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.:	**141-8098**
SRP Section:	**12.03-12.04 - Radiation Protection Design Features**
Application Section:	**12.3**
Date of RAI Issue:	**08/07/2015**

Question No. 12.03-8

REQUIREMENT

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.

INFORMATION NEEDED

SRP 12.3-12.4 indicates that the shielding should be specified for each of the radiation sources identified in Chapter 11 and Section 12.2, and other applicable sections. Staff has identified the following shielding information that is missing or incorrect.

1. While FSAR Table 12.3-4 identifies design basis radiation shield thicknesses for plant rooms for which shielding is necessary, there are several rooms containing significant sources, or significant dose rates (some of them potentially greater than 100 Rad/hour), for which no shielding thicknesses are provided. Please provide the minimum required shield thicknesses for the following rooms in FSAR Table 12.3-4 or justify why they are not needed (if an area is inaccessible then minimum shielding thicknesses are not needed):

    a. Room 089-C01 (Core Debris Chamber, Figure 12.3-3)

    b. Room 086-A01A (Filter Area, Figure 12.3-3)

    c. Room 063-P38 (Solidification and Drum Conveyor Room, Figure 12.3-10)

    d. Room 085-P32 (Primary Sampling Sink Room, Figure 12.3-12)

    e. Room 085-P45 (Drum Removal Chase, Figures 12.3-11 through 12.3-12)

f. Room 100-P02 (GRS Equipment Removal Area, Figure 12.3-13)

g. Room 100-P10 (Spent Filter Drum Storage Area, Figure 12.3-13)

h. Room 120-P01 (Gaseous Radwaste Sample Control Panel Room, Figure 12.3-14)

i. Room 120-P02 (Gaseous Radwaste Sample Valve Rack Room, Figure 12.3-14)

2. In FSAR Table 12.3-4 Room 063-005 is labeled “Future Use” and Room 063-P06 is labeled “Spent Resin Long-term Storage Tank Room” however, in FSAR Figure 12.3-12 Room 063-005 is labeled “Spent Resin Long-Term Storage Tank Room” and Room 063-P06 is labeled “Future Use.” Please correct this discrepancy.

3. While the FSAR indicates that there are four gaseous radwaste system delay beds, it is unclear which rooms each delay bed is located. FSAR Table 12.3-4 indicates that Rooms 096-P01 and 096-P02 are delay bed rooms. Please specify in the FSAR which rooms each of the delay beds (1, 2, 3, and 4) are located.

Response – (Rev. 2)

1. The minimum required shield thicknesses for the above rooms except for Core Debris Chamber and Filter Area is provided in DCD Table 12.3-4.

   Core Debris Chamber (089-C01) is designed to minimize the direct containment heating as a severe accident mitigation feature and personnel access to this area is not allowed during normal operation. Since this area is surrounded by massive concrete structure with more than 6 feet, it is not necessary to provide additional shielding requirement.

   The Filter Area (086-A01A) shown in Figure 12.3-3 is an open space above the filter cubicles used for replacement of the spent filters. Therefore, shielding for this area is not required. The arrow marker for the Filter Area in Figure 12.3-3 looks like it is indicating the Filter Cartridge Storage Room (077-A15A), which is shown in Figure 12.3-2. Minimum shield thicknesses for the Filter Cartridge Storage Room are provided in Table 12.3-4.

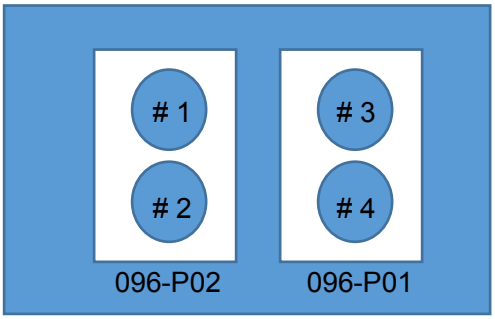
   In addition, the minimum shield thicknesses for other missing rooms such as Chemical Drain Sump Pump room (055-A31B), Condensate Return Unit room (055-A46A), Valve room (055-A59A), and Refueling Canal (119-A01B) also were added in DCD (Rev.1) Table 12.3-4.

   Table 12.3-4 was originally prepared to provide the minimum shield thicknesses required to maintain the radiation zone during normal operation. However, since the eventual shield thicknesses are determined to provide accessibility to vital areas during post-accident conditions, Table 12.3-4 is updated to provide the thicknesses which meet both normal operation and accident conditions. In addition, Table 12.3-4 is updated to correct some discrepancies between the table and the supporting shielding calculations.

In addition, DCD Tier 1 Table 2.2.1-1 will be revised to incorporate the consistent information with Tier 2 Table 12.03-8 on the minimum required shielding thickness for the south wall of the volume control tank room as indicated in Attachment.

2. As shown in DCD Figure 12.3-12, Room 063-P05 is the Spent Resin Long-term Storage Tank Room, and Room 063-P06 is a room for “Future Use”. Therefore, Table 12.3-4 was updated to correct this discrepancy.

3. Two delay beds are located in a cubicle. The first and second delay beds are located in Room 096-P02, and the third and fourth beds are in Room 096-P01 as below;



In addition, based on follow-up discussion regarding issues of 1) the piping case study by using the dose conversion factors in ICRP-74 and 2) no consideration of backscatter radiation within the piping areas, KHNP provided the responses to NRC as indicated in the supplemental questions and responses below.

Supplemental Questions and Responses

Clarification Questions Related to Dose Rate Calculation
(Public call date: April 23, 2017)

As part of the shielding audit, we requested KHNP provide the input and output file to their MCNP calculations for determining zoning for piping areas, as well as the case study summary. The applicant is using special multiplication factors to determine dose rates for piping areas, instead of just multiplying by the number of pipes. These comments are the result of reviewing the case study and MCNP calculations.

1) Dose rates calculated in the piping case study are based on the dose conversion factors in ICRP-74. This is inconsistent with all the other shielding calculations reviewed by staff which use the dose conversion factors of ICRP-51. Using the dose conversion factors of ICRP-74 results in doses approximately 7% lower than if ICRP-51 is used. It is unclear why the applicant is using the dose conversion factors of ICRP-74 for the piping calculations, but ICRP-51 for everything else.

2) The applicant does not model walls around the piping, therefore, there is no consideration of backscatter radiation within the piping areas. Staff estimates that this could also account for nearly 10% increase in dose.

One acceptable way to resolve these issues would be to simply add 20% to the dose rate within piping areas.

KHNP Response

1) Shielding analyses, including the piping shielding calculations, are performed using the dose conversion factors (DCFs) from ICRP 51. ICRP 74 was only used to determine the Multiplication Factors (MFs) which are the adjustment factors based on the comparisons of the dose rates of groups of multiple pipes to that of a single pipe. The primary objective of the MFs is to facilitate the use of Microshield software to expedite shielding analyses. In the development of the MFs, standard models of groups of piping are formed with 2 to 10 pipes of similar sizes and dose rates. The dose rate for a single group of piping is analyzed using the MCNP program to calculate the composite dose rate to include radiation scattering from the piping. The composite dose rate, is then compared to the dose rate of a single pipe to determine the MF. The MFs are comparisons based on ratios of the dose rates, and KHNP used ICRP 74 DCFs for only these comparable dose rate calculations. The DCFs were applied on a consistent basis for all piping cases in the development of the MF ratios. KHNP believes that, if the ICRP 51 DCFs were used for the determination of the MFs, the results would be similar as the calculated dose rates are only used on a ratio basis.

2) KHNP agrees that radiation backscatter from shield walls is not included in the development of the MFs in the Technical Notes titled “A Case Study to Determine Dose Rate Multiplication Factors for Areas with Multiple Piping” (Technical Notes), which was provided to the NRC to support the response to RAI Question 12.03-8 and the subsequent shielding audit. KHNP also agrees that the dose rates as determined in the Technical Notes are lower than the case with radiation backscatter from the concrete walls included.

   Through further analysis using the calculation models developed in the preparation of the Technical Notes study, KHNP analyzed the dose rates to include the impact of backscatter from the concrete walls. KHNP found that with backscatter included, the dose rate for the piping model of 10 pipes increases by about 7.25%, with the concrete walls located 1 foot, at Dose Point 1 (DP1), from the piping source.

   KHNP believes that the maximum composite dose rates contain sufficient conservatism for the development of the MFs and their intended uses on zoning and shielding. For example, in the 10-pipe model, the highest dose rate is 8.87 mSv/hour (at the center dose point in the vertical configuration.) This dose rate, or the MF associated with this dose rate, is used to designate the zoning and to develop the shielding for pipe chases in both the horizontal and vertical configuration. This dose rate, as compared to the DP1 case in the horizontal configuration, provides a margin of nearly 300% (=8.87/2.98x100%). This margin far outweighs the effect of 7.25% due to backscatter to DP1. Please note that the impact of the backscatter effect diminishes as the dose points get further away from the wall. It should also be noted in the development of the pipe grouping, the pipe containing the highest individual dose rate in each group is used in conjunction with the corresponding MF as the basis for development of the

composite dose rate for the pipes in the group, which adds further margins to the shielding analysis. The zoning thus designated assumes all 10 pipes in this example contain the same level of radioactivity. It is for these reasons that KHNP believes that the impacts of backscatter to the zoning designation and piping calculation are considered to be adequately covered by the conservative assumptions built into the analysis.

Impact on DCD

DCD Tier 1 Table 2.2.1-1 will be revised as indicated in 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.

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Table 2.2.1-1 (8 of 10)

100'-0"

Wall or Section Description	Column Lines	Floor Elevation or Elevation Range	Concrete Thickness (1)	Applicable Radiation Shielding Wall (Yes/No)
Column Line AD Wall	From 15 to 17 From 22 to 26	From 55'-0" to 120'-0" From 55'-0" to ~~156'-0"~~	3'-0"	Yes
~~Column Line AD Wall~~	~~From 12 to 15~~	~~From 78'-0" to 100'-0"~~	~~2'-6"~~	~~No~~
~~Column Line AD Wall~~	~~From 12 to 15~~	~~From 137'-6" to 156'-0"~~	~~2'-6"~~	~~No~~
Column Line AD Wall	From 12 to 15	From 156'-0" to 174'-0"	2'-0"	Yes
Column Line AE Wall	From 12 to 15 From 22 to 23	From 55'-0" to 195'-0" From 55'-0" to 156'-0"	3'-0"	Yes
Column Line AE Wall	From 23 to 24	From 100'-0" to 137'-6"	3'-0"	Yes
Column Line AE Wall	From 24 to 25	From 100'-0" to 137'-6"	4'-0"	Yes
Column Line AE Wall	From 23 to 26	From 137'-6" to 156'-0"	3'-0"	Yes
Column Line AF Wall	From 12 to 15	From 55'-0" to 156'-0"	2'-6"	No
Column Line AF Wall	From 22 to 26	From 55'-0" to 120'-0"	4'-0"	Yes
Column Line AF Wall	From 22.5 to 25.5	From 120'-0" to 156'-0"	8'-7"	Yes
Column Line AF Wall	From 22 to 26	From 156'-0" to 213'-6"	4'-0"	Yes
Column Line AF Wall	From 13 to 15	From 174'-0" to 195'-0"	3'-0"	No
Column Line AG Wall	From 12 to 15 From 22 to 23	From 55'-0" to 195'-0"	3'-0"	Yes
Column Line AG Wall	From 25 to 26	From 55'-0" to 171'-0"	3'-0"	Yes
Column Line AH Wall	From 15 to 17	From 55'-0" to 120'-0"	3'-0"	Yes
Column Line AH Wall	From 12 to 15	From 78'-0" to 100'-0"	2'-6"	No

Column Line AD Wall	From 22 to 24 From 25 to 26	From 100'-0" to 137'-6"	3'-0"	Yes
Column Line AD Wall	From 24 to 25	From 100'-0" to 137'-6"	3'-6"	Yes
Column Line AD Wall	From 22 to 26	From 137'-6" to 156'-0"	3'-0"	Yes