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.:	**343-8420**
SRP Section:	**12.02 – Radiation Sources**
Application Section:	**12.2**
Date of RAI Issue:	**12/22/2015**

Question No. 12.02-24

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.

Issues

As a result of staff's review of the applicant's responses to draft audit questions from an August 2015 audit (ML15303A400, dated October 30, 2015), staff has the following questions:

1. SRP section 12.2 specifies that "the staff will review the description of airborne radioactive material sources in the plant considered in the design of the ventilation systems and used for the design of personnel protective measures and for dose assessment."

   Regarding question 3 of the "Additional Follow up Questions from the August 12, 2015 teleconference" section of the document referenced above (on page 6), the staff requested that the applicant clarify in the FSAR that the ventilation flow rate values are minimum flow rates for the actual design of the ventilation system, instead of just flow rates assumed for calculation purposes. Initially, the applicant indicated that the values were assumed values, however, in the final response, the applicant updated the FSAR to remove the word "assumptions" in the FSAR. The final response to the question states that the minimum HVAC flow rates provided are the flow rates to maintain the DAC fractions less than 1.0 DAC, but does not specify if the HVAC system design will meet the flow rates specified. Therefore, it is still not clear if the plant ventilation system will actually be designed to meet the flow rates provided in FSAR Table 12.2-26. Please specify if the ventilation flow rates provided in FSAR Table 12.2- 26 represent actual minimum flow rate requirements for the design of the ventilation system.

2. SRP 12.2 indicates that source descriptions should include the methods, models, and assumptions used as the bases for all values provided in SAR Section 12.2. The calculations for determining Auxiliary Building ventilation filter activity were not included as part of the source term audit.

   In the response to question 4 of the “Additional Follow up Questions from the August 12, 2015 teleconference” section of the document referenced above (on page 6), the applicant indicates that the Auxiliary Building ventilation filter source term was calculated based on values from the PWR-GALE code which were then back calculated based on the Auxiliary Building flow rate and then adjusted to take into account the shielding design basis source term of 0.25% fuel defect. Since the PWR-GALE code is based on data from nuclear power plant operation with minimal fuel damage and also uses different assumptions than those used in the 0.25% source term calculations of airborne radioactive material, it is unclear to staff how the values of releases from the PWR-GALE code would be converted to the 0.25% fuel defect source term in the ventilation system. Please provide a detailed description and/ or calculations demonstrating the methodology used to convert GALE code results to Auxiliary Building ventilation system values based on 0.25% fuel defect.

Response

1. KHNP confirms that the room ventilation flows for HVAC design are higher than the HVAC flows in Table 12.2-26; and that the individual room HVAC flows in Table 12.2-26 are based on the minimum flow determined for individual room DAC fractions to be less than 1.0. Examples of the HVAC flow development are summarized in Table 1 to illustrate the basis for the HVAC ventilation flow design evolution.

   Individual room HVAC flow is calculated for the corresponding room DAC. For example, CS pump and miniflow HX Room (Rooms 050-A01C and D) air flow is determined to be 32 SCFM for a corresponding DAC fraction of 0.1 [Calculation #1-035-N377-013, Revision 02]. In assigning the HVAC flow to Table 12.2-26, the air flow is rounded upward to 100 SCFM (converted to 170 m^3/hour). In the AB controlled area HVAC design, the actual flow for this cubicle is 1050 SCFM. HVAC design ventilation flows for other rooms follow the same approach.

   A note is added to Table 12.2-26 to denote that the HVAC flows listed in this table are based on the minimum flow rates required for the ventilation for the corresponding rooms for DAC fraction less than 1.0.

Table 1 Examples of Determination of HVAC Flow in Controlled Area

Cubicle	Cubicle Number	Calculated minimum HVAC Flow(1)	Assigned HVAC Flow in Table 12.2-26			Actual HVAC flow(3)
		scfm	m^3/h	scfm	DAC Fraction(2)	scfm
CS Pump and Minflow HX Rm	050-A01C, D	32	170	100	0.067	1050
SI Pump Rm	050-A02C, D/050-A03A,B	413	850	500	0.021	1050
Floor Drain Sump Pump Rm	055-A08C, D/055-A34A,B	360	680	400	0.881	500
Shutdown Cooling HX Rm	055-A30A,B	less than 1	170	100	0.016	500
Charging Pump Rm	055-A42A	361	850	500	0.729	1050
Charging Pump Miniflow HX Rm	055-A43A	20	170	100	0.201	1050
EDT Rm	055-A51B	31	170	100	0.038	600
RDT Pump Rm	055-A52B/53B	400	850	500	0.804	1050
Gas Stripper Rm	068-A06A	764	1444	850	0.902	1150
Filter and Demi. Valve Area	068-A10A	818	1529	900	0.865	900
VCT RM	100 -A25A	37	170	100	0.42	450

(1) The minimum flow rate to maintain the DAC less than 1.0.
(2) DAC fractions if the assigned minimum flow rate is applied.
(3) The flow data are extracted from P&ID #1-606-M105-002 and #1-606-M105-003, Revision 0.

2. KHNP revised the calculation method for the determination of HVAC filter activity using a direct ratio of the nuclide activity from 0.25% fuel defect to the corresponding activity from the GALE code calculation. Specifically, the expected release activity is adjusted with the individual radionuclide concentration ratios between the nuclide concentration from the 0.25% fuel defect to the corresponding nuclide concentration from the PWR-GALE code calculation (summarized in DCD Table 11.3-1) as follows:

$$\text{Concentration Ratio, }(\mathrm{CR}_i) = \frac{C_{0.25\%\,F.F,i}}{C_{PWR-GALE,i}}$$

Where,

CR_i = Concentration Ratio of nuclide i

$C_{0.25\%\,F.F,i}$ = Activity of nuclide i based on 0.25% failed fuel

$C_{PWR-GALE,i}$ = Activity of nuclide i based on the PWR-GALE Calculation

3. Using I-131, the following calculation illustrates the methodology to demonstrate the conversion of the PWR-GALE code results of the Fuel Handling Area & Auxiliary Building ventilation system shielding design values to the source term based on 0.25% fuel defect:

i. Expected I-131 release rate = 3.66E+07 (Bq/year) × $MF_{I\text{-}131}$ = 1.11E+10 Bq/year, where $CR_{I\text{-}131}$ = 2.48E+04 ÷ 8.18E+01 = 303.29

Where 2.48E+04 Bq/year is the I-131 activity based on 0.25% fuel defect from DCD Tier 2 Table 12.2-5 (1 of 2); and 8.18E+01 is the corresponding activity from GALE code calculation in DCD Tier 2 Table 11.3-1.

ii. The airborne activity concentration before entering the charcoal filter is then calculated as follows:

$$C_{0.25\%} = Q_{PWR-GALE} \times MF \times U.C \times \frac{1}{F \times (1-E)}$$

Where,

C = Airborne activity concentration [Bq/cc]

Q = Annual activity release rate [Bq/yr] (from Table 11.3-1)

CR = Concentration Ratio

F = Total AB ACU exhaust flow [ft3/min] (from Figure 11.3-2)

E = Filter efficiency (90%)

U.C = Unit conversion

$$\left[\frac{1\ year}{365\ days} \times \frac{1\ day}{24\ hours} \times \frac{1\ hour}{60\ mins} \div \left(\frac{ft^3}{min} \times \frac{28{,}316.8\ cc}{ft^3}\right) = 6.719\text{E-}11\right] C_{0.25\%} = 3.66\text{E+}07 \times 303.29 \times 6.719\text{E-}11 \times \frac{1}{111{,}600 \times (1-0.9)}$$

$$= 6.68\text{E-}05\ \text{Bq/cc}$$

iii. The buildup of radioactivity is then calculated as follows:

$$B = C_{0.25\%} \times F \times E \times U.C \times \frac{1-\exp(-\lambda t)}{\lambda}$$

Where,

B = Buildup activity in filter [Bq]

C = Airborne activity concentration [Bq/cc]

F = AB ACU exhaust flow [ft^3/min] (from Figure 11.3-2)

E = Filter efficiency (conservatively assumed as 1.0)

U.C = Unit conversion

$$[\frac{Ci}{cc} \times \frac{ft^3}{min} \times \frac{28{,}316.8cc}{ft^3} \div \left(\frac{1}{sec} \times \frac{60sec}{1min}\right) = 4.719E+2\ ]$$

$$B = 6.68E\text{-}05 \times 38{,}000 \times 1 \times 4.719E+02 \times \frac{1 - \exp(-9.976E\text{-}07 \times 31{,}536{,}000)}{9.976E\text{-}07}$$

$$= 1.20E+09\ Bq$$

iv The same approach is used for calculation of buildup of particulate activities for the HEPA filter in the AB ACU.

v. The AB ACU shielding calculation is documented in KHNP/KEPCO E&C calculation 1-328-N376-001, AUX BLDG E. 190'-0" Shielding Calculation.

Impact on DCD

DCD Tier 2 Section 12.2, Table 12.2-26 will be updated 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 Reports.

RAI 207-8247 Question 12.02-18

RAI 343-8420 Question 12.02-24

Table 12.2-26 (8 of 8)

Minimum Required Ventilation Flow

Cubicle	Volume (m^3)	Leak Sources and Number of Sources	Leak Rate (~~m^3~~ L/min)	Source Terms (1), (2)	~~HVAC Flow~~ Minimum Required Ventilation Flow (m^3/hr)
Valve Rm (085-P15)	263	Valve 3″ (~~2~~ 1) Valve 6″ (4)	~~5.00E-07~~ 5.00E-04 ~~4.01E-06~~ 5.00E-03	1 PCA (Except for NG)	510
Valve Rm (085-P16)	269	Valve 4″ (1) Valve 6″ (2) Valve 6″ (3) Valve 6″ (1) Valve 4″ (2)	~~6.66E-07~~ 6.66E-04 ~~2.00E-06~~ 2.00E-03 ~~3.00E-06~~ 3.00E-03 ~~9.99E-07~~ 9.99E-04 ~~1.33E-06~~ 1.33E-03	0.32 PCA 0.32 PCA 0.1 PCA 0.44 PCA 0.01 PCA	1,444

(1) PCA: Fraction of primary coolant activity concentrations

(2) NG: Noble gases

(3) The HVAC flows listed in this table represent the actual minimum flow rates required for the ventilation for the corresponding rooms