KHNPDCDRAIsPEm Resource

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Sent: Monday, August 31, 2015 6:36 AM
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Subject: APR1400 Design Certification Application RAI 176-8089 (03.11 - Environmental Qualification of Mechanical and Electrical Equipment)
Attachments: image001.jpg; APR1400 DC RAI 176 RPAC 8089.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, 60 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
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REQUEST FOR ADDITIONAL INFORMATION 176-8089

Issue Date: 08/31/2015
Application Title: APR1400 Design Certification Review – 52-046
Operating Company: Korea Hydro & Nuclear Power Co. Ltd.
Docket No. 52-046
Review Section: 03.11 - Environmental Qualification of Mechanical and Electrical Equipment
Application Section: 3.11

QUESTIONS

03.11-9

10 CFR 50.49 and 10 CFR 50, Appendix A, criterion 4 require that certain components important to safety be designed to withstand environmental conditions, including the effects of radiation, associated with design basis events, including normal operation, anticipated operational occurrences, and design basis accidents.

SRP Section 3.11 indicates that the applicant's safety analysis report should be sufficient to support the conclusion that all items of equipment that are important to safety are capable of performing their design safety functions under all environmental conditions that may result from any normal mode of plant operation, anticipated operational occurrence, design basis events, post-design basis events, and containment tests.

In addition, SRP Section 3.11 states that radiation dose and dose rate used to determine the radiation environment for qualification of electrical and mechanical equipment must be based on an NRC staff approved source term and methodology, as discussed in NUREG-0588 and as supplemented by Section II.B.2 of NUREG-0737, "Clarification of TMI Action Plan Requirements," and NUREG-0718, "Licensing Requirements for Pending Applications for Construction Permits and Manufacturing License," or as discussed in NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants." The radiation environment must be based on the integrated effects of the normally expected radiation environment over the equipment's installed life, plus the effects associated with the most severe design basis event during or following which the equipment is required to remain functional. The effects of beta radiation must also be considered in the qualification process. The effects of radiation exposure due to re-circulatory fluid must be considered for equipment located outside the containment.

Finally, SRP Section 3.11 states that the staff will conclude that the environmental design and qualification of mechanical, electrical, and I&C equipment that are important to safety is acceptable and meet applicable regulations, based on the finding that the applicant has implemented an environmental design and qualification program that provides adequate assurance that mechanical, electrical, and I&C equipment that are important to safety will function as intended in the event of anticipated operational occurrences, as well as in the normal, accident, and post-accident environmental conditions. The applicant's environmental design and qualification program is in accordance with the requirements and guidance described in the regulations, regulatory guides and industry standards identified in Subsection II of SRP Section 3.11.

In addition, RGs 1.89 and 1.183 provide guidance on how to do the radiological analysis related to equipment qualification. These guides indicate that assuming 1% failed fuel cladding, would be an acceptable assumption for calculating normal operation equipment qualification dose.

GENERAL ISSUES

Staff does not fully understand the applicant's approach for assigning total integrated (TID) dose rates to plant areas and components, as described in FSAR Section 3.11 and APR1400-E-X-NR-14001-P, Rev. 0 and needs additional clarification. In addition, it appears that there may be errors or inconsistences within the application which need to be corrected or addressed. Finally, it is unclear if the applicant is meeting all applicable guidance and acceptance criteria (specific guidance and acceptance criteria beyond the guidance referenced above, is provided below, where appropriate).

DESCRIPTION OF SPECIFIC ISSUES AND INFORMATION REQUESTED

The following questions are based on the December 2014 revision of the APR 1400 DCD application. They are based on the radiation protection review of FSAR Section 3.11. During a public conference call on June 23, 2015, the applicant informed staff that they plan to delete FSAR Table 3.11-2 and APR1400-E-X-NR-14001-P, Table 2 (both titled, "Environmental Data"). If the applicant decides to delete these tables, the applicant should do the following:

- Provide justification for why the tables are not needed (this justification should indicate where comparable information can be found, if applicable, or why the information was not needed, and should consider not just radiological information but all information in the tables). The NRC staff, from all subject areas, will review the justification provided to determine if it is acceptable to delete the information.

- In order to identify the TID values for each component, the applicant should provide the room number in FSAR Table 3.11-3 and Table 3 of APR1400-E-X-NR-14001.

- Instead of just providing the TID in Table 4 of APR1400-E-X-NR-14001, the applicant should also provide dose contributions for neutrons, betas, and gammas individually, where applicable (this is necessary because the tables being deleted already include information on beta dose and SRP 3.11 indicates that the effects of beta dose should be considered. For neutrons, the application discusses the effects of neutron exposure, therefore, it should be clear how neutrons effect the TID values, where appropriate.

- Provide a statement in FSAR Section 3.11, where appropriate, indicating that TID information for each room can be found in Table 4 of APR1400-E-X-NR-14001.

- Table 2 of APR1400-E-X-NR-14001, includes a footnote includes a statement indicating that accident doses are based on the limiting design basis accident. Ensure that a statement indicating that doses are based on the limiting design basis accident is retained somewhere within APR1400-E-X-NR-14001.

If the applicant decides to delete FSAR Table 3.11-2 and APR1400-E-X-NR-14001-P, Table 2, and provide the above requested information, questions 2, 3, and 4 below need not be addressed. Other questions referencing FSAR Table 3.11-2, still need to be addressed, as appropriate, but information regarding Table 3.11-2 need not be provided if the tables have been deleted.

Based on the review, staff requests the following:

1. FSAR Section 3.11.5.2 indicates that the normal operational exposures are based on the design basis source terms presented in Section 11.1 and that the dose contribution from adjacent rooms are accounted for by adding 20 percent to the TID inside the room, except when 20 percent is not bounding, in which case the actual values are used.

   a. It is unclear which source terms in Section 11.1 the applicant is referring to. Please specify which source terms in Section 11.1 were used in the equipment qualification analysis and include this information in FSAR Section 3.11.5.2.

   b. Staff needs a better understanding of how dose rates for equipment qualification were determined in order to determine if the applicant's approach is acceptable. Please describe the approach used for calculating the normal operation one percent failed fuel TID values used for equipment qualification. Begin with the one percent failed fuel source term provided in FSAR Table 11.1-2 and provide a general description of how this source term was used to determine the dose rates in rooms and how the dose from adjacent rooms was determined (were the minimum shield wall thicknesses in Chapter 12 considered? Was 20% just added to the adjacent room regardless of shielding thickness?). Indicate any significant differences in assumptions from assumptions used in creating the Chapter 12 source terms and Chapter 12 radiation zone maps. Then describe what the TID values in FSAR Table 3.11-2 and Table 4 of APR1400-E-X-NR-14001-P represent (e.g. is it at the maximum dose within the given room or area? Is it the dose where the maximally exposed piece of equipment is located?) Ensure that it is clear how bounding values are being applied for all equipment relevant to equipment qualification. (As part of this response, staff suggests picking a normal operation TID value from Table 3.11-2 (such as for the purification ion exchanger provided for Category C) or a room in Table 4 of APR1400-E-X-NR-14001-P and explaining how the specific TID value was determined, what specific location was the given dose calculated at, and why it is adequate for all equipment within that region.)

   c. Update the FSAR or APR1400-E-X-NR-14001-P, as appropriate, to provide the general methodology used to develop the normal operation TID values, including referencing relevant computer codes or special assumptions used in the calculations. Indicate if the approach used for determining normal operation source terms is similar to the approach used for developing sources in Chapter 12 (except with 1 percent failed fuel instead of with 0.25 percent). Airborne radioactivity should be considered in the TID values, where appropriate, and the basic methodology for determining the airborne contributions to the TID values should also be included in these documents, as appropriate.

2. FSAR Table 3.11-2, Category C, provides equipment qualification parameters for the Auxiliary Building. The application identifies the following radiation areas within Category C; "accessible areas and I&C equipment," "RTSG, DRCS," "VCT," and "purification ion exchanger". It is unclear to staff what those radiation areas represent. For example, is purification ion exchanger just the purification ion exchanger room, or is it some region of the building surrounding the purification ion exchanger. The FSAR should be updated, perhaps by providing a figure, to clearly indicate which areas of the Auxiliary Building are considered within each radiation dose area.

3. As discussed in Question 2 above, FSAR Table 3.11-2 provides four different radiation areas within Category C. However, in FSAR Table 3.11-3, it is unclear which radiation area within Category C, each component belongs. For example, FSAR Table 3.11-3 (7 of 66) provides item CV-0508, "Three way valve and actuator, RCP CBO Diversion," as being located in Category C. However, FSAR Table 3.11-3 does not specify if CV-0508 is within the "accessible areas and I&C equipment" area, the "RTSG, DRCS" area, the "VCT" area, or the "purification ion exchanger" area. Therefore, FSAR Table 3.11-3 needs to be updated to clearly indicate which radiation area each piece of equipment within Category C is within. One way to resolve this issue would be to provide the room that each component is located in

FSAR Table 3.11-3. Staff recommends this approach to avoid confusion regarding which TID value applies to each component.

4. While FSAR Table 3.11-2 provides the TID values for outside the biological shield wall, it does not provide TID values inside the biological shield wall. Please include this information or provide the room that each component is located in FSAR Table 3.11-3, as discussed in item 3, above.

5. The following information regarding the volume control tank (VCT) TID provided in FSAR Table 3.11-2 and the TID for the VCT room in Table 4 of APR1400-E-X-NR-14001-P, is requested.

   a. FSAR Section 3.11.5.2 indicates that normal operational exposures from equipment qualifications are based on the 1 percent failed fuel design basis source terms provided in FSAR Section 11.1 and consistent with RG 1.89. One of the sources specifically provided in FSAR Table 3.11-2, is the VCT and the TID value for the VCT is provided in Table 4 of APR1400-E-X-NR-14001-P. However, the VCT source term provided in FSAR Section 11.1 (Table 11.1-8) only provides the gaseous radionuclide inventory for noble gases, tritium, and iodines and does not contain the liquid inventory or source term. Please indicate if this source term was used in determining the values in Table 3.11-2 or Table 4 of APR1400-E-X-NR-14001-P.

   b. FSAR Figures 12.3-4 and 12.3-5 provide the radiation zones for the VCT room, based on an assumed 0.25% failed fuel percentage (instead of the 1% used for equipment qualifications). Dose rates on Figures 12.3-4 and 12.3-5 show doses in the VCT room of greater than 5000 mSv/hour (approximately 5 Gray/hour). A dose rate of 5 Gray/hour, over the 60 year life of the plant, excluding 40 months for refueling outages where dose rates would be expected to be lower during refueling(as discussed in FSAR Section 3.11.5.2), would result in a normal operation TID of greater than the 1.88×10^5 Gray provided in FSAR Table 3.11-2 and the 1.9×10^4 Gray provided in Table 4 of APR1400-E-X-NR-14001-P (assuming the units in Table 4 are Gray, consistent with the units of radioactivity provided in other FSAR Section 3.11 tables). Please explain these apparent discrepancies and provide the units for TID in Table 4 of APR1400-E-X-NR-14001-P.

6. FSAR Section 3.11.5.2 indicates that, "In the auxiliary building, exposures are based on the assumption that significant portion of the core fission product inventory are recirculated in the containment sump water plus other post-accident airborne radioactivities as presented in Table 12.2-20." Table 12.2-20 provides liquid radwaste system tank source terms and not airborne source terms. In addition, the LWMS is located in the Compound Building and not the Auxiliary Building. Please explain why and how the source term information in Table 12.2-20 is being used for determining post-accident airborne sources in the Auxiliary Building.

   In addition, it is the staff's understanding that all normal operations sources in Chapter 12, including airborne radioactivity, are based on an assumed 0.25% failed fuel fraction. RGs 1.89 and 1.183 indicate that an acceptable method for determining normal operations source terms for equipment qualification is using a 1 percent failed fuel fraction. If the applicant assumed less than a 1 percent failed fuel fraction for calculating the airborne contribution to the TID for equipment qualification, then the failed fuel percentage used needs to be justified.

7. Page 3.11-11 of the FSAR indicates that the basis for establishing an equivalent gamma source to simulate neutron radiation is provided in FSAR Table 3.11-2. However, Table 3.11-2 does not appear to provide a basis or even provide neutron dose values. Please provide;

   a. The basis for establishing an equivalent gamma source to simulate neutron radiation in the application.
   b. The neutron dose contribution in the application, as appropriate (therefore, the gamma, beta, and neutron contributions should be identified in the application, for areas and components that have gamma, beta, and neutron dose contribution).

8. Several columns in FSAR Table 3.11-3 contain listings for certain components of "N/A." Please update the FSAR to define what a designation of "N/A" means for the columns labeled "Required Operational Time," "Environmental Condition," "Radiation Condition," and "Influence of Immersion (Yes/No)"

9. SRP Section 3.11 states that, "the equipment shall be designed to have the capability of performing its design safety functions under all anticipated operational occurrences and normal, accident, and post-accident environment, and for the length of time for which its function is required."

   Please ensure that the application is clear as to what the TID value for each component is. The specific TID value for each component should be clearly provided or the application should clearly specify how long the accident source term is to be provided and the type of accident so that it is clear what the TID value (normal operation and accident) for each component is. For example, currently it is unclear how long components with required operational times of "varies" and "intermittent" are expected to be exposed to the post accident source terms and what the TID for those specific components are.

10. The post-accident sampling system is considered a vital area in FSAR Section 12.3.1.9. FSAR Section 12.3.1.9 indicates that this area is irregularly accessed for samples during an accident. Therefore, it is unclear to staff why the post-accident sampling room isolation dampers (equipment numbers VK-Y0050A, VK-Y0050B, VK-Y0050C, and VK-Y0050D) are only required to be operational short-term following an accident, in FSAR Table 3.11-3. FSAR Section 3.11.1.3 states that short-term is for components that are required to operate one time. It would appear to staff that

short-term would only be appropriate for components that need to operate one time at the initial onset of the accident, because after the initial onset of the accident, the components will be exposed to accident environmental conditions through the duration of the accident regardless of when they are required to be functional.

Please justify why the post-accident sampling room isolation dampers are considered to have a short-term operational time following an accident or provide a different designation for the operational time with justification for the designation chosen.

11. As indicated in the previous question, regarding FSAR Table 3.11-3, staff believes that it would seem appropriate that required operational times labeled as "Short-Term," should only apply to components that are only required to be functional in the moments immediately following the onset of an accident. If this is the case, please update the definition of "Short-Term" in FSAR Section 3.11.1.3 to indicate that it only applies to equipment needed to operate during the initial onset of the accident and ensure that all the equipment in Table 3.11-3 labeled as "Short-Term" are properly labeled.

    If the applicant believes that "Short-Term" should also apply to components needed for one time (or occasional) functionality later in the duration of the accident (following the first few initial hours of the accident), then the applicant should justify why this is acceptable.

12. FSAR Section 3.11.1.3 indicates that components whose operability times are "varies" are capable of operating throughout the design basis accident (up to 6 months) depending on the situation, but it is not needed if something else can perform the same task. However, the applicant needs to be aware how long equipment is required to be operational during the worst case design basis accident for each piece of equipment in order to ensure that the appropriate safety functions can be performed or the applicant needs to ensure it is operational for the duration of the accident. Therefore, please update the FSAR to specify that all equipment with an operability time labeled as "varies" will be operational for the duration of the most limiting design basis accident or provide specific operational times for each piece of equipment labeled as varies with justification for the times chosen.

13. For several components in FSAR Table 3.11-3, instead of providing an equipment number, the application states, "Later." Please provide the appropriate equipment number for those components.

14. SRP Section 3.11 indicates that staff review will consider the definition of anticipated operational occurrences, normal, accident and post-accident environments.

    The application uses 6 months as the maximum amount of time any component is exposed to an accident environment. Please justify the use of 6 months for the maximum equipment operability time following an accident (instead of a year or some other operability time).

15. SRP Section 3.11 states that the staff's position is that, a mild radiation environment for electronic equipment is a total integrated dose less than 10 Gy (1E3 rad), and a mild radiation environment for other equipment is less than 100 Gy (1E4 rad).

    APR1400-E-X-NR-14001-P, Rev. 0, section 2.21 indicates that an area with a TID greater than 102 Gy is considered a harsh environment (10 Gy for electronic components). However, FSAR Section 3.11.1.1 indicates that an environment with a TID of greater than 100 Gy is considered a harsh environment (10 Gy for electronic components). Please correct this discrepancy and justify any deviation from the SRP.

16. FSAR Section 3.11.5.2 indicates that in the fuel handling area, exposures are based on a fuel handling accident. However, FSAR Table 3.11-2 only provides fuel handling area TID values for normal operation and for LOCA/MSLB. Please ensure that the application is consistent and verify that all design basis accidents were considered in the fuel handling area TID values. Also indicate if the limiting TID values for accident conditions in the fuel handling areas are based on a fuel handling accident.

17. APR1400-E-X-NR-14001-P, Rev. 0 indicates that additional information on the radiation levels and how they are defined can be found in the Environmental Qualification Parameters Report (EQPR). However, the EQPR is not properly referenced in the EQ program document. Please provide the document number for the EQPR and submit it for staff review or remove all references to this document in the FSAR and APR1400-E-X-NR-14001-P and ensure that the FSAR and APR1400-E-X-NR-14001-P appropriately provides the methods, models, and assumptions used for determining the TID (both normal operation and accident) for the components listed in FSAR Table 3.11-3 and ensure that the TID value applicable to each component is clearly labeled or identifiable.

03.11-10

10 CFR 50.49 and 10 CFR 50, Appendix A, criterion 4 require that certain components important to safety be designed to withstand environmental conditions, including the effects of radiation, associated with design basis events, including normal operation, anticipated operational occurrences, and design basis accidents.

SRP Section 3.11 indicates that the applicant's safety analysis report should be sufficient to support the conclusion that all items of equipment that are important to safety are capable of performing their design safety functions under all environmental conditions that may result from any normal mode of plant operation, anticipated operational occurrence, design basis events, post-design basis events, and containment tests.

SRP 3.11 also states that, "the equipment shall be designed to have the capability of performing its design safety functions under all anticipated operational occurrences and normal, accident, and post-accident environment, and for the length of time for which its function is required."

If consideration is not properly given to the combined effects of normal operation and accident conditions, equipment could unnecessarily exceed its design limitations during a design basis accident which could result in significant complications or significant personnel exposure. For example, if a piece of equipment is designed to a designed dose of 10,000 Rad and it is expected to receive 7,000 Rad during the worst case design basis accident for which that piece of equipment is required to operate, then the dose to that piece of equipment should be limited to 3,000 Rad during normal operation prior to replacement, unless the piece of equipment is intended to be replaced during an accident. Please indicate if it is anticipated that any equipment under the equipment qualification program will exceed its designed pressure, temperature, relative humidity, radiation dose, or chemical limitations (or combination thereof) or need to be replaced, due to potentially exceeding its design limits, during the period which it is needed to remain functional during a design basis accident.

If no, then please clearly include a statement in the FSAR indicating that replacement of equipment will be made before the maximum calculated DBA conditions could result in exceeding design limits for a piece of equipment, when considering the cumulative effects of the normal operating conditions that each piece of equipment has received, as well as the maximum cumulative worst case conditions calculated for the worst case accident.

If yes (design limits could be exceeded and/or may need to be replaced during an accident due to potentially exceeding limits for certain components), please discuss, in the FSAR, how environmental conditions will permit workers to access these areas in order to replace equipment during accident conditions and evaluate the radiation dose that a worker would receive in order to make the replacement.

03.11-11

10 CFR 50.49 and 10 CFR 50, Appendix A, criterion 4 require that certain components important to safety be designed to withstand environmental conditions, including the effects of radiation, associated with design basis events, including normal operation, anticipated operational occurrences, and design basis accidents.

Regulatory Guide (RG) 1.183 provides assumptions for evaluating radiation doses for equipment qualification. RG 1.183 indicates that, "EQ equipment located outside of containment may be exposed to (1) radiation from sources within the containment building, (2) radiation from activity contained in piping and components in systems that re-circulate containment sump water outside of containment (e.g., ECCS, RHR, sampling systems), (3) radiation from activity contained in piping and components in systems that process containment atmosphere (e.g., hydrogen recombiners, purge systems), (4) radiation from activity deposited in ventilation and process filter media, and (5) radiation from airborne activity in plant areas outside of the containment (i.e., leakage from recirculation systems). The amount of dose contributed by each of these sources is determined by the location of the equipment, the time-dependent and location-dependent distribution of the source, and the effects of shielding."

SRP Section 3.11 indicates that the applicant's safety analysis report should be sufficient to support the conclusion that all items of equipment that are important to safety are capable of performing their design safety functions under all environmental conditions that may result from any normal mode of plant operation, anticipated operational occurrence, design basis events, post-design basis events, and containment tests.

Finally, SRP 12.2 states that, the description of radiation sources, during normal operations and accident conditions in the plant, is used as the basis for designing the radiation protection program and for shield design calculations. This description should include isotopic composition, location in the plant, source strength and source geometry, and the basis for the values.

The applicant's approach for calculating the accident dose rates for equipment qualification outside containment is unclear. In addition, the applicant does not provide any post-accident source terms for systems and components transporting design basis accident containment sump water outside of containment. Therefore, staff has the following questions.

1. Please update the FSAR to provide the maximum post design basis accident containment sump fluid source term, and the assumptions used to develop this source term (if the assumptions are already provided in the FSAR, the applicant may reference the appropriate FSAR section).

2. Please update the FSAR to include the maximum post design basis accident source term information for major components outside containment that would contain significant post design basis accident source terms, such as the shutdown cooling system pumps and main control room filters, and provide the assumptions used to develop these source terms in the FSAR. In addition, for any source terms provided, please ensure that FSAR Table 12.2-25 includes the parameters for the source term, or include them elsewhere in the FSAR.

3. Please identify each system that re-circulates containment sump water outside of containment during a design basis accident (e.g. shutdown cooling system and containment spray system), and for each of these systems:

    a. Describe the methods, models, and assumptions used to calculate the post-accident total integrated dose values, for rooms or cubicles in APR1400-E-X-NR-14001-P, Table 4, which contain a system or component transporting containment sump water outside of containment, and for rooms adjacent to such systems or components.

4. Please identify each system (if any) that will be used to process the containment atmosphere during design basis accidents, and for each of these systems:

    a. Describe the methods, models, and assumptions used to determine the radioactive contents within the systems.

    b. Describe the methods, models, and assumptions used to calculate the accident total integrated dose values, for rooms or cubicles in APR1400-E-X-NR-14001-P, Table 4, which contain a system used to process the containment atmosphere during design basis accidents, and for rooms adjacent to such systems or components.

5. Please identify the locations of post-accident ventilation process and filter media (e.g. emergency control room ventilation system filter media) and for each of these systems:

    a. Describe the methods, models, and assumptions used to determine the radioactive contents of the filter media.

b. Describe the methods, models, and assumptions used to calculate the accident total integrated dose values, for rooms or cubicles in APR1400-E-X-NR-14001-P, Table 4, which contain post-accident filter media, and for rooms adjacent to such systems or components.

6. Please indicate if airborne activity associated with leakage from recirculation systems has been considered in the total integrated dose values for rooms and cubicles in APR1400-E-X-NR-14001-P, Table 4? If so, please describe the methods, models, and assumptions used in determining the airborne activity contributions associated with these sources to the total integrated dose values.

7. Please update the FSAR or APR1400-E-X-NR-14001-P, as appropriate, to provide a description of the methodology used to calculate post-accident total integrated dose values for equipment qualification outside of containment (for example, identify the applicable systems and components and provide general information regarding the assumptions used in determining the dose contributions from these systems and components).

8. Please indicate if the source terms and methodology used in developing the post-accident zoning provided in FSAR Figures 12.3-20 through 12.3-51, is consistent with the assumptions used in determining the post-accident total integrated dose values for rooms in Table 4 of APR1400-E-X-NR-14001-P. If different source terms or a different methodology was used to calculate these different doses, please provide the differences.