
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.: 254-8270
SRP Section: 11.02 – Liquid Waste Management System
Application Section: 11.2
Date of RAI Issue: 10/19/2015

Question No. 11.02-7

10 CFR 50 Appendix A GDC 1 and 2 as they relate to Quality Assurance standards and identification of structures systems and components important to safety must be designed to withstand the effects of natural phenomena. 10 CFR 50 Appendix A GDC 60 and Regulatory Guide 1.143 as they relate to the control of release of radioactive materials and the radwaste system safety classifications must be applied here.

Staff review of DCD section 10.4.8 indicates that insufficient details are provided to describe the boundaries of the systems and their corresponding safety classifications. Staff is seeking sufficient details describing the radwaste systems including their respective isolation components. Currently the Staff is unable to determine if each system's isolation components are also included in the safety classification for the systems. DCD section 10.4.8.1.2 that states:

“The safety classification for the SGBS components applies to components up to and including the nearest valves, fittings, and/or welded/flanged nozzle connections.” This does not provide a description of isolation components in the description of LWMS systems.

DCD Section 11.3.1.3 clarifies this stating:

“The safety classification for the GRS components applies to components, up to and including the nearest isolation valves, fittings, and/or welded/flanged nozzle connections.”

Each radwaste SSC classifications need to address the following information:

1. All components connected to a component classified as a RW-IIa (ex. Piping, pumps, etc) are also classified as RW-IIa, up to and including the nearest isolation component (ex. Isolation valves), on each connection, to the RW-IIa component.
2. All components connected to a component classified as a RW-IIb (ex. Piping, pumps, etc) are also classified as RW-IIb, up to and including the nearest isolation component (ex. Isolation valves), on each connection, to the RW-IIb component.

3. All components connected to a component classified as a RW-IIc (ex. Piping, pumps, etc) are also classified as RW-IIc, up to and including the nearest isolation component (ex. Isolation valves), on each connection, to the RW-IIc component.

Please address the items above and provide a mark-up on the proposed DCD changes.

Response – (Rev. 1)

The radiological source terms provided in DCD Table 12.2-18 cannot be used to determine the radwaste safety classification of the SGBS (Steam Generator Blowdown System) since they are used for shielding and HVAC design purposes. The source terms provided in Chapter 12 are based on 0.25% fuel defect and the SG leakage rate of 0.6 gpm for the two SGs.

In order to comply with RG 1.143 C.5, which requires the applicant to use the maximum inventory when determining the radwaste class, APR1400 assumed 1% fuel defect and a SG leakage rate of 75 lb/day to calculate the maximum inventory of the SGBS components. As addressed in Chapter 11, use of 1% fuel defect is considered as the maximum design basis source term. The SG leak rate of 75 lb/day came from NUREG-0017; this value is the average of the measured data for the U.S. operating NPPs in 1970s and is considered as the expected SG leak rate that can be used to evaluate the expected annual effluent releases. However, for current PWRs, which adopt the latest SG management program or guidance such as NEI 97-06, 'Steam Generator Program Guidelines', 2005 and EPRI-1022832, 'PWR Primary-to-secondary Leak Guidelines', Rev.4, 2011, the SG leak rate of 75 lb/day, which is equivalent to 9 gal/day, is not expected to continuously occur during normal operation. In fact, the Korean NPP operating procedures that implement the above guidelines typically limit the SG leak rate to less than 4.2 gal/day (=0.8 L/h) for the two SGs during normal operation. If it is indicated that the measured SG leakage exceeds this limit, proper operator actions are taken to monitor and prevent the development of the leakage including shutdown of the plant. Therefore, continuous operation with a SG leak rate greater than 4.2 gal/day is very unlikely.

Therefore, it is recognized that the use of 75 lb/day (9 gal/day) for SG leak rate, which is about two times the typical limit of 4.2 gal/day in SG monitoring procedures, in combination with 1% fuel defect RCS source term is considered conservative with regards to complying with the requirements of RG 1.143 for radwaste safety classification of SGBS.

The SGBS source term data calculated based on the above approach will be provided in DCD Tier 2 Table 10.4.8-4. In addition, DCD Tier 2 Subsection 10.4.8.1.2 will be revised to address the information on how to RW classification was determined for the SGBS and component boundary for each radwaste safety classification.

Impact on DCD

DCD Tier 2 Section 10.4.8.1.2 and 10.4.12 will be revised and DCD Tier 2 Table 10.4.8-4 is added as indicated in the Attachment.

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 254-8270 - Question 11.02-7_Rev.1

10.4.8.1.2 Non-Safety Power Generation Design Bases

The non-safety-related functions and design basis requirements of the SGBS are as follows:

- a. Remove non-volatile materials generated from condenser tube leaks, primary-to-secondary tube leaks, and corrosion that would otherwise become more concentrated in the shell side of the SGs, in order to help maintain SG shell-side water chemistry as specified in Table 10.3.5-1 (GDC 13)
- b. Enable blowdown concurrent with SG tube leak to remove radioactive materials from the secondary side without release of radioactivity to the environment
- c. Sample blowdown water for chemistry analysis and monitor the SG primary-to-secondary tube leakage with SG blowdown water radiation monitor (GDC 14)
- d. Establish and maintain wet and dry lay-up of the steam during plant shutdown
- e. Drain the secondary water of the SG for maintenance
- f. Control the blowdown water temperature to protect the demineralizer resin from high temperatures
- g. Monitor the radiation level downstream of the post-filter

All components, piping, and their associated supports downstream of the outermost containment isolation valves of the SGBS are non-safety and meet the following intents of the quality standards of Position C.1.1, C.4, and C.7 of NRC RG 1.143 (Reference 27).

- a. Table 10.4.8-3 details the equipment codes for design and construction as required in Table 1 of NRC RG 1.143. The structures, systems, and components (SSCs) of the SGBS are designed in conformance with applicable codes and standards, and guidelines provided in NRC RG 1.143.

The SGBS components are determined for the radioactive safety classification in accordance with the guidance provided in RG 1.143. The component safety

insert A in next page

RAI 254-8270 - Question 11.02-7_Rev.1

The radioactive inventories in the SGBS components are determined based on 1 percent fuel defect and compared with the A1 and A2 values in Appendix A of 10 CFR 71 (Reference 40). If the radioactivity inventories of a component exceed the A1 quantities, the component is classified as RW-IIa. If the radioactivity inventories are less than A1 quantities and greater than A2 quantities, the component is classified as RW-IIb. All other components are classified as RW-IIc. The results are included in Table 10.4.8-4.

classification is summarized in Table 10.4.8-1. Accordingly, the SGBS is classified as RW-IIc, based on the highest safety classification for the components within the system boundary. The SGBS components are housed within the auxiliary building designed as seismic Category I, which exceeds seismic design requirements for radwaste safety classification RW-IIc.

~~The safety classification for the SGBS component applies to the components, up to and including the nearest valves, fittings, and/or welded/flanged nozzle connections.~~

~~isolation~~

- b. The quality assurance (QA) program for the design, installation, procurement, and fabrication of SGBS components conforms with Regulatory Position C.7 of NRC RG 1.143.

All components connected to the SGBS components classified as RW-IIc (Piping, pumps, etc.) are also classified as RW-IIc, up to and including the nearest isolation component (ex. Isolation valves), on each connection, to the RW-IIc component.

The SGBS follows the ALARA design and operational approach described in Sections 12.1 and 12.3 in accordance with NRC RG 8.8 (Reference 19). The SGBS' demineralizers are located in a shielded area to reduce the occupational radiation exposure (ORE).

10.4.8.2 System Description

10.4.8.2.1 General Description

SGBS schematic diagrams are shown in Figure 10.4.8-1. Classification of SGBS equipment and components is shown in Section 3.2.

The blowdown subsystem (BDS) consists of blowdown piping connected to each SG, a blowdown flash tank, a regenerative heat exchanger, two pre-filters, two demineralizers, a post-filter, and control valves. The wet lay-up subsystem (WLS) consists of two recirculation trains (one for each SG) and shares filters and demineralizers with the BDS.

APR1400 DCD TIER 2

RAI 254-8270 - Question 11.02-7_Rev.1

36. NUREG-0800, Standard Review Plan, BTP 5-4, "Design Requirements of the Residual Heat Removal System," U.S. Nuclear Regulatory Commission, March 2007.
37. NUREG-0800 Standard Review Plan, BTP 10-1, "Design Guidelines for Auxiliary Feedwater System Pump Drive and Power Supply Diversity for Pressurized Water Reactor Plants," U.S. Nuclear Regulatory Commission, March 2007.
38. NRC RG 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants," Rev. 4, U.S. Nuclear Regulatory Commission, June 2006.
39. ASME Boiler and Pressure Vessel Code, Section VIII, "Rules for Construction of Pressure Vessels," The American Society of Mechanical Engineers, the 2007 Edition with 2008 Addenda.



40. 10 CFR 71, "Packaging and Transportation of Radioactive Material," U.S. Nuclear Regulatory Commission.

Table 10.4.8-4 (1 of 3)

RAI 254-8270 - Question 11.02-7_Rev.1

Design Basis Radioactive Source Terms for SGBD Components (1 % Fuel Defect)

Nuclide	SGBD Pre-filter		SGBD Post-filter		SGBD Demineralizer		SGBD Flash Tank		Wet Layup Recirculation Pump		SGBD Regenerative Heat Exchanger ¹⁾	
	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
Br-84	-	-	-	-	7.11E-06	2.63E+05	1.13E-06	4.17E+04	7.73E-06	2.86E+05	1.13E-06	4.17E+04
I-131	-	-	-	-	1.03E+00	3.81E+10	4.49E-04	1.66E+07	3.07E-03	1.13E+08	4.49E-04	1.66E+07
I-132	-	-	-	-	2.21E-03	8.19E+07	8.08E-05	2.99E+06	5.53E-04	2.05E+07	8.08E-05	2.99E+06
I-133	-	-	-	-	1.51E-01	5.58E+09	6.03E-04	2.23E+07	4.13E-03	1.53E+08	6.03E-04	2.23E+07
I-134	-	-	-	-	3.41E-04	1.26E+07	3.30E-05	1.22E+06	2.26E-04	8.35E+06	3.30E-05	1.22E+06
I-135	-	-	-	-	2.41E-02	8.90E+08	3.00E-04	1.11E+07	2.06E-03	7.61E+07	3.00E-04	1.11E+07
Rb-88	-	-	-	-	2.30E-04	8.50E+06	7.16E-05	2.65E+06	4.91E-04	1.82E+07	7.16E-05	2.65E+06
Cs-134	-	-	-	-	2.15E+00	7.95E+10	7.11E-05	2.63E+06	4.87E-04	1.80E+07	7.11E-05	2.63E+06
Cs-136	-	-	-	-	3.22E-02	1.19E+09	9.49E-06	3.51E+05	6.50E-05	2.41E+06	9.49E-06	3.51E+05
Cs-137	-	-	-	-	2.68E+00	9.93E+10	8.22E-05	3.04E+06	5.63E-04	2.08E+07	8.22E-05	3.04E+06
N-16	-	-	-	-	2.70E-09	9.98E+01	2.76E-06	1.02E+05	1.88E-05	6.96E+05	2.76E-06	1.02E+05
Na-24	-	-	-	-	1.38E-03	5.12E+07	7.76E-06	2.87E+05	5.31E-05	1.96E+06	7.76E-06	2.87E+05
Sr-89	-	-	-	-	8.11E-03	3.00E+08	5.97E-07	2.21E+04	4.10E-06	1.52E+05	5.97E-07	2.21E+04
Sr-90	-	-	-	-	1.47E-03	5.43E+07	4.08E-08	1.51E+03	2.80E-07	1.04E+04	4.08E-08	1.51E+03
Sr-91	-	-	-	-	9.11E-05	3.37E+06	7.92E-07	2.93E+04	5.42E-06	2.01E+05	7.92E-07	2.93E+04
Y-91m	-	-	-	-	2.14E-06	7.93E+04	2.16E-07	8.00E+03	1.48E-06	5.48E+04	2.16E-07	8.00E+03
Y-91	-	-	-	-	1.29E-03	4.78E+07	8.70E-08	3.22E+03	5.96E-07	2.20E+04	8.70E-08	3.22E+03

Table 10.4.8-4 (2 of 3)

RAI 254-8270 - Question 11.02-7_Rev.1

Nuclide	SGBD Pre-filter		SGBD Post-filter		SGBD Demineralizer		SGBD Flash Tank		Wet Layup Recirculation Pump		SGBD Regenerative Heat Exchanger ¹⁾	
	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
Y-93	-	-	-	-	2.24E-06	8.27E+04	1.84E-08	6.81E+02	1.26E-07	4.66E+03	1.84E-08	6.81E+02
Nb-95	-	-	-	-	9.16E-04	3.39E+07	9.38E-08	3.47E+03	6.43E-07	2.38E+04	9.38E-08	3.47E+03
Mo-99	-	-	-	-	4.03E-02	1.49E+09	5.03E-05	1.86E+06	3.44E-04	1.27E+07	5.03E-05	1.86E+06
Tc-99m	-	-	-	-	1.83E-03	6.78E+07	2.58E-05	9.53E+05	1.77E-04	6.53E+06	2.58E-05	9.53E+05
Ru-103	-	-	-	-	3.51E-04	1.30E+07	3.24E-08	1.20E+03	2.22E-07	8.20E+03	3.24E-08	1.20E+03
Ru-106	-	-	-	-	4.22E-04	1.56E+07	1.38E-08	5.11E+02	9.47E-08	3.50E+03	1.38E-08	5.11E+02
Ag-110m	-	-	-	-	6.73E-03	2.49E+08	2.37E-07	8.77E+03	1.62E-06	6.01E+04	2.37E-07	8.77E+03
Te-129m	-	-	-	-	1.03E-02	3.82E+08	1.09E-06	4.03E+04	7.47E-06	2.76E+05	1.09E-06	4.03E+04
Te-129	-	-	-	-	7.97E-06	2.95E+05	5.84E-07	2.16E+04	4.00E-06	1.48E+05	5.84E-07	2.16E+04
Te-131m	-	-	-	-	1.76E-03	6.51E+07	4.92E-06	1.82E+05	3.37E-05	1.25E+06	4.92E-06	1.82E+05
Te-131	-	-	-	-	2.73E-06	1.01E+05	5.49E-07	2.03E+04	3.76E-06	1.39E+05	5.49E-07	2.03E+04
Te-132	-	-	-	-	3.27E-02	1.21E+09	3.54E-05	1.31E+06	2.42E-04	8.94E+06	3.54E-05	1.31E+06
Ba-137m	-	-	-	-	1.30E-06	4.82E+04	2.57E-06	9.52E+04	1.76E-05	6.52E+05	2.57E-06	9.52E+04
Ba-140	-	-	-	-	2.66E-03	9.85E+07	7.30E-07	2.70E+04	5.00E-06	1.85E+05	7.30E-07	2.70E+04
La-140	-	-	-	-	1.19E-04	4.41E+06	2.49E-07	9.20E+03	1.70E-06	6.30E+04	2.49E-07	9.20E+03
Ce-141	-	-	-	-	2.51E-04	9.29E+06	2.73E-08	1.01E+03	1.87E-07	6.90E+03	2.73E-08	1.01E+03
Ce-143	-	-	-	-	2.92E-05	1.08E+06	7.43E-08	2.75E+03	5.09E-07	1.88E+04	7.43E-08	2.75E+03
Ce-144	-	-	-	-	2.28E-03	8.44E+07	7.84E-08	2.90E+03	5.36E-07	1.98E+04	7.84E-08	2.90E+03

Table 10.4.8-4 (3 of 3)

RAI 254-8270 - Question 11.02-7_Rev.1

Nuclide	SGBD Pre-filter		SGBD Post-filter		SGBD Demineralizer		SGBD Flash Tank		Wet Layup Recirculation Pump		SGBD Regenerative Heat Exchanger ¹⁾	
	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq	Ci	Bq
W-187	-	-	-	-	1.21E-04	4.49E+06	4.27E-07	1.58E+04	2.92E-06	1.08E+05	4.27E-07	1.58E+04
Np-239	-	-	-	-	2.61E-04	9.66E+06	3.89E-07	1.44E+04	2.67E-06	9.87E+04	3.89E-07	1.44E+04
Cr-51	1.80E-02	6.65E+08	1.80E-04	6.65E+06	1.98E-02	7.32E+08	1.21E-03	4.49E+07	1.73E-05	6.39E+05	1.21E-03	4.49E+07
Mn-54	7.89E-03	2.92E+08	7.89E-05	2.92E+06	8.68E-03	3.21E+08	9.05E-02	3.35E+09	2.00E-06	7.40E+04	9.05E-02	3.35E+09
Fe-55	6.76E-03	2.50E+08	6.76E-05	2.50E+06	7.43E-03	2.75E+08	1.02E-02	3.76E+08	1.50E-06	5.55E+04	1.02E-02	3.76E+08
Fe-59	5.97E-04	2.21E+07	5.97E-06	2.21E+05	6.57E-04	2.43E+07	1.05E-01	3.88E+09	3.75E-07	1.39E+04	1.05E-01	3.88E+09
Co-58	1.28E-02	4.74E+08	1.28E-04	4.74E+06	1.41E-02	5.22E+08	3.24E-03	1.20E+08	5.74E-06	2.12E+05	3.24E-03	1.20E+08
Co-60	3.08E-03	1.14E+08	3.08E-05	1.14E+06	3.38E-03	1.25E+08	4.05E-04	1.50E+07	6.63E-07	2.45E+04	4.05E-04	1.50E+07
Zr-95	1.60E-03	5.91E+07	1.60E-05	5.91E+05	1.76E-03	6.50E+07	3.05E-04	1.13E+07	7.57E-07	2.80E+04	3.05E-04	1.13E+07
Zn-65	2.39E-03	8.83E+07	2.39E-05	8.83E+05	2.62E-03	9.71E+07	7.27E-05	2.69E+06	6.37E-07	2.36E+04	7.27E-05	2.69E+06
Sum of Fractions												
$\sum A_i/A_{1i}$	1.17E-03		1.17E-05		1.96E-01		8.01E-03		7.48E-04		8.01E-03	
$\sum A_i/A_{2i}$	1.22E-03		1.22E-05		3.59E-01		8.16E-03		1.75E-03		8.16E-03	
Radwaste Classification												
	RW-IIc		RW-IIc		RW-IIc		RW-IIc		RW-IIc		RW-IIc	

1) The SGBD Regenerative Heat Exchanger is located downstream of the SGBD Flash tank. Therefore, source term of the SGBD Regenerative Heat Exchanger is assumed to be same as the SGBD Flash Tank.