
REVISED 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. Safety-related 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 safety-related 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 – (Rev.1)

- 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.

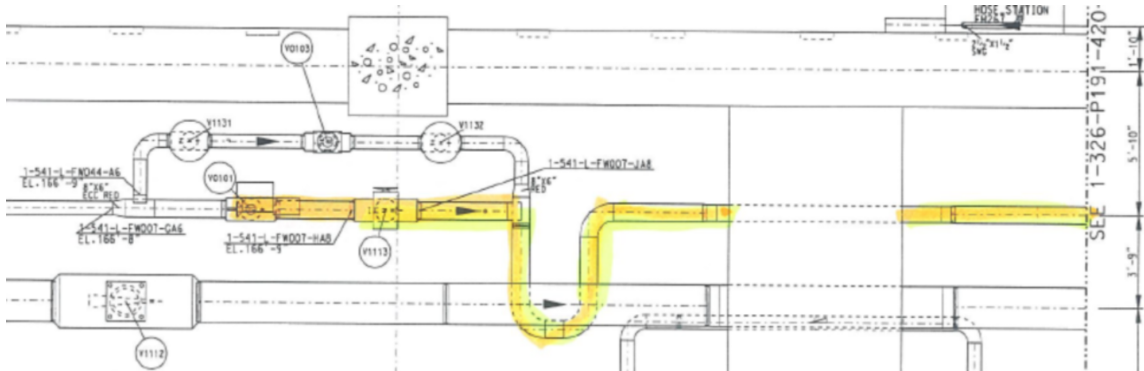


Figure 1 Piping layout in the OPR1000 design

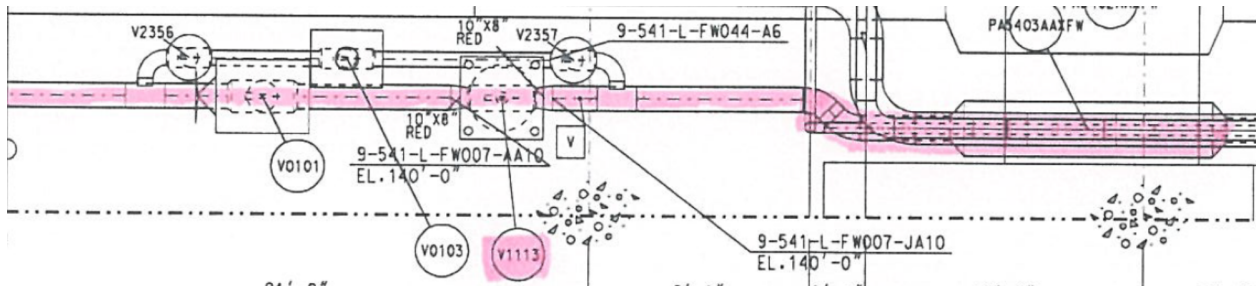


Figure 2 Piping layout in the APR1400 design

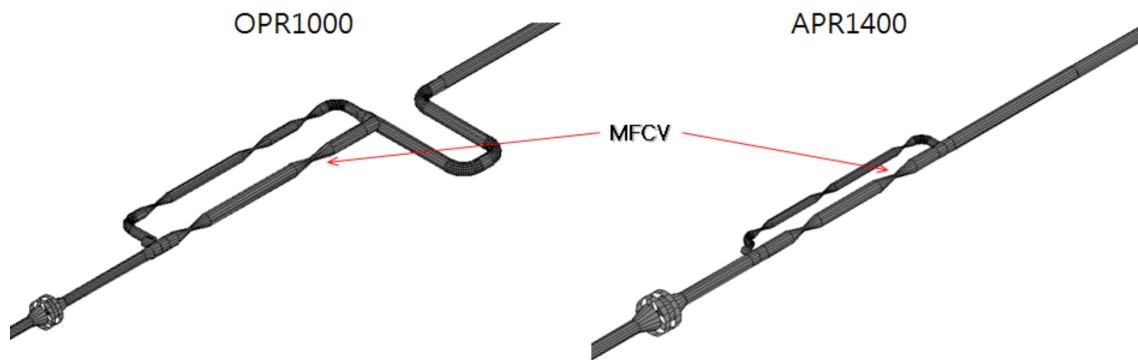


Figure 3 Piping layout comparison of the OPR1000 and APR1400 designs

- 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.

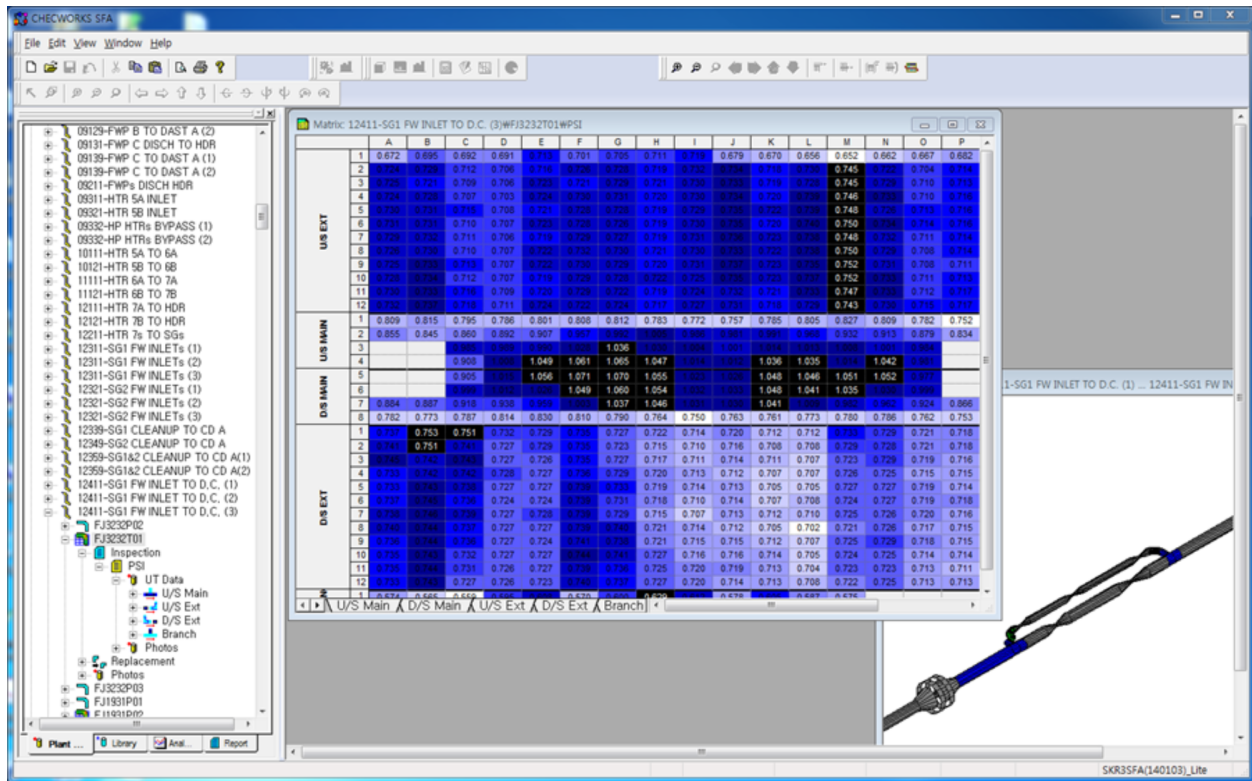


Figure 4 UT inspection data measured in prior to the pre-operation testing

Impact on DCD

DCD Tier 2, Table 10.3.2-4 and Subsection 10.3.6.3 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.

APR1400 DCD TIER 2

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	B31.1
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)	
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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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	600 (24)	B31.1
	A-234 WPC	812.8 (32)	
Feedwater heaters 7 outlet header to MFCVs	A-106 Gr.B (seamless, welded)	250 (10)	B31.1
		600 (24)	
Fittings	A-234 WPB	250 (10)	B31.1
		600 (24)	

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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	650	26.000
30	750	30.000

APR1400 DCD TIER 2

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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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)	Section III, Class 2
		600 (24)	
MFIV to SG	SA-335 Gr. P22 (seamless)	150 (6)	Section III, Class 2
		250 (10)	
		350 (14)	
		600 (24)	
Fittings	SA-234 WP22	150 (6)	Section III, Class 2
		250 (10)	
		350 (14)	
		600 (24)	

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RAI 452-8545 - Question 10.03.06-20

RAI 506-8649 - Question 10.03.06-26

D

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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	250	10.750	-	Section III, Class 2
		24	600	24.000		
MFIV to SG	SA-335 Gr. P22 (seamless)	6	150	6.625	-	Section III, Class 2
		10	250	10.750		
		14	350	14.000		
Fittings	SA-234 WP22	24	600	24.000	-	Section III, Class 2
		6	150	6.625		
		10	250	10.750		
		14	350	14.000		
		24	600	24.000		

steel steam and water piping in consideration of the 40 years of design life. The piping layout is also considered to minimize the incidence of FAC or erosion/corrosion in piping.

Most of the piping on steam and feedwater systems is made of carbon steel. Materials for the piping portions that are extremely susceptible to FAC are installed using an FAC-resistant alloy such as Cr-Mo steel.

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.
- b. As shown in Table 10.3.2-4, the main feedwater piping from the main feedwater isolation valve (MFIV) in the MSVH to SGs and the piping downstream of downcomer feedwater control valves are made of high-content chrome-moly materials. This portion of the feedwater system is potentially susceptible to FAC, and the design specifications require FAC-resistant piping materials as described above. Other feedwater system piping is generally made of carbon steel with 1.524 mm (0.06 in) additional margin in design.
- c. SG blowdown piping from SG to the blowdown flash tank is made of chrome-moly materials. FAC-susceptible portions are made of stainless steel; FAC-susceptible portions include wet layup recirculation lines, filters on upstream and downstream lines, and mixed-bed demineralizer upstream and downstream lines. Other SG blowdown piping is made of carbon steel with 1.524 mm (0.06 in) additional margin in design.

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