are required on component nozzles, fabrication techniques and sequencing require that the stainless steel piece be welded to the component after final stress relief. This is accomplished by welding a NiCrFe overlay on the end of the nozzle. Following final stress relief of the component,

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #14 (AI 6-14.14)

In FSAR Section 6.1.1, on page 6.1-13, Table 6.1-1 has the following information:



Emergency Core Cooling System Safety Injection Pump		
Pressure casting	SA-351	Gr. CF3 or CF3M Gr. CF8 or CF8M
Pressure forgings	SA-182	Gr. F304 or F304L/LN Gr. F316 or F316 L/LN
	SA-508	Gr. 3 Cl.1
Tubes and pipes	SA-213 SA-312	Gr. TP304 or TP304L Gr. TP316 or TP316L
Closure stud bolts	SA-193	Gr. B6 or B7
	SA-638	Gr. 660
Closure stud nuts	SA-194	Gr. 6 or 7
	SA-638	Gr. 660
Cladding, buttering	Type 308L/309L stainless steel strip electrode	-

The Safety Injection Pump is a class 2 component as defined in Section 3.2, Table 3.2-1. Buttering of this component is required to meet ASME Code, Section III Subsection NC.

Revise the table to add a specification for the buttering material that will meet the requirements of the ASME Code.

Response

Tables 6.1-1 and 6.1-2 will be revised to specify that austenitic stainless steel is to be used for accumulator (SIT) cladding, as shown in the attachment associated with this response. SIT data are summarized in Table 6.3.2-1.

Impact on DCD

The DCD will be revised, as shown in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

Table 6.1-1 (3 of 5)

ESF Component	Material	Class, Grade, or Type
Valves		
Class 1 valves	Table 5.2-2	
Class 2 valves	Material for Class 2 valves are the same as for Class 1 (Table 5.2-2)	-
Fitting / flange	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
	SA-182	Gr. F304, F304L
	SA-479	Type 304, 304L
Emergency Core Cooling System		
Safety Injection Pump		
Pressure casting	SA-351	Gr. CF3 or CF3M Gr. CF8 or CF8M
Pressure forgings	SA-182	Gr. F304 or F304L/LN Gr. F316 or F316 L/LN
Tubes and pipes	SA-213 SA-312	Gr. TP304 or TP304L Gr. TP316 or TP316L
Closure stud bolts	SA-193	Gr. B6 or B7
	SA-638	Gr. 660
Closure stud nuts	SA-194	Gr. 6 or 7
	SA-638	Gr. 660
~~Cladding, buttering~~	~~Type 308L/309L stainless steel strip electrode~~	~~-~~

Issue#14

Table 6.1-1 (4 of 5)

ESF Component	Material	Class, Grade, or Type
Accumulator (SIT)		
Pressure plates	SA-516	Gr. 60 or 70
Pressure forgings	SA-105	-
	SA-182	Gr. F304, F304L, F316, or F316L
	SA-350	Gr. LF1 or LF2
Pipes	SA-312	Gr. TP304, TP304L, TP316, and TP316L
Closure bolts	SA-193	Gr. B6, B7, B8, B16
Closure nuts	SA-194	Gr. 2, 2H, 4, 8, 8M or 16
Clad	Austenitic stainless steel	
Piping		
Class 1 piping	Table 5.2-2	-
Class 2 piping	SA-312 SA-358	Gr. TP304, TP304L Gr. 304, 304L
Valves		
Class 1 valves	Table 5.2-2	
Class 2 valves	Material for Class 2 valves are the same as for Class 1 (Table 5.2-2)	-
Fitting / flange	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
	SA-182	Gr. F304, F304L
	SA-479	Type 304, 304L

Issue#14

Table 6.1-2 (2 of 3)

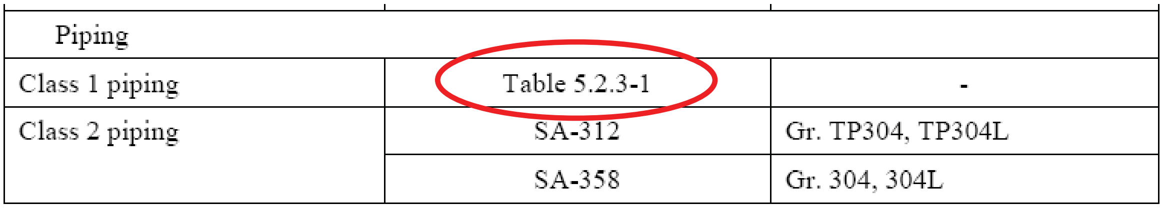
ESF Component	Material	Class, Grade, or Type
Emergency Core Cooling System		
Accumulator (SIT)		
Pressure plates	SA-516	Gr. 60, 70
Pressure forgings	SA-105	-
	SA-182	Gr. F304, F304L, F316, F316L
	SA-350	Gr. LF1, LF2
Internal parts	SA-240	Type 304, 304L, 316, 316L
	SA-182	Gr. F304, F304L, F316, F316L
Pipes	SA-312	Gr. TP304, TP304L, TP316, TP316L
Closure bolts	SA-193	Gr. B6, B7, B8, B16
Closure nuts	SA-194	Gr. 2, 2H, 4, 8, 8M, 16
Clad	Austenitic stainless steel	
Piping		
Class 1 piping	Table 5.2-2	-
Class 2 piping	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
Valves		
Class 1 valves	Table 5.2-2	
Class 2 valves	Material for Class 2 valves are the same as for Class 1 (Table 5.2-2)	
Fitting / flange	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
	SA-182	Gr. F304, F304L
	SA-479	Type 304, 304L

Issue#14

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #15 (AI 6-14.15)

In FSAR Section 6.1.1, on page 6.1-12, Table 6.1-1 has the following information:



Piping		
Class 1 piping	Table 5.2.3-1	-
Class 2 piping	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L

Table 5.2.3-1 does not exist in the application. Revise Table 6.1-1.

Response

Table 5.2.3-1 is an erratum and will be revised to Table 5.2-2 as shown in the attachment associated with this response.

Impact on DCD

The DCD will be revised as shown in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

Table 6.1-1 (2 of 5)

ESF Component	Material	Class, Grade, or Type
CS/CS Mini-flow/SC/SC Mini-flow Heat Exchanger		
Pressure plates	SA-240	Type 304, 304L, 316, 316L
	SA-516	Gr. 60, 70
Pressure forgings	SA-105	-
	SA-182	Gr. F304, F304L, F316, F316L
	SA-266	Gr. 2
	SA-350	Gr. LF1, LF2
Tubes and pipes	SA-106	Gr. B
	SA-213 SA-312	Gr. TP304, TP304L, TP316, TP316L
Closure bolts	SA-193	Gr. B6, B7, B8, B16
Closure nuts	SA-194	Gr. 2, 2H, 4, 8, 8M, 16
Piping		
Class 1 piping	~~Table 5.2.3-1~~	-
Class 2 piping	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L

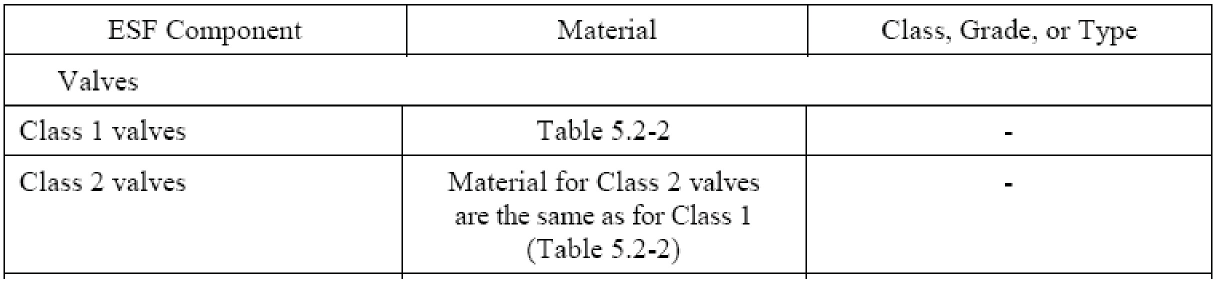
Table 5.2−2

Issue#15

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

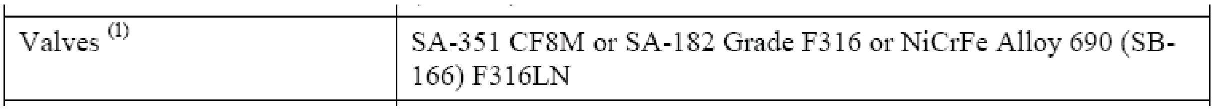
Issue #16 (AI 6-14.16)

In FSAR Section 6.1.1, on page 6.1-13, Table 6.1-1 notes the following:



ESF Component	Material	Class, Grade, or Type
Valves		
Class 1 valves	Table 5.2-2	-
Class 2 valves	Material for Class 2 valves are the same as for Class 1 (Table 5.2-2)	-

On page 5.2-56, Table 5.2-2, the referenced valve materials; class, grade, or type are listed:



Valves [1]	SA-351 CF8M or SA-182 Grade F316 or NiCrFe Alloy 690 (SB-166) F316LN

NiCrFe Alloy 690, Specification SB-166 is the “Specification for nickel-chromium-iron alloys Rod, Bar, and Wire.” Provide additional information regarding the valves:

- Will Alloy 690 rod, bar, or wire be used to create a valve?
- Will the Alloy 690 material be utilized for a component of the valve which acts as pressure-retaining material or structural material? If the answer is no, delete the reference to Alloy 690 from the table.

Response

DCD Tier 2, Table 5.2-2 will be revised to remove, Alloy 690 as indicated in the attachment associated with this response. Please refer to the answer to Issue #2 regarding Section 5.2.3

Impact on DCD

DCD Tier 2, Table 5.2-2 will be revised as indicated in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specification.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

AI 5-8.2_5.2.3_#2

Response to Action Item 5-8 Section 5.2.3

MCB Issue List Regarding APR-1400, FSAR Section 5.2.3

Issue #2 (AI 5-8.2)

APR-1400 FSAR Table 5.2-2, under Piping Nozzles and Safe Ends, lists "NiCrFe Alloy 690 (SB-166) F316LN" as a material specification. This appears to be an error, as F316LN is an austenitic stainless steel, not a Ni-based alloy.

Revise FSAR Table 5.2-2 to cite the corrected material specification.

Response

This is a miswording. The materials applicable to "Valves" of Table 5.2-2 (3 of 5) will be revised as indicated on the marked attachment (3/4) of Issue #1.

Impact on DCD

DCD Table 5.2-2 (3 of 5) will be revised as indicated on the attached markup.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specification.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical or Environmental Reports.

AI 6-14_6.1.1_#16

Attachment(2/4)

AI 5-8.2_5.2.3_#2

Table 5.2-2 (3 of 5)

Component	Material Specification
Reactor Coolant Pumps	
Casing	SA-508 Grade 3 Class 1 and clad with austenitic stainless steel
Cladding (1)	Weld-deposited austenitic stainless steel with 5FN-18FN delta ferrite
Internals (1)	SA-487 CA6NM, SA-336 Type 304, 304LN, 347 or austenitic stainless steel
Shaft (1)	SA-182 Grade F6NM
Reactor Coolant Piping	
Pipe (30 in and 42 in ID)	SA-516 Grade 70 or SA-508 Grade 1 or Grade 1a
Cladding (1)	Weld-deposited austenitic stainless steel with 5FN-18FN delta ferrite
Piping Nozzles and Safe Ends	
Nozzle forgings	SA-508 Grade 1, Grade 1a, or Grade 3 Class 1
Instrument nozzles (1), (3)	NiCrFe Alloy 690 (SB-166)
Nozzle safe ends(1)	SA-182 Grade F316, F316N, F316LN, F347, or NiCrFe Alloy 690 (SB-166)
Valves (1)	SA-351 CF8M or SA-182 Grade F316 or NiCrFe Alloy 690 (SB-166) F316LN
Surge line (1)	SA-312 TP347 or TP316N (piping) SA-403 WP347 or WP316N (elbows)
DVI and shutdown lines inside containment	SA-312 TP316 or TP304

Revise
Replace with the valves on page Attachment (2/3)

Revise
Replace with the "Other RCS piping" on page Attachment (3/3)

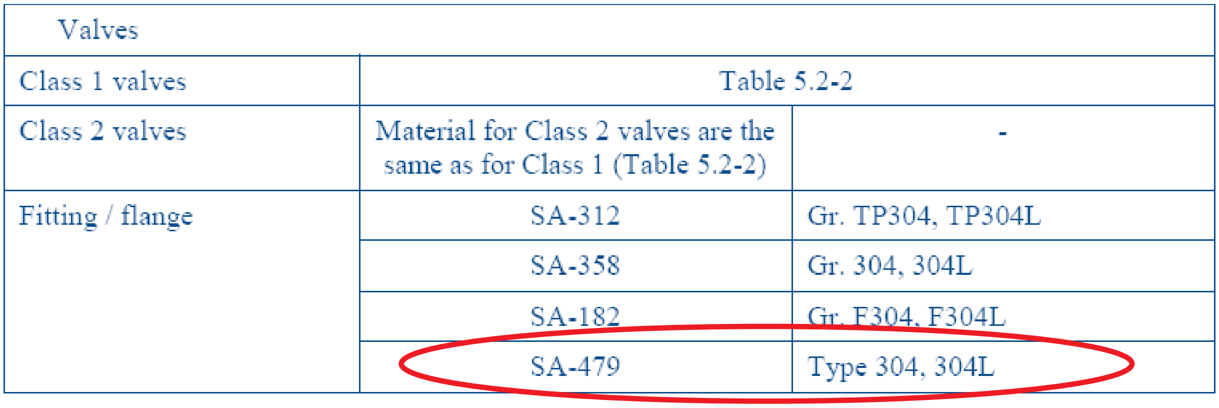
Component	**Material Specification**	
Motor Operated Valve1), and Pneumatic Operated Valve1), Manual Valve1), Check Valve1), Solenoid Valve1)		
Bodies	SA-351	CF3, CF3A, CF3M, CF8, CF8A CF8M
	SA-182	Gr.F304, F304L, F304LN Gr.F316, F316L, F316LN
Bonnets/Cover	SA-351	CF3, CF3A, CF3M, CF8, CF8M
	SA-240	Type 304, 304L, 304LN Type 316, 316L, 316LN
	SA-182	Gr.F304, F304L, F304LN Gr.F316, F316L, F316LN
Disks	SA-564	Type 630
	SA-479	Type 304, 304l, 304LN Type 316, 316L, 316LN
	SA-351	CF3, CF3A, CF3M, CF8, CF8M
	SA-182	Gr.F304, F304L, F304LN Gr.F316, F316L, F316LN
	SB-637	UNS N07718
Stems	SA-564	Type 630
	SA-479	Type 304, 304l, 304LN Type 316, 316L, 316LN
	SB-637	UNS N07718
Closure Stud Bolts	SA-453	Gr.660
	SA-193	Gr.B7, B16, Gr.B8,
	SA-564	Type 630
Closure Nuts	SA-453	Gr.660
	SA-194	Gr.6 , Gr.8, Gr. 8M
Relief Valve1)		
Base	SA-479	Type 316L
Cylinder	SA-351	CF3, CF3M, CF8, CF8M
Lap Joint Stub End/Lab Joint Flange	SA-479	Type 316L
Disc Insert	SA-479	Type 316L
Spindle	SA-479	Type 316L
Spring	Ni base alloy	Alloy X-750
Spring Washer/Adjust Bolt	SA-479	Type 316L

Other RCS Piping1)	
PZR spray lines including auxiliary spray line	SA-312 Grade TP316
RCS drain lines	SA-312 Grade TP316
RCGVS lines	SA-312 Grade TP316
Sampling lines	SA-312 Grade TP316, SA-213 Grade TP316
RCP CBO lines	SA-312 Grade TP304
Charging and letdown lines	SA-312 Grade TP316 or TP304

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #17 (AI 6-14.17)

In FSAR Section 6.1.1, on page 6.1-14, Table 6.1-1 notes the following material and specification:



Valves		
Class 1 valves	Table 5.2-2	
Class 2 valves	Material for Class 2 valves are the same as for Class 1 (Table 5.2-2)	-
Fitting / flange	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
	SA-182	Gr. F304, F304L
	SA-479	Type 304, 304L

On page 6.1-4 the applicant stated:

c. Cold-worked austenitic stainless steel is not normally used for pressure boundary applications.

SA-479 is a specification for “Stainless Steel Bars and Shapes.” Confirm whether the fitting/flange made from this component will be hot-finished or cold-finished. If the bar is cold finished, revise the statement on FSAR page 6-1.4 to list all ESF stainless steel components that will be cold worked.

Response

SA-479 cold-finished is not used.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

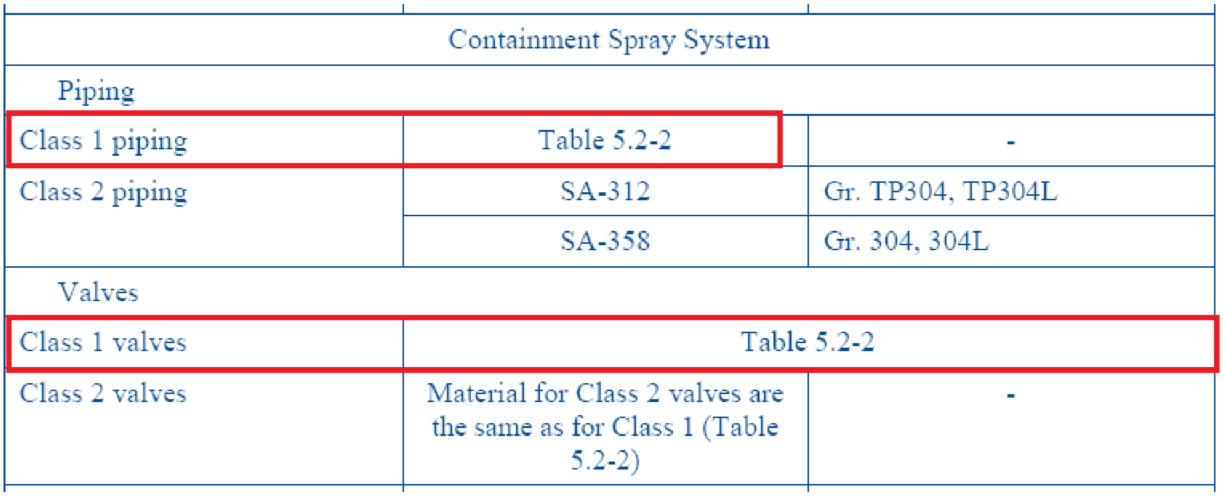
Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #18 (AI 6-14.18)

In FSAR Section 6.1.1, on page 6.1-16, Table 6.1-2 notes the following material and specification:



Containment Spray System		
Piping		
Class 1 piping	Table 5.2-2	-
Class 2 piping	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
Valves		
Class 1 valves	Table 5.2-2	
Class 2 valves	Material for Class 2 valves are the same as for Class 1 (Table 5.2-2)	-

The staff has noted the following discrepancies:

1. On FSAR pages 3.2-27 and 3.2-28, Table 3.2-1 states that there are no Class 1 components in the Containment Spray System.
2. Table 5.2-2 has only 1 item that classifies as pipe; page 5.2-56 lists the reactor cooling piping. Does the applicant intend to use 30 or 42 inch inner diameter piping for the Containment Spray System? Figure 6.2.2-1 shows that the maximum pipe diameter in the containment spray system is 16 inches.

Revise the information contained in Table 6.1-2 to ensure that it is correct for the containment spray system. Also revise the information in Tables 5.2-2 and 3.2-1 as needed.

Response

Class 1 piping and Class1 valves are not included in the Containment Spray System and CS/CS Mini-flow/SC/SC Mini-flow Heat Exchanger. The items will be deleted in Tables 6.1-1, and 6.1-2.

Impact on DCD

The DCD will be revised, as shown in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

Table 6.1-1 (2 of 5)

ESF Component	Material	Class, Grade, or Type
CS/CS Mini-flow/SC/SC Mini-flow Heat Exchanger		
Pressure plates	SA-240	Type 304, 304L, 316, 316L
	SA-516	Gr. 60, 70
Pressure forgings	SA-105	-
	SA-182	Gr. F304, F304L, F316, F316L
	SA-266	Gr. 2
	SA-350	Gr. LF1, LF2
Tubes and pipes	SA-106	Gr. B
	SA-213 SA-312	Gr. TP304, TP304L, TP316 TP316L
Closure bolts	SA-193	Gr. B6, B7, B8, B16
Closure nuts	SA-194	Gr. 2, 2H, 4, 8, 8M, 16
Piping		
~~Class 1 piping~~	~~Table 5.2.3-1~~	
Class 2 piping	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L

Issue#18

Delete class 1 piping

Table 6.1-1 (3 of 5)

Issue#18

Delete class 1 valves

ESF Component	Material	Class, Grade, or Type
Valves		
~~Class 1 valves~~	~~Table 5.2-2~~	
Class 2 valves	Material for Class 2 valves are the same as for Class 1 (Table 5.2-2)	-
Fitting / flange	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
	SA-182	Gr. F304, F304L
	SA-479	Type 304, 304L
Emergency Core Cooling System		
Safety Injection Pump		
Pressure casting	SA-351	Gr. CF3 or CF3M Gr. CF8 or CF8M
Pressure forgings	SA-182	Gr. F304 or F304L/LN Gr. F316 or F316 L/LN
Tubes and pipes	SA-213 SA-312	Gr. TP304 or TP304L Gr. TP316 or TP316L
Closure stud bolts	SA-193	Gr. B6 or B7
	SA-638	Gr. 660
Closure stud nuts	SA-194	Gr. 6 or 7
	SA-638	Gr. 660
Cladding, buttering	Type 308L/309L stainless steel strip electrode	-

Table 6.1-2 (1 of 3)

Principal Engineered Safety Features Materials
Exposed to Core Coolant and Containment Spray

ESF Component	Material	Class, Grade, or Type
Containment		
Containment liner plate	SA-516 SA-240	Gr. 60 or 70 Type 304
Penetrations		
Head Fitting	SA-182 SA-350 SA-516 SA-240	Gr. F 22 Class 3 Gr. LF2 Gr. 60 Type 304
Pipe	SA-106 SA-312	Gr. B, C Gr. TP304, TP304L, Gr.
Sleeve	SA-516	Gr. 70
	SA-333	Gr. 6
Containment Spray System		
Piping		
~~Class 1 piping~~	~~Table 5.2-2~~	
Class 2 piping	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
Valves		
~~Class 1 valves~~	~~Table 5.2-2~~	
Class 2 valves	Material for Class 2 valves are the same as for Class 1 (Table 5.2-2)	-
Fitting / flange	SA-312	Gr. TP304, TP304L
	SA-358	Gr. 304, 304L
	SA-182	Gr. F304, F304L
	SA-479	Type 304, 304L

Issue#18

Delete class 1 piping

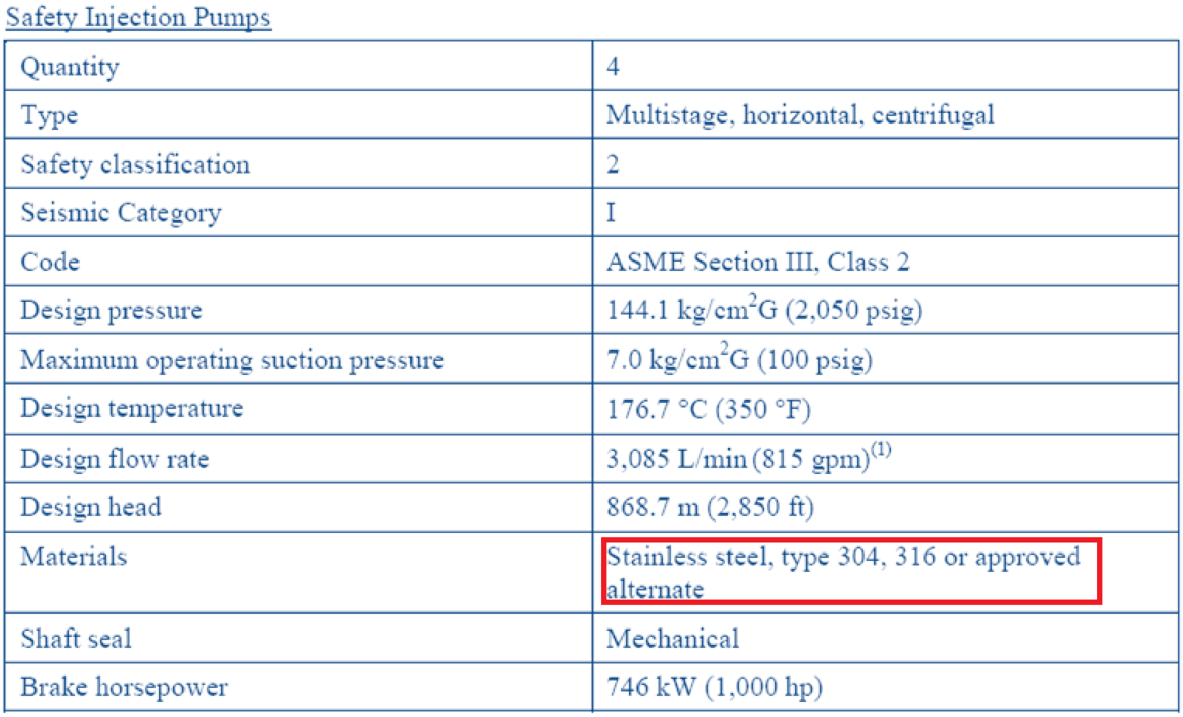
Issue#18

Delete class 1 valves

MCB Issue List Regarding APR1400 FSAR Section 6.1.1

Issue #19 (AI 6-14.19)

Table 6.3.2-1:



Safety Injection Pumps

Quantity	4
Type	Multistage, horizontal, centrifugal
Safety classification	2
Seismic Category	I
Code	ASME Section III, Class 2
Design pressure	144.1 kg/cm^{2}G (2,050 psig)
Maximum operating suction pressure	7.0 kg/cm^{2}G (100 psig)
Design temperature	176.7 °C (350 °F)
Design flow rate	3,085 L/min (815 gpm)(1)
Design head	868.7 m (2,850 ft)
Materials	Stainless steel, type 304, 316 or approved alternate
Shaft seal	Mechanical
Brake horsepower	746 kW (1,000 hp)

Revise Table 6.3.2-1 to delete the phrase “or approved alternate” and, for consistency with Table 6.1-1, add the phrase “or Gr. 3, Cl. 1 alloy steel.”

Response

DCD Tier 2, Table 6.3.2-1 will be revised to point readers to Table 6.1-1 and 6.1-2 for information regarding materials of the safety injection pumps and safety injection tanks, and their class, grade, or type, as shown in the attachment associated with this response.

Impact on DCD

The DCD will be revised, as shown in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

Table 6.3.2-1 (1 of 3)

SIS Component Parameters

Safety Injection Pumps

Quantity	4
Type	Multistage, horizontal, centrifugal
Safety classification	2
Seismic Category	I
Code	ASME Section III, Class 2
Design pressure	144.1 kg/cm^{2}G (2,050 psig)
Maximum operating suction pressure	7.0 kg/cm^{2}G (100 psig)
Design temperature	176.7 °C (350 °F)
Design flow rate	3,085 L/min (815 gpm)(1)
Design head	868.7 m (2,850 ft)
Materials	~~Stainless steel, type 304, 316 or approved alternate~~ See Tables 6.1-1 and 6.1-2
Shaft seal	Mechanical
Brake horsepower	746 kW (1,000 hp)

Safety Injection Pump NPSH

	Flow/Pump L/min (gpm)	Maximum NPSH required m (ft)	Minimum NPSH available m (ft)
Long-Term Cooling Mode	4,675(1,235) (2)	6.1 (20) (3)	6.7 (22) (3)

(1) Does not include minimum bypass flow.

(2) Including minimum bypass flow.

(3) Calculation is based on the NRC RGs 1.1 and 1.82. SI pumps take suction from the IRWST at runout flows.

Table 6.3.2-1 (2 of 3)

Safety Injection Tanks

Quantity	4	
Safety classification	2	
Seismic Category	I	
Code	ASME Section III, Class 2	
Design pressure, internal/external	49.2 kg/cm^{2}G / 7.0 kg/cm^{2}G (700 psig / 100 psig)	
Design temperature	93.3 °C (200 °F)	
Operating temperature	48.9 °C (120 °F) 10.0 °C (50 °F)	
Normal operating pressure	42.9 kg/cm^{2}G (610 psig)	
Nominal internal volume	68.1 m^3 (2,406 ft^3)	
Normal liquid volume	52.6 m^3 (1,858 ft^3)	
Fluid	Borated water	4,400 ppm (maximum) 2,300 ppm (minimum)
Material	Clad	~~Stainless steel, type 304, 316, or approved alternate~~
	Body	~~Carbon steel, type SA-516 Gr. 70, or approved alternate~~
In-containment Refueling Water Storage Tank	Refer to Section 6.8	
Piping		
Internal volume from first RCS check valve to direct vessel injection nozzle, each line, maximum	0.35 m^3 (12.4 ft^3)	
Resistance coefficient K from SIT discharge to the reactor vessel, based on a cross sectional area of 0.05195 m^2 (0.5592 ft^2), each line, range	6 – 10	

See Tables 6.1−1 and 6.1−2

Table 6.3.2-1 (3 of 3)

Safety Injection Filling Tanks

Quantity	2
Safety classification	NNS
Code	ASME Section VIII
Design pressure, internal/external	0.105 kg/cm^{2}G / 0.105 kg/cm^{2}g (1.5 psig / 1.5 psig)
Design temperature	93.3 °C (200 °F)
Operating temperature	10 ~ 48.9 °C (50 ~120 °F)
Normal operating pressure	Atmosphere
Nominal internal volume	5.68 m^3 (200.52 ft^3)
Normal liquid volume	3.79 m^3 (133.68 ft^3)
Fluid	Borated water: 4,400 ppm (maximum)
Material	Austenitic stainless steel