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Sent:	Tuesday, December 22, 2015 7:37 AM
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Subject:	APR1400 Design Certification Application RAI 343-8420 (12.02 - Radiation Sources)
Attachments:	APR1400 DC RAI 343 RPAC 8420.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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United States Nuclear Regulatory Commission
Protecting People and the Environment

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REQUEST FOR ADDITIONAL INFORMATION 343-8420

Issue Date: 12/22/2015
Application Title: APR1400 Design Certification Review – 52-046
Operating Company: Korea Hydro & Nuclear Power Co. Ltd.
Docket No. 52-046
Review Section: 12.02 - Radiation Sources
Application Section: 12.2

QUESTIONS

12.02-22

This is a follow-up to RAI 7856, Questions 12.02-2 and 12.02-3. (Note: this follow-up applies to Revision 1 of the response to these questions (ML15258A675)).

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.

SRP 12.2 indicates that source descriptions should include all pertinent information required for (1) input to shielding codes used in the design process, (2) establishment of related facility design features, (3) development of plans and procedures, (4) assessment of occupational exposure and (5) determination of radiation dose to electrical equipment important to safety as described in 10 CFR 50.49.

SRP Section 12.3-12.4, indicates that the plant structures, as well as the general plant yard should be subdivided into radiation zones, with maximum design dose rate zones and the criteria used in selecting maximum dose rates identified. SRP Section 12.3-12.4 also indicates that doses to workers and members of the public should be ALARA.

Issues

1. In the response to Question 12.02-2 and 12.02-3, the applicant provided source term information for tanks containing liquid radioactive material. The source term information indicated that the source terms used for radiation shielding and zoning for many of the tanks was based on the tanks being filled to only a small fraction of the tanks' total volume. Since the SRP specifies that zoning (and therefore shielding) should be based on the maximum dose rate, it isn't appropriate that the maximum designed dose rates would be based on a fraction of the total tank volume. Examples include the following:

   a. Holdup Tank – 12.5% full (See response to Question 12.2-3, FSAR Table 12.2-25 markup).

   b. Boric Acid Storage Tank - 50% full (See response to Question 12.2-3, FSAR Table 12.2-25 markup).

   c. Reactor Makeup Water Tank – 80% full (See response to Question 12.2-3, FSAR Table 12.2-25 markup).

   d. Reactor Drain Tank – 62% full (See response to Question 12.02-2, FSAR Table 12.2-25 markup)

   e. Equipment Drain Tank – 37% full (See response to Question 12.02-2, FSAR Table 12.2-28 markup)

   f. IRWST – 75% full (See response to Question 12.02-2, FSAR Table 12.2-25 markup)

   Please revise the radiation source terms, shielding, and zoning for these tanks and all other liquid containing tanks in the FSAR (which are not currently based on the tanks being at or very near full capacity), so that they are based on tanks filled to their full capacity. The revised tank source terms should assume the additional liquid volume comes from input pathways that would result in the maximum source term for shielding and zoning as indicated in SRP 12.2 (i.e. the original radionuclide concentrations should not be decreasing with the increased liquid volume, except for additional decay time which may be appropriate, unless appropriate justification is provided for other assumptions resulting in diminished source term concentrations). The revisions should also consider the effects of source term changes made as part of responses to other Section 12.2 RAIs.

   The above concern regarding tank volumes was initially discussed with the applicant during the Chapter 12 source term audit conducted during August 10 - 14, 2015, with the focus on the holdup tank and equipment drain tank, however, a subsequent review of the RAI responses reveals that the other tanks listed above were also only filled to a fraction of their total volume.

2. In the proposed FSAR addition of Table 12.2-28, it is unclear what the "low level fraction" and "high level fraction" values for the tanks represent and how they are associated with the source term calculations. Staff notes that the high and low level fractions presented in Table 12.2-28 do not correspond with the values in Table 12.2-25, which provides the water

level for sources. For example, the proposed addition to Table 12.2-25 indicates that the boric acid storage tank is 50% full of liquid, but Table 12.2-28 indicates that the low level fraction is 40% and the high level fraction is 95%. Please explain what the "low level fraction" and "high level fraction" values for the tanks represent, the purpose for including the low level fraction and high level fraction in Table 12.2-28, and the reason for the differences between Tables 12.2-28 and 12.2-25.

3. In the proposed FSAR markup to FSAR Table 12.2-13, the staff noted that the total activity for the holdup tank changed, while the total activity in the other tanks in that table did not change. Please discuss why the activity values for the holdup tank changed from the values originally provided in the FSAR.

4. In part 5 of question 12.02-3, the staff requested that the applicant provide the methods, models, and assumptions used in calculating the source term for the holdup tank, in accordance with SRP Section 12.2. While the applicant provided the general methods, models, and assumptions used, they did not provide the quantity of material associated with each input path to the holdup tank. Therefore, it is unclear that the assumptions for input pathways to the holdup tank are conservative or reasonable for determining the maximum source term for zoning and shielding.

   In addition, the tank only being considered 12.5% full as indicated in question 1 above, and the questions regarding CVCS ion exchanger decontamination factors in RAI 8339, Question 12.02-19, would also affect the inventory of the holdup tank. Also, the contribution of radioactive daughter buildup is not included, as indicated in other RAIs (see the follow-up to RAI 8090, Question 12.02-13). It appears that the combination of all of these, may be resulting in a significantly underestimated CVCS holdup tank source term.

   With the response to all of the above questions taken into account, please provide the quantity of material (i.e. total volume from each input pathway and information regarding the activity concentration from each pathway) from each input pathway to the holdup tank with the tank filled to its full capacity, used in the source term calculation, with an explanation for why the assumptions are reasonable for determining the maximum plant shielding and zoning.

5. In the response to Question 12.02-3, the applicant indicates that the holdup tank and boric acid storage tank will be surrounded by concrete shielding on all sides, from the bottom to the top of the tanks, with no gap between the tank surface and the concrete, and that the dose rate outside the concrete will be less than 0.25 mrem/hour. However, there does not appear to be any shielding provided on the top of the tanks and the dose rate on the top of the tanks is not discussed. The Auxiliary Building is located near these tanks in FSAR Figure 1.2-1 and it is unclear if these tanks could result in elevated dose rates on the Auxiliary Building roof or other elevated areas that could result in dose to workers or members of the public.

   Since radiation exposure could result from accessing areas above the tanks please justify why no radiation shielding is needed for above the top of the tanks. In the response, indicate if there is expected to be a need for individuals to access the Auxiliary Building roof or other nearby areas above the tanks on a routine basis (e.g. security guard station). If so, please evaluate the dose rate to these areas and provide shielding, as appropriate, to ensure doses are ALARA. Update the FSAR, as appropriate.

6. In the response to Question 12.02-3, the applicant indicates that the holdup tank and BAST are surrounded by concrete from the bottom to the top of the tank with sufficient thickness to maintain dose rates outside the tanks to less than 2.5 micro Sieverts per hour. Please specify the minimum concrete thicknesses in the FSAR, for example in FSAR Table 12.3-4.

7. Regulatory Guide (RG) 8.8 specifies that station features and design should, to the extent practicable, permit inspections to be accomplished expeditiously and with minimal exposure of personnel and that maintaining doses ALARA can be added by a design that allows for prompt access. However, in the response to Question 12.02-3, the applicant indicates that the Holdup Tank and BAST are surrounded by concrete from the bottom to the top of the tank. Please specify how the above criteria from RG 8.8 is being met for these thanks and how tank inspections or repairs are to be performed on these tanks, while keeping worker dose ALARA.

8. In addition, there appear to be a number of editorial errors or inconsistencies associated with the response to RAI 7856. They are provided below. Please correct or explain them, as appropriate.

   a. The proposed FSAR addition on page 9 of 23 of the response to Question 12.02-2 states, "The liquid and vapor volumes are obtained from the low water level to maximize the VCT vapor source terms." The staff believes that the intent of this sentence was to state that the vapor volumes were obtained from low water level and the sentence should therefore be reworded to state, "The vapor volumes are obtained from the low water level to maximize the VCT vapor source terms."

      Please make this correction, if accurate. If the wording provided in the original response is correct (both the liquid and vapor source term are based on the minimum water level), then please provide additional explanation for why the current wording is accurate.

   b. In the response to Question 12.02-2, the applicant provides Table 5 on Page 8 of 13. The applicant indicates that "Case 2" in Table 5 provides assumptions used in the shielding calculations, however, in the proposed markup to FSAR Table 12.2-25, "Radioactive Source Dimensions and Parameters Used in Shielding Analysis," the applicant provides a different liquid water volume for the Reactor Drain Tank than is provided in Case

2. Case 2 indicates the liquid volume fraction is 73% and the revised Table 12.2-25 indicates that it is 62%. Please correct this discrepancy.

c. The revised Equipment Drain Tank dimensions provided in FSAR Table 12.2-25 indicate a significantly different volume than the volume provided in FSAR Table 9.3.4-2. Please correct this discrepancy.

d. The revised Table 12.2-25 indicates that the volume control tank source term is based on being filled 40% with water, however, the response to question 2.b of Question 12.02-2, states that in the shielding calculations 60% of the water volume is used. Please correct this discrepancy.

e. The IRWST volume provided in the revised FSAR Table 12.2-25 is different from the volume provided in the new FSAR Table 12.2-28. Please correct this discrepancy.

12.02-23

This is a follow-up to RAI 8090, Question 12.02-13.

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.

Issue

In the response to Question 12.02-13, the applicant indicates that source terms for components are conservative because the RCS source term is based on five cycle operation.n the response to Question 12.02-13, the applicant indicates that source terms for components are conservative because the RCS source term is based on five cycle operation. However, the applicant provides no justification for why this is conservative. Past staff experience with previous applications indicates that typically RCS activity reaches near equilibrium value after several months of operation and would not be expected to change significantly after that time (with fuel leakage and operating conditions staying the same, the RCS concentrations of most radionuclides are constant). Therefore, it is unclear why assuming five cycle operation is conservative. No justification is provided why it is conservative, versus normal fuel replacement.

In addition, the applicant indicated that the nuclides selected in the source terms in FSAR Chapters 11 and 12 are consistent with the nuclides included in ANSI/ANS 18.1. As indicated in the SRP, it is acceptable to only consider the nuclides listed in ANSI/ANS 18.1 (as well as it is acceptable to consider the additional nuclides in those source associated with the liquid waste management system, because the DIJESTER code considers the additional nuclides).

However, the applicant indicates that only the DIJESTER code considers the buildup of radioactive daughters (besides Ba-137m, which is acceptably considered to have the same activity as Cs-137 in all sources, except for in the Steam Generator Blowdown, Condensate Polishing System, and Spent Fuel Pool Demineralizer source terms). Therefore, in the other source terms down stream of the RCS, some of the nuclide activity values listed do not provide an accurate estimation of the nuclide concentrations. Staff review indicates that the buildup of some the daughter products in some components may be significant to some of the gamma source terms in the plant (and therefore, the shielding and zoning for those components). For example, for the gaseous waste management system components, the accumulation of Rb-88 from the decay of Kr-88 would likely provide a difference in the gamma dose rates from those components. Staff analysis indicates that the daughters of noble gasses (mostly Rb-88) listed in ANSI/ANS 18.1 may contribute nearly 20% to the source terms of the guard beds and the delay beds. In addition, the decay of Te-132 to I-132, would significantly increase I-132 activity in many components. There are several other radionuclides listed in ANSI/ANS 18.1 which would also impact source terms, to a lesser extent.

SRP 12.2 indicates that the buildup of radionuclides in components and systems should be addressed. Part of the buildup in components is from daughters generated in the decay of parents. Therefore, update the source terms and plant shielding and zoning, as appropriate, to include the contribution of daughter radionuclides for daughters listed in ANSI/ANS 18.1 (including for Ba-137m in the Steam Generator Blowdown, Condensate Polishing System, and Spent Fuel Pool Demineralizer source terms in Tables 12.2-18 and 12.2-17a), or provide additional detailed justification for why due to the RCS activity source terms are already more conservative than they would be if the contribution of daughters was included.

REQUEST FOR ADDITIONAL INFORMATION 343-8420

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.

12.02-25

This is a follow-up to RAI 7998, Question 12.02-11.

Regulatory Basis

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.

SRP Section 12.2 also indicates that source descriptions should include the methods, models and assumptions used as the bases for all values provided in SAR Section 12.2.

Information Needed

REQUEST FOR ADDITIONAL INFORMATION 343-8420

1. In the response to Question 12.02-11, the applicant provided information and added an equation to FSAR Section 11.3.1.5 to explain how the value for “at inlet” in FSAR Tables 11.3-11 and 12.2-19 were calculated.

    a. The addition to FSAR Section 11.3.1.5 does not clearly specify what the equation is used for. Please update the FSAR to specify that the equation is used to calculate the “at inlet” concentrations in FSAR Tables 11.3-11 and 12.2-19.

    b. To use the equation, the venting rates for the gas stripper, reactor drain tank, equipment drain tank, and volume control tank are needed. The venting rates for the reactor drain tank, gas stripper, and equipment drain tank are found in the footnotes to FSAR Table 11.1-8, but staff cannot find the venting rate for the volume control tank in the FSAR. Please update the FSAR to provide this information.

2. The header drain tank dimensions which the applicant added to FSAR Table 12.2-25 are inconsistent with the volume provided in FSAR Table 11.3-4. Please justify why the tank volume used for source term dimensions in Table 12.2-25 is much less than the volume in Table 11.3-4, or correct the values. As a result of this response, please ensure that the source term used in the shielding analysis is based on the tank's full volume.

3. The waste gas dryer source term provided in the addition to FSAR Table 12.2-19 (0.25% Fuel Defect) is significantly lower than the source term provided in Table 11.3-11 (1% Fuel Defect). For many isotopes, the activity is 100 times lower or more. Staff understands that the values in Table 11.3-11 are based on continuous gas stripping and the values in Table 12.2-19 are based on processing RCS after operation with no gas stripping (so there will be differences with different isotopes), however, this would not appear to account for why all isotopes are so significantly lower for the gas dryer in Table 12.2-19. Please explain why the values in the proposed addition to FSAR Table 12.2-19 are so much lower than the values in FSAR Table 11.3-11, for the waste gas dryer.

4. The gaseous waste management system source terms do not include the contribution for daughter products which would accumulate from the decay of the noble gases (for example Rb-88). All source terms should include the contribution of daughters that are generated from the decay of the parent radionuclides (for, at a minimum, those daughters listed in ANSI 18.1), as indicated in the follow-up to RAI 8090, Question 12.02-13. Therefore, all components source terms, including the HEPA filter source term, should be updated to include the expected contribution from the daughter products.


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