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.:	**263-8329**
SRP Section:	**12.03 – 12.04 Radiation Protection Design Features**
Application Section:	**12.3 – 12.4**
Date of RAI Issue:	**10/22/2015**

Question No. 12.03-47

This is a follow-up to RAI 7858, Question 12.03-4.

10 CFR 50, Appendix A, Criterion 61 requires in part that radioactive waste systems and other systems which may contain radioactivity contain suitable shielding for radiation protection.

In the response to RAI 7858, Question 12.03-4, the applicant indicates that the zoning and shielding of piping is based on assuming piping of a length of 20 feet with the dose rate taken 1 foot away from the pipe. However, staff calculations using the radionuclide concentration of the purification ion exchange resins in a 20 foot long pipe, assuming piping diameters ranging from 5 inches to 10 inches, indicate the dose rate a foot away from this piping would be greater than 500 rad/hour. However, the pipe chases in the areas where the staff would expect the resin transfer piping would to be located are zoned less than 500 rad/hour.

1. Please provide additional information indicating how the dose rate 1 foot away from the resin transfer piping was determined. For example, indicate what diameter piping was assumed and if any credit was taken for dilution of the resin (provide the basis for the assumptions used). If any FSAR changes are necessary as a result of this response, such as updated shielding or zoning, please update the FSAR, as appropriate.

2. In order for the staff to verify that the appropriate areas are being considered, please indicate which rooms the resin transfer piping that is used to transfer resin from the CVCS purification ion exchangers to the spent resin long term storage tank, is located.

   In addition, Question 12.03-4, requested that the applicant provide information on how shielding and zoning was determined for all radiation sources which are not explicitly modeled in FSAR Section 12.2. However, the applicant did not provide any information on shielding for ventilation system components, such as ventilation ducting and filters, or if the zoning considered these sources.

3. Therefore, provide information on the shielding for ventilation system components and how shield thicknesses for these components were determined. Also indicate how ventilation system sources were considered for plant zoning. Please update the FSAR to provide this information.

Response – (Rev. 1)

1. The spent resin transfer line from the purification ion exchanger to the spent resin long term storage tank (SRLST) is a 2-inch diameter pipe modeled for an assumed length of 20 feet. Modeled as a Schedule 40S pipe with a nominal diameter of 2 inches, the actual diameter included in the shielding and dose rate analysis is 2.068 inches (inner diameter) with a wall thickness of 0.154 inches. A 2-inch pipe is used in order to fluidize the spent resin and maintain turbulent flow to prevent resin settling and clogging.

   The source terms included in the model are the maximum design basis source terms, assuming 0.25% failed fuel and no gas stripping for the purification of reactor coolant. These source terms are presented in DCD Table 12.2-11. The radionuclides not included in the model are the noble gases, tritium, and nitrogen-16, as these nuclides are in the gaseous form and are not removed from the input stream by the ion exchanger resin. Normally the spent resin transfer from the CVCS ion exchangers to the SRLST is diluted by water to facilitate transfer. For conservatism in the shielding calculation, the transfer pipe is assumed to be filled with 100% resin in the pipe, yielding maximum source terms from the spent resin.

   Following these inputs and assumptions, a model of the pipe is created in MicroShield and the dose rate is determined at 1 foot away from the piping. From the results determined using this approach, the radiation dose rate increases from 926 to 2317 mSv/hour, resulting in a zone change during spent resin transfer to Zone 7 (10 < Dose Rate ≤ 5,000 mSv/hr).

2. The spent resin transfer line from the CVCS ion exchangers to the spent resin long term storage tank is routed entirely within hot pipe chases from the CVCS ion exchanger area (Elevation 78’ and valve area on Elevation 68’) in the auxiliary building to the SRLST cubicles in the compound building (Elevations 63’ and 85’ and valve area on Elevation 85'). From the purification ion exchanger cubicle, the spent resin transfer line is routed through the valve area (068-A10A) and the hot pipe chase located on elevation 68’ of the auxiliary building. From the auxiliary building hot pipe chase, the resin transfer line is routed into the compound building, where it is routed through the hot pipe chase located on Elevation 77’. From the compound building hot pipe chase, the spent resin transfer line is routed through the SRLST valve room (room 085-P06) to the SRLST cubicles. The radiation level of the hot pipe chase in the auxiliary building and compound building is increased during resin transfer, and the radiation zone designation of the some of the adjacent areas will be reclassified to higher levels during resin transfer. The specific information on the minimum thickness of the slabs around 3 rooms will be provided in the response to the RAI 141-8098, Question 12.03-10, Rev.1.

3. The shielding design for the APR1400 includes shielding for ventilation components including ducts carrying radiologically contaminated air streams, as well as the filters contained in the HVAC air cleaning units (ACUs), which remove radiological

contaminants from the air streams before release. The revised source terms of the HVAC air cleaning unit and the minimum thickness of the structures are provided in the response to the RAI 343-8420, Question 12.02-24.

Development of source terms

The airborne radiological source terms for the ACUs i.e., HEPA filters and charcoal adsorbers, are calculated based on adjusting individual radionuclide concentrations using the ratios between the corresponding nuclides 0.25% fuel defect to that from the PWR-GALE code calculation in order to obtain the design basis source terms. A detailed description of the calculation methodology is presented in KHNP's response to RAI 343-8420, Question No. 12.02-24, item 2.

Shielding and zoning calculations:

The activity for each of the ACU filters is calculated based on the buildup of removed radionuclides for an operational period of one year, after which the filter will be replaced. The decay of the radionuclides removed by the filters over the operational period is factored in when the accumulated source term is calculated. The decontamination efficiency of the HEPA filters and the charcoal filters are assumed to be 100%. The HEPA filters contain the source terms for the radionuclides present in particulate form. The charcoal filters contain the source terms for the halogens removed from the contaminated air stream.

Using the calculated shielding design basis source terms discussed above, models of each filter contained in the ACU are created in MicroShield following the same methodology used for the other radiation sources within the plant. The dose rates determined for each filter are summed to determine the overall dose rate for the ACU(s) for designation of radiation zoning (calculated at 1 foot away from the sources), and for the determination of the minimum shielding thickness required (calculated at 1 inch from the shield wall).

It should be noted that the ventilation ducts in and near the vicinity of cubicles that contain, store, or handle radioactive fluid are not shielded. It is expected that entry into these cubicles is administratively controlled and that entry is based on operational necessity for inspection, calibration, and maintenance only. When the airborne releases from the component, including vents and leakage on the cubicle floors, are vented through the HVAC ventilation inside the cubicle, the radioactivity in the airborne vents is diluted due to partitioning of airborne portion from the liquid portion, and that the airborne portion is diluted with the cubicle ventilation, as well. Hence the activity is expected to be lower than that of the component fluid. Once the ventilation ducts exit the cubicles, the ducts are routed into the nearby duct chases, which are provided with 18 inches of concrete for shielding in the CB. Ducts passing through general access areas are by design routed in duct chases for ALARA purposes. This wall thickness provided in the duct chases is adequate to provide shielding for radiation ALARA.

DCD Subsection 12.3.3 will be updated to include a description of the shielding design methodology for ventilation components.

Impact on DCD

DCD Figure 12.3-1 through 3, and 10, Subsection 12.3.3 is updated as indicated in Attachments 1 and 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, or Environment Report.

Security-Related Information – Withhold Under 10 CFR 2.390

Figure 12.3-1 Radiation Zones(Normal) Auxiliary/Containment Building El.55'-0"

Security-Related Information – Withhold Under 10 CFR 2.390

Figure 12.3-2 Radiation Zones (Normal) Auxiliary Building - Partial Plan El. 68'-0", 77'-0", and 86'-0"

Security-Related Information – Withhold Under 10 CFR 2.390

Figure 12.3-3 Radiation Zones (Normal) Auxiliary/Containment Building El.78'-0"

Security-Related Information – Withhold Under 10 CFR 2.390

Figure 12.3-10 Radiation Zones (Normal) Compound Building El. 63'-0" pipe chase. The resin transfer lines are also provided with a flushing capability to minimize the potential for hot spots in the piping.

The ICI chase is potentially a high-radiation area (greater than 1 Gy/hr) during ICI withdrawal. Stringent access control is provided to this area during movement of the ICI. A lockable access door is provided with a warning light. During withdrawal of the ICI, the warning light illuminates, providing indication that the ICI is being moved. An area radiation monitor is located in the ICI chase to provide indication of radiation levels and to alarm the personnel when the ICI is being withdrawn. Emergency egress from the area is also provided from the ICI chase.

Components that handle a significant amount of radioactive materials, such as LWMS floor drain tanks and equipment waste tanks, are located in shielded cubicles separated from the pump and valve galleries that are provided with labyrinths for access to the galleries. This design approach minimizes radiation streaming and scattering but permits inspection and maintenance access and removal of smaller items such as pumps, valves, and instruments for repair in lower-radiation areas. This design approach meets the requirements of NRC RG 8.8 2.b(4). The plant shielding is designed not only to maintain personnel occupational exposure ALARA, but also to maintain exposure to the general public ALARA.

The APR1400 shielding design has target dose rates that are below the limits for radiation zone designations provided in Table 12.3-2 to provide a sufficient margin in maintaining radiation exposure to plant personnel and the public ALARA.

12.3.3 <u>Ventilation</u>

Inserts

The spread of airborne contamination within the plant is minimized by the design of the plant HVAC systems to provide airflow from areas of lower potential for airborne contamination to areas of greater potential for airborne contamination. For building compartments with the potential for contamination, the exhaust from the areas is designed with pressure and flow balances to minimize the amount of uncontrolled exfiltration from these areas. These design features provide reasonable assurance that the average concentration of radioactive material in the air in the areas that are normally occupied is less than the small fraction of DAC prescribed in 10 CFR Part 20 Appendix B. Therefore,

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The APR1400 design provides shielding for ventilation components, including cubicle ventilation for cubicles that contain components with radiological contamination, filters in the HVAC air cleaning units (ACUs) that remove radiological contaminants from the air streams before release, and ducts carrying radiologically contaminated vent streams to the maximum extent practicable. The shielding design for the ventilation exhaust treatment components are determined using adjusted design basis airborne radiological source terms presented in DCD Table 11.3-1 by multiplication factors derived from the ratio of the activity increase of each nuclide between design basis and expected source terms. The source for each of the ACU filters is calculated based on the buildup of the removed radionuclides during its period of operation up to one year. The dose rates determined the individual filters are summed to determine the overall dose rate for the ACU(s) for determination of radiation zoning and the minimum shield wall thicknesses required. HVAC duct chases are provided with structural walls of 18-inch concrete walls in the auxiliary building and compound building, for shielding purpose.