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.:	**22-7930**
SRP Section:	**12.03-12.04 - Radiation Protection Design Features**
Application Section:	**12.3**
Date of RAI Issued:	**06/04/2015**

Question No. 12.03-5

REQUIREMENTS

10 CFR 50, Appendix A, General Design Criterion (GDC) 19, requires that control room access and occupancy shall not result in a dose exceeding 5 rem total effective dose equivalent (TEDE) for the duration of an accident.

10 CFR 52.47(a)(2)(iv)(A), requires that an individual located at any point on the boundary of the exclusion area for any 2-hour period following the onset of a postulated fission product release, would not receive a radiation dose in excess of 25 rem TEDE.

SRP Section 12.3-12.4 indicates that the staff will review the radiation protection aspects of compliance with GDC 19.

ISSUE

FSAR Section 11.1.1.1 indicates that the activities for iodine and noble gasses are limited to 1.0 microcuries per gram I-131 dose equivalent and 300 microcuries per gram Xe-133 dose equivalent. However, technical specification 3.4.15 conditions A and B do not Indicate what the dose equivalent I-131 and Xe-133 limit is and while the technical specification basis section discusses the limits, the discussion also contains other values which could be misinterpreted as the limits.

INFORMATION NEEDED

Consistent with standard technical specification and previously approved design certification documents and in order to add clarity to the APR 1400 technical specifications, please include the dose equivalent I-131 and Xe-133 limits within technical specification 3.4.15 conditions A and B, respectively.

Response

The specific activities for the primary system shall be limited to;

- DE I-131 specific activity ≤ 3.7E+4 Bq/g
- DE Xe-133 specific activity ≤ 1.11E+7 Bq/g

For clarity, Technical Specification 3.4.15 will be revised to include the above TS LCO values. Refer to Attachment for the DCD markups.

Impact on DCD

DCD Ch.16, TS LCO 3.4.15 will be revised as indicated in Attachment.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

TS LCO 3.4.15 will be revised as indicated in Attachment.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical and Environmental Reports.

3.4 REACTOR COOLANT SYSTEM (RCS)

3.4.15 RCS Specific Activity

LCO 3.4.15 ~~RCS DOSE EQUIVALENT I-131 and DOSE EQUIVALENT XE-133 specific activity shall be within limits.~~

The specific activity of the reactor coolant shall be limited to:
a. DOSE EQUIVALENT I-131 specific activity ≤ 3.7×10^4 Bq/g
b. DOSE EQUIVALENT XE-133 specific activity ≤ 1.11×10^7 Bq/g

APPL

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. ~~DOSE EQUIVALENT I-131 not within limit.~~	---------- NOTE ---------- LCO 3.0.4 is not applicable. ----------	
	A.1 Verify DOSE EQUIVALENT I-131 ≤ 2.22×10^6 Bq/g.	Once per 4 hours
	AND	
	A.2 Restore DOSE EQUIVALENT I-131 to within limit.	48 hours
B. ~~DOSE EQUIVALENT XE-133 not within limit.~~	---------- NOTE ---------- LCO 3.0.4 is not applicable. ----------	
	B.1 Restore DOSE EQUIVALENT XE-133 to within limit.	48 hours
C. Required Action and associated Completion Time of Condition A or B not met. OR DOSE EQUIVALENT I-131 > 2.22×10^6 Bq/g.	C.1 Be in MODE 3. AND C.2 Be in MODE 5.	6 hours 36 hours

DOSE EQUIVALENT I-131 > 3.7×10^4 Bq/g

DOSE EQUIVALENT XE-133 > 1.11×10^7 Bq/g

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Question No. 12.03-6

REQUIREMENTS

10 CFR 52.47(a)(5) requires that the FSAR contain the kinds and quantities of radioactive materials expected to be produced in the operation and the means for controlling and limiting radioactive effluents and radiation exposures within the limits set forth in 10 CFR 20.

10 CFR 50, Appendix A, Criterion 61, requires that the fuel storage and handling, radioactive waste, and other systems which may contain radioactivity be designed to assure adequate safety under normal and postulated accident conditions, with suitable shielding for radiation protection, and with appropriate containment, confinement, and filtering systems.

SRP Section 12.3-12.4 indicates that the plant shielding design and normal operation radiation zoning should consider conditions of normal operation, refueling, and anticipated operational occurrences (AOOs), including fuel handling and storage and radioactive material handling, processing, use, storage, and disposal.

ISSUE

FSAR Table 12.3-4 provides design basis minimum radiation shield thicknesses for the plant. However, the applicant does not provide any minimum shielding thickness for the refueling canal (room 119-A01B). In addition, the radiation zones do not appear to account for radiation dose rates during fuel transfer nor is there any note on the figure indicating the dose rates in surrounding areas during fuel transfer operation. Finally, it is unclear if other AOOs were considered in the zoning and shielding design.

INFORMATION NEEDED

1. Please update FSAR Table 12.3-4 to provide the minimum radiation shield thicknesses for the refueling canal based on transferring of the maximum source term (maximum two fuel assemblies) that could be contained within the canal.

2. Please ensure that zoning for the areas surrounding the refueling canal in FSAR Figures 12.3-4 through 12.3-8 include dose contributions from the maximum source term that would be expected within the refueling canal during fuel transfer operations (considering the required minimum shielding to be provided in FSAR Table 12.3-4). If dose rates in surrounding areas are higher during refueling operations the applicant may choose to include a note or additional figures to indicate dose rates during refueling. In any case, the application should clearly indicate the expected dose rates in areas surrounding the refueling canal based on the expected maximum source term during refueling operations. While FSAR Figure 12.3-52 provides dose rates during fuel transfer, it is insufficient to determine dose rates for surrounding rooms.

3. Please indicate if radiation shielding and zoning for the plant includes consideration of AOOs, including refueling; purging; fuel handling and storage; radioactive material handling; processing (including resin transfer), use, storage, and disposal; normal maintenance; routine operational surveillance; inservice inspection; and calibration.

Response

1. DCD Table 12.3-4 will be revised to include the minimum radiation shield thicknesses for the refueling canal. Refer to Attachment 1 for the DCD markups.

2. Radiation zones in areas around the refueling canal presented in Figures 12.3-4 through 12.3-8 are also maintained during fuel transfer operations. The radiation shielding requirements of the structure surrounding the refueling canal are determined assuming that spent fuel assemblies are being transferred. In order to maintain the designated radiation zones in the areas adjacent to the refueling canal during fuel transfer operations, the shielding analyses are performed by using the conservative assumptions presented in DCD Subsection 12.3.2.3 (third paragraph in Page 12.3-28).

   As a result, the required shield thicknesses around the refueling canal to maintain the the dose rates lower than the designated radiation zones are determined as indicated in the markups in the Attachment 1 of this response. Table 1 shows the radiation zoning, required minimum shield thicknesses to maintain the dose rates lower than the upper dose rate limits and the actual structure thicknesses around the refueling canal.

   Table 1 also shows that the actual structure thicknesses of the shields are much thicker than the minimum required shield thicknesses. This ensures that the dose rates in those areas during fuel transfer operations are maintained lower than those designated in the radiation zone maps.

   However, since the expected dose rate in the refueling canal could be as high as 2.2E+06 mSv/hr during refueling operation, the radiation zone maps for this area will be revised to

include a note that “Refueling canal (119-A01B) is Zone 8 during refueling operation”. Please refer to Attachment 2 for the DCD markups.

Table 1. Shielding and Actual Thicknesses in Areas Surrounding the Refueling Canal

Structure Around Refueling Canal (119-A01B)	Surrounding Areas (Room ID)	Designated Zone ID (Upper Dose Rate, mSv/hr)	Minimum Required Shield Thickness (inches)	Actual Structure Thickness (inches)
North Wall	Spent Fuel Pool (114-A01B) Pipe & HVAC Chase (100-A29B)	8 (> 5,000) 4 (≤ 0.2)	60 Note 1) 30	84 30
South Wall	Fuel Handling Area Emergency ACU Rm (120-A24A)	2 (≤ 0.025)	59	103
East Wall	HELB HVAC Duct Tray Pipe Way (117-A02A)	2 (≤ 0.025)	62	87
West Wall	Refueling Canal (119-A01B)	8 (> 5,000)	N/A	N/A
Floor	Storage Area (100-A27B)	2 (≤ 0.025)	62	64
Ceiling	Area above SFP	N/A	-	-

Note 1) Shielding requirement for the North Wall is determined based on the source term in the SFP to maintain the refueling canal as Zone 2 during normal operation, where fuels are not being transferred.

3. Radiation shielding and zoning for APR1400 take into consideration AOOs, including refueling, handling of radioactive materials, routine maintenance and inspection, and calibration. The APR1400 design features with respect to shielding and zoning for the above plant conditions are discussed as follows:

   a. Refueling, Fuel Handling and Storage

      Basis for shielding and zoning during refueling and storage operations of spent fuel is discussed in DCD Subsection 12.3.2.3 and supplemented in the response to RAI RPAC 7-7855 (ML15166A300). With regards to the fuel transfer canal, responses to Item No. 1 and 2 above provide the details of the design basis for shielding and zoning.

   b. Purging

      As indicated in DCD Subsection 9.4.6.2.2, the APR1400 Reactor Containment Building Purge System consists of High Volume Purge Subsystem and Low Volume Purge Subsystem. For a conservative design, the source term calculations for the components of this system assume the maximum primary coolant leak rate of 0.5 gal/min allowed in the Technical Specifications and the design basis 0.25% fuel defect primary coolant activity concentrations. The zoning and shielding requirements are determined using the conservative assumption that all particulates are trapped in the HEPA and charcoal filters.

c. Handling (Processing, Use, Storage and Disposal) of Radioactive Materials

Source terms used to determine the radiation zoning and shielding requirements for radwaste systems are discussed in Section 12.2. As discussed throughout Sections 11.2 – 11.4, all the radwaste system components are located in cubicles with sufficient shielding. The shielding design takes into account the anticipated handling (processing, use, transfer, storage) of gaseous, liquid and solid radioactive materials. For example, the pipe used to transfer spent CVCS resins to the Spent Resin Long-Term Storage Tank is routed through a shielded Hot Pipe Way, of which thicknesses are determined based on the design basis (0.25% fuel defect) source term of the resin being transferred. Radwaste storage areas in the Compound Building are also designed with shielding determined based on the maximum storage capacities for spent resins, filters, sludge, and dry active waste.

d. Normal Maintenance, Routine Surveillance and Inservice Inspection

Design features to maintain occupational exposure ALARA during normal maintenance, routine surveillance and inservice inspection are described in Subsection 12.3.1.1 ‘General Arrangement Design Features’. Titles of the relevant items in that subsection are listed as follows:

a. Locations of radioactive systems and equipment
b. Pipe routing
c. Component access
d. Hot tool cribs and hot machine shop
h. Accessways and entrances to high-radiation areas
k. Inservice inspection equipment

e. Calibration

Instrument calibration facility (063-P74) located on El. 73’-0” in the Compound Building is shielded assuming that the calibration operation is being conducted in the room. The radiation source of the multi-source gamma calibrator is assumed to be Cs-137/Ba-137m and that the exposure rate at 50 cm away from the source is 2,400 R/hr. The required shield thicknesses of the cubicle and the dose rate at the entrance to the labyrinth are determined using MCNP 5 calculations.

Impact on DCD

DCD Table 12.3-4 will be updated to include the minimum radiation shield thicknesses for the refueling canal as indicated in Attachment 1.

DCD Figures 12.3-5 and 12.3-6 will be updated to include a note as indicated in Attachment 2.

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 Reports.

Table 12.3-4 (4 of 7)

Room Number	Room Name	Minimum Required Shield Thickness (inches)					
		North	South	East	West	Floor	Ceiling
Auxiliary Building (cont.)							
078-A37A	Deborating IX Room	15	12	10	26	24	24
078-A38A	SFP Cleanup Pump Room	18	16	23	10	32	32
078-A39A	Gas Stripper Effluent Radiation Monitor Room	23	23	23	10	16	35
078-A40B	Boric Acid Concentrator Room	16	23	23	14	16	16
100-A32B	SFP Cooling HX Room	10	10	10	10	10	10
100-A29B	Pipe and HVAC Chase	10	10	10	10	10	10
100-A13A	Mechanical Penetration Room	25	22	22	30	34	14
100-A13B	Mechanical Penetration Room	35	10	23	21	36	10
100-A16D	Pipe Chase	23	21	23	23	10	13
100-A16C	Pipe Chase	21	10	10	10	10	10
100-A24A	SFP Cooling HX Room	12	10	12	32	24	10
100-A26A	Valve Room	28	20	20	28	32	10
100-A25A	Volume Control Tank Room	42	47	42	47	48	53
111-A01B	Cask Loading Pit	48	14	48	48	42	-
114-A01B	Spent Fuel Pool	62	60	59	71	73	-
120-A16B	Mechanical Penetration Room	29	27	10	21	18	29
120-A16A	Mechanical Penetration Room	23	12	23	21	17	19
119-A01B	Refueling Canal	60/30 (1)	59	62	–	62	–
120-A14A	SG Blowdown Regen. HX Room	12	10	10	21	14	21
137-A19A	SG Blowdown Flash Tank Room	18	18	18	21	18	18
156-A14A	Aux. Bldg Controlled Area (I) Normal Exhaust ACU Room	18	18	18	18	18	18
174-A15B	Containment High- and Low-volume Purge ACU Room	21	21	21	21	15	10
195-A08B	Aux. Bldg. Controlled Area (II) Normal Exhaust ACU Room	18	18	18	18	18	18

(1) Minimum required shield thicknesses of the portions in contact with spent fuel pool(114-A01B) and pipe & HVAC chase (100-A29B) are 60 inches and 30 inches, respectively.

Figure 12.3-5 Radiation Zones(Normal) Auxiliary/Containment Building El.120'-0"

Figure 12.3-6 Radiation Zones(Normal) Auxiliary/Containment Building El.137'-6"