

## KHNPDCDRAIsPEm Resource

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**Sent:** Monday, April 10, 2017 8:43 AM  
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**Subject:** APR1400 Design Certification Application RAI 544-8756 (12.03-12.04 - Radiation Protection Design Features)  
**Attachments:** APR1400 DC RAI 544 RPAC 8756.pdf

KHNP,

The attachment contains the subject request for additional information (RAI). This RAI was sent to you in draft form. Your licensing review schedule assumes technically correct and complete responses within 30 days of receipt of RAIs. However, KHNP requests, and we grant, 45 days to respond to this RAI. We may adjust the schedule accordingly.

Please submit your RAI response to the NRC Document Control Desk.

Thank you,

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## REQUEST FOR ADDITIONAL INFORMATION 544-8756

Issue Date: 04/10/2017

Application Title: APR1400 Design Certification Review – 52-046

Operating Company: Korea Hydro & Nuclear Power Co. Ltd.

Docket No. 52-046

Review Section: 12.03-12.04 - Radiation Protection Design Features

Application Section: 12.3

### QUESTIONS

#### 12.03-55

This is a follow-up to the applicant's response to RAI 8599, Question 12.03-53.

10 CFR 50.34(f)(2)(vii) requires that the applicant perform radiation and shielding design reviews of spaces around systems that may, as a result of an accident, contain accident source term, and design as necessary to permit adequate access to important areas and to protect safety equipment from the radiation environment.

In the response to RAI 8599, Question 12.03-53, the applicant indicated that there are numerous conservatisms in the post-accident shielding and zoning and mission dose analysis and concluded that the calculations contain sufficient conservatism to ensure mission dose rates will remain below the 5 rem limit (including conservatism associated with the accident shielding and zoning for piping areas, inhalation dose rates, etc). The staff requires additional information regarding the applicant's response to RAI 8599, Question 12.03-53 (items 1 through 3 below). In addition, in reviewing the listed conservatisms provided in the response, staff performed a review of the post-accident radiation shielding and zoning and vital area mission dose information. Therefore, the remaining questions (items 4 and 5), request additional clarification and information regarding post-accident shielding and zoning and mission doses, based on the staff's review.

- 1) The first bullet under the response to Part 1 of Question 12.03-53 indicates that the "Shielding results were updated based on the revised radionuclide concentrations and component data (i.e., IRWST volume) for the affected systems in the revised DCD Table 12.2-24 as indicated in the response to the RAI 207-8247, Question 12.02-16, Revision 2 (ML16306A454)." The staff requires the following information:
  - a. Please verify that this means that the up-to-date and correct values for the accident source terms for the shutdown cooling system, safety injection system, containment spray system, and all associated components and piping for those systems (as well as the accident leakage and airborne radioactivity from those systems), are provided in the Post-Accident Recirculating Water source term provided in Table 12.2-24 as updated in the response to RAI 8247, Question 12.02-16, Revision 2.
  - b. Please verify that the radiation shielding, zoning, and EQ information for accident conditions are now all correct based on the revised and corrected data in the revised DCD Table 12.2-24.
  - c. If the unrevised source term data is still being used as the basis for any of the information in the DCD, please justify its use.
- 2) On page 6 of 9, the RAI response indicates that inhalation dose rates are based on an assigned protection factor of 10 and that the protection factors in Appendix A to 10 CFR

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Part 20 range from 10 to 1000 based on the particulate filter efficiencies. However, during an accident the largest contributor to inhalation dose would likely be radioiodine. Footnote c to 10 CFR 20, Appendix A specifies that a protection factor of 1 should be assigned to sorbent cartridges as protection against radioiodine in air purifying respirators unless the licensee applies to the Commission to assign a value of greater than 1. Without prior approval, atmospheric supplying respirators or self-contained breathing apparatus (SCBA) are needed to credit protection against radioiodines and other gases and vapors. Therefore, please clarify whether the applicant is referring to respirators for particulates only, as is implied in the response, or to respirators that may be credited for particulates, gases, and vapors, as specified in 10 CFR Part 20, Appendix A.

In addition, it appears a protection factor of 10 is required to meet the 5 rem limit, yet there is nothing in the DCD to ensure that such respirators will be available if an accident were to occur. Also, as indicated in the response, mission doses are very close to the 5 rem limit when a protection factor of 10 is used and it appears that the use of atmosphere supplying respirator or SCBA with an assigned protection factor of 100 or greater would very significantly reduce the mission doses to well below 5 rem. This would eliminate any concerns of calculation errors or uncertainties resulting in exceeding the 5 rem limit, with calculations so close to the 5 rem limit. Therefore, please verify that the doses are acceptable regardless of respirator type and related protection factor, including uncertainties, or revise the DCD to specify which types of respirators are required to be available and functional during an accident in order to meet the dose limit and include a COL item to ensure that such equipment is available and functional.

- 3) KHNP indicates in the response to Question 12.03-53 that they continue to perform evaluation and checking of the data and shielding evaluation results and will advise the NRC of any changes or updates. It is unclear when the applicant will complete the evaluation and checking of sources and shielding. The staff needs the data and information in the DCD and RAI responses to be complete and accurate in order to complete its review and make a determination of acceptability. Please ensure that source terms, shielding design information, radiation zoning, and mission dose rate calculations and reviews are completed and accurate at the time of the final response submittal (except for issues related to remaining open RAIs).
- 4) In reviewing the applicant's response to Question 12.03-53 including the stated conservatisms, staff performed a review of the vital area access shielding and mission rate information. In this review, staff noted numerous apparent problems and missing information associated with the post-accident radiation shielding and zoning which could impact the mission doses. Therefore the staff has the following questions:
  - a. The containment spray heat exchanger rooms (055-A01C and 055-A01D), which contain post-accident re-circulating fluid during an accident and have dose rates of greater than 500 rad/hour, are identified as having a required minimum shielding thickness of only 10 inches of concrete on all sides and 10 inches for the ceiling in Table 12.3-4 (as provided in the response to RAI 8098, Question 12.03-08). However, the vital areas outside the CS pump rooms (in rooms 055-A07C and 055-A07D) are directly east of each of these rooms and are zoned at 15 mrem/hour during an accident (100 mrem/hour during the first hour). In addition, other vital area walkways are located at Elevation 78' nearly directly above the containment spray heat exchanger rooms, which are also zoned at 15

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mrem/hour during an accident. It does not seem accurate that 10 inches of concrete shielding is sufficient to lower dose rates this magnitude (the containment spray pump and miniflow heat exchanger rooms are also zoned greater than 500 rad/hour and have a minimum of 48 inches of shielding to rooms 055-A07C and 055-A07D).

- i. Please verify that the post-accident shielding thicknesses for rooms 055-A01C and 055-A01D are accurate (including for the ceiling above these rooms).
  - ii. Ensure that the post-accident radiation zoning for areas adjacent to rooms 055-A01C and 055-A01D (including above these rooms) are accurate.
  - iii. If all of the above information is determined to be accurate, please provide justification demonstrating that the shielding for these rooms is sufficient.
- b. The piping for the containment spray heat exchanger rooms passes through a portion of rooms 055-A57C and 055-A57D. In the postaccident figures, the areas where the piping appears to pass through are labeled as greater than 500 rad/hour. In the response to RAI 8098, Question 12.03-9, the applicant indicated that this area contains a mezzanine floor at the 70 foot elevation (which is where the piping would be located) yet the areas directly next to where the piping is located are labeled as being between 15 mrem/hour and 1 rem/hour (depending on the time after the accident) and no shielding is specified for the piping. The biggest concerns, as related to vital areas, are as follows: 1) There is no shielding specified between the piping and the vital areas outside the containment spray pump rooms, which as discussed in question 2, are zoned at 15 mrem/hour (100 mrem/hour during the first hour). 2) The minimum required shielding for the ceiling of room 055-A057C and 055-A57D (as provided in the response to RAI 8098, Question 12.03-08) is 14 inches. The areas above these piping areas include walkways to other vital areas which are labeled as 15 mrem/hour during accidents. It is unclear if 14 inches of shielding is sufficient to reduce dose rates this magnitude.

As a result of the above, staff requests the following:

- i. Describe the radiation shielding for the piping containing post-accident re-circulating fluid going to and from the containment spray heat exchanger rooms and ensure that the shielding is sufficient and adequately described in the DCD (including the area above the piping).
  - ii. Ensure that the post-accident zoning for the areas adjacent to the piping (including above) is accurate, including consideration for the response to question a, and revise the DCD to include any changes to the zoning information. If the current zoning is accurate explain why.
- c. The response to RAI 8247, Question 12.02-16 indicates that the shutdown cooling pumps re-circulate post-accident fluid during the design basis accident. Therefore, please explain the drop in dose rate in the shutdown cooling heat

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exchanger rooms (055-A30A and 055-A30B) during an accident. Please discuss how the west wall thickness of 22 inches is sufficient to reduce dose rates to the vital areas to the dose rates shown. Also discuss where the piping going into and out of this area is located and the adequacy of the shielding provided for this piping.

- d. Room 078-A10C (general access area) contains several vital area access paths and is zoned as 15 mrem/hour after an accident. However, there are numerous rooms with significant radiation levels (up to 10 rem/hour) adjacent to room 078-A10C such as rooms 078-A12D, 078-A13D, 055-A10C, and 078-A12C. Yet there is no minimum shielding provided for these rooms. Please provide in the DCD the shielding for these rooms and other rooms which require shielding to reduce the dose for vital area access paths on the 78' elevation.
- e. Table 12.3-4 (as modified in the response to RAI 8098, Question 12.03-8) specifies that the ceiling of room 078-A21B (pipe chase) (zoned greater than 500 rad/hour), is 10 inches thick. Yet a very low dose rate general access area (zoned as 100 mrem/hour or less) is directly above a portion of the pipe chase area. Please explain why 10 inches of shielding is sufficient or update the DCD as necessary.
- f. The personnel air lock entrance (100-A14A) is a significant radiation area (zoned as less than 500 rad/hour) during an accident, yet no shielding thicknesses are provided for this area. The east wall and a portion of the north wall separate the area from a vital area access path. Please provide the shielding for this area in the DCD or justify why shielding is not necessary.
- g. The Auxiliary Building Controlled Area ECCS Equipment Room Exhaust Accumulation rooms (120-A21A and 120-A32A) are significant radiation areas during an accident (zoned as greater than 500 rad/hour, except for the one month radiation zone map, where it is zoned as less than 500 rad/hour). A portion of the vital area access route for the remote control console room (137-A41A) runs directly above these rooms and that area is zoned as less than 15 mrem/hour. However, no shielding is specified for this room in Table 12.3-4 (as modified in the response to RAI 8098, Question 12.03-8) and the applicant calculates the vital dose for this mission to be 4.95 rem at 4 hours after an accident, so even a small discrepancy could result in exceeding the 5 rem limit. Please provide the shielding for this area in the DCD and make any radiation zoning changes that may be necessary.
- h. The main steam valve room (room 137-A31C) is zoned as high as 10 rem/hour after an accident. East of room 137-A31C is the vital area access path for accessing the remote control console room (137-A41A). However, no shielding is specified for the main steam valve room in Table 12.3-4 (as modified in the response to RAI 8098, Question 12.03-8) and the applicant calculates the vital dose for this mission to be 4.95 rem at 4 hours after an accident, so even a small discrepancy could result in exceeding the 5 rem limit. Please provide the radiation shielding for this area in the DCD and make any radiation zoning changes that may be necessary.

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- i. There are numerous 10 rem/hour areas at 1 hour after an accident on the 156' elevation of the Auxiliary Building which are assumed to contain shielding which reduces the dose to vital area access paths to 15 mrem/hour, for which no shielding is provided. Examples of missing shielding for vital areas include rooms 137-A31C, 157-A19C, 157-A20C, 078-A09C, 078-A14C, 078-A09D, 157-A20D, 157-A19D, and 137-A31D. Please provide the minimum shielding for the walls to these rooms that shield vital area access paths in the DCD.
  - j. There are other areas that require significant shielding for the purpose of vital area access and mission dose for which minimum shielding is not provided in the DCD including rooms 100-A08C, 100-A08D, and 100-A09C. Please do a full evaluation of all significant shielding associated with vital area access and mission doses and ensure that all shielding is provided and that all shielding and zoning is accurate. Also ensure that all radiation zoning associated with vital area access and mission doses are accurate and provided in the DCD.
  - k. Including consideration of the responses to all of the above parts of this question, please verify that the post-accident mission doses remain accurate. Please explain your answer in the response.
- 5) In reviewing the post-accident information it is unclear if the mission dose rates are calculating starting and ending at the MCR/TSC or starting outside of the facility. It does not appear that there are any mission pathways in the post-accident radiation zone maps that enter the buildings from the outside. If the workers performing the missions are assumed to be located inside the MCR/TSC, please explain why this is an appropriate assumption. Have the dose rates received by workers accessing the facilities from the outside to perform these missions been considered?

