RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**482-8593**
SRP Section:	**05.02.03-22 – Reactor Coolant Pressure Boundary Materials**
Application Section:	**05.02.03**
Date of RAI Issue:	**05/16/2016**

Question No. 05.02.03-22

10 Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix A, General Design Criteria (GDC) 1 and 30; and 10 CFR Part 50.55a contain provisions regarding quality standards for material specifications that are met by compliance with the applicable provisions of the ASME Boiler and Pressure Vessel Code (ASME Code) and by acceptable application of materials Code Cases as described in Regulatory Guide (RG) 1.84, “Design, Fabrication, and Materials Code Case Acceptability, ASME Section III.” Specifications for permitted materials are identified in the ASME Code, Section III, Appendix I, or described in detail in the ASME Code, Section II. 10 CFR Part 50, Appendix A, GDC 4 requires that components be compatible with environmental conditions associated with normal operation, maintenance, testing, and postulated accidents.

In order for the staff to determine whether the APR1400 design meets these criteria with regard to reactor coolant pressure boundary (RCPB) materials, the staff is requesting the following information.

Per RAI Question No. 447-8548, Q No. 05.02.03-20, the staff requested that the applicant address the cast austenitic stainless steel (CASS) screening criteria of 260°C (500°F) either by amending it to the staff approved criteria of 250°C (482°F) or by providing a substantive technical basis for the higher temperature criteria. The applicant did not address this aspect of the RAI in the provided response.

The staff position, as presented in License Renewal Issue No. 98-0030 (ADAMS Accession No. ML003717179) identifies that CASS components with service conditions above 250°C (482°F) should adhere to Table 2 of the same. Limits on delta ferrite are noted in DCD Sections 5.2.3.4.1.c and 5.2.3.4.5 for CASS components with service conditions above 260°C (500°F). This discrepancy is inconsistent with the staff position on the adequate control of CASS aging which supercedes the applicant's cited precedent from the CESSAR-DC.

The staff requests that the applicant conform fully to the staff position as outlined in License Renewal Issue No. 98-0030 with regards to the screening temperature of 250°C, not the proposed 260°C; alternatively that the applicant provide a substantive technical basis for the higher criteria.

Response

DCD Sections 5.2.3.4.1.c, 5.2.3.4.5 and 6.1.1.1 will be revised to change the criteria on service condition from above 260°C (500°F) for cast austenitic stainless steel (CASS) components to above 250°C (482°F) to be consistent with the criteria identified in License Renewal Issue No. 98-0030 (ADAMS Accession No. ML003717179).

Impact on DCD

DCD 5.2.3.4.1.c, 5.2.3.4.5 and 6.1.1.1 will be revised as indicated in the attached markup.

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 and Environmental Report.

procedures on the susceptibility of unstabilized Type 300 series stainless steels to sensitization induced intergranular corrosion. Only the procedures and/or practices demonstrated not to produce a sensitized structure are used in the fabrication of RCPB components. ASTM A262 Practices A or E is the criterion used to determine susceptibility to intergranular corrosion. The test has shown excellent correlation with a form of localized corrosion peculiar to sensitized stainless steels. As such, ASTM A262 Practice A or E is used as a go/no-go standard for acceptability.

As a result of the above test, a relationship was established between the carbon content of Type 304 stainless steel and weld heat input. This relationship is used to avoid weld-heat-affected-zone sensitization as described in Item d below.

c. Unstabilized austenitic stainless steel

The unstabilized grades of austenitic stainless steels with carbon content of more than 0.03 percent used for components of the RCPB are Type 304 and Type 316. These materials are furnished in the solution-annealed condition. Completed or partially fabricated components are not exposed to temperatures from 427 °C (800 °F) to 816 °C (1,500 °F).

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

CF8M, CF8	Cast stainless steel: delta ferrite 8 percent to 30 percent, 8 percent to 20 percent for normal operating temperature above 260 °C (500 °F), 14 percent maximum for static cast stainless steel of CF8M
Type 308, 309, 312, 316	Singly and combined stainless steel weld filler metals: delta ferrite controlled to 8FN-15FN (8FN-16FN for Type 309 (L)) with no reading below 5FN as deposited

250 °C (482 °F)

for normal operating temperature above 250 °C (482 °F)

b. NRC RG 1.34

NRC RG 1.34 is addressed in Subsection 5.2.3.3.

c. NRC RG 1.71

NRC RG 1.71 is addressed in Subsection 5.2.3.3.

5.2.3.4.5 Toughness of Cast Austenitic Stainless Steels or Welds

Reasonable assurance of the fracture toughness of cast stainless steels is provided by limiting the delta ferrite in the materials as follows:

a. For normal operating temperatures less than or equal to 260 °C (500 °F), 8 percent to 30 percent

250 °C (482 °F)

b. For normal operating temperatures above 260 °C (500 °F), 8 percent to 20 percent

c. Static cast stainless steel of CF8: 14 percent maximum

For normal operating temperature above 250 °C (482 °F), static

Reasonable assurance of the fracture toughness of stainless steel welds is provided by limiting the delta ferrite in the weld materials as follows:

a. Singly and combined stainless steel weld filler metals: 8FN-15FN (8FN-16FN for Type 309 (L)) with no reading below 5FN as deposited.

5.2.3.4.6 Nondestructive Examination

Nondestructive examinations of austenitic stainless steel tubular products for components of RCPB are carried out in accordance with ASME Section III, Subsection NB-2500, under their construction, and Section XI during inservice inspections. Additional testing and inspection for major components are explained in Subsections 5.3.1.3, 5.4.1.4, 5.4.2.3, 5.4.3.4, and 5.4.10.4.

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)

250 °C (482 °F)

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.