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.:	**314-8378**
SRP Section:	**10.03.06 – Steam and Feedwater System Materials**
Application Section:	**10.3.6**
Date of RAI Issue:	**11/16/2015**

Question No. 10.03.06-11

Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix A, General Design Criteria 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.

In table 10.3.2-3, the applicant states that the material specification for flanges within the “Pipe chase to AF pump turbine steam isolation valve” system is SA-350 LF2 or ASTM A-105. The ASME Class of these components is Section III, Class 2.

While NCA-1200 permits the procurement of ASTM material (if certain conditions are met) it also requires that the material be provided by a CMTR or CoC from an ASME Materials Organization. The quality assurance requirements of a certified Materials Organization is a requirement for ASME Section III, Class 2 components.

Revise Table 10.3.2-3 to change the material specification to ASME SA-105 or add a note to the table stating that the ASTM material must meet the requirements of ASME Section III, NCA-1200.

Response

The material specification for flanges and valves in Table 10.3.2-3 will be deleted because there are no flanges and valves within the pipe chase for main steam branch piping.

Impact on DCD

DCD Tier 2, Table 10.3.2-3 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 Specifications.

Impact on Technical/Topical/Environmental Reports

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

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.: **314-8378**

SRP Section: **10.03.06 – Steam and Feedwater System Materials**

Application Section: **10.3.6**

Date of RAI Issue: **11/16/2015**

Question No. 10.03.06-12

Title 10 of the Code of Federal Regulations (10 CFR) Part 52.47(a)(9) requires that information submitted as part of the FSAR for a standard design certification shall describe differences in design features that deviate from the acceptance criteria in the SRP.

NUREG-0800 (Standard Review Plan, SRP) Section 10.3.6, Acceptance Criteria requires that "The materials specified for use in Class 2 and 3 components should conform to … Parts A, B, and C of Section II of the Code."

Tables 10.3.2-2, 10.3.2-3, and 10.3.2-4 do not contain information on the welding materials to be used. Welding materials specifications for ASME Class 2 and 3 components are located in ASME Section II Part C.

Provide the ASME Section II-C welding material specifications that will be used or information on the proposed alternative.

Response

Welding material specifications for ASME Class 2 and 3 components will be decided by the manufacturer or constructor in accordance with the ASME Section III NC-2400(Class 2) and ND-2400(Class 3). The manufacturer or constructor will prepare the WPS and PQR in accordance with the ASME Section III NC/ND and ASME Section IX and it will be reviewed by ANI (Authorized Nuclear Inspector).

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 REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

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

Docket No. 52-046

RAI No.: **314-8378**

SRP Section: **10.03.06 – Steam and Feedwater System Materials**

Application Section: **10.3.6**

Date of RAI Issue: **11/16/2015**

Question No. 10.03.06-13

Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix A, General Design Criteria 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.

Figure 10.4.7-1 shows a “CF FW Chemical Injection Line” that contains an ASME Class 2 break. The line contains a control and check valve but does not appear to meet the criteria for a “Main Feed Isolation Valve.” Additionally, the 1 inch diameter line does not correspond to any items contained in Table 10.3.2-4 (wherein the Main Feed Isolation Values are listed).

Supplement Table 10.3.2-4 with information on the ASME Class 2 portion of the CF FW Chemical Injection Line.

Response

The main criterion of Main Feed Isolation Valve (MFIV) is containment isolation after receipt of a main steam isolation signal (MSIS). The CF FW chemical injection line is designed to isolate the containment after receipt of a MSIS. The design description of valves in CF FW Chemical lines is provided in Item No.9 in DCD Tier 2 Table 6.2.4-1 “List of Containment Penetrations and System Isolation Positions”.

Because the items in Table 10.3.2-4 include only pipes larger than 2.5 inch, the CF FW chemical injection line (1 inch) is not included in this table. DCD Tier 2, Table 10.3.2-4 will be revised as indicated on the attached markup. The information CF FW chemical injection line is as following table.

Description	Material Specification	Norminal OD (mm (in))	ASME Class
CF FW Chemical Injection Line	SA-312 Gr.TP304 or SA-376 Gr.TP304	25.4 (1)	Section III Class 2
- Fittings	SA-182 Gr.F304		

Impact on DCD

The DCD 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 Specifications.

Impact on Technical/Topical/Environmental Reports

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

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.: **314-8378**

SRP Section: **10.03.06 – Steam and Feedwater System Materials**

Application Section: **10.3.6**

Date of RAI Issue: **11/16/2015**

Question No. 10.03.06-14

Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix A, General Design Criteria 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.

In Table 10.3.2-3 the applicant states that the fittings, valves, and flanges within the “pipe chase to AF pump turbine steam isolation valve” system are ASME Section III, Class 2.

In Table 3.2-1, Sheet 3 of 86, the applicant states that the “Steam admission/exhaust/ preheating lines and valves” are ASME Section III, Class 3 piping and components.

The staff believes that both tables describe the same components but do not have consistent codes of construction. Revise Table 10.3.2-3 and/or Table 3.2-1 to correct or clarify the code classes of the piping and components.

Response

The code class of fittings within the pipe chase to AF pump turbine steam isolation valve will be revised to ASME Section III, Class 3 and the material specification for flanges and valves in Table 10.3.2-3 will be deleted because there are no flanges and valves within the pipe chase for main steam branch piping

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Impact on DCD

DCD Tier 2, Table 10.3.2-3 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 Specifications.

Impact on Technical/Topical/Environmental Reports

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

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.:	**314-8378**
SRP Section:	**10.03.06 – Steam and Feedwater System Materials**
Application Section:	**10.3.6**
Date of RAI Issue:	**11/16/2015**

Question No. 10.03.06-15

Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix A, General Design Criteria 4 requires that structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of coolant accidents. Additionally, structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit.

In Section 10.4.9.2.5, “Design Features for Minimization of Contamination,” relates to Auxiliary Feedwater (AF) system which connects to the feedwater system downstream of the Main Feed Isolation Valves and upstream of the Steam Generators. In the paragraph titled “Reduction of Cross-Contamination, Decontamination, and Waste Generation” the applicant states “Auxiliary feedwater piping is required to be fabricated of stainless steel material…”

The connection between the two systems will result in a dis-similar metal joint. Provide information on how this connection will be made: describe the type of connection (e.g. welding), any joint preparation that will be made (e.g. buttering), necessary process controls (e.g. Code Cases, compliance to Regulatory Guides), and overall configuration of the joint.

Response

The information on the connection between two systems with a dis-similar metal joint is as follows:

1) The type of joint: Welding Joint

2) Any Joint preparation that will be made: The low alloy steel member is buttered with type 309 or 309L prior to welding to the austenitic stainless steel member.

3) Necessary process controls (e.g. Code Cases, compliance to Regulatory Guides): For welding of low alloy steel, RG 1.50 “Control of Preheat Temperature for Welding of Low-Alloy Steel” will be applied. And for welding of austenitic stainless steel, RG 1.31 “Control of Ferrite Content in Stainless Steel Weld Metal” and RG 1.44 “Control of processing and Use of Stainless Steel” will be applied. Welder performance qualification for areas of limited accessibility complies with the recommendations of RG 1.71 “Welder Qualification for Area of Limited Accessibility”.

4) Overall configuration of the joint: Welding end complies with ASME Sec.III (NC-4250) and ASME B16.25.

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 REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

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

Docket No. 52-046

RAI No.:	**314-8378**
SRP Section:	**10.03.06 – Steam and Feedwater System Materials**
Application Section:	**10.3.6**
Date of RAI Issue:	**11/16/2015**

Question No. 10.03.06-16

Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix A, General Design Criteria 4 requires that structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of coolant accidents. Additionally, structures, systems, and components shall be appropriately protected against dynamic effects, including the effects of missiles, pipe whipping, and discharging fluids, that may result from equipment failures and from events and conditions outside the nuclear power unit.

In Section 10.3.6 the applicant states the following:

e. "… the entire portion of the MSS piping is made of carbon steel with a 0.889 mm (0.035 in) additional margin in design"

A similar statement is made for the feedwater piping.

Later the applicant states:

> "The specified wall thickness (prior to fabrication) is a standardized wall thickness stipulated in ASME B36.10M. [The wall thickness] is determined to exceed the required design wall thickness with consideration of minus tolerances … during fabrication."

The staff seeks further information: Does the "design thickness" discussed in relation to ASME B36.10M the analytical design thickness plus the additional margin for wear (e.g. design thickness = analytical thickness + wear margin, and: ASME B36.10 thickness > design thickness)?

Response

Design thickness includes the analytical design thickness plus the additional margin for wear in accordance with our design standard for Pipe Wall Thickness and ASME B31.1 102.4.4.

In the design standard, the calculated minimum wall thickness (tm) means a calculated minimum thickness required for internal pressure, plus allowance (A, 0.035 inch for MS) for mechanical strength, corrosion and erosion. Also, in ASME 31.1 102.4.4, it recommends adding the additional margin for the mechanical strength in the wall thickness of the pipe to prevent damage, collapse, excessive sag, or buckling of the pipe due to superimposed loads from supports or other causes.

Meanwhile, actual minimum wall thickness (ta) includes manufacturing tolerances for schedule and plate pipe, allowance for backing rings for plate pipe and allowance to compensate for wall thinning due to bending.

WALL THICK	SCHEDULE PIPE
t_m	$\frac{PD}{2S + 2yP} + A$
t_a	$\frac{T_m}{0.875} \times F$ (See Notes 1 and 2)
t_n	Available Schedule tabulated wall (Equal to or greater than t_a)
	Nominal diameter and t_n

Therefore, the design thickness (actual minimum wall thickness (ta)) equals the analytical design thickness plus the additional margin for wear and ASME B36.10 thickness(tn) equals to or greater than the design thickness.

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.

Table 10.3.2-3

Main Steam Branch Piping Design Data (2.5 Inches and Larger)

Segment	Material Specification	Nominal OD (mm (in.))	ASME Class
Main steam piping to MSADV	SA106 Gr. C (seamless)	500 (20)	Section III, Class 2
MSADV discharge piping to silencer	A106 Gr. B (seamless)	400 (16)	B31.1
Main steam piping to MSSV	SA-105	200 (8)	Section III, Class 2
MSSV discharge piping to vent stack	A106 Gr. B (seamless)	250 (10), 650 (26)	B31.1
Main steam piping to pipe chase	SA-333 Gr. 6 (seamless)	200 (8)	Section III, Class 2
Pipe chase to AF pump turbine steam isolation valve	SA-106 Gr. B (seamless)	200 (8)	Section III, Class 3
Fittings	ASTM (S)A-234 WPB	65 (2.5) and larger	Section III, Class ~~2~~
~~Flanges~~	~~SA-350 LF2, ASTM A-105~~	~~65 (2.5) ~ 600 (24)~~	~~Section III, Class 2~~
~~Valves (globe, gate, check)~~	~~ASTM (S)A-216, WCB or WCC, A352 LCB~~	~~65 (2.5) and larger~~	~~Section III, Class 2~~
Main steam piping to moisture separator reheater	A106 Gr. B (seamless)	250 (10), 300 (12)	B31.1
Fittings	ASTM A-234, WPB	250 (10), 300 (12)	
Flanges	ASTM A-105	80 (3) and larger	
Valves (globe, gate, check)	ASTM A-216, WCB or WCC	65 (2.5) ~ 650 (26)	
HP turbine to moisture separator reheater	A588 Gr. C (welded)	1,050 (42)	B31.1
Moisture separator reheater to LP turbine	A588 Gr. C (welded)	1,050 (42)	B31.1
Fittings	ASTM A-234, WPB	1,050 (42)	

Q. 10.3.6-14

3

Deleted

Q. 10.3.6-11

Q. 10.3.6-14

(2.5 Inches and Larger)

Table 10.3.2-4 (1 of 2)

Feedwater Piping Design Data Q. 10.3.6-13

Segment	Material Specification	Nominal OD (mm (in))	ASME Class
Feedwater pump to feedwater pump discharge header	A-106 Gr. B (seamless)	600 (24)	B31.1
Feedwater pump discharge header	A-672 Gr. B60 (welded)	762 (30)	
Feedwater pump discharge header to feedwater heaters 5/6/7	A-672 Gr. B60 (welded)	660.4 (26), 762 (30)	
Feedwater heaters 7 to feedwater heaters 7 discharge header	A-672 Gr. B60 (welded)	660.4 (26)	
Feedwater heaters 7 discharge header	A-672 Gr. B60 (welded)	812.8 (32)	
Fittings	A-234 WPB	600 (24), 660.4 (26), 762 (30), 812.8 (32)	
Flanges	ASTM A-105	80 (3) and larger	
Valves (globe, gate, check)	ASTM A-105 or ASTM A-216 WCB or WCC	65 (2.5) ~ 660.4 (26)	
Feedwater heaters 7 discharge header to MFIV	A-106 Gr. B (seamless, welded)	250 (10), 660.4 (24), 762 (26), 812.8 (32)	B31.1
Fittings	A-234 WPB	250 (10), 660.4 (24), 762 (26), 812.8 (32)	
Flanges	ASTM A-105	80 (3) and larger	
Valves (globe, gate, check)	ASTM A-105 or ASTM A-216 WCB or WCC	65 (2.5) ~ 660.4 (26)	

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.: **314-8378**

SRP Section: **10.03.06 – Steam and Feedwater System Materials**

Application Section: **10.3.6**

Date of RAI Issue: **11/16/2015**

Question No. 10.03.06-17

Title 10 of the Code of Federal Regulations (10 CFR) Part 50.65 requires monitoring of the condition and operation of Structures, Systems, and Components (SSCs) to ensure that they are capable of maintaining their intended function. The functions are established from design goals which are based on operating experience. The requirements of 10 CFR 50.65 are applicable to nonsafety systems “whose failure could cause a reactor scram or actuation of a safety-related system;” a main steam-line or feed-line break would result in an Engineered Safety Feature (ESF) actuation. Generic Letter (GL) 89-08. “Erosion/Corrosion-Induced Pipe Wall Thinning,” defined a Flow Accelerated Corrosion (FAC) program that would meet the requirements of 10 CFR 50.65 for secondary, non-safety related systems. GL 89-08 states that a FAC program meeting all the requirements of EPRI NSAC-202L-R2 would be meet the produce reasonable assurance that adequate protection could be achieved.

In FSAR Section 10.3.6.3, on page 10.3-27, the applicant states:

> The following piping portions with potential for FAC are generally based on NSAC-202L-R3 (Reference 17) and NUREG-1344 (Reference 18) attached to GL 89-08 (References 19).
>
> a. For other safety/non-safety carbon steel piping with relatively mild FAC degradation identified in NUREG-1344 attached to GL 89-08, NSAC-202L-R3, and through experience, the average thinning rates of 2.54 × 10-6 mm/hr (0.1 × 10^{-6} in/hr) in steam system and 4.35 × 10^{-6} mm/hr (0.17 × 10^{-6} in/hr) in the water system are given based on the actual measurement records from Korea standard nuclear plants. The additional thickness of 0.889 mm (0.035 in) for the portion of steam system piping, and 1.524 mm (0.06 in) for the portion of water system piping in design are applied in consideration of the 40 years of design life.

The staff has compared the wear rates of the APR-1400 to extended and stretch power uprates for four operating PWRs of Combustion Engineering or Westinghouse designs. The wear rates on feedwater and steam systems for these operating plants are between 2x and 6x the wear

rates of the APR-1400 design. The licensees provided multiple data points for the wear rates and the large majority of the wear rates (80% of the data points or more) were larger than the APR-1400 wear rates.

The staff understands that data from the power uprates of US operating plants may represent the bounding thinning rates of components in a system and the wear rates in the APR-1400 FSAR is an average rate. However, operating experience demonstrates that secondary piping systems fail locally rather than globally. The staff questions the accuracy of "a 40 year design life" of the secondary piping system.

Provide the staff with additional information on the wear rates. The data should include: location of measurements, type of component (pipe, elbow, orifice, etc.), measured wear, CHECWORKS wear rate, and any additional information that would be helpful in validating the discrepancy between the Korean Standard Nuclear Plant wear rates and those that have been seen in the US.

Response

It is well recognized that wear of secondary piping systems is generally induced in localized areas. It is thought that the wear rates the staff compared for four operating PWRs are the maximum wear values. On the other hand, the wear rates suggested by the applicant are the average values of all components that are predicted to be the most susceptible locations to FAC. If the maximum wear rates were applied to pipe thickness design, pipe thicknesses would need to be increased greatly. Wear analysis was performed on the components that were predicted to be most susceptible to FAC. Wear rate data for ten components for five systems has been provided in the attachment.

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.

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