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. 12.02-22

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)

2. 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.

3. 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.

4. 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.

5. 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.

6. 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.

7. 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.

8. 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.

9. 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.

Response – (Rev. 1)

1. The source terms are calculated based on normal plant operation.
   For the shielding analyses of the CVCS tanks, the methodologies including the identification of source terms and the conditions for the analyses are summarized based on the various CVCS tank level as follows:

   Holdup Tank (HUT)

The function of the holdup tank is to store recoverable reactor coolant generated during plant operation.

Tank Volume : 420,000 gal (1.590E+09 cm^3)

- The volume allows for holdup of total waste water generated by one cold shutdown and subsequent startup (see DCD Tier 2 Section 9.3.4.2.8.2, Item e).

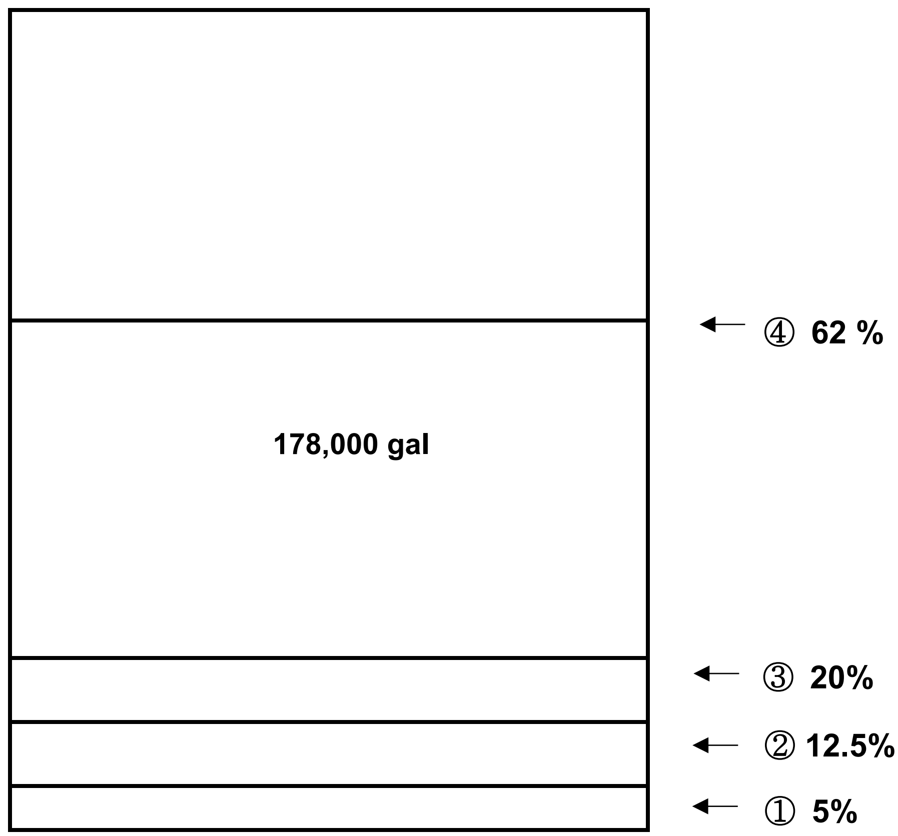

Figure 1. Tank Levels of the Holdup Tank.

<Tank Volume>

① Low Level Fraction (5%) : It is equal to the low level alarm setpoint which is based on the minimum tank volume required to supply the minimum NPSH to the holdup pumps with instrument channel accuracy.

③ High Level Fraction (20%) : It is equal to the high level alarm setpoint which is set to accommodate water volume for one cold shutdown and subsequent startup, and indicates that tank processing needs to be initiated. This level is the highest level for normal power operation from the beginning of fuel cycle except the shutdown operation.

③~④ Additional inflow volume (42%) from shutdown operation.

<Source Term>

For the activity calculation for the Holdup Tank,

1) To calculate HUT vapor activity, the low level fraction (5%) is used in order to maximize vapor space activities.

2) To calculate HUT liquid activity, the water level (62%) is used in order to maximize liquid space activities. This level (62%) includes the normal power operation volume (20%) and additional inflow volume (42%) from shutdown, refueling operation and startup operations for shutdown operation.

<u>Calculation of Noble Gas Vapor Activities for the Holdup Tank</u>

The noble gas activities of the vapor space for the Holdup Tank are determined initially by using Henry's law. Henry's law, however, is applied only if the tank is at equilibrium. If the tank is not at equilibrium and Henry's law is invalid, then partition factors are used to revaluate the vapor space activity.

The noble gas vapor activities are calculated by using the following equations:

For noble gas liquid activities,

$$A_{L-HUT,i} = \frac{Q_{HUT} * a_{i-HUT}}{\lambda_i + \frac{Q_{HUT}}{V_{L-HUT}}}\left(1 - e^{-\left(\lambda_i + \frac{Q_{HUT}}{V_{L-HUT}}\right)t}\right)$$

For noble gases at equilibrium condition,

$$A_{V-HUT,i} = \frac{(18)(H)(V_{V-HUT})(A_{L-HUT,i})}{(V_{L-HUT})(R)(T)} \qquad (1)$$

For noble gases at non-equilibrium condition,

$$A_{V-HUT,i} = \left(\frac{PF}{PF+1}\right)\left(\frac{Q_{HUT} * a_{i-HUT}}{\lambda_i}\right)\left(1 - e^{-\lambda_i t}\right) \qquad (2)$$

Where:

A_{L-HUT}, A_{V-HUT} = liquid and vapor activity, respectively, Bq

a_{i-HUT} = influent specific activities to Holdup Tank, Bq/cm^3

$$a_{i-HUT} = \frac{a_{i-PHIX}}{DF_{PHIX} * DF_{GS}}$$

a_{i-PHIX} = influent specific activity to Preholdup Ion Exchanger, Bq/cm^3

DF_{PHIX} = 1 (upstream Preholdup Ion Exchanger DF for noble gases)

DF_{GS} = 1,000 (upstream Gas Stripper DF noble gases)

V_{L-HUT}, V_{V-HUT} = liquid and vapor volume, respectively, gallons

V_{L-HUT} = 420,000 gallons * 5% = 21,000 gallons

V_{V-HUT} = 420,000 gallons * 95% = 399,000 gallons

Q_{HUT} = influent flowrate, gallons per day ([ ]TS)

λ_i = decay constant of a nuclide, day^{-1}

PF = partition factor ([ ]TS for all noble gases)

t = transit time through tank (cycle), sec (480 day)

18 = molecular weight of water, gram/gram-mol

H = Henry's law constant, atm/mole fraction

Krypton : 2.43E+04 ([ ]TS), Xenon : 1.07E+04 ([ ]TS)

R = ideal gas constant, 82.06 atm-cm^3/K-gram-mol

T = temperature, K (([ ]TS)

The operability of Gas Stripper is described in DCD Tier1, Section 2.4.6.1 as Attachment 1

o Activities at Equilibrium Condition

The noble gas vapor activities at equilibrium condition are calculated initially by using Equation (1) with the following parameters.

The results (A_{V-HUT}) of calculation at equilibrium condition by using Equation (1) are shown in the following table.

[ ]TS

Henry's law, however, applies only if the tank is at equilibrium. To check this, the theoretical maximum activity of each nuclide that could possibly enter the vapor space with 100% partitioning and no credit for decay is calculated by using the following equation.

$$A_{V-HUT(Max)} = a_{i-HUT} * Q_{HUT} * t$$

The results of this calculation are shown in the last column of the above table. Comparing the theoretical maximum value ($A_{V\text{-}HUT(Max)}$) and the initially calculated vapor activity at equilibrium condition ($A_{V\text{-}HUT}$), Kr-85, Xe-131m and Xe-133 are not at equilibrium (that is, $A_{V\text{-}HUT}$ larger than $A_{V\text{-}HUT(Max)}$) and Henry's law is invalid. Therefore, the vapor activities of Kr-85, Xe-131m and Xe-133 for the Holdup Tank should be revaluated.

o Activities at Non-Equilibrium Condition

For noble gases at non-equilibrium condition, partition factors are used to revaluate the vapor activities as shown in the Equation (2).

The calculated vapor activities ($A_{V\text{-}HUT}$) of Kr-85, Xe-131m and Xe-133 at non-equilibrium condition are shown in the following table.

TS

o Final Vapor Activities of Noble Gases
Then the resulting vapor activities of the noble gases at equilibrium and non-equilibrium conditions are as follows.

TS

<Shielding Calculation>

② The shielding calculation of the Holdup Tank includes the use of liquid and vapor phase design basis source terms at 0.25% failed fuel fraction. The liquid phase volume uses 12.5% of the total tank volume, but the source term includes the radioactivity for the

maximum water level 62%, concentrated to the 12.5% liquid volume. The shielding calculation also includes the vapor phase radioactivity at 87.5% tank volume, which is based on that of noble gases. The radioactivity from the noble gases is higher than that of the liquid, contributing to about 90% of the shielding source terms. Hence the summation of these two source terms and calculation method results a more conservative shielding design for the Holdup Tank.
Please note that the 12.5% volume is an artificial assumption to adjust liquid and vapor phase volumes to 100% in order to maximize the vapor phase volume and source term. Even though that the liquid volume can be as high as 62%, the combined source terms for shielding calculation are based on a liquid volume of 12.5% and a vapor phase volume of 87.5% in order to make the conservative shielding source terms.

<u>Boric Acid Storage Tank (BAST)</u>

The BAST is a reservoir of boric acid to be used to make up the RCS during normal plant operation.

Tank Volume : 250,000 gal (9.464E+08 cm^3)

- The volume is enough to permit one shutdown operation to cold shutdown and startup, followed by a shutdown for refueling (see DCD Tier 2 Section 9.3.4.2.8.2, Item d).

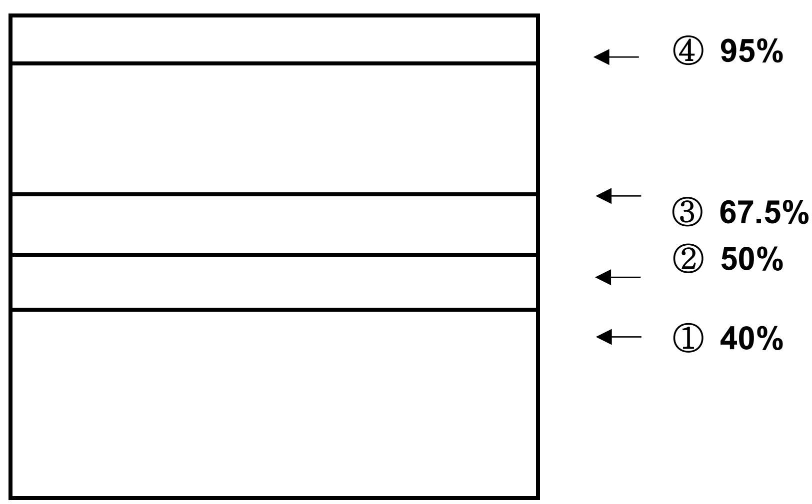

Figure 2. Tank Levels of the Boric Acid Storage Tank.

<Tank Volume>

① Low Level Fraction (40 %) : It is equal to the low level alarm setpoint which is based on the minimum tank volume required for one cold shutdown and subsequent startup, and indicates that filling of the tank needs to be initiated.

④ High Level Fraction (95 %) : It is equal to the high level alarm setpoint , which is used to warn of possible tank overflow and indicates that filling of the tank needs to be secured.

<Source Term>

Current Method

To calculate the BAST(liquid and vapor) activity, the average liquid level (67.5%) of ① and ④ has been used.

New Method

The calculation method for the BAST activity is changed to use the low and high level fraction instead of the average liquid level as follows;

① To calculate BAST vapor activity, the low level fraction (40 %) is used in order to maximize vapor space activity.

④ To calculate BAST liquid activity, the high level fraction (95 %) is used to maximize liquid space activity.

The results with the change in BAST water level, including the effects of the change in IRWST water level are given in the revised response of RAI 13-7856, Question 12.02-2_Rev.2 for Holdup Tank, BAST and IRWST and Attachment 2 of this response for boric acid filter. The activities of boric acid filter are affected because it is located at the downstream of BAST and the activities of holdup tank are affected due to the boric acid water recycle among the BAST, IRWST and RCS during refueling operation, heatup and power operation.

<Shielding Calculation>

Current Method

② The shielding calculation of the boric acid storage tank (BAST) includes the use of liquid and vapor phase design basis source terms at 0.25% failed fuel fraction. The source terms are modeled with a liquid phase volume of 50%, and a vapor phase of 50% for the shielding calculation. It is noted that the liquid phase volume uses 50% of the total tank volume, but the source term includes the radioactivity for the maximum water level 67.5%, concentrated to the 50% liquid volume. And the radioactivity from the liquid is much higher than that of the vapor, and contributes to more than 99% of the total dose rate. Hence the summation of these two source terms and calculation method results a more conservative shielding design for the BAST.

New Method

The shielding calculations for BAST and HUT were re-performed using the revised source terms determined based on the new method described above. As a result, the minimum required shield thicknesses for these components are increased due to the increase of the source terms. However, it is not required to change the structure design since the current structure thicknesses meet the increased minimum shield thicknesses.

Then, KHNP found that the 13 inches, presented in DCD Table 12.3-4, for the minimum thickness of the ceiling of the BA filter pit is calculation error. Hence, the shielding calculation for the ceiling was performed again for the ceiling. As a result, it was given that the right thickness is 20 inches. And, shielding calculation for the BA filter pit was re-performed based on the increased source term due to the BAST source term change, and resulted in only 2 inch increase for the ceiling of BA filter pit, however, this increase can meet the current structure thickness of 24 inches. In addition, for the other wall thicknesses around the BA filter, such as north, south, east, west walls, and floor, the sufficient margins in the previous shielding thickness analyses were applied already. Therefore, it is not required to increase the thickness more.

Based on above changes, DCD Table 12.3-4 was revised as indicated in Attachment 3.

Reactor Makeup Water Tank (RMWT)

The RMWT is a reservoir of demineralized water to be used to make up the RCS during normal plant operation.

Tank Volume : 395,000 gal (1.495E+09 cm^3)

- The volume is based on providing dilution to allow total recycle and providing dilution for one cold shutdown and subsequent startup (see DCD Tier 2 Section 9.3.4.2.8.2, Item f).

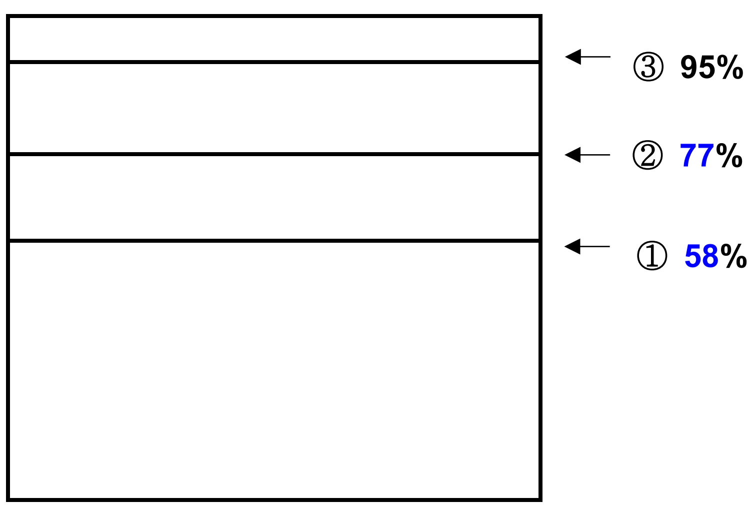

Figure 3. Tank Levels of the Reactor Makeup Water Tank.

<Tank Volume>

① Low Level Fraction (58%) : It is equal to the low level alarm setpoint which is based on the minimum water volume required for one cold shutdown and subsequent startup and indicates that filling of the tank needs to be initiated.

③ High Level Fraction (95 %) : It is equal to the high level alarm setpoint, which is used to warn of possible tank overflow and indicates that filling of the tank needs to be secured.

<Source Term>

① To calculate RMWT vapor activity, the low level fraction (58%) is used in order to maximize vapor space activity.

③ To calculate RMWT liquid activity, the high level fraction (95 %) is used to maximize liquid space activity.

The results with the change in RMWT water level are given in the revised response to RAI 13-7856 Question 12.02-2 Rev.3 for the RMWT and Attachment 2 of this response for the RMW filter. The activities of RMW filter are affected because it is located at the downstream of RMWT.

<Shielding Calculation>

② The shielding calculation of the reactor makeup water tank (RMWT) includes the use of liquid and vapor phase design basis source terms at 0.25% failed fuel fraction. The liquid phase volume uses 77% of the total tank volume, but the source term is based on the radioactivity for the maximum water level at 95% and concentrated into the 77% liquid volume. The liquid source term is based on recycle of treated reactor makeup water. It is noted that the vapor phase volume uses 23% of the total tank volume, but the source term includes the radioactivity for the minimum water level 58%, 42% vapor source term inventory was concentrated to the 23% vapor volume. And the adioactivity from the vapor is much higher than that of the liquid, and contributes to more than 95% of the total dose rate. Hence the summation of these two source terms and the calculation method results a more conservative shielding design for the RMWT.

<u>Reactor Drain Tank (RDT)</u>

The function of the RDT is to receive various influxes from inside containment.

Tank Volume : 4,000 gal (1.514E+07 cm^3)

- The volume of RDT is based on the quantities as follows (see DCD Tier 2 Section 9.3.4.2.8.2, Item b):

  a. leakage from the pressurizer pilot operated safety relief valves (POSRVs)
  b. discharges from the thermal relief valves in the containment

c. gravity drains and leakage of reactor grade water from components in the containment
d. gravity drains from the RCS
e. discharges from the reactor coolant gas vent system for a limited period
f. a diversion of RCP controlled bleed-off for a limited period

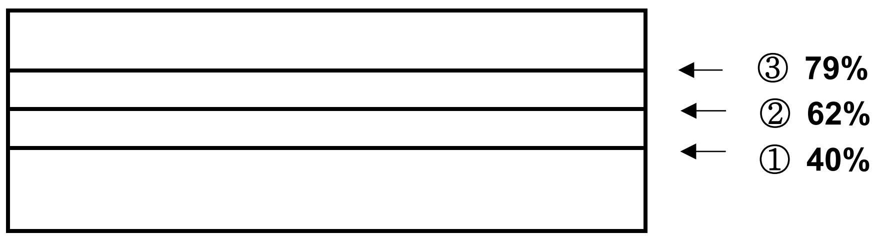

Figure 4. Tank Levels of the Reactor Drain Tank.

<Tank Volume>

① Low Level Fraction (40 %) : It is equal to the low level alarm setpoint which is set to be above the water level to prevent vortex formation at tank outlet and the minimum water volume to quench the high temperature leakage from POSRVs.

③ High Level Fraction (79 %) : It is equal to the high level alarm setpoint which is set to be above the collected volume of reactor grade leakage without any transient volume including the volume for the POSRV leakage and the bypass volume of the RCP controlled bleed-off flow for a limited period.

<Source Term>

① To calculate RDT vapor activity, the low level fraction (40 %) is used in order to maximize vapor space activities.

③ To calculate RDT liquid activity, the high level fraction (79 %) is used in order to maximize liquid space activities.

<Shielding Calculation>

② The shielding calculation of the reactor drain tank (RDT) includes the use of liquid and vapor phase design basis source terms at 0.25% failed fuel fraction. The liquid phase models a volume of 62% of the total tank volume (normal operation volume), but the source term is based on the radioactivity for the maximum water level at 79%, concentrated to the 62% liquid volume. The shielding calculation also includes a vapor phase radioactivity of noble gases at 38%, which is concentrated from 60% volume. The radioactivity from the noble gases is about 100 times higher than that of the liquid. The high contribution of noble gases activity increases the shielding requirement. Hence the summation of these two source terms and calculation method results a more conservative shielding design for the RDT.

Equipment Drain Tank (EDT)

The function of the EDT is to receive various gravity drains from outside containment.

Tank Volume : 9,500 gal (3.596E+07 cm^3)

- The volume is enough to accept gas stripper bypass flow and to accept discharges from miscellaneous relief valves (see DCD Tier 2 Section 9.3.4.2.8.2, Item c).

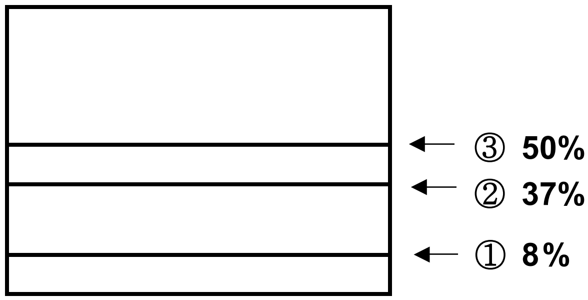

Figure 5. Tank Levels of the Equipment Drain Tank

<Tank Volume>

① Low Level Fraction (8 %) : It is equal to the low level alarm setpoint which is set considering the minimum height for vortex prevention.

② High Level Fraction (37 %) : It is equal to the high level alarm setpoint which is set to be above normal operating volume except gas volume and volume for gas stripper bypass. The normal operating volume is to accept flow from the ion exchanger sluicing volume which is greater than normal drain and sampling purge.

<Source Term>

① To calculate EDT vapor activity, the low level fraction (8 %) is used in order to maximize vapor space activities.

② To calculate EDT liquid activity, the high level fraction (37 %) is used in order to maximize liquid space activities.

<Shielding Calculation>

③ The shielding calculation of the equipment drain tank (EDT) includes the use of liquid and vapor phase design basis source terms at 0.25% failed fuel fraction. The liquid phase models a volume of 50% of the total tank volume. The shielding calculation also includes a vapor phase radioactivity of noble gases at 50%, which is concentrated from 92% volume. The radioactivity from the noble gases is about 50 times higher than that of the liquid and dominates the total dose rate. Hence the summation of these two source terms and calculation method results a more conservative shielding design for the EDT.

<u>In-containment Refueling Water Storage Tank (IRWST)</u>

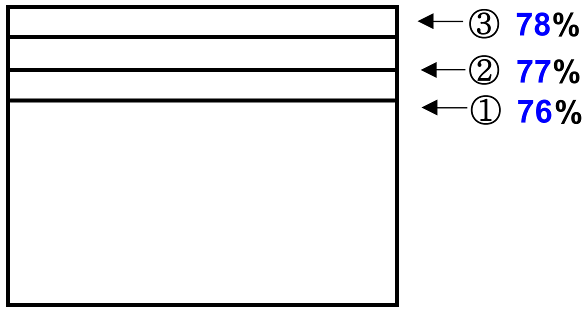

Figure 6. Tank Levels of the In-containment Refueling Water Storage Tank

<Tank Volume>

IRWST volume is sufficient for flooding the refueling pool during normal refueling operation assuming the initial RCS level is at the center of hot leg, and for providing the water for the ESF systems operation during LOCA.

① Low Level Fraction (76%) : It is equal to the low level alarm setpoint which is based on the required water volume for providing adequate ESF pumps operation during accident operation.

③ High Level Fraction (78%) : It is equal to the high level alarm setpoint which is based on the water level to prevent the reactor vessel breach from flooding caused by inadvertent operation of the cavity flooding system during normal operation.

<Source Term>

<u>Current Method</u>

② Midpoint of ① and ③ : The middle (77%) of low level fraction (76%) and high level fraction (78%) is assumed as liquid volume and rest of this is assumed as vapor volume. The liquid and vapor source terms are identified at this level.

<u>New Method</u>

The calculation method for the IRWST activity is changed to use the low and high level fraction instead of the average liquid level as follows;

① To calculate IRWST vapor activity, the low level fraction (76%) is used in order to maximize vapor space activity.

③ To calculate IRWST liquid activity, the high level fraction (78%) is used to maximize liquid space activity.

The results with the change in IRWST water level, including the effects of the change in BAST water level are given in the revised response of RAI 13-7856, Question 12.02-2 for

Holdup Tank, BAST and IRWST. The activities of holdup tank are affected due to the boric acid water recycle among the BAST, IRWST and RCS during refueling operation, heatup and power operation.

<Shielding Calculation>

Since the IRWST is located inside the containment and surrounded with the walls which have sufficient wall thickness for shielding, it is expected not to cause any significant impact on the plant structure design. Radiation zoning inside IRWST was determined based on the zoning for SFP since the source term of SFP is comparable to that of IRWST.

2. Low and high level fractions in Table 12.2-28 of the response to RAI 7856 Question 12.02-2 mean the low and high level alarm setpoints to control the tank level. The tank level is maintained between low and high level alarm setpoints during normal operation.

   The low level fraction is used in order to maximize vapor space activities. The high level fraction is used to maximize liquid space activities.

3. The activity for the holdup tank was changed because the concentration factor (CF) of boric acid concentrator was increased from 10 to 100. The deborating ion exchanger is operated to reduce the reactor coolant boron concentration when it reached 50 ppm near the end of core life. The feed-and-bleed operation is not used for RCS boron dilution below 50 ppm and there is no more excess coolant transferred to the holdup tank.

   The boron concentration of concentrated water from BAC package is about 4000 ~ 4400 ppm. Therefore, CF is assumed to be as follows:

   CF for non-noble gases = 100 (~ 4400 ppm/ 50 ppm)

   CF for noble gases and N-16 = 1

   The liquid activity of holdup tank (HUT) is calculated as follows (Cs-137) ;

$$A_{HUTL} = A_{HUTL1} + A_{HUTL2} + A_{HUTL3} + A_{HUTL4} + A_{HUTL5}$$

where

A_{HUTL1} = *normal power operation activity,*

A_{HUTL2} = *additional filling activity from low to high water level,*

A_{HUTL3} = *shutdown boration waste to HUT activity,*

A_{HUTL4} = *drain waste to HUT for Reactor Head removal activity, and*

A_{HUTL5} = *startup dilution waste to HUT activity.*

   For conservatism, activities of shutdown (A_{HUTL3}), drain (A_{HUTL4}), and startup (A_{HUTL5}) are considered in calculation of total holdup tank activity. However, these activities ($A_{HUTL3} + A_{HUTL4} + A_{HUTL5}$) are not considered in holdup tank specific activity calculation. Because they are based on zero power condition, these specific activities are lower than those ($A_{HUTL1}+A_{HUTL2}$) of normal power operation. So, to calculate specific activity in holdup tank (a_{HUT}), only normal power operation activity (A_{HUTL1}) and additional filling activity (A_{HUTL2}) are considered and calculated as follows;

(1) The normal power operation activity of HUT is calculated based on following equation

$$A_L = \frac{Q_i a_i}{\lambda + \frac{Q_i}{V_L}}(1 - e^{-(\lambda + \frac{Q_i}{V_L})t})$$

In this case,

$A_L = A_{HUTL1}$

$Q_i = Q_{HUT}$

$a_i = a_{i,HUT}$

$t = T_{CYCLE}$

$V_L = V_{HUTL1} = V_{HUTL} f_{LOW}$

Where,

A_{HUTL1} = HUT liquid activity

$Q_i = Q_{HUT} = Q_{PHIX}$ = Pre-holdup Ion Exchanger flow rate

[ ]TS

a_i = HUT influent specific activity = [ ]TS (From SHIELD-APR output)

λ = decay constant = 7.27E-10 sec-1

T_{CYCLE} = one cycle length = 480 days

V_{HUTL1} = HUT liquid volume = 420,000 gallons X 0.05 = 21,000 gallons

V_{HUT} = HUT total volume = 420,000 gallons

f_{LOW} = HUT low level fraction = 0.05

Therefore,

A_{HUTL1} = HUT liquid activity = [ ]TS

(2) The tank is filled from low level to high level with decay. The filled liquid activity(low level to high level) of HUT is calculated based on following equation

$$A = \frac{Q_i a_i}{\lambda}(1 - e^{-\lambda t_R})$$

In this case,

$$A = A_{HUTL2}$$

$$a_i = a_{i,HUT}$$

$$t_R = T_{F,HUT} = \frac{V_{F,HUT}}{Q_{HUT}}$$

$$V_{F,HUT} = (f_{HIGH} - f_{LOW})V_{HUT}$$

Where,

A_{HUTL2} = HUT filled liquid activity

[ ]TS

$a_{i,HUT}$ = HUT influent specific activity = 1.90E+01 Bq/cc (From SHIELD-APR output)

λ = decay constant = 7.27E-10 sec^{-1}

[ ]TS

$V_{F,HUT}$ = HUT filling liquid volume = 420,000 gallons X (0.2-0.05) = 63,000 gallons

f_{HIGH} = HUT high level fraction = 0.2

f_{LOW} = HUT low level fraction = 0.05

V_{HUT} = HUT total volume = 420,000 gallons

Therefore,

A_{HUTL2} = HUT filled liquid activity = [ ]TS

The specific activity of HUT is;

[ ]TS

The specific activity for Concentrate Pump of BAC components is calculated as follows (Cs-137) ;

[ ]TS

Same specific activity is applied to Concentrate Heater, Concentrate Transfer Pump, Concentrate Cooler, Flash Tank, and Vapor Separator ([ ]TS).

The concentration ([ ]TS) of Cs-137 in the BAC package is 100 times more than the concentration ([ ]TS) in the Holdup Tank. In addition, the comparison of NRC and KHNP's HUT specific activity calculation is shown in following table.(NRC staff said in conference call that NRC applied 8.9E+09 Bq (DCD table 12.2-12, this should be revised to 1.0E+10 Bq according to RAI 13-7856 Question 12.02-2_Rev.1 Table 12.2-13) for HUT total activity and 52,500 gal for HUT volume. However, the application can't make the concentration factor (CF) of 35. So, to make the CF of 35, 1.0E+10 Bq and 50,000 gal seem to be assumed for NRC calculation.)

TS

4. Holdup tank receives the influent flow from pre-holdup ion exchanger during normal power operation, shutdown operation, and startup operation. The liquid activity of holdup tank is calculated as follows:

   1) Normal power operation at low water level by considering the decay and removal of the RCS activity.

   2) Normal power operation from low water level to high water level by considering the decay and removal of the RCS activity.

   3) Shutdown operation to borate the RCS for refueling by considering the decay and removal of the RCS activity and the boric acid storage tank activity. It is assumed that 46,000 gal of boric acid batching tank is required to borate the RCS. The flow path for shutdown operation is same as that for normal operation.

   4) Drain operation to remove the reactor vessel head. It is assumed that 42,680 gal of the RCS water is drained to remove the reactor vessel head. The coolant is drained to the reactor drain tank and sent to the holdup tank by passing the pre-holdup ion exchanger.

   5) Startup operation to dilute the RCS for startup by considering the decay and removal of the RCS activity and the reactor makeup water tank activity. It is assumed that 88,700 gal of reactor makeup water tank is required to dilute the RCS in order to remove the volume added during shutdown operation and drain operation. The flow path for startup operation is same as that for normal operation.

The response regarding CVCS ion exchanger decontamination factors is provided in the response to RAI 8339, Question 12.02-19.

5. The holdup tank (HT) and the boric acid storage tank (BAST) are located near the plant north wall of the auxiliary building (AB) at a distance about 56-feet away from the wall. The tank information is as follows:

	Holdup Tank	Boric Acid Storage Tank
Inside Diameter, feet	56’-0”	44’-0”
Height (tank bottom to top of wall), feet	25’-3”	28’-3”
Perpendicular Distance from AB Wall outside to Tank outside Insulation	About 56’-2”	About 54’-0”
Approximate Elevation of Top (Including Roof Top)	130’-10”	133”-0”
Elevation of AB with 6’-0” Parapet (4’-0” thick)	219’-6”	219’-6”

Based on the information in the above table, the tanks are located over 50 feet away, and with an elevation difference of about 86 feet, from the roof top to the top of parapet. The AB is designed with a parapet that is 6’-0” tall surrounding the roof. The section of the parapet near the tanks is about 4’-0” thick. Because of the parapet, individual on top of the roof is shielded from radiation shines from the HT and the BAST.

Access to the AB roof top is administratively controlled and is not expected to be accessed routinely.

KHNP also evaluated the dose rate in the AB roof area to be Radiation Zone 2 based on the radiation shines from the yard tanks but without consideration of parapet. It is noted that in this dose assessment, the tank roof is not credited. Based on this evaluation, the roof area will be classified with Zone 2 as indicated in Attachment 4.

Also, as indicated in Attachment 5, a new COL item will be added that states the following:

“COL applicant is to provide information to ensure that radiation levels at the site boundary not exceed the limits of 40 CFR Part 190, from all radiation sources, including the outdoor tanks”

6. In the response to RAI 7856, Question 12.02-3, KHNP provided an insert to Table 12.2-25 with the minimum shield wall thicknesses for the yard tanks. The minimum shield wall thicknesses for holdup tank (steel shell: 0.635 cm and concrete 37.465 cm) and boric acid storage tank (concrete: 40.64 cm) are designed to maintain a dose rate of less than 2.5 μSv/hr outside the tanks for Radiation Zone 1. Please refer to discussion and the insert for RAI 7856, Question 12.02-3 for more details.

7. According to ASME Section XI, periodic inspection is not required for the holdup tank (HUT) and the boric acid storage tank (BAST). During normal operation (including refueling operation), these tanks are filled with radioactive water, hence, periodic

inspection inside the tanks is not performed. However, they are designed with a roof manway and a shell manway to facilitate access for inspection and maintenance. The roof manway is located on the boundary of the tank roof, and is accessible through a caged vertical ladder and a roof platform with guard rail. The shell manway is located on the bottom portion of the tank side. The size of each manway is 24 inches in diameter.

In the event of tank leakage, the provision for the leak detection installed in the sump inside the tank piping tunnel (Refer to Figure 8) ensures early detection of the leakage. For the repair of the tanks, the tanks are drained and flushed with demineralized water to remove residual radioactivity and the leak or damaged area is identified. This repair work should be performed in accordance with the site radiation safety management procedures to minimize the exposure to the personal.

a. Additional information on the side manway and the ability to access the tanks for inspection and maintenance and how the manway effects shielding

The yard tanks are surrounded by a 9 feet high dike. An administrative control entrance door is provided to go inside and exit the tank structure. The door is located at ground level. Behind this door is a step up staircase located approximately 8 feet from the floor on the outside of the structure wall. Another step down staircase is located inside the wall to provide tank(s). The entrance door is equipped with a key lock to prevent inadvertent access in close vicinity of the tanks.

The outdoor tanks are equipped with side manways (24” diameter) that are not covered by concrete. Each manway, which has a hinged cover, is located at a section of 24” pipe. The pipe for the entrance manway protrudes through the concrete shield for easy access. The manway cover is small when compared to the tank size (e.g. inner diameter and height of the HUT are 44’ and 37’, respectively); further, the shell side manway is designed to be located on the bottom of the tank side wall. Therefore, only a small portion of the radiation can be scattered through the manway. However, the scattered radiation is not significant due to the limited manway size and the self-shielding effects. Additionally, the shell manway cover is made of 46 mm (about 2”) thickness of steel, which provides additional shielding. It should also be noted that the 9’ high structure wall also provides additional shielding of radiation to the outside. Hence the impact of the radiation from the tank source terms to the environment is negligible.

However, the radiation level of the area around the side manway of the yard tank can be higher than zone 1 criteria. Thus, a clarification will be added to DCD Subsection 12.2.1.6 to clarify that the radiation doses in the proximity of the side manways for the outdoor tanks may exceed the Zone 1 dose criterion as indicated in Attachment 6.

b. Additional information on the heaters accessed for inspection and maintenance

The heater is installed inside the guide tube. The end of this guide tube is located inside tank, and is welded to prevent water leakage to the outside. Hence, the heater can be removed from this guide tube anytime for inspection and maintenance.

c. Additional information on the level monitoring instruments connected to the tank

A Differential pressure type level transmitter and an instrument root valve are installed close to the hold-up tank nozzle located outside of the concrete shield. The low pressure nozzle on the tank for the instrument tubing line connection is located at an elevation of 25'-11"above the ground. The high pressure nozzle is located at an elevation of 9" above the ground. The length of the 3/8"sized tubing line between the transmitter and the root valve is designed to be as short as possible.

The transmitter is installed on the instrument mounting bracket which has a 3-way manifold valve and instrument valves (drain/vent valves). The mounting bracket is installed on an instrument station 4'-6" above the ground level.

The transmitter may be either removed for bench calibration or calibrated in place. The preferred method of transmitter calibration is an "installed as per plan" calibration to minimize exposure to contaminated water, as discussed below.

1. Close the instrument root valves to isolate the transmitter from the process.
2. Tightly close the high pressure isolation valve in the 3-way manifold valve.
3. Open equalizing valve in 3-way manifold valve.
4. Tightly close the low pressure isolation valve in 3-way manifold valve.
5. Open instrument valves to drain contaminated water between instrument valves and 3-way manifold valve.
6. Connect the hand pump and standard test gauge, digital meter and D.C. power supply of required voltage to the transmitter.

Following the above calibration procedure, there is little chance the contaminated water inside the tubing/transmitter could be spilled inadvertently.

Even if small amounts of process water are spilled inadvertently, the water is collected in the yard dike area sump as shown in Figure 9.3.4-1 of DCD Tier 2. The collected water in the yard dike area sump is transported to the equipment drain sump in radioactive drain system, as shown in Figure 9.3.3-1 of DCD Tier 2. The water in the equipment drain sump is transported to the liquid radwaste system for radioactive radwaste treatment. Therefore, the exposure of contaminated water to the environment is minimal during the calibration.

d. Additional information on the tank house and leakage collection

There is no epoxy coating between the concrete shield wall and the tank steel shell.

The yard tanks, primarily the holdup tank (HUT) and the boric acid storage tank (BAST), are designed with weld seam channels, similar to those alongside and at the bottom of the spent fuel pool steel plates, to collect any leakages developed along the weld seams. The channels collect and direct the leakages to a drain pipe that is equipped with a leak detection design. This is connected to a sump in the piping tunnel (Refer to Figures 7 and 8 for schematic representation).

The tanks are fabricated with stainless steel for life-cycle planning and to prevent leakage through the tank wall. KHNP's opinion is that the tank wall and bottom steel plates are unlikely to develop pin-hole leakages. If any leakages may occur, it is more likely to be developed along the weld seams between the plates. Therefore, the current design provides leak chase channels to collect any potential leakages and route the leakages to a tank leak collection pipe for detection of leaks. The leak detection design is equipped with a liquid detection instrument, such as a level switch, and an isolation valve that is normally closed. If leaked liquid is collected in this leak collection pipe, the liquid detection instrument initiates an alarm in the main control room for operator actions, including investigation of leaks, mitigation, maintenance, and repair, as applicable. This design approach minimizes the possibility for leakage to be lost outside the tank wall/inside the concrete, which would go undetected.

It is also noted that the tanks are protected from the elements with the addition of concrete shielding, insulation, and aluminum jackets surrounding the tanks. This design approach prevents the spread of contamination and therefore negates the possibility of leakage to be lost in the outside concrete. This approach is supported by industry experiences with respect to the operation of spent fuel pools and the IRWST in the Korean domestic nuclear power plants.

e. Additional information on the prevention of tank overflows to the rain water sump

The water levels of BAST and HUT are monitored and the high level of each tank is annunciated independently in the main control room. These tanks is also equipped with an internal overflow outlet, any overflow of the water in these two tanks are collected and routed to the equipment drain sump inside the AB as shown in DCD Figures 9.3.4-1 (sheet 4 and sheet 6) and 9.3.3-1 (sheet 5). The isolation valve and the overflow drain line is sloped to prevent overflow back flowing to the dike sump. With the sloped piping and isolation valve, the overflow water from BAST and HUT flows to the equipment drain sump, and is not released to the dike sump as shown in DCD Figures 9.3.4-1 (sheet 4 and sheet 6).

The water level of RMWT is monitored by a level instrument. At high water level, the level instrument initiates an alarm in the MCR for the operator actions. Therefore, the water level of RMWT is controlled and unmonitored release of overflow is prevented. The slope symbol will be added in Figure 9.3.4-1 (sheet 6) as shown in the Attachment 6.

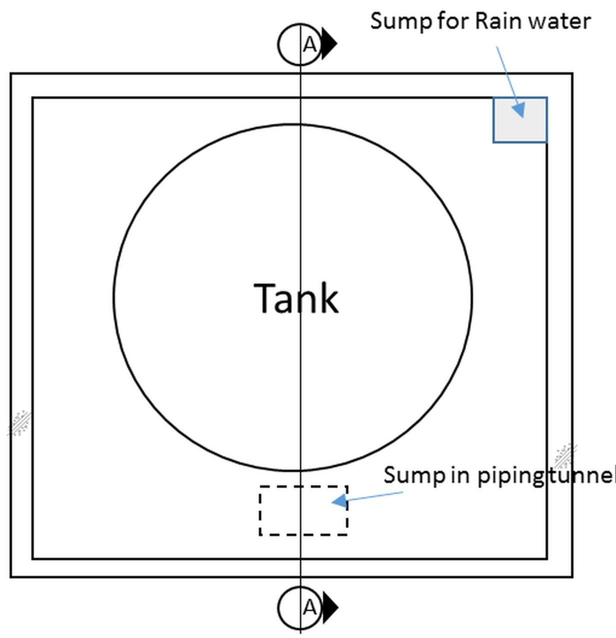

Figure 7 BAST Layout Plan

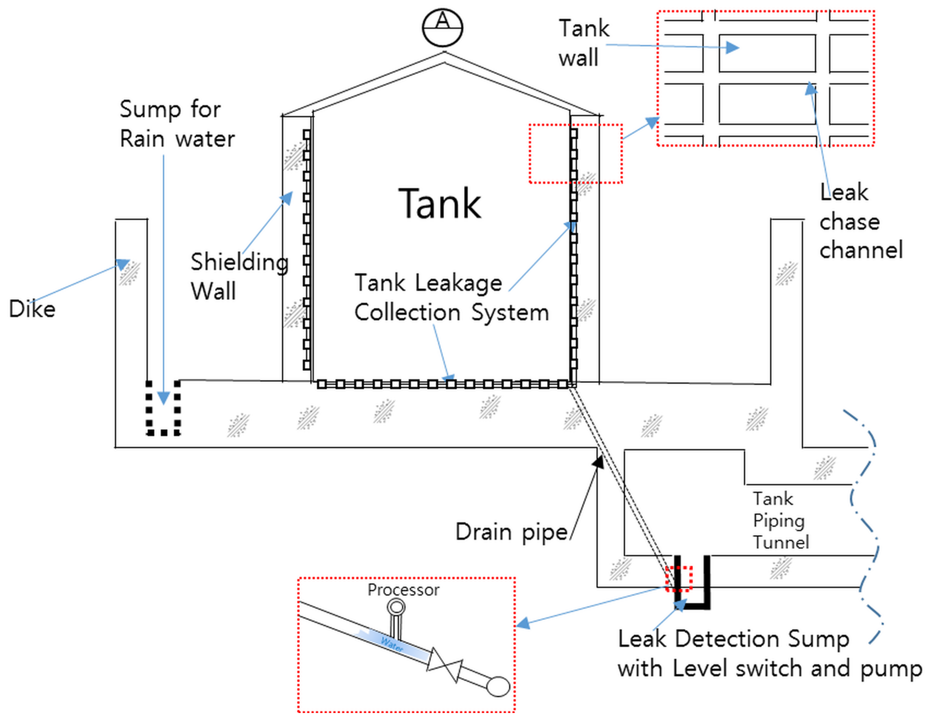

Figure 8 Schematic Diagram for Leak Collection and Detection Design

f. Additional information on the epoxy coating on the floor of the tank house

The epoxy coating on the floor of the tank house is to be maintained as part of the overall plant epoxy coating maintenance program. The epoxy coating in the tank house is Services Level III for outdoor tanks. DCD Subsection 9.3.4.2.10 will be updated to indicate that the epoxy coating will be maintained as indicated in Attachment 6.

g. Additional information on the sump for rain water

As illustrated in Figure 8 above, the rain water sump is designed to be separated from the outdoor tank leak detection sump, it is therefore not expected to contain radiologically contaminated water. Rain water collected is normally routed to the storm water system for discharge. In the rare event that leakage is detected in the outdoor tank leak detection sump, the content of the rain water sump is to be sampled and analyzed for contamination before it is discharged. It is noted that the outdoor tank leak detection sump discharge is connected to the radioactive drain system (DE). Contaminated rain water can be directed to the DE system, from which the rain water is then routed to the liquid radwaste system for processing and discharge.

h. Additional information on the freeze protection for sump

The sumps for the outdoor tanks are located within the structural walls surrounding the tanks. The sumps are enclosed with their individual sump covers, similar to the indoor sumps, which serve to protect the sump from the elements. The outdoor sump design is site-specific. If freeze protection is required, electric sump heaters are to be provided by the COL applicant. The sump heater can be a similar submersible type for the tanks (See response for Item 1.b above). Exposed outdoor piping is electrical heat traced for freeze protection until the piping is routed inside a concrete tunnel. The freeze protection for piping inside the concrete tunnel is also site-specific; the tunnel can be heated by low pressure steam pipe for freeze protection. A COL item (COL 9.3(8)) will be added to facilitate the COL applicant to determine the need and the provision of freeze protection for the outdoor sumps in Tier 2 DCD Subsection 9.3.5, as indicated in Attachment 6.

i. Additional information on the reason for why RMWT is not included in the COL 9.3(8)

The reactor make-up water tank (RMWT) is an austenitic stainless tank designed to store reactor makeup water, primarily the condensate from the boric acid concentrator (BAC). The condensate is further polished in the BAC ion exchanger for removal of residual contamination and is then routed to RMWT for makeup. Thus the RMWT makeup is slightly contaminated, primarily due to the tritiated water in the originated reactor coolant letdown. Other source of RMWT makeup is demineralized water. The RMWT is equipped with a level monitoring instrument and is blanketed with nitrogen gas to minimize oxygen infiltration.

The RMWT is located in the same yard area as the holdup tank. Because of low contamination level, the RWMT is insulated only. The RWMT and the HUT is surrounded with a dike wall that is 9-foot high and share the same rainwater sump.

Because the RMWT is designed with austenitic stainless steel for life-cycle planning, and that the content is of low contamination, the RWMT is not designed with specific leak detection features. Any leakage is to be drained to the outside of the tank and collected in the rainwater sump. Even though the tank has level monitoring instrument, minor leakage is unlikely to be detected by the level instrument. If leakage is significant, from the leak rate and duration standpoint, the level instrument provides liquid level information that needs to be coupled with operator inspection and analysis of sump content to determine the significance of leakage and the contamination level. Periodic inspection of the RMWT is therefore implemented as part of the normal operational program. Operational procedures and maintenance programs as related to leak detection and contamination control for the RMWT are part of overall RG 4.21 Program and to be prepared by the COL applicant (COL 9.3(2)).

The RMWT design approach is therefore consistent with the low risks associated with the RMWT content and the requirements of RG 4.21.

j. Additional information on the water collected in rainwater sump inside the dike

Water collected in the rainwater sump (yard dike area sump) inside the RMWT structure is not automatically discharged based on sump level. The water is to be sampled and analyzed for contamination before the valve (Valve # V1170) is manually open to route the water to the catch basin, after the water is confirmed to be free of radiological contamination from the RWMT and the HUT. Even though the catch basin is site specific, the rainwater in the catch basin is also sampled and analyzed for contamination before the storm water is discharged. If the sump water is contaminated, another valve (Valve #2015) is manually open to facilitate draining the water to the equipment drain sump inside AB via the same piping that route the HUT leakage. The water in the equipment drain sump is normally routed to the LWMS for treatment and release. Hence, the rainwater in the rainwater sump is sampled, analyzed and then routed to a point upstream of the final composite sample points before discharge and is accounted for as part of the plant effluent releases either way.

KHNP will update the DCD Subsection 9.3.4.2.10 to require periodic inspection of the RWMT, and sampling and analysis of the rainwater sump prior to routing the rainwater to the applicable treatment and release locations, as indicated in Attachment 6.

8.

a. The sentence is correct. Both liquid and vapor source terms are initially calculated based on the low water level. This maximizes the vapor source term by using the maximum vapor volume. As for the liquid source term, the liquid volume between low and high water levels is considered. The liquid source term due to this volume is added to the liquid source term which is calculated at low water level.

b. The water and vapor fraction of the reactor drain tank source terms provided in DCD Table 12.2-25 was revised as indicated in Attachment 2 of response to RAI 13-7856 Question 12.02-2_Rev.4 [ML17093A969].

c. The discrepancy about EDT dimensions was corrected as indicated in Attachment 2 of the response to RAI 13-7856 Question 12.02-2_Rev.4 [ML17093A969].

d. The discrepancy about the vapor and water volume fraction of VCT was corrected as shown in the response to RAI 13-7856 Question 12.02-2_Rev.4 [ML17093A969].

e. The discrepancy about the IRWST volumes provided in DCD Tables 12.2-25 and 12.2-28 was corrected as indicated in the response to RAI 13-7856 Question 12.02-2_Rev.4 [ML17093A969].

Impact on DCD

DCD Tier 1, Section 2.4.6.1 will be revised as shown in Attachment 1.

DCD Table 12.2-12 will be revised as shown in Attachment 2.

DCD Table 12.3-4 was revised as shown in Attachment 3.

DCD Figure 12.3-9 will be revised as shown in Attachment 4.

DCD Sections 12.3.2.3, 12.3.4, 12.3.4.1.6, 12.3.6, and Table 1.8-2 will be revised as shown in Attachment 5.

DCD Sections 9.3.4.2.10, 9.3.5 and 12.2.1.6 will be revised as indicated in Attachment 6.

DCD Figure 9.3.4-1 will be revised as indicated in Attachment 6 DCD Figure 12.3-9 will be revised as shown in Attachment 4.

DCD Sections 12.3.2.3, 12.3.4, 12.3.4.1.6, 12.3.6, and Table 1.8-2 will be revised as shown in Attachment 5.

DCD Sections 9.3.4.2.10, 9.3.5 and 12.2.1.6 will be revised as indicated in Attachment 6.

DCD Figure 9.3.4-1 will be revised as indicated in Attachment 6

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.

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2.4.6 Chemical and Volume Control System

2.4.6.1 Design Description

The chemical and volume control system (CVCS) controls the purity, volume, and chemistry of the reactor coolant. The portions of the CVCS which accomplish reactor normal makeup and normal reactivity control are classified at least safety Class 3.

The CVCS maintains the required volume of water in reactor coolant system (RCS) in conjunction with the pressurizer level control system. The CVCS also provides backup spray water to the pressurizer and cooling water to the RCP seals.

The gas stripper is operated as necessary to ensure that dose rate outside the HT remains less than 2.5 μSv/hr.

The CVCS also has the following safety-related functions: maintaining integrity of components (including piping and valves) in the reactor coolant pressure boundary, isolating the CVCS lines passing through the containment penetrations following a postulated DBA, and limiting the magnitude of a boron dilution source to the RCS to prevent inadvertent RCS boron dilution.

Major portion of CVCS is located in the auxiliary building and reactor containment building, except the holdup tank (HT), reactor makeup water tank (RMWT), and boric acid storage tank (BAST) are located in the yard and surrounded by a dike.

The gas stripper is operated as necessary to ensure that dose rate outside the HT remains less than the Zone 1 criteria.

1. The functional arrangement of the CVCS is as described in the Design Description of Subsection 2.4.6.1 and in Table 2.4.6-1 and as shown in Figure 2.4.6-1.

2.a The ASME Code components identified in Table 2.4.6-2 are designed and constructed in accordance with ASME Section III requirements.

2.b The ASME Code piping including supports identified in Table 2.4.6-1 is designed and constructed in accordance with ASME Section III requirements.

3.a Pressure boundary welds in ASME Code components identified in Table 2.4.6-2 meet ASME Section III requirements.

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Table 12.2-12 (1 of 2)

CVCS Filter Inventories, Maximum Values (Bq)

Nuclide	Seal Injection	Reactor Drain	Boric Acid	Purification	Reactor Makeup Water
H-3	9.8E+08	1.7E+09	1.6E+09	2.0E+09	1.9E+09
N-16	0.0E+00	0.0E+00	0.0E+00	1.8E+08	0.0E+00
Kr-85m	7.7E+07	6.9E+07	0.0E+00	1.6E+08	7.1E-03
Kr-85	3.4E+08	5.7E+08	2.7E+04	6.7E+08	~~1.7E+02~~ 2.0E+02
Kr-87	5.6E+07	5.3E+07	0.0E+00	1.2E+08	4.6E-04
Kr-88	1.6E+08	1.5E+08	0.0E+00	3.4E+08	6.2E-03
Xe-131m	3.4E+08	4.9E+08	3.3E+02	6.7E+08	4.8E+01
Xe-133m	2.0E+07	2.3E+07	2.2E-02	4.1E+07	2.5E-01
Xe-133	2.2E+10	2.9E+10	1.5E+03	4.4E+10	8.2E+02
Xe-135m	3.4E+07	3.8E+07	0.0E+00	9.0E+07	1.5E-05
Xe-135	4.4E+08	4.1E+08	0.0E+00	9.0E+08	1.7E-01
Xe-137	6.3E+06	8.8E+06	0.0E+00	2.1E+07	2.4E-07
Xe-138	2.9E+07	3.3E+07	0.0E+00	7.8E+07	1.0E-05
Br-84	1.2E+04	1.3E+06	0.0E+00	3.0E+06	1.3E-06
Rb-88	6.6E+07	1.5E+08	0.0E+00	3.5E+08	3.4E-04
Sr-89	4.9E+03	4.0E+05	5.4E+04	4.9E+05	~~2.3E+00~~ 2.4E+00
Sr-90	3.3E+02	2.8E+04	3.2E+04	3.3E+04	3.7E-01
Sr-91	7.2E+03	3.3E+05	1.6E-12	7.3E+05	1.2E-03
Y-91m	1.9E+05	1.8E+05	0.0E+00	4.3E+05	7.6E-04
Y-91	3.6E+04	6.0E+04	8.6E+05	7.3E+04	~~3.4E+01~~ 3.5E+01
Y-93	8.6E+03	8.0E+03	1.5E-11	1.7E+04	4.4E-03
Zr-95	2.3E+03	1.9E+05	3.5E+04	2.3E+05	1.3E+00
Nb-95	7.8E+02	6.3E+04	5.0E+03	7.8E+04	~~2.8E-01~~ 2.9E-01
Tc-99m	2.4E+05	1.1E+07	0.0E+00	2.5E+07	1.6E-02
Mo-99	4.2E+05	2.5E+07	7.8E+02	4.3E+07	3.5E+00
Ru-103	2.6E+02	2.1E+04	2.0E+03	2.6E+04	~~1.0E-01~~ 1.1E-01
Ru-106	1.1E+02	9.5E+03	6.9E+03	1.1E+04	1.1E-01
Ag-110m	7.8E+03	6.6E+05	4.0E+05	7.8E+05	~~6.9E+00~~ 7.1E+00

Source terms for Boric Acid Filter have been revised in DCD, Rev.1.

Table 12.2-12 (2 of 2)

Nuclide	Seal Injection	Reactor Drain	Boric Acid	Purification	Reactor Makeup Water
Te-129m	4.5E+03	7.2E+05	5.1E+04	9.0E+05	~~2.9E-01~~ 3.1E-01
Te-129	4.3E+03	4.1E+05	0.0E+00	9.5E+05	1.9E-06
I-131	1.9E+06	2.6E+08	8.4E+05	3.8E+08	2.1E+01
Te-131m	2.1E+04	2.2E+06	4.1E-02	4.3E+06	5.9E-03
Te-131	6.8E+03	7.2E+05	0.0E+00	1.7E+06	4.6E-07
Te-132	1.5E+05	1.8E+07	1.3E+03	3.0E+07	3.1E-01
I-132	4.8E+05	4.4E+07	0.0E+00	1.0E+08	8.3E-04
I-133	2.6E+06	2.6E+08	5.3E-02	5.3E+08	3.8E-01
I-134	2.7E+05	2.6E+07	0.0E+00	6.2E+07	7.3E-05
Cs-134	1.3E+07	4.5E+07	1.7E+07	5.3E+07	~~2.2E+02~~ 2.3E+02
I-135	1.5E+06	1.4E+08	0.0E+00	3.0E+08	2.2E-02
Cs-136	1.8E+06	5.4E+06	3.0E+04	7.3E+06	~~4.0E+00~~ 4.1E+00
Cs-137	1.5E+07	5.2E+07	2.5E+07	6.2E+07	2.8E+02
Ba-140	6.2E+03	4.6E+05	5.5E+03	6.2E+05	~~7.5E-01~~ 7.6E-01
La-140	2.1E+03	1.1E+05	7.8E-02	2.1E+05	6.3E-03
Ce-141	2.3E+02	1.8E+04	1.3E+03	2.3E+04	~~7.8E-02~~ 8.1E-02
Ce-143	6.1E+02	3.2E+04	3.1E-03	6.2E+04	~~1.3E-03~~ 1.2E-03
Ce-144	6.7E+02	5.7E+04	3.7E+04	6.7E+04	~~6.1E-01~~ 6.3E-01
Na-24	2.7E+05	1.3E+07	6.5E-06	2.7E+07	1.1E-01
Cr-51	5.7E+10	1.8E+10	8.5E+08	8.6E+12	~~5.2E+05~~ 5.3E+05
Mn-54	4.9E+10	1.6E+10	9.5E+09	7.4E+12	1.4E+06
Fe-55	5.0E+10	1.7E+10	1.4E+10	7.6E+12	1.6E+06
Fe-59	2.0E+09	6.4E+08	6.3E+07	3.0E+11	~~2.7E+04~~ 2.8E+04
Co-58	4.8E+10	1.6E+10	2.7E+09	7.3E+12	~~8.5E+05~~ 8.8E+05
Co-60	2.4E+10	8.0E+09	7.4E+09	3.6E+12	8.0E+05
Zn-65	3.1E+03	2.6E+05	1.5E+05	3.1E+05	~~2.7E+00~~ 2.8E+00
Ba-137m(1)	1.5E+07	5.2E+07	2.5E+07	6.2E+07	2.8E+02
W-187	1.5E+04	7.4E+05	1.3E-03	1.5E+06	1.6E-02
Np-239	1.3E+04	7.5E+05	7.8E+00	1.3E+06	7.8E-02

(1) This nuclide is a daughter nuclide in secular equilibrium and the activity is that of the parent nuclide (Cs-137).

Source terms for Boric Acid Filter have been revised in DCD, Rev.1.

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Table 12.3-4 (3 of 10)

Room Number	Room Name	Minimum Required Shield Thickness (inches)					
		North	South	East	West	Floor	Ceiling
Auxiliary Building (cont.)							
068-A06A	Gas Stripper Room	37	35	45	35	30	24
068-A07A	Hot Pipe Way	13	29	31	29	24	24
068-A08B	Hot Pipe Way	33	24	24	20	23	30
068-A09B	Valve Room	19	17	23	19	17	10
068-A10A	Filter and Demin. Valve Area	10	10	33	33	30	24
068-A11A	Filter and Demin. Valve Area	10	24	10	22	24	21
068-A12A	Filter and Demin. Valve Area	10	18	10	18	17	29
077-A01A	Reactor Drain Filter Pit	35	10	10	15	10	23
077-A02A	SFP Cleanup Filter Pit	10	10	10	10	23	23
077-A03A	SFP Demin Filter Pit	10	17	10	24	23	23
077-A04A	SFP Cleanup Filter Pit	10	10	10	10	23	23
077-A05A	SFP Demin. Filter Pit	10	10	10	10	23	23
077-A06A	Purification Filter Pit	10	10	10	10	10	39
077-A07A	Reactor Makeup Water Filter Pit	18	32	24	18	10	10
077-A08A	Purification Filter Pit	10	10	10	10	10	39
077-A09A	SGBD Filter Pit	10	10	10	10	22	23
077-A10A	Seal Injection Filter Pit	10	10	10	11	24	24
077-A11A	SGBD Filter Pit	10	10	10	10	22	23
077-A12A	Seal Injection Filter Pit	10	13	10	10	13	24
077-A13A	SGBD Filter Pit	35	10	10	10	22	23
077-A14A	Boric Acid Filter Pit	13	18	10	29	10	22
077-A15A	Filter Cartridge Storage	32	39	39	39	25	39
078-A21A	Pipe Chase	10	36	48	48	10	24
078-A21B	Pipe Chase	36	10	48	48	10	10
078-A32A	SPF Cleanup Demin. Room	10	22	22	21	12	24
078-A33A	SG Blowdown Demin. Room	33	10	23	10	10	23
078-A34A	Pre-Holdup IX Room	33	15	15	33	15	24
078-A35A	Purification IX Room	12	24	29	43	29	42
078-A36A	Boric Acid IX Room	24	18	18	18	18	18

This value has been revised in DCD Revision 1

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Table 12.3-4 (7 of 10)

Room Number	Room Name	Minimum Required Shield Thickness (inches)					
		North	South	East	West	Floor	Ceiling
Compound Building (cont.)							
085-P32	Primary Sampling Sink Room	10	13	12	12	14	18
085-P42	IX Module Room	10	30	30	27	14	28
085-P43	IX Module Room	30	10	30	30	14	28
085-P44	RO Feed Tank Room	10	27	32	22	19	25
085-P45	Drum Removal Chase	15	15	15	15	-	25
085-P46	MF Membrane Module Room	23	10	20	15	18	16
085-P47	MF Membrane Module Room	23	16	10	12	15	16
085-P48	RO Membrane Module and Valve Skid Room	43	24	43	34	32	36
096-P01	Charcoal Delay Bed Room	22	19	21	14	28	17
096-P02	Charcoal Delay Bed Room	47	44	14	38	36	42
100-P02	GRS Equipment Removal Area	13	11	38	10	23	10
100-P07	Future Extension Area	24	30	36	37	24	31
100-P08	Truck Bay	24	24	36	37	36	31
100-P09	Waste Drum Storage Area	28	24	36	26	34	31
100-P10	Spent Filter Drum Storage Area	36	28	48	37	36	43
120-P01	Gaseous Radwaste Sample Control Panel Room	10	10	10	11	17	25
120-P02	Gaseous Radwaste Sample Valve Rack Room	20	10	25	17	17	25
139-P06	Normal Exhaust ACU Room	20	20	20	20	20	20
Yard							
-	Boric Acid Storage Tank	16	16	16	16	-	-
-	Holdup Tank	15(1)	15(1)	15(1)	15(1)	-	-

(1) Including the Tank wall of 0.25 inches

This table has been added in DCD Revision 1.

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Figure 12.3-9 Radiation Zones (Normal) Auxiliary/Containment Building El. 195'-0" and Roof Plan

Table 1.8-2 (26 of 38)

Item No.	Description
COL 11.5(8)	The COL applicant is to develop detailed locations, tubing installations, and provide the sampling method including the sampling frequency and time to acquire representative sampling.
COL 11.5(9)	The COL applicant is to determine the monitor type, safety class, measuring range, and installed location of the RE-165 and RE-166.
COL 11.5(10)	The COL applicant is to provide operational procedures and maintenance programs related to leak detection and contamination control.
COL 12.1(1)	The COL applicant is to provide the organizational structure to effectively implement the radiation protection policy, training, and reviews consistent with operational and maintenance requirements, while satisfying the applicable regulations and Regulatory Guides including NRC RGs 1.33, 1.8, 8.8, and 8.10.
COL 12.1(2)	The COL applicant is to describe the operational radiation protection program to provide reasonable assurance that occupational and public radiation exposures are ALARA.
COL 12.1(3)	The COL applicant is to describe how the plant follows the guidance provided in NRC RGs 8.2, 8.4, 8.7, 8.9, 8.13, 8.15, 8.20, 8.25, 8.26, 8.27, 8.28, 8.29, 8.34, 8.35, 8.36, and 8.38.
COL 12.2(1)	The COL applicant is to provide any additional contained radiation sources, such as instrument calibration radiation sources, that are not identified in Subsection 12.2.1.
COL 12.3(1)	The COL applicant is to determine the areas that will require either electro or mechanical polishing.
COL 12.3(2)	The COL applicant is to establish how the water chemistry pH control reduces radiation fields.
COL 12.3(3)	The COL applicant is to provide the material composition and shielding properties of the following doors/hatches, and these thicknesses equivalent to the minimum required concrete shield thicknesses. - Personnel Air Lock between Containment Annulus Area (100-C01) and Personnel Air Lock Entrance (100-A14A) - Personnel Air Lock between Operating Area (156-C01) and Containment Entrance Area (156-A04B) - Equipment Hatch between Operating Area (156-C01) and Equipment Hatch Access Room (156-A10A) - Door between Equipment Hatch Access Room (156-A10A) and the building exterior - Doors between Truck Bay (100-P08) and the building exterior Also, the COL applicant is to provide the service life of these doors/hatches and perform periodic in-service inspection and maintenance for these doors/hatches to provide reasonable assurance of functionality throughout the life of the plant.
5 COL 12.3(~~4~~)	The COL applicant is to provide portable instruments and the associated training and procedures in accordance with 10 CFR 50.34(f)(2)(xxvii) and the criteria in Item III.D.3.3 of NUREG-0737 as well as the guidelines of RG 8.8.
6 COL 12.3(~~5~~)	The COL applicant is to determine the ARM setpoints for WARN, ALARM, and the containment purge isolation and fuel handling area emergency ventilation actuation signals, based on the site-specific conditions and operational requirements.
COL 12.3(4)	COL applicant is to provide information to ensure that radiation levels at the site boundary not exceed the limits of 40 CFR Part 190, from all radiation sources, including the outdoor tanks.

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 doors or hatches being relied on to maintain doses within the radiation zone designations provided in the Chapter 12 radiation zone figures are as follows:

a. Personnel Air Lock between Containment Annulus Area (100-C01) and Personnel Air Lock Entrance (100-A14A)

b. Personnel Air Lock between Operating Area (156-C01) and Containment Entrance Area (156-A04B)

c. Equipment Hatch between Operating Area (156-C01) and Equipment Hatch Access Room (156-A10A)

d. Door between Equipment Hatch Access Room (156-A10A) and the building exterior

e. Doors between Truck Bay (100-P08) and the building exterior

The COL applicant is to provide the material composition and shielding properties of these doors/hatches, and these thicknesses equivalent to the minimum required concrete shield thicknesses. Also, the COL applicant is to provide the service life of these doors/hatches and perform periodic inservice inspection and maintenance for these doors/hatches to provide reasonable assurance of functionality throughout the life of the plant (COL 12.3(3)). 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.

COL applicant is to provide information to ensure that radiation levels at the site boundary not exceed the limits of 40 CFR Part 190, from all radiation sources, including the outdoor tanks (COL 12.3(4))

12.3.2.4 <u>Access Control to High Radiation and Very High Radiation Areas</u>

The high radiation and very high radiation areas, areas potentially greater than 1 Gy/hr and 5Gy/hr, respectively, as identified in Table 12.3-5, which are located in the containment

HVAC systems are described in Section 9.4.

12.3.4 Area Radiation and Airborne Radioactivity Monitoring Instrumentation

The area radiation monitoring system (ARMS) supplements the personnel and area radiation survey provisions of the plant health physics program described in Section 12.5 and provides reasonable assurance of conformance with the personnel radiation protection requirements of 10 CFR 20, 10 CFR Part 50, 10 CFR Part 70 (Reference 19); the guidelines of NRC RGs 1.21 (Reference 20), 1.97, 8.2 (Reference 21), 8.25 (Reference 5), and 8.8 (Reference 1); and American National Standards Institute (ANSI) N13.1-1999 (Reference 22) and Institute of Electrical and Electronics Engineers (IEEE) Std. 497-2002 (Reference 23). The ARMS is in conformance with ANSI/ANS HPSSC-6.8.1 (Reference 24).

The process and effluent radiation monitoring system and sampling systems are described in Section 11.5.

Portable instruments are used and the associated training and procedures are provided to accurately determine the airborne iodine concentration in areas within the facility where plant personnel could be present during an accident in accordance with the requirements of 10 CFR 50.34(f)(2)(xxvii) and the criteria in Item III.D.3.3 of NUREG-0737. Portable instruments are also used as needed during normal operation in accordance with the guidelines of RG 8.8. The COL applicant is to provide portable instruments and the associated training and procedures in accordance with 10 CFR 50.34(f)(2)(xxvii) and the criteria in Item III.D.3.3 of NUREG-0737 as well as the guidelines of RG 8.8 (COL 12.3(~~4~~5)).

With regard to the criticality accident monitoring, the requirements in 10 CFR 50.68(b) (Reference 25) are followed to prevent criticality as described in Subsection 9.1.1.

12.3.4.1 Area Radiation Monitoring System

12.3.4.1.1 Design Objective

The ARMS monitors the radiation levels in selected areas throughout the plant. Most area monitors are designed to warn operators and station personnel through visible and audible alarms when unusual radiological events occur. Some area monitors are designed to monitor the post-accident radiation level in areas where access to equipment that is

12.3.4.1.6 Range and Alarm Setpoints

The ranges of the ARMS are shown on Table 12.3-6. Alarm setpoints for safety-related monitors are determined by plant procedures and the Offsite Dose Calculation Manual (ODCM). The setpoint methodology includes the relationship between the analytical limit, setpoint, and channel uncertainty. The setpoint methodology also provides channel uncertainty calculations associated with the setpoints used for ESF actuation functions. The setpoint methodology follows the methodology in ANSI/ISA-67.04-1994 (Reference 27). The COL applicant is to determine the ARM setpoints for WARN, ALARM, and the containment purge isolation and fuel handling area emergency ventilation actuation signals, based on the site-specific conditions and operational requirements (COL 12.3(~~5~~ 6)).

12.3.4.1.7 Calibration Methods and Frequency

The methodology to determine the calibration methods and frequency of the ARMS is provided by the ODCM based on plant procedures.

12.3.4.1.8 Power Supplies

Instrument loops of safety-related monitors are powered from the appropriate train of Class 1E 120 AC distribution panel in the instrument power system (IP), which is powered by the onsite Class 1E emergency diesel generator. When the emergency diesel generator restores power to the skid, skid equipment such as sample pumps returns to the original operating status without having to be manually restarted. The TSC area radiation monitor, which is non-safety-related, is powered from permanent non-safety buses that are backed up by an alternate ac generator. Instrumentation and control power are described further in Subsection 8.3.2.

12.3.4.2 Airborne Radioactivity Monitoring Instrumentation

Airborne radioactivity monitors are installed in selected areas and HVAC systems to provide plant operating personnel with continuous information on the airborne radioactivity levels throughout the plant. These monitors, consisting of gaseous process and effluent radiation monitors (PERMS), are described in Section 11.5 and listed in Table 11.5-1. The airborne radioactivity monitors are as follows:

a. High-energy line break area HVAC exhaust monitor

b. Auxiliary building controlled area common HVAC exhaust monitor

COL 12.3(3) The COL applicant is to provide the material composition and shielding properties of the following doors/hatches, and these thicknesses equivalent to the minimum required concrete shield thicknesses.

- Personnel Air Lock between Containment Annulus Area (100-C01) and Personnel Air Lock Entrance (100-A14A)
- Personnel Air Lock between Operating Area (156-C01) and Containment Entrance Area (156-A04B)
- Equipment Hatch between Operating Area (156-C01) and Equipment Hatch Access Room (156-A10A)
- Door between Equipment Hatch Access Room (156-A10A) and the building exterior
- Doors between Truck Bay (100-P08) and the building exterior

Also, the COL applicant is to provide the service life of these doors/hatches and perform periodic in-service inspection and maintenance for these doors/hatches to provide reasonable assurance of functionality throughout the life of the plant.

COL 12.3(4) : COL applicant is to provide information to ensure that radiation levels at the site boundary not exceed the limits of 40 CFR Part 190, from all radiation sources, including the outdoor tanks.

COL 12.3(~~4~~5) The COL applicant is to provide portable instruments and the associated training and procedures in accordance with 10 CFR 50.34(f)(2)(xxvii) and the criteria in Item III.D.3.3 of NUREG-0737 as well as the guidelines of RG 8.8.

COL 12.3(~~5~~6) The COL applicant is to determine the ARM setpoints for WARN, ALARM, and the containment purge isolation and fuel handling area emergency ventilation actuation signals, based on the site-specific conditions and operational requirements.

12.3.7 References

1. Regulatory Guide 8.8, “Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations will be ALARA,” Rev. 3, U.S. Nuclear Regulatory Commission, June 1978.

MCR for operator action. This design approach minimizes contamination of the environment.

Reduction of Cross-Contamination, Decontamination, and Waste Generation

a. The SSCs are designed with life-cycle planning through the use of nuclear industry-proven materials compatible with the chemical, physical, and radiological environment, thus minimizing waste generation.

b. The primary coolant purity is maintained with chemical injection for optimal reactor operation. Boric acid is added to compensate for reactivity changes, fuel burnup, and xenon variations, and to provide shutdown margin. Lithium hydroxide is added for pH control, and hydrogen is added to minimize the occurrence of radiolysis. The addition of chemicals helps to minimize the generation of contaminated waste.

c Boric acid in the letdown flow is recovered for reuse to the maximum extent possible. In the event that the boric acid concentrate contains an abnormal quantity of radioactivity, the concentrate is sent to the liquid waste management system (LWMS) for neutralization, treatment, and release. The boric acid concentrator operates automatically to the desired boron concentration and sends the concentrate to the BAST for reuse. This design approach minimizes waste generation.

d. The holdup tank, BAST, and the RMWT are located outside in a tank house designed to prevent the infiltration of rainwater and the spread of contamination. The tank house is designed with a sloped floor that is coated with epoxy to facilitate draining and cleaning, and is equipped with a sump that has level switch instrumentation to detect leakage and overflows.

The epoxy coating on the floor of the tank house is Services Level III for outdoor tanks, and is to be maintained as part of the overall plant epoxy coating maintenance program.

In the event that leakage is detected, the level switch sends a signal to the MCR for operator actions. The fluid collected in the sump is routed to a auxiliary building equipment drain sump, and transfered to the LWMS. This design approach minimizes the spread of contamination and waste generation.

The sump for the outdoor tanks (HUT and BAST) is located within the structural walls surrounding the tanks. The sump is enclosed with a sump cover, similar to the indoor sumps, which serve to protect the sump from the elements. The outdoor sump design is site-specific. The COL applicant is to determine the need and the provision of freeze protection for the outdoor sumps (COL 9.3(8)).

e. The process piping containing contaminated fluids is properly sized to facilitate flow with sufficient velocities to prevent the settling of solids. The piping is designed to reduce fluid traps, thus reducing decontamination needs and waste generation. Decontamination fluid is collected and routed to the LWMS for processing and release.

f. Utility connections are designed with a minimum of two barriers to prevent the spread of contamination to clean systems.

Decommissioning Planning

a. The SSCs are designed with decontamination capabilities. Design features, such as integrated component packages, welding techniques used, and surface finishes are intended to minimize the need for decontamination and the resulting waste generation.

b. The SSCs are designed for the full service life of the plant and are fabricated as individual assemblies for easy removal to the maximum extent practicable.

c. The CVCS is designed with minimal embedded and buried piping. Piping between buildings is equipped with piping sleeves so that leakage is directed back to the building for collection, thus preventing unintended contamination.

Operations and Documentation

a. The CVCS is designed for automated operation with manual initiation. Boron injection is controlled by the makeup subsystem to maintain the desired boron concentration. Adequate instrumentation, including level, flow, and pressure elements, as well as process sampling, is provided to monitor and control the CVCS operations to prevent undue interruption, thus minimizing the spread of contamination and waste generation.

b. Leak detection instruments are provided to detect individual tank leakage. Adequate space is provided around the equipment to enable prompt assessment and responses when required.

c. ~~Operational procedures and maintenance programs as related to leak detection and contamination control are to be prepared by the COL applicant (COL 9.3(2)). Procedures and maintenance programs are to be completed before fuel is loaded for commissioning.~~

Contamination control procedures, inspection and maintenance program for the yard tanks includes sampling and analysis of the rainwater sump for the yard tanks before the rainwater is routed to either the equipment drain sump inside the AB for treatment by LWMS, if contaminated with tank leakage, or to the storm water collection pond if it is not radiologically contaminated.

COL 9.3(3) The COL applicant is to maintain complete documentation of system design, construction, design modifications, field changes, and operations.

COL 9.3(4) The COL applicant is to provide the flow diagram of turbine generator building drain system and the interconnection from the auxiliary boiler building sump, and the flow diagram of CCW heat exchanger building drain system to LWMS or turbine generator building (TGB) sump.

COL 9.3(5) The COL applicant is to provide connection provisions at the nearest accessible area to the valve and sight glass room of the IRWST leakage pipe line for detecting and cleaning blockage due to crystallized boron inside the leakage collection channel and pipes.

COL 9.3(6) The COL applicant is to prepare the site radiological environmental monitoring program.

COL 9.3(7) The COL applicant is to provide primary side water chemistry threshold values and recommended operator actions for chemistry excursions in compliance with the latest version of the EPRI PWR Primary Water Chemistry Guidelines in effect at the time of COLA submittal. The COL applicant is to establish the operational water chemistry program six months before fuel load.

COL 9.3(8) The sump for the outdoor tanks (HUT and BAST) is located within the structural walls surrounding the tanks. The sump is enclosed with a sump cover, similar to the indoor sumps, which serve to protect the sump from the elements. The outdoor sump design is site-specific. The COL applicant is to determine the need and the provision of freeze protection for the outdoor sumps.

9.3.6 References

1. 10 CFR 50.63, “Station Blackout Rule,” U.S. Nuclear Regulatory Commission.

2. ANSI/ISA S7.3R, "Quality Standard for Instrument Air". International Society for Measurement and Control, 1975(R1981).

3. 10 CFR Part 50, Appendix A, General Design Criterion 5, “Sharing of Structures, Systems, and Components,” U.S. Nuclear Regulatory Commission.

4. 10 CFR Part 50, Appendix A, General Design Criterion 56, “Primary Containment Isolation,” U.S. Nuclear Regulatory Commission.

5. 10 CFR Part 50, Appendix A, General Design Criterion 2, “Design Bases for Protection against Natural Phenomena,” U.S. Nuclear Regulatory Commission.

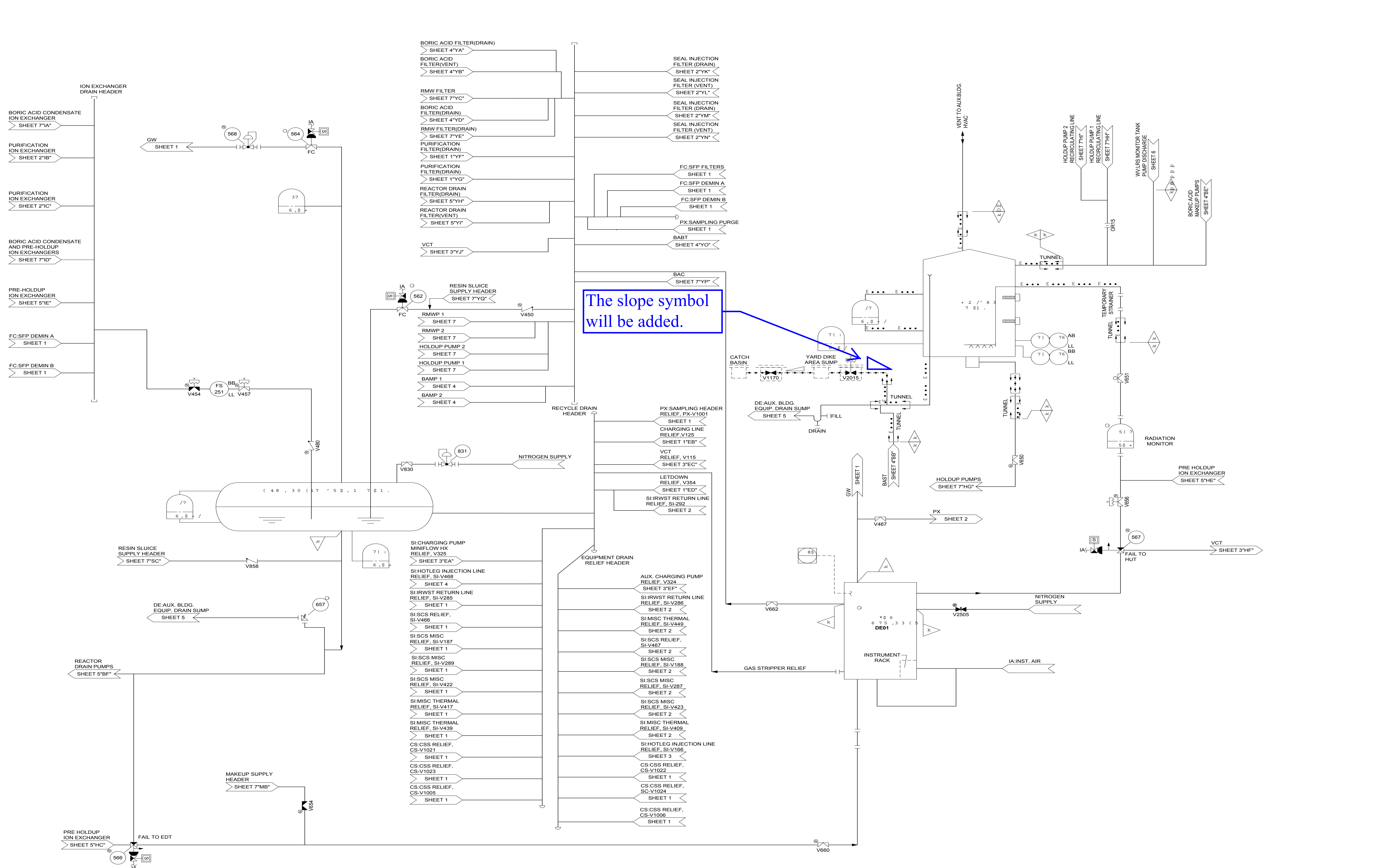

Figure 9.3.4-1 Chemical and Volume Control System Flow Diagram (6 of 7)

resins from the LWMS, SGBD, and SFPCCS for 1 year and the source terms for the LWMS are highest, it is conservative that the LASRT is only filled with LWMS resin. Additionally, the source term in the waste drum storage area is presented in Table 12.2-22a.

Dimensions and parameters of the radiation sources in compound building used in the shielding analyses are listed in Table 12.2-25.

12.2.1.5 Sources Resulting from Design Basis Accidents

Design parameters and source terms for design basis accidents (DBAs) are addressed in Chapter 15.

12.2.1.6 Stored Radioactivity

The holdup tank, reactor makeup water tank (RMWT), and boric acid storage tank (BAST) are the principal sources of activity outside the plant buildings. The surface dose rate of these tanks is designed so that it does not exceed 2.5 μSv/hr, except the immediate areas outside the side manways for these outdoor tanks which may exceed the Zone 1 criterion. ~~Administrative~~ A physical barrier and administrative controls are in place to prevent personnel from occupying the immediate vicinity of the outside tanks.

Spent fuel is stored in the SFP until it is placed in the spent fuel shipping cask for transport to an onsite interim storage facility or to an offsite storage facility.

Storage space is allocated in the compound building for the storage of spent filter cartridges and dewatered spent resin in the spent filter drum and HIC storage area as well as for solidified R/O concentrates and dry active waste (DAW) in drums in the waste drum storage area. The shielding design for the spent filter drum and HIC storage area is based on using the expected stored waste volumes for normal operation and the design basis source term (0.25% fuel failure) for the activity of wastes. For the source term of HICs, the volume and the associated source term of spent resin (not decayed) is increased by a factor of 1.656 (=Volume of 16 HICs / 1-cycle volume of spent resin) for conservatism. The zoning for this area is determined by summing the dose rates from the HIC and the spent filter drums. However, in determining the minimum shield wall thicknesses, the two dose rates are calculated individually since the impact of shield wall thicknesses is dominated by the close proximity of the individual sources (HIC or spent filter drum) to the walls around the designated storage areas. The shielding design for the waste drum area is based on the use of the design basis source term for the solidified R/O concentrate and the source term for the DAW is based on a waste drum with the highest activity at Korean domestic nuclear power plants to ensure that the shielding design is sufficiently