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.:	**506-8649**
SRP Section:	**10.03.06 – Steam and Feedwater System Materials**
Application Section:	**10.3.6**
Date of RAI Issue:	**07/26/2016**

Question No. 10.03.06-26

Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix A, General Design Criteria 4 requires that SSCs important to safety shall accommodate the effects of environmental conditions during normal, off normal, and accident conditions. Safetyrelated components in the main steam and feedwater lines shall be designed with consideration for FAC.

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.

During the audit on May 10, 2016, the staff reviewed design documents for the feedwater system. While reviewing the design documents, the staff noted that a portion of downcommer feedwater line downstream of the downcommer flow control valve has a configuration of chrome-moly steel . carbon steel . chrome-moly steel. This configuration was not apparent to the staff prior to the audit.

DCD Tier 2, FSAR Table 10.3.2-4 lists material specifications for components in the feedwater system. This table does not have an entry for the carbon steel portion of the line between the chrome-moly portions of the downcommer feedwater line. The material specifications were not found in DCD Tier 2, FSAR Chapter 10 or Chapter 6. The carbon steel portion of the line contains the safetyrelated Main Feedwater Isolation Valves.

Operational experience has shown that components downstream of FAC resistant materials are more susceptible to FAC (EPRI NSAC-202L-R3, Section 4.4).

The staff asks the following:

a. What material specifications are utilized for the carbon steel portion of the downcommer feedwater line between the chrome-moly portions of the same line (including the Main Feedwater Isolation Valves and connected safety-related piping)? This information should be added to DCD Tier 2, FSAR Chapter 10 or 6.

b. Are the carbon steel portions of the downcommer feedwater line between the chrome-moly steel portions subject to augmented in-service inspection (ISI)? If augmented ISI will be performed on this section of piping, DCD Tier 2, FSAR Section 6.6 should be updated to state that these components are subject to augmented ISI and the augmented ISI should be described. If augmented ISI will not be performed, provide a justification on why additional ISI is not necessary considering that there may be an active degradation mechanism (FAC).

Response

a. In the OPR1000 design, chrome-moly steel is utilized between the MFCV and MSVH line, which contain sharp bending portions susceptible to FAC as shown in Figure 1. In the APR1400 design, carbon steel is utilized between the MFCV and MSVH line, which do not have sharp bending portions as shown in Figure 2. A 3D piping layout is presented in Figure 3 between the MFCV and MSVH line comparing the OPR1000 and APR1400 designs. Accordingly Table 10.3.2-4 will be revised.

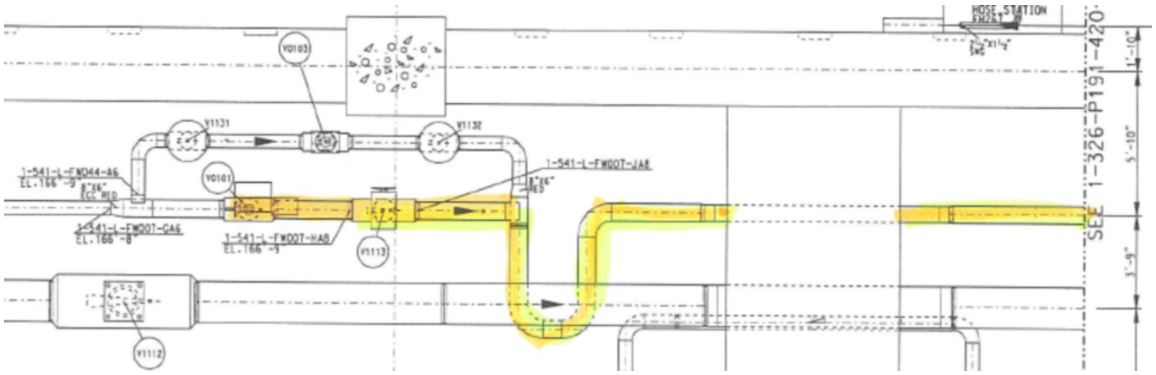

Figure 1 Piping layout in the OPR1000 design

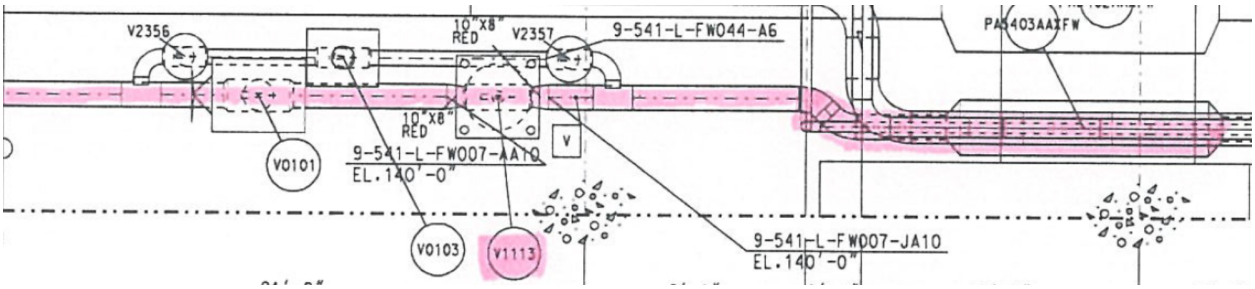

Figure 2 Piping layout in the APR1400 design

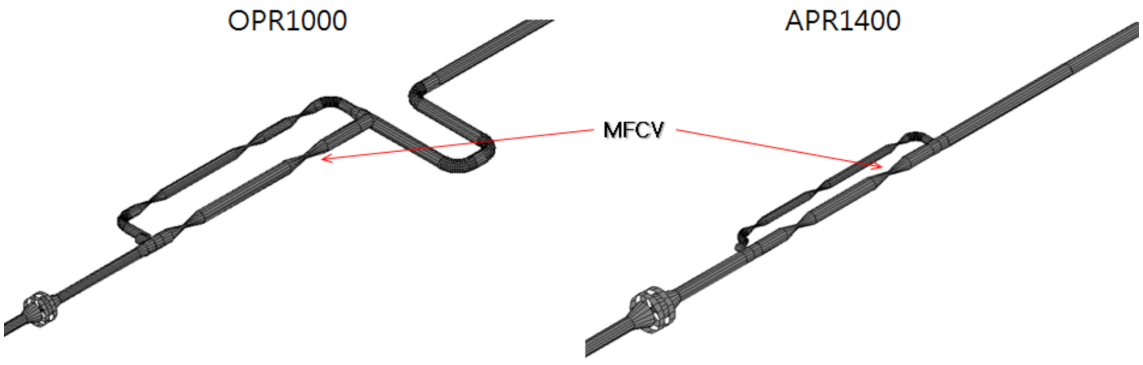

Figure 3 Piping layout comparison of the OPR1000 and APR1400 designs

b. The carbon steel portions of the downcommer feedwater line between the chrome-moly steel portions are not subject to augmented in-service inspection (ISI). ISI is performed to evaluate weld degradation on the entire welding area. UT thickness inspection is performed to evaluate component wear beyond the toe of the weld. Initial wall thickness is taken in components placed downstream of the MFCV and will be inspected periodically during plant operation. Figure 4 shows the UT inspection data inputted to CHECWORKS, which has been taken prior to the pre-operation testing.

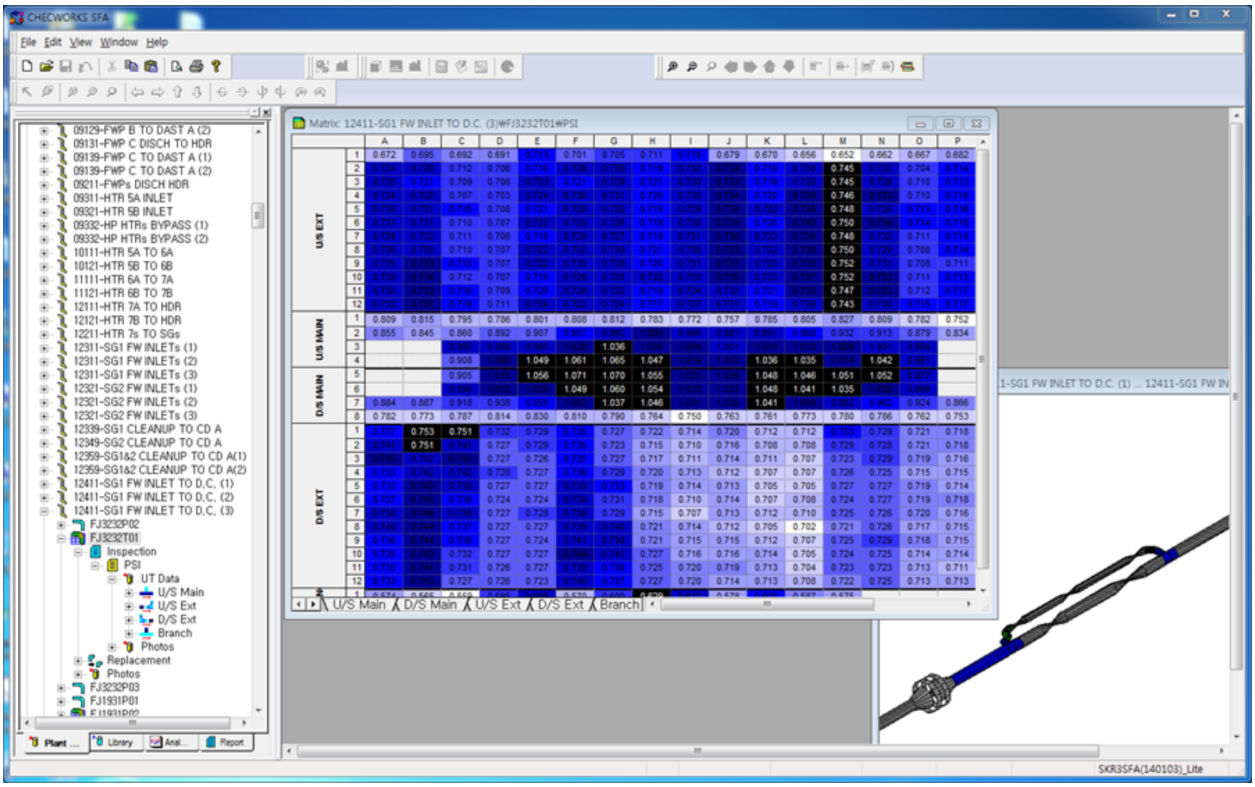

Figure 4 UT inspection data measured in prior to the pre-operation testing

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Impact on DCD

DCD Tier 2, Table 10.3.2-4 will be revised.

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.

RAI 314-8378 - Question 10.03.06-3

RAI 452-8545 - Question 10.03.06-20

Table 10.3.2-4 (1 of 2)

Feedwater Piping Design Data

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)	

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RAI 314-8378 - Question 10.03.06-3

RAI 452-8545 - Question 10.03.06-20

Table 10.3.2-4 (1 of 2)

Feedwater Piping Design Data

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)	B31.1
Feedwater pump discharge header to Feedwater heaters 5/6/7	A-672 Gr.B60 (welded)	650 (26) 812.8 (32)	B31.1
Feedwater heaters 7 to Feedwater heaters 7 outlet header	A-672 Gr.B60 (welded)	650 (26)	B31.1
Feedwater heaters 7 outlet header	A-672 Gr.B60 (welded)	812.8 (32)	B31.1
Fittings	A-234 WPB A-234 WPC	600 (24) 812.8 (32)	B31.1
Feedwater heaters 7 outlet header to MFCVs	A-106 Gr.B (seamless, welded)	250 (10) 600 (24)	B31.1
Fittings	A-234 WPB	250 (10) 600 (24)	B31.1

Replace with C

RAI 452-8545 - Question 10.03.06-20
RAI 506-8649 - Question 10.03.06-26
RAI 514-8671 - Question 10.03.06-28

Table 10.3.2-4 (1 of 2)

C

Feedwater Piping Design Data

Segment	Material Specification	NPS	DN	Outside Diameter (in)	Remark	ASME Class
Feedwater pump to feedwater pump discharge header	A-106 Gr.B (seamless)	24	600	24.000	-	B31.1
Feedwater pump discharge header	A-672 Gr.B60 (welded)	30	750	30.000	-	B31.1
Feedwater pump discharge header to Feedwater heaters 5/6/7	A-672 Gr.B60 (welded)	26 32	650 800	26.000 32.000	-	B31.1
Feedwater heaters 7 to Feedwater heaters 7 outlet header	A-672 Gr.B60 (welded)	26	650	26.000	-	B31.1
Feedwater heaters 7 outlet header	A-672 Gr.B60 (welded)	32	800	32.000	-	B31.1
Fittings	A-234 WPB A-234 WPC	24 32	600 800	24.000 32.000	-	B31.1
Feedwater heaters 7 outlet header to MFCVs	A-106 Gr.B (seamless, welded)	10 24	250 600	10.750 24.000	-	B31.1
Fittings	A-234 WPB	10 24	250 600	10.750 24.000		B31.1

Insert "A" "A"

MSVH

Insert "B" "B"

26 30	650 750	26.000 30.000

RAI 314-8378 - Question 10.03.06-3

RAI 452-8545 - Question 10.03.06-20

Table 10.3.2-4 (2 of 2)

Segment	Material Specification	Nominal OD (mm (in))	ASME Class
Downcomer feedwater control valve to main steam valve house (MSVH)	A335 Gr. P22 (seamless)	250 (10)	B31.1
Fittings	A-234 WP22	250 (10)	
Flanges	ASTM A-182 Gr. F22	-	
Valves (globe, gate, check)	ASTM A-182 Gr. F22 or ASTM A-217 Gr. WC9	-	
MFIV to SG	SA-335 Gr. P22 (seamless)	150 (6), 250 (10), 350 (14), 600 (24)	Section III, Class 2
Fittings	SA-420 WPL6, SA-234 WP22	150 (6), 250 (10), 350 (14), 600 (24)	
Flanges	SA-350 LF2, SA-182 F22	150 (6) ~ 600 (24)	
Valves (globe, gate, check)	SA-182 F22 or SA-217 WC9, SA-350 LF2	150 (6) ~ 600 (24)	

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RAI 314-8378 - Question 10.03.06-3

RAI 452-8545 - Question 10.03.06-20

Table 10.3.2-4 (2 of 2)

Segment	Material Specification	Nominal OD (mm (in))	ASME Class
Downcomer MFCV to main steam valve house (MSVH)	A-335 Gr.P22 (seamless)	250 (10)	B31.1
Fittings	A-234 WP22	250 (10)	B31.1
MSVH to MFIV	SA-333 Gr.6 (seamless)	250 (10) 600 (24)	Section III, Class 2
MFIV to SG	SA-335 Gr. P22 (seamless)	150 (6) 250 (10) 350 (14) 600 (24)	Section III, Class 2
Fittings	SA-234 WP22	150 (6) 250 (10) 350 (14) 600 (24)	Section III, Class 2

Replace with D

RAI 452-8545 - Question 10.03.06-20
RAI 506-8649 - Question 10.03.06-26

D

Delete

Table 10.3.2-4 (2 of 2)

Segment	Material Specification	NPS	DN	Outside Diameter (in)	Remark	ASME Class
Downcomer MFCV to main steam valve house (MSVH)	A-335 Gr.P22 (seamless)	10	250	10.750	-	B31.1
Fittings	A-234 WP22	10	250	10.750	-	B31.1
MSVH to MFIV	SA-333 Gr.6 (seamless)	10 24	250 600	10.750 24.000	-	Section III, Class 2
MFIV to SG	SA-335 Gr. P22 (seamless)	6 10 14 24	150 250 350 600	6.625 10.750 14.000 24.000	-	Section III, Class 2
Fittings	SA-234 WP22	6 10 14 24	150 250 350 600	6.625 10.750 14.000 24.000	-	Section III, Class 2

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The main feedwater system splits into two lines after the feedwater headers: the downcommer feedwater line and the economizer feedwater line. The downcommer feedwater line utilizes chrome-moly steel downstream of the flow control valves. The economizer feedwater line does not have chrome-moly steel in the same portion of the economizer line.

DCD Tier 2, FSAR Table 10.1-1 provides the flow rates of both lines. By using the pipe diameters specified in DCD Tier 2, FSAR Figure 10.4.7-1 and the flow data in Table 10.1-1, the staff calculates that the flow velocity in the economizer feedwater line should be comparable to, and possibly greater than, the flow velocity in the downcommer feedwater line. Considering that the economizer feedwater line has a greater flow rate than the downcommer feed water line, the consequences of a feedwater line break in the economizer line could be more severe than a feedwater break in the downcommer feedwater line. Yet, the downcommer feedwater line utilizes more FAC-resistant material than the economizer feedwater line.

Based on the observation above, explain why the use of FAC-susceptible carbon steel in the subject portion of the economizer feedwater line is adequate to ensure that FAC-related piping degradation does not occur in the economizer feedwater line.

Response

In the APR1400 design, carbon steel is utilized with an additional thickness of 0.06 in. to provide for greater corrosion allowance between the MFCV and MSVH line. Accordingly, the FAC susceptibility comparison is not necessary between the economizer and the downcomer feedwater line. In addition, the FAC susceptible portions are periodically inspected as part of a long term inspection plan between the economizer and the downcomer feedwater line.

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.