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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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APR1400 SUBCOMMITTEE

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TUESDAY

NOVEMBER 14, 2017

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:31 a.m., Ronald G. Ballinger, Chairman, presiding.

COMMITTEE MEMBERS:

RONALD G. BALLINGER, Chairman

CHARLES H. BROWN, JR., Member

WALT KIRCHNER, Member

JOSE MARCH-LEUBA, Member

DANA A. POWERS, Member

JOY REMPE, Member*

PETER C. RICCARDELLA, Member

GORDON R. SKILLMAN, Member

JOHN W. STETKAR, Member

MATTHEW W. SUNSERI, Member

DESIGNATED FEDERAL OFFICIAL:

MAITRI BANERJEE*

CHRISTOPHER BROWN

ALSO PRESENT:

TONY AHN, KHNP

JOHN BUDZYNSKI, NRO

LARRY BURKHART, NRO

RICH CLEMENT, NRO

TIM DRZEWIECKI, NRO

ZACHARY GRAN, NRO

BRAD HARVEY, NRO

JOHN HONCHARIK, NRO

JASON HUANG, NRO

SANGHO KANG, KEPCO E&C

HANSANG KIM, KHNP

JEONGMANN KIM, KEPCO E&C

JOONKON KIM, KEPCO E&C

JUNGHO KIM, KHNP

TAEHAN KIM, KEPCO E&C

YOUNGSEOK KIM, KEPCO E&C

CAROLYN LAURON, NRO

HIEN LE, NRO

DONGSU LEE, KEPCO E&C

DAEHEON LIM, KEPCO E&C

KWANGIL LIM, KEPCO E&C

GREG MAKAR, NRO

MICHAEL MAZAIKA, NRO

MICHAEL MCCOPPIN, NRO

JIYONG OH, KHNP

ROB SISK, Westinghouse

EDWARD STUTZCAGE, NRO

ROBERT SWEENEY, KHNP

GETACHEW TESFAYE, NRO

JESSICA UMANA, NRO

ANDREA D. VEIL, Executive Director, ACRS

DAVID WAGNER, KHNP

WILLIAM WARD, NRO

STEPHEN WILLIAMS, NRO

*Present via telephone

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P R O C E E D I N G S

8:31 a.m.

CHAIRMAN BALLINGER: (presiding) The meeting will now come to order.

This is a meeting of the APR1400 Subcommittee of the Advisory Committee on Reactor Safeguards. I'm still Ron Ballinger, Chairman of the APR1400 Subcommittee.

ACRS members in attendance are, my goodness, Dana Powers, Matt Sunseri, John Stetkar, and Jose March-Leuba.

We have had a travel vortex. Member Rempe is on the phone. A lot of people are having trouble getting here.

MEMBER POWERS: It is no reflection on the presenters, just the Chairman.

(Laughter.)

CHAIRMAN BALLINGER: Correct. Okay. So noted.

The purpose of today's meeting is for the Subcommittee to receive briefings from Korea Electric Power Corporation and Korea Hydro & Nuclear Power Company regarding their Design Certification Application and the NRC staff regarding their Safety Evaluation Report with no open items, specific to

Chapters 2 -- 2.5 will be later -- Chapter 5, Chapter 11, and Chapter 12.

The ACRS was established by statute and is governed by the Federal Advisory Committee Act, FACA. That means that the Committee can only speak through its published letter reports. We hold meetings to gather information to support our deliberations.

Interested parties who wish to provide comments can contact our offices requesting time after the meeting announcement is published in The Federal Register. That said, we set aside 10 minutes for comments from members of the public attending or listening to our meetings. Written comments are also welcome.

And Walt Kirchner has arrived.

The ACRS section of the U.S. NRC public website provides our charter, bylaws, letter reports, and full transcripts of all full and subcommittee meetings, including slides presented at these meetings.

A transcript of the meeting is being kept and will be made available, as stated in The Federal Register notice. Therefore, I request that participants in this meeting use the microphones located throughout the meeting room when addressing the Subcommittee. Participants should first identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

We have a bridge line established for interested members of the public to listen in. The bridge number and password were published in the agenda posted on the NRC public website.

To minimize disturbance, this public line will be kept in the listen-only mode. The public will have an opportunity to make a statement or provide comments at a designated time towards the end of this meeting.

I request that meeting attendees and participants silence cell phones and other things that may go "beep".

Chris Brown is the Designated Federal Official for this meeting.

And now -- there is a little column over there -- I will invite Bill Ward, the NRO Project Manager, to introduce presenters and start the briefing.

Bill?

MR. WARD: Thank you.

Again, the staff and KHNP are pleased to present another set of chapters. We appreciate the ACRS's supporting our aggressive schedule for running these through you.

This series is like the more recent ones in phase 4-phase 5 where we are doing more of a minimalist approach to allow more time for your questions. So, we look forward to a productive day.

Thank you.

CHAIRMAN BALLINGER: Bob?

MR. SISK: Rob Sisk, Westinghouse, consulting to APR1400 and KHNP.

Again, I want to echo Bill's comments. We are very pleased to be here to be able to present these chapters in phase 5, as we begin to complete these reviews.

And without further delay, I'm going to introduce Mr. Youngseok Kim, and he will lead us through Chapter 2.

MR. Y. KIM: Good morning, gentlemen. My name is Youngseok Kim. I'm a hydrologic engineer working at KEPCO Engineering & Construction Company.

Today I am going to present our work research entitled, "APR1400 DCD 202, Chapter 2, Site Characteristics," excluding Section 2.5.

And so, this presentation consists of

four parts: Overview of Chapter 2, Response to the ACRS Subcommittee Questions, Current Status, Attachments.

Overview of Chapter 2. Chapter 2 consists of Section 2.0 through 2.5, and this presentation includes Section 2.0 through 2.4. As noted in this slide, Section 2.5 is not discussed in this meeting.

Section 2.0 describes site characteristics. Section 2.1 describes geography and demography. Section 2.2 describes nearby industrial, transportation, and military facilities. Section 2.3 describes some meteorology.

Next.

Section 2.4 describes hydrologic engineering.

List of submitted documents for these site characteristics are shown in the upper table of this slide. There is no open item for Chapter 2.

In the ACRS, page 3, Subcommittee 21 September 2016, there were several questions for Chapter 2, and I will explain our responses from this slide.

First, a member noted to staff that the "exclusion area boundary" and "site boundary' were used interchangeably, although these terms are not necessarily the same for all facilities. The staff provided a response to KHNP as follows:

The revisions to SER Subsection 2.3.5.4 note that the terminology "EAB Site Boundary" in SER Table 2.3.5-1 is directly based on the Applicant's response. And the staff also notes that the annual average dispersion factors for the APR1400 design appropriately associate these values with the "site boundary". The context for the SER discussion is the staff's evaluation of these postulated site parameter values for reasonability by comparison to not only the values of the Applicant, but to other values identified by the staff in the SER.

Next slide.

MEMBER REMPE: Can I interrupt for a minute? Am I talking too loud or should I put the phone way over?

CHAIRMAN BALLINGER: You're fine.

MEMBER REMPE: Okay. I am looking up the updated slides that KHNP provided versus the earlier version that we got, and there have been some substantial changes.

And I know that in the RAI response back you may have used the correct usage of "site boundary" and "EAB," but in the earlier slides we've used these terms interchangeably. Does KHNP plan to somewhere state in the actual Design Certification clearly that it has the same distance, whether it's 800 or 805 meters, for this location that applies equally to the EAB and the site boundary?

MR. KANG: This is Sangho Kang at KEPCO E&C.

In the original in the description of our presentation we mentioned that we used the "EAB" and "site boundary," the terminology interchangeably, but we changed it, based on the staff's comments, to provide the staff's position on the terminology. But, actually, when the COL applicant is embarked for the APR1400 design in the United States, it means that there is a specific site. In that case, the exclusion area boundary is decided by the calculation of the radiological consequences for the loss-of-coolant accident.

And the definition of "EAB" is defined, provided in 10 CFR 100.3. It says that the exclusion area means that the area surrounding the reactor in which the reactor licensee has the authority to determine all activities, including exclusions or removal of personal property from this area.

Otherwise, while the site boundary is defined in 10 CFR 20.1003, it says that the site boundary means that "the line beyond which the land or property is not owned, leased, or otherwise controlled by the licensee". But the definition is quite similar.

But in the real situation in Korea, the exclusion area boundary is the minimum distance the licensee should own the land, and the site boundary might be the same distance or greater than the minimum distance. So, it will be decided by the owner of the site or licensee, depending on the situation of the site.

So, in the Design Certification phase, we assume that the site boundary and the exclusion area boundary have the same distance.

MEMBER REMPE: It clears up the case, and what I'm asking is, will you actually clearly state that in your Design Certification documents themselves, that you have clearly, as you've said right now, "we've assumed the same distance for this Design Certification"? But it may be changed when you actually have an applicant.

MR. SISK: This is Rob Sisk, Westinghouse.

I guess I'm curious, is it necessary to

explicitly make a statement like that versus simply referring to the rules and requirements? I think where we are in the current Design Certification documentation, it would be clear to an applicant what their requirements would be.

MEMBER REMPE: You clearly stated it in the response back in your RAI, and they have to delve down into it. But, again, that's something that will be between you and the staff, but it does seem like it's only indirectly stated.

MR. SISK: Appreciate the comment, but -- thank you.

MEMBER REMPE: Okay.

CHAIRMAN BALLINGER: Joy, when you talk, are you on a speaker phone?

MEMBER REMPE: I am.

CHAIRMAN BALLINGER: Because about every third word gets kind of chopped off.

MEMBER REMPE: Okay. I'll try -- I can take it off the speaker phone. Does that work better for you?

CHAIRMAN BALLINGER: Well, we'll find out the next time you give an answer to a question. Thanks.

MR. Y. KIM: I continue.

This question is related to design basis flood and maximum groundwater level. It was asked to explain which buildings outside the nuclear island need to be protected water level limits, including the turbine generator building, and provide the related COL information item.

For this question, KHNP provided the response that, though this is important to safety, safety in Section 3.2 consists of the buildings in the nuclear island and buildings outside the nuclear island, including turbine generator building, as shown in this slide.

And the maximum flood and groundwater elevations are addressed in DCD Tier 2, Table 2.0-1, and applied to the design of these buildings.

Lastly, COL Information 2.4(1) states that COL applicant is to provide the site-specific information on flood protection requirements.

Yes, next slide.

CHAIRMAN BALLINGER: I should comment that we have been joined by Charlie Brown, member.

MR. Y. KIM: Yes, I continue.

This question is related to Subsection 2.4.4, potential dam failures. For this question, KHNP provided the response that, as stated in DCD

Tier 2, Subsection 2.4.4, artificially large floods means the floods to safety-related facilities due to the failure of upstream and downstream water control structures such as dam, reservoir, and levee.

Next slide.

This question is related to Subsection 2.4.11, low water considerations. It was commented that downstream dam, impoundment of cooling water dikes, et cetera, are not addressed.

For this question, KHNP provided the response that downstream water control structures such as downstream dam, impoundment of cooling water dikes, et cetera, are addressed in DCD Tier 2, Subsection 2.4.4. And according to COL information 2.4(1), the COL application is to provide site-specific hydrologic information and meet the requirements of low water considerations and any potential failures addressed in Section 2.4.

Next.

Currently, Chapter 2, Revision 1, is issued and completed with no open items. However, KHNP continues to monitor Chapter to assure any conforming changes are addressed.

Acronyms for the presentation of DCD Section 2.1 through 2.4 are shown in this slide.

Thank you for your attention. Any question?

MR. SISK: That completes -- this is Bob Sisk, Westinghouse -- that completes our presentation on Chapter 2, unless there's any questions from the members.

CHAIRMAN BALLINGER: I think we're rapidly getting ahead of schedule, which is a good thing. I'm looking at the schedule. Next up is Chapter 5.

Oh, I'm sorry. I'm sorry. Okay, I'm sorry. Okay. We've got to do a little changeout here. And anybody that wears bifocals will understand the problem.

(Laughter.)

Okay. We're ready to go? Thank you. I sort of expected three or four people to be sitting up there.

MS. LAURON: Good morning. My name is Carolyn Lauron, and I'm the Project Manager for Chapter 2, Site Characteristics.

Today's presentation will cover Sections 2.1 through 2.4. The review team for these sections is listed on this slide, and some are available today, this morning, to answer any questions you may have.

The phase 2 Draft SER with open items for Sections 2.1 through 2.4 had no open items.

On slide 4, there are a few errors that I will point out as I give the presentation.

The staff completed it's phase 4 Advanced SER for Sections 2.1 through 2.4 and submitted it for your review about a month ago. The report covered geography and demography, human-related hazards, meteorology, and hydrology. Geology is not covered in today's presentation.

The report closed confirmatory items previously identified and discussed with you earlier this year. The report also includes a confirmatory item related to some clarification questions we discussed previously with the applicant and expected to be included in DCD Revision 1.

Section 2.5 on geology, seismology, and geotechnical engineering will be presented at an ACRS meeting in January.

We expect all confirmatory items in this Advanced Safety Evaluation Report to be closed with Revision 2 of the DCD expected next year.

Thank you.

MEMBER STETKAR: Carolyn, I had a question. We have had some discussions about zero percent exceedance temperatures and 1 percent exceedance temperatures and 5 percent exceedance temperatures. There had been exchanges between the staff and the applicant regarding that.

In particular, what I want to ask you about is in Table 2.0-1 of the DCD. They state that, for the purposes of the ultimate heat sink, as opposed to the ventilation systems, the ambient zero percent exceedance value for the maximum non-coincident wet bulb temperature is 81 degrees Fahrenheit. I'm saying that from memory, as you're looking up things.

There's an expanded discussion of that issue in the current version of the SER. And I came across the following statement, and if you want to search for it, it's in your Section 2.3.1.4.6.

It says, "The staff also found that about 33 percent of weather stations in the 48 contiguous U.S., as recorded in 2005 database of Climatic Design Information by ASHRAE, had reported an extreme historical maximum wet bulb temperature less than or equal to 27.2 degrees C, 81 degrees Fahrenheit." Then, it goes on to say that that's the single peak hourly observed value and there's zero percent exceedance value; it excludes things that are less than two hours, et cetera, et cetera.

Is it really true that 67 percent of the reporting stations in the United States have a maximum non-coincident wet bulb temperature that's higher than 81 percent? Sixty-seven percent? I want to make sure that that wasn't mistyped as less than versus greater than. It says 33 percent reported less than, meaning 67 percent must have greater than, meaning two-thirds of the country you can't meet the DCD requirements.

MS. LAURON: So, Michael Mazaika, who is the primary reviewer for Section 2.3, is available to answer your question.

MR. MAZAIKA: This is Mike Mazaika. I'm a meteorologist with NRO/DSEA.

I can verify that 67 percent, but I'm pretty sure that it's fairly close.

MEMBER STETKAR: Okay. I just wanted to make sure. It says 33 percent was less than, and I just wanted to make sure that it wasn't a typo, that you were trying to say 33 percent was greater than. But you're confirming that it is 33 percent of the country is less than this, meaning if I was going to build this plant in the United States, I have 67 percent probability that I would have to take an exception to the DCD?

MR. MAZAIKA: Based on the information there, I believe that's correct.

MEMBER STETKAR: Okay. Thank you.

MR. MAZAIKA: I think we had a very spirited debate about it, and it was in --

MEMBER STETKAR: We did --

MR. MAZAIKA: In dry climates --

MEMBER STETKAR: Yes.

MR. MAZAIKA: -- is where most of those stations are located.

MEMBER STETKAR: Yes. We did, and I had notes from -- I have about three pages of notes for this. As I said, it went on for quite a while.

And I just wanted to confirm because it is in the SER. I just wanted to make sure that that's an accurate statement in the SER.

MR. MAZAIKA: I will verify that.

MEMBER STETKAR: Yes. I mean, I don't care about four significant figures. I just wanted to make sure that it was not reversed.

MR. MAZAIKA: Yes, I believe that's fairly accurate.

MEMBER STETKAR: Okay. Thank you.

CHAIRMAN BALLINGER: That was quick.

MS. LAURON: Thank you.

CHAIRMAN BALLINGER: Thank you.

Now we continue the musical chairs.

MR. JEONGMANN KIM: Good morning. My name is Jeongmann Kim. I have taken the lead for Chapter 5 for KEPCO E&C.

It is my pleasure to present Chapter 5, RCS and Connecting System.

Next, please.

This slide shows the contents of the Chapter 5 presentation. Overview of Chapter 5 includes section overview, list of submitted documents, and list of open items. And the summary of open items, current status of Chapter 5, and attachments with acronyms.

Next, please.

This slide shows the overview of Chapter 5. Chapter 5 consists, of course, of sections such as Subsection 5.1, Summary Description; 5.2, Integrity of Reactor Coolant Pressure Boundary; 5.3, Reactor Vessel, and 5.4, RCS Component and Subsystem Design.

Next, please.

This table shows that KHNP submitted the DCD Tiers 1 and 2, Revision 1, with four Technical Reports for Chapter 5. There have been 78 RAIs, and all of these RAIs were responses by KHNP.

There are open items for justifiable SERs in the phase 2. Six open RAIs are related to RCP motor flywheel integrity. The last three open RAIs are POSRV sizing, LTOP analysis, and the prevention of potential gas accumulation.

Next, please.

The profile already introduced the summary of open items. This open item is related to POSRV sizing. Staff wants to know the referenced sensitivity study containing assumptions used for the POSRV sizing study.

Therefore, staff requested to provide additional POSRV capacity details, the basis for DCD Figure 5.2.2-1, and to provide access to the analysis referenced in the DCD which contains an assessment describing the basis for POSRV sizing.

KHNP provided the response with detailed capacity basis and the sizing analysis of the POSRV.

Next, please.

This open item is related to the LTOP analysis. The APR1400 does not contain the analysis demonstrating the adequacy of the LTOP design. Therefore, staff requested to provide description of the analysis and, more specifically, provide the mass and energy addition transient results, including analysis assumptions, evaluation model, methodology, computer codes, and input parameters.

Next.

In response, KHNP provided a discussion of the analysis of mass and energy limiting events. However, staff identified additional questions regarding the analysis of the limiting events where LTOP applied.

In the later response to additional questions, KHNP provided method of analysis, basic data, assumptions, input parameters, and the conservatism of input data for mass and energy transients.

Included is the balance of open items are related to RCP motor flywheel integrity. The first one is related to fracture toughness.

Staff requested to provide either the fracture toughness barrier, using the direct method or include the fracture toughness as an ITAAC.

KHNP revised the DCD to state fracture toughness, however, and this was 150 ksi by the direct method.

Next.

This item is related to the operating

experience for the material. Staff requested to provide the relevant information demonstrating the performance of the proposed flywheel material under the APR1400 operating conditions. KHNP revised the operating experience table with only relevant flywheels.

This item is related to the stress limit of RCP flywheel. Staff requested to apply an RCP flywheel stress limit of one-third of the yield strength of the material or provide technical justification for use of one-third of ultimate strength. This applies as to what the flywheel stress limit of one-third of the yield strength of the material according to the SRP 5.4.1.1 is applied in the KHNP APR1400 Flywheel Integrity Report. This Technical Report was made available for staff's audit.

Next, please.

This item is related to the hub analysis and the fatigue crack growth rates. Staff asked us to revise the Technical Report to include an analysis of the hub and provide the appropriate fatigue crack growth rate.

In the response, a separate stress plot of the hub is added in the KHNP APR1400 Flywheel

Integrity Report. This Technical Report includes the analysis with regards to the crack growth rate.

Next.

This item is related to the critical flaw size for the motor flywheel. Staff requested to specify the maximum flaw size used as the acceptance criteria for the pre-service inspection. Staff requested also that it is bounded by the flaw size used in determining the critical flaw size.

In response, KHNP revised the DCD to include the inspection acceptance criteria of less than .5 inches.

Next, please.

This is the last item as to the motor flywheel integrity. Staff requested to revise the DCD to state that the hub will be inspected for both PSI and ISI in the same manner. And also, staff requested to provide a discussion on the extent and acceptance criteria of UT inspections that could be performed or other alternatives of performing in-service inspections, given these geometric interferences, such as oil channels.

Oil channels in the hub make it difficult to perform UT inspections. Therefore, dye penetration or magnetic particle test, instead of UT, is added to the DCD for ISI instructions.

The last item is related to the potential gas accumulation. GL 2008-01 requests to prevent potential gas accumulation in safety-related systems of SCS, SIS, and CSS, including potential gas entrainment during the mid-loop operations from vortexing.

Staff requested to address GL 2008-01 and NEI 09-10, Revision 1a-A, as they relate to SCS, SIS, and CSS or provide and justify an alternate approach to managing gas accumulation.

KHNP provided a markup of ITAAC regarding potential air ingestion and/or vortexing during refueling conditions and gas accumulation during power operation.

ITAAC for gas accumulation was revised in DCD Tier 1 for SIS, SCS, and CSS. ITAAC for air entrainment during mid-loop operations was revised in DCD Tier 1.

Next, please.

According to staff, Chapter 5 is complete. However, KHNP continues to monitor Chapter 5 to assure that any conforming changes are addressed.

Nine open items that were identified in phases 2 and 3 have been resolved with adequate and sufficient discussion with the staff.

Changes in Chapter 5, as reviewed and marked-up in response to the RAIs, will be incorporated the next revision, Revision 2 of the DCD.

This slide shows acronyms used in Chapter 5.

Thank you for your attention.

MR. SISK: That's the presentation on Chapter 5.

CHAIRMAN BALLINGER: Note that we've been joined by Member Riccardella.

MEMBER STETKAR: Mr. Kim --

MR. JEONGMANN KIM: Yes?

MEMBER STETKAR: -- I noticed that Revision 1 of the DCD, Section -- if I can find it here -- 5.2.3.2.1, the section on reactor coolant chemistry, and the associated tables, have been expanded considerably, have been expanded a lot from Revision 0. There are discussions in here that say things like, well, if I look at the possible combinations of -- what do you use for -- lithium something-or-other -- lithium hydroxide monohydrate, and boric acid, if I look at possible combinations that are allowed, you could have a pH in the primary system as low as 4.2 or as high as 10.7. That's quite a range. You also have tables. You have curves.

Could you explain, please, why you added all of this material? And more importantly to me, could you explain how you are going to control reactor coolant system pH and chemistry through all of the operating regimes, all the way from cold shutdown to startup at new core, all the way through the end of core life? That's a big request, but you, apparently, were concerned about this because you added a lot of material to the DCD about it. So, tell me why, and please tell me how you are actually going to control chemistry.

MR. T. KIM: This is Taehan Kim, KEPCO E&C.

Actually, these items were incorporated by EPRI chemistry guidelines with the discussion with staff for chemistry control, based on RAI 8367. But I'm afraid I'm not the person for the exact number of each.

MEMBER STETKAR: Does KHNP have anybody here who can explain this, since it's a major addition to the DCD?

MR. SISK: This is Rob Sisk,

Westinghouse.

We do not have any chemists to discuss it in detail here today.

MEMBER STETKAR: Okay. Thank you.

MEMBER POWERS: I'm not sure what you're asking for, John.

MEMBER STETKAR: Okay. I think I know how they're going to try to control chemistry, but it is not at all clear to me from what's written there. And the troubling thing to me -- and, Dana, you might be able to help -- is that range of pH that they say is a pretty big range. I don't think that they actually expect to be anywhere near the extremes of that range, but I'm not at all clear how in the DCD -- they specify the range in the text. And it's not clear to me what sort of controls they are going to have to keep you kind of around 7, for example.

(Laughter.)

MEMBER POWERS: Well, I mean, you just measure the pH and you admit a little extra boron or extra base to be near whatever you want.

(Laughter.)

MEMBER STETKAR: No, no. I understand how to do it. I'm not sure how they're -- I think I know how they are proposing to do it, but I wanted a little bit of elaboration from the people who wrote this.

MEMBER POWERS: Yes. I can understand your --

MEMBER STETKAR: And I don't want to presume -- as I said, I think I know how they're going to do it, and you probably think you know how they're going to do it.

MEMBER POWERS: Well, technically, there are about 30 chemical technicians at a nuclear power plant. I assume they have about 30 chemical technicians at a nuclear power plant just to do exactly this. But it isn't rocket science. There are lots of things that are poorly understood about this chemistry at the operating temperatures, but, presumably, people have discovered this works; anything else doesn't work. That's what they do.

(Laughter.)

CHAIRMAN BALLINGER: And they committed to adhering to the EPRI guidelines.

MEMBER POWERS: Things work well if your plant falls within the envelope of what the EPRI guidelines were written for.

MEMBER STETKAR: These guys have a much higher -- "these guys"? -- KHNP has a much higher boron concentration during shutdown.

MEMBER POWERS: Yes.

MEMBER STETKAR: They have 4400 ppm.

MEMBER POWERS: Yes.

MEMBER STETKAR: So, they're kind of different from --

MEMBER POWERS: They're really --

MEMBER STETKAR: They're really borated.

(Laughter.)

MEMBER POWERS: Yes. And the only problem you worry about there is boron precipitation if you get too cold.

MEMBER STETKAR: That's one, yes.

MEMBER POWERS: Because that's, basically, painful when it occurs.

MEMBER STETKAR: Seeing no traction on this one, let me try one that's perhaps easier. In Section -- this is a long one -- 5.4.7.2.6 regarding reactor level control during shutdown conditions, you added descriptions of four level-monitoring systems. One of those systems -- I have to get the acronyms here because it's full of acronyms -- the Local Refueling Water Level Indiction System, LRWLIS, it says, "The LRWLIS (site class) has a minimum visible span of 150 inches above the bottom of the hot leg."

Then it goes on. It says, "High-low and low-low alarms are provided in the main control room." How do you get high-low and low-low alarms from a site class?

It also says, "Two level instrumentations are providing for monitoring coolant level." Does this mean you have two site classes?

Turn the microphone on, so you're on the record, please.

MR. JEONGMANN KIM: Your question was -- there is alarm levels --

MEMBER STETKAR: No.

MR. JEONGMANN KIM: -- like high-high --

MEMBER STETKAR: Yes, I'm asking particularly, this section describes four different level monitoring systems, a PWR LIS wide range, a PWR LIS narrow range, and LRW LIS and a ULMS, since we like acronyms.

In particular, I'm asking about the LWR LIS, which is characterized as a local site class that is outside of the secondary shield wall and provides level indication from somewhere in the pressurizer to the bottom of the hot leg. And the statement in the DCD says that high-low and low-low alarms are provided in the MCR. I'm asking, how do you provide high-low and low-low level alarms from a site class? It's unusual to do that, especially since you have three other electrical systems.

MR. JEONGMANN KIM: Yes.

MEMBER STETKAR: Yes.

MR. JEONGMANN KIM: Okay. I will explain about that.

MEMBER STETKAR: Okay.

MR. JEONGMANN KIM: There are some boundaries in the site class. So, the levels come down; the levers come down. They make a signal to --

MEMBER STETKAR: So, you actually do plan to provide alarms from that site class?

MR. JEONGMANN KIM: Yes.

MEMBER STETKAR: Thank you. That's what I was -- okay. I know it can be done. It's just really unusual.

The second question I had is the ultrasonic level indication. It says, "Two ultrasonic level monitoring systems are installed temporarily on the bottom of both hot legs." Do you do that in Korea?

MR. JEONGMANN KIM: Yes.

MEMBER STETKAR: You do?

MR. JEONGMANN KIM: Yes.

MEMBER STETKAR: The dose rates aren't too high on the hot legs to install those local monitors?

MR. JEONGMANN KIM: Yes, temporary, we use the temporary ultrasonic device.

MEMBER STETKAR: Right, but what I'm asking about is, those are installed only during the outage, is that correct? Those are not permanent?

MR. JEONGMANN KIM: Yes, just the mid-loop.

MEMBER STETKAR: Just mid-loop?

MR. JEONGMANN KIM: Yes, temporary.

MEMBER STETKAR: Typically, dose rates near the hot leg are fairly high.

MR. JEONGMANN KIM: Yes, yes.

MEMBER STETKAR: But they're not too high for people to install these monitors?

MR. JEONGMANN KIM: Yes, but that's a high-level dose rate, but we wanted to ensure the actual level during the middle of operations.

MEMBER STETKAR: No, I understand. This is the final very fine at the bottom of the loop indication that you have.

MR. OH: Yes, this is Andy Oh, KHNP Washington office.

Before going into the middle, we do some of the purification loop and reduce the RCS radiation level. The workers can access that area. So, I think it can be possible to attach the UT to the hot leg.

MEMBER STETKAR: You have to remove the insulation from the piping to install these?

MR. OH: That detail I need to consult some other people who are the expert for that, but --

MEMBER STETKAR: I'm not concerned about the technology here at all. I'm concerned about the practicality of a COL applicant committing to install these things during an outage.

MR. OH: As per the radiation concerns, we are just using a purification loop and reduce the level of the radiation before entering the --

MEMBER STETKAR: So, you get the dose rates down far enough, so that they can install them? And this is done in Korea today on these?

MR. OH: Yes.

MEMBER STETKAR: I mean, you don't have these plants operating, but is it done on similar plants?

MR. JEONGMANN KIM: Yes, we do for --

MEMBER STETKAR: It is?

MR. SISK: So, just to be clear -- this is Rob Sisk, Westinghouse -- just to clarify I think some of the discussion we've had, this is done --

MEMBER STETKAR: This is done? I'm looking for actual operating experience because it's somewhat unusual.

MR. SISK: Yes, this is done in Korea.

MEMBER STETKAR: Okay.

MR. SISK: And also, to answer the question, the insulation does need to be removed.

MEMBER STETKAR: Yes. That's --

MR. SISK: Yes, the purification of this system is required before you can install the caps.

MEMBER STETKAR: Okay. Okay. Thank you. That helps.

CHAIRMAN BALLINGER: Any additional questions? Other questions?

(No response.)

Okay. We're, by this schedule, 15 minutes ahead, but the next presentation is scheduled for 45 minutes. I think we don't have to keep to the schedule, but I'm just wondering whether adding 45 minutes -- well, okay, why don't we start? Okay, I've been overruled.

Yes, it's the staff's turn.

MS. UMANA: Good morning. My name is Jessica Umana. I'm the Project Manager for Chapter 5, Reactor Coolant Systems and Related Systems.

And today the staff is going to present to the ACRS Subcommittee their issues, resolutions, and conclusions coming out of the phase 2, going into phase 4, Safety Evaluation with no open items.

This slide lists the names of the reviewers that were involved in the development of the phase 4 Safety Evaluation with no open items. Today you are going to be hearing from John Budzynski and John Honcharik.

Okay. This is just a quick description overview of Chapter 5. The reactor coolant system circulates water in a closed cycle, removing heat from the reactor core and internals and transferring it to a secondary system. And then, components of the RCS include the reactor vessel, the steam generator, the reactor coolant pumps, the pressurizer, and any associated piping.

These are the sections in Chapter 5 that had open items. We have 5.2.2, Overpressure Protection, and John Budzynski will be presenting those open items. We have 5.4.1.1., which is the RCP Flywheel Integrity, and John Honcharik will be presenting that. And then, we'll go back to John Budzynski for 5.4.7, which is the Residual Heat Removal System.

So, I'm going to turn it over now to John Budzynski, so he can elaborate further on Section 5.2.2.

MR. BUDZYNSKI: 5.2.2, yes.

My name is John Budzynski. I work with the Reactor Systems Branch.

And this open item, RAI 8244, Question 05.02.02-1, refers to the sensitivity study that they referenced in the DCD pertaining to the sizing of the POSRVs. They provided it to us. I took a review of the sensitivity study. There were 20 cases in the sensitivity study, and there are indications they varied the pressurizer level and they also varied the pressurizer pressure. And the worst case was with the level of 45 percent, was the pressure of 24 and 75 psia. And that provided a reactor cooling pressure of about 2700 psia.

I reviewed their inputs and their assumptions, and it is a little conservative. I also consulted with Chapter 15 personnel, the staff that was reviewing ATWS, because this is kind of similar to ATWS condition where you have a loss of load with a delayed trip. And their analysis showed that there is sufficient sizing of the POSRVs, and I accepted that as sufficient proof.

The second open item is RAI 8609, Question 05.02.02-7, and we requested additional information on methodology for the balance of limiting events at low pressure protection conditions. They provided us with a methodology and computer codes. For the past addition transient, what they did was a hand calculation of the mass balance. I have reviewed their initial conditions and assumptions, and it seemed reasonable of what they did.

For the energy addition transient, they used a computer code called AvERP. It's a pass-through transient code. One of the assumptions they made was that the differential pressure between the secondary side and the reactor coolant side was a delta T of 250 degrees, and that's about 150 degrees greater than what the tech specs ask for. I feel that they did this to make it the most conservative input.

MEMBER STETKAR: John, we had some discussion about this at the Subcommittee meeting.

MR. BUDZYNSKI: Yes.

MEMBER STETKAR: Is it actually physically possible to get that large a delta T between the secondary and the primary side?

MR. BUDZYNSKI: I can't answer that right now. I'm going to have to look that up.

MEMBER STETKAR: What they're saying is the secondary side temperature is about 250 degrees higher than the primary side temperature.

MR. BUDZYNSKI: That probably can't happen, right? But I would have to look that up. And, yes, that seems pretty large.

MEMBER STETKAR: I understand that it's pretty conservative. I'm just curious whether it defies physics, for example.

MR. BUDZYNSKI: Yes.

CHAIRMAN BALLINGER: That would imply the heat source is in a different location.

MEMBER STETKAR: That would.

(Laughter.)

Or you have some sort of really strange transient on the primary side, but -- okay, thanks.

MS. UMANA: Okay. We are now moving to the RCP Flywheel Integrity, and John Honcharik is going to present that to you.

MR. HONCHARIK: My name is John

Honcharik, Senior Materials Engineer in NRO.

Today I will talk to you about the reactor coolant pump flywheel integrity. There were several open items. The first two here dealt with the material, basically, the termination of how you determine the fracture toughness and also the operating experience of the flywheel material.

KHNP responded, and, basically, they said that they were going to use the direct method of determining fracture toughness, which is in accordance with the SRP. And also, they provided satisfactory operating experience for the flywheel material. And therefore, we found this part acceptable and closed out these two open items.

MEMBER RICCARDELLA: By direct method, do you mean measurement?

MR. HONCHARIK: Yes, that is correct.

The next two items are basically about the flywheel analysis. Basically, the original flywheel analysis was based on design criteria of using one-third of the ultimate strength of the material, instead of one-third of the yield strength.

So, basically, we asked for technical justification for using that or use the one-third ultimate and one-third of the yield. So, in their response, they basically modified the analysis and basically used one-third of the yield strength. This was accomplished by optimizing the stresses for the strength fit between the hub and the flywheel. That's what introduced a lot of stresses for there. So, they optimized that for that. And we found that part acceptable. And also, they were using applicable crack growth rates for this flywheel material. And therefore, we found these two open items to be resolved and closed.

And the last two open items dealt with pre-service inspection and in-service inspection. Basically, what were the criteria for the hub? Because, right now, they had no ISI for the hub. And also, whether or not the acceptance criteria for the inspections, were they bounded by the flaw size that they used in their analysis.

And the Applicant responded and provided and confirmed that the acceptance criteria for the PSI is bounded by the flaw size that they used in determining their critical flaw size. And they also revised their DCD to include the acceptance criteria for both the PSI and ISI of the hub, which included UT during the PSI and service inspections for ISI. And based on these responses, the staff found that these responses were acceptable and closed out these two open items.

MEMBER RICCARDELLA: Excuse me. What is the ISI inspection interval?

MR. HONCHARIK: Every 10 years.

MS. UMANA: Okay. The last open item we're going to go back to John Budzynski.

MR. BUDZYNSKI: Yes. This is open item RAI 8614, Question 05.04.07-4. And it involves ITAAC. When we did the review of ITAAC, we found that there was no ITAAC to address gas accumulation in the safety systems and vortexing in mid-loop operation.

And so, we requested that they provide an ITAAC for those two conditions. And we provided similar ITAACs have been used in the past almost like a standard ITAAC. They came back and their ITAACs were sufficient. We reviewed them, and it covers the three documents, the guidance in the three documents I listed there.

MEMBER KIRCHNER: John, just a process question. Once you're done with the ITAACs, how is that captured downstream for the actual operation of the plant?

MR. BUDZYNSKI: The ITAAC for the gas

accumulation, what they do is they look at the as-built compared to the design.

MEMBER KIRCHNER: Yes.

MR. BUDZYNSKI: If they determine that there are some high points where gas can accumulate, then they will commence a balance test or sometimes they put in a monitoring system, like AP1000 put in a monitoring system to alert the operators whenever the gas got to a certain level in these pipe stuffs that they installed.

MEMBER KIRCHNER: Right. Is that the expectation here, that there will be some monitoring system for actual plant operation?

MR. BUDZYNSKI: Yes, there will be surveillance tests. This is a very slow process.

MEMBER KIRCHNER: Yes.

MR. BUDZYNSKI: I believe they will have tech spec, EPR tech specs in there with surveillance tests, which they would do periodically to determine --

MEMBER KIRCHNER: That's why I was asking.

MR. BUDZYNSKI: Yes.

MEMBER KIRCHNER: This is captured in tech specs then?

MR. BUDZYNSKI: Yes, yes.

MEMBER KIRCHNER: Okay. Thank you.

MR. BUDZYNSKI: Any other questions on that?

(No response.)

MS. UMANA: Okay. So, to draw this presentation to a conclusion, the staff that all open items are resolved, and we're awaiting incorporation of the confirmatory items in Revision 2 of the DCD.

The staff also concludes that the Applicant has demonstrated compliance with NRC regulations and guidance.

And that is all we have for you today.

CHAIRMAN BALLINGER: Thank you.

MEMBER SUNSERI: Well, actually, I have a question.

CHAIRMAN BALLINGER: Oh.

MEMBER SUNSERI: I'm sorry for the delayed question here, but back on slide 8, please, you talked about optimizing the shrink fit stress. Was that an analytical optimization? I mean, what does that mean exactly? And did it affect the way the shaft is actually -- the flywheel is actually coupled?

MR. HONCHARIK: Yes, it was a shrink fit

basically from the flywheel onto the hub. So, before they had very high shrink fit stresses on it. And it had to do with some other criteria that they impose themselves on their reactor coolant pump, which was to meet over 150 percent overspeed. Usually, it's only 125. So, they really had a lot of high shrink fit for that. So, what they did was they reduced that shrink fit between the two pieces, so that it wouldn't be as high. Therefore, they could use to one-third of yield strength.

MEMBER SUNSERI: So, that actually resulted in some material change?

MR. HONCHARIK: Yes.

MEMBER SUNSERI: Or not material, but some design changes to the sizes --

MR. HONCHARIK: Changes for the problem.

MEMBER SUNSERI: -- of the physical --

MR. HONCHARIK: Correct.

MEMBER SUNSERI: Okay. Thank you.

MEMBER RICCARDELLA: Out of curiosity, when they do the ISI every 10 years, do they unshrink it to do the inspection?

MR. HONCHARIK: Oh, yes. Yes. It's all from the surface.

MEMBER RICCARDELLA: From the outside

surface?

MR. HONCHARIK: From the outside surface.

MEMBER RICCARDELLA: Okay.

CHAIRMAN BALLINGER: Other questions?

(No response.)

Okay. So, this is a convenient break point. So, we'll recess until five minutes until 10:00.

(Whereupon, the foregoing matter went off the record at 9:40 a.m. and went back on the record at 9:56 a.m.)

CHAIRMAN BALLINGER: We're back in session.

Okay.

MR. SISK: Thank you, Mr. Chairman. I'll turn it over to Mr. Sangho Kang to lead us through Chapter 11. Thank you.

MR. KANG: Thank you, Rob.

My name is Sangho Kang, Nuclear Engineering Supervisor at KEPCO E&C.

Today I'm going to talk about the open items for Chapter 11, Radwaste Management System, which were identified in phase 3, and how we resolved them.

Before I start my presentation, I would

like to introduce Chapters 11 and 13. Sitting on my left, Mr. Dongsu Lee, who is Radiation Protection Team Lead, and Mr. Joonkon Kim, sitting on my right. That's INC Team Lead, who is responsible for RMS design.

Now I'm going to move on to the next slide.

The contents of the presentation is show in this slide. After a brief overview of the status of the RAI and open items, I will talk about the summary of the open items.

Next one, please.

As all of you know, Chapter 11 of the DCD Tier 2 consists of five sections, excluding the sections for the COL items and references.

Section 11.1 addresses the relative source terms, and Sections 11.2 through 11.4 provide the Design Basis System descriptions, radiological surge assessment, testing and inspection requirements of the three different radwaste systems; descriptions of the process and effluent radiation monitoring and sampling system, as presented in Section 11.5.

Next.

The review of the APR1400 Radwaste Management System, KHNP submitted DCD Tier 1 and Tier

2, Chapter 11. There is no Topical or Technical Reports submitted for the review of the Radwaste Management System.

We received a total of 38 RAI questions and responded to all questions. Based on the current SER, there is no open item for this chapter.

This slide shows the list of open items for Chapter 11 at the time of the end of phase 3. The total number of open items is nine. Six open items were identified in the staff phase 2 SER, but three items were added as a result of a phase 3 ACRS Subcommittee meeting. The staff issued additional RAIs reflecting the comments of the ACRS members during the phase 3 Subcommittee meeting.

Now I'm going to move on to the open items. The first item is about control of radioactive release to the environment, which was discussed in RAI 8201, Question 11.02-6. In this RAI the staff requested to clarify the design features of the liquid waste management system with respect to effluent risk control. The RAI requested to provide details on how the operator initiates and terminates the LWMS process operation to achieve the design objectives and to provide P&ID of the LWMS to qualify how the system controls the release, and to provide the description to clarify what input streams to the LWMS are. And lastly, to provide the operator actions is tank leakage is detected.

In the response, KHNP provided the requested information. As for their LWMS operation, the operator can initiate treatment using one of the two LWMS trains. Some components are kept with the crossties to add flexibility of treatment operation. The treated effluent in the monitor tanks can be recycled for further treatment when the release exceeds a radiological setpoint. The internal components inside the reverse osmosis and the ion exchanger module are arranged as predetermined treatment process in order to meet the regulatory limits.

As a response to the second question, KHNP also provided the P&ID of the LWMS to indicate the release of the processed liquid.

For the third request, we also provided the DCD descriptions which were modified to clearly indicate the liquid waste input streams.

As for the release termination method, we responded that, first, the operator will investigate the cause of the leakage to determine appropriate mitigation actions. The mitigation actions may include termination of liquid waste collection, decontamination for contaminated area, or repair work as required. The associated program and procedures will be developed by the COL applicant. In the RAI response, all necessary information was attached as a markup of the DCD.

The second open item is about classification of the Steam Generator Blowdown System, which is RAI 8270, Question 11.02-07. The staff noted that there was a lack of information available to make any kind of determination for the radwaste classification of the Steam Generator Blowdown System demineralizer, which should be a different radwaste safety class, possibly RW-IIa.

KHNP responded that the radwaste classification of the Steam Generator Blowdown System components were determined based on 1 percent fuel defect and the steam generator leakage rate of 75 pounds per day. In addition, KHNP added the source term data and the corresponding radwaste classification of the Steam Generator Blowdown System in the revised response.

Next.

The next open item is about liquid tank failure analysis in accordance with BTP 11-6, which was raised by RAI 8731, Question 11.02-11. The staff requested to justify the CVCS yard tank source terms used for the BTP 11-6 analysis, which is provided in DCD Table 11.2-9. Staff noted that the source term is not consistent with those provided in the response to RAI 7856, Question 12.02-2.

KHNP provided a response that the source terms for the BTP analysis was calculated in accordance with ANSI/ANS 18.1, not by assuming a fuel defect rate of .12 percent.

We also addressed that, since the CVCS yard tank source term calculation method was changed in RAI 7856, Question 12.2-2, to consider 95 percent of the tank volume, the expected source terms in Table 11.2-9 were also changed.

So, we re-performed the BTP 11-6 analysis using the revised task version and updated the results in the DCD as a markup of the response.

The next three items were raised by the ACRS members during the phase 3 Subcommittee meeting and issued as official RAIs by the staff. The first one is related to the bench design of the Solid Waste Management System tanks. The staff requested to address means to direct the Solid Waste Management System tank gases to the ventilation system and the basis from a radiation protection perspective.

In the response KHNP provided a response as follows:

The gaseous effluents from the SWMS are processed through the compound building controlled area HVAC system. The system includes HEPA and charcoal filters to ensure that the releases do not exceed the regulatory limits.

For the Spent Resin Long-Term Storage Tank, the tank vent is directed to the cubicle vent to minimize the transport of radionuclides to the room. The tank vent is separated from the ventilation duct and equipped with screens to prevent discharge of any fluid and solids into the ventilation system.

For the Low Activity Spent Resin Tank, the tank vent is routed to the proximity of the floor drain inside the tank room. The gases from the tank are vented to the room atmosphere for collection by the ventilation system and treated within the ventilation system prior to release to the environment. The gases are vented only during the resin transfer process or tank depressurization.

KHNP updated the DCD to include this information.

MEMBER STETKAR: So, Mr. Kang, we had questions about both the solid waste management tank vents and the liquid waste management tank vents. And as I understand it, you have not changed the design. You are just venting those tanks to the room? You're not piping the vents to the gaseous radwaste management system, is that correct?

MR. KANG: Yes, that's correct.

MEMBER STETKAR: Okay.

MR. KANG: That's how we answer the question.

MEMBER STETKAR: Thank you.

MR. KANG: Okay. The next item is about the fire protection design features of the GRS charcoal delay beds. The staff requested to provide description of how the design complies with NFPA 804 and the details of the fixed water spray systems for the charcoal absorber beds that contain more than 100 pounds of charcoal.

KHNP provided a response as follows:

The gaseous radwaste system is designed to prevent formation of an explosive mixture by controlling the hydrogen and oxygen concentration. The charcoal delay beds are located inside a shielded cubicle, which also acts as a fire barrier, and there is no additional combustible material that could cause fire or the spread of fire.

These design features help to preclude a fire condition. Hence, a fixed water spray system for charcoal delay beds is not required to be provided for the gaseous radwaste system. The associated information and conclusion has been included in a fire hazard analysis report for the charcoal delay bed area in the DCD Section 9.5, Appendix A. KHNP updated the DCD to include this information.

The next item is about prevention of release of gaseous effluents from the GRS. The staff requested to justify how the gaseous effluent discharge would be terminated if the isolation valve did not close. The staff also requested to provide the function of the manual valve located which is located at the gaseous effluent bypass line.

As for the release termination, KHNP responded that another isolation valve in the GRS package can be closed remotely when the main isolation valve fails to close. The vendor for the GRS package is required to provide the isolation valve in the effluent discharge line. And also, the two manual valves located at both sides of the main isolation valve can be closed for limiting the release of discharge flow.

And for the function of the manual valve at the bypass line, we responded that the full flow bypass line around the main isolation valve is provided to maintain the continuous GRS process flow. When the main discharge line is isolated due to fail position or maintenance of the main isolation valve, the valve located at the bypass line is opened for continuous process flow until the main isolation valve is fixed. We updated the DCD to include the above information.

If you do not have any question, I will turn it over to Mr. Joonkon Kim for RMS issues.

MR. JOONKON KIM: Good morning. My name is Joonkon Kim, working for KEPCO E&C Engineering Group. It's my great pleasure to give a presentation to ACRS members.

I'm going to start with the open item related to Chapter 11.5, Process and Effluent Radiation Monitoring and Sampling Systems. In RAI 8087 and 8088, the staff requested KHNP to update the DCD to provide the following information:

First, the purpose of each monitor should be described, to describe which gaseous channel initiates the alarm or interrogation. The third one was the QA commitment and calibration procedure should be described. The first one was that the line loss of the containment air monitors' sample should be discussed to verify that the monitors are capable of detecting minimum leakage rate. The staff noted whether the pumps have tritium or noble gas sampling capability.

The staff noted that the Applicant should provide more detailed description for the condenser pit sump monitor and CCWS heat exchanger building sump monitor.

KHNP has discussed and resolved the open items which the staff has shown on the slides. Regarding the purpose of the RMS monitor, KHNP provided detailed clarification on the RMS monitor with relation to ODCM and REMP in the revised response.

In the response KHNP stated that the COL applicant prepares an ODCM that contains the methodology and parameters for the calculation of the offsite doses. Also, the COL applicant is to develop an REMP that describes the potential radiation exposure pathways associated with radioactive materials and the cumulative gaseous effluent and direct external radiation from the structure, system, and components.

KHNP clarified that the RMS initiate an alarm or internal action when one channel of the three channels will exceed the setpoint first. In the revised response, KHNP described components and the calibration procedure will meet the relevant Regulatory Guide requirement. The COL applicant will develop the calibration procedure.

Okay. In the revised response, KHNP stated that the COL applicant design the sample nozzle location, sample line size, line routing/configuration/length, and the monitor location to minimize the line loss in accordance with ANSI-N13.1. This is verified to ensure the particle penetration factor is not less than 50 percent using the computational fluid dynamics methodology and particle penetration analysis.

A description has been added such that the RMS has the capability to obtain grab samples for particulates, iodine, gases, and tritium.

DCD 11.5 has been updated to contain detailed test description and table information for condenser pit sump monitors and CCW heat exchanger building sump monitor.

All of the open items have been resolved through the revised response to RAI 8087 and 8088.

Okay. Next.

In RAI 8203 the staff requested KHNP to address sensitivity, response time, and alarm limit for the primary-to-secondary leakage detection instrumentation. Also, additional information about the steam line effluent monitors should be provided.

In the revised response KHNP provided or discussed this information of the main steam line monitors for detecting primary-to-secondary leakage. A calculation to demonstrate the ability to monitor N-16 activity in the main line was provided. Appendix 11B shows compliance with the monitoring steam generator tube leakage. The open items have been discussed and resolved through the revised response.

This is my presentation.

MR. KANG: Okay. I'm Sangho Kang again.

According to the Draft SER, the RAI process for Chapter 11 is completed. The nine open items identified during phase 2 and 3 were all resolved and incorporated in the updated DCD.

The next slide provides the acronyms used in this presentation, and the next slide shows the list of COL items which were affected during the resolution process of the open items.

That's all for my presentation, and thank you for your attention. Any questions?

CHAIRMAN BALLINGER: Thank you.

We can change out. Ready to roll?

MS. LAURON: Yes. So, good morning. Again, my name is Carolyn Lauron. I'm a Chapter PM for Chapter 11, the Radioactive Waste Management chapter.

Today I have Zachary Gran and Steve Williams, the technical reviewers for this chapter.

As you recall, the phase 4 Advanced Safety Evaluation Report was submitted to you about a month ago for review. The report resolved several confirmatory items and the open items identified and discussed with you previously at an ACRS meeting earlier this year.

Now Zach will discuss the closure of these open items in detail.

CHAIRMAN BALLINGER: Green light on.

MR. GRAN: Hello. My name is Zach Gran, and I'll be presenting today.

The open items from the last Subcommittee meeting about Sections 11.2, Liquid Waste Management System, and 11.5, Process and Effluent Radiation

Monitoring and Sampling System.

This presentation will first go over the open items from the last Subcommittee meeting before discussing additional RAIs that came back to the Subcommittee.

Next slide, please.

This is our summary slide. Chapter 11 consists of the following sections: the coolant source terms, Liquid Waste Management System, Gaseous Waste Management System, Solid Waste Management System, and the Process and Effluent Radiological Monitoring and Sampling System. Also listed is a summary of regulatory requirements and guidance used for resolving the open items.

Slide 5, please.

So, the first open item. This RAI requested additional details regarding the detergent radwaste tank releases. This was also for the radwaste system as a whole, but the detergent waste tank releases were what was holding up the open item.

The Applicant provided DCD markups to include the P&IDs for the liquid radwaste system and also provided a description of actions operators can take to limit worker doses, such as recycling water for additional treatment.

The effluents from the detergent waste were monitored. This also allowed staff to verify sample lines on the detergent radwaste system. The staff is now tracking this RAI as resolved and closed.

Slide 6, please.

Our second open item, this RAI was in regards to providing adequate descriptions and consistent definitions for the radwaste seismic classifications for components found in DCD Section 10.4.8 to be consistent with Sections 11.2, .3, and .4.

The Applicant provided DCD markups to clearly state the start and endpoints for radwaste seismic classifications. In addition, the Applicant provided the radioactive source terms for the Steam Generator Blowdown System components.

This allowed the staff to verify the inclusion of isolation valves for the radwaste seismic classifications. In addition, the source term information for the Steam Generator Blowdown System allowed staff to verify the classifications of components as described by Reg Guide 1.143. Staff is tracking this RAI as resolved and closed as well.

Slide 7, please.

For open items 3 and 4, I believe it's

11.05. This RAI was issued to have the Applicant provide clear and consistent information as is described by NUREG-0800, the staff's guidance.

The Applicant provided all the information requested of them by the RAI. So, we have this list of nine items provided in this slide here. We wanted to make sure that each of the monitors have all this information. Some had it; some didn't. So, we wanted to make sure that it was consistent against all monitors.

So, the Applicant provided all of this information. Examples of changes provided by the Applicant included process configuration, figures now contained in 11.5; clear monitoring locations provided in the DCD text and in Figures in 11.5, and discussions of COL item commitments for outside the calculation manual and the Radiological Effluent Monitoring Program. The staff is tracking these RAIs as confirmatory items.

Slide 8, please.

Oh, this RAI was issued to request clarification on the primary-to-second leak detection calculation provided by DCD Appendix 11B.

The Applicant provided the staff with a response that included DCD text inserts for Section

11.5 on the main steam line effluent monitors and the N-16 monitors. In addition, the Applicant provided clarifying text in the DCD Appendix 11B to aid the staff in performing confirmatory calculations.

This information allowed the staff to verify the calculations provided by the Applicant to demonstrate the ability to detect primary-to-secondary leakage. The staff is tracking this RAI as resolved and closed.

Slide 9, please.

This slide is the slide of RAIs which were issued since the last Subcommittee meeting. This RAI was issued because in the response to RAI 7856, Question 12.02-2, the staff observed an updated source term for liquid waste tanks relating to the staff's BTP 11-6 analysis.

The response to Question 12-02-2 provided a source term equivalent to .25 percent failed fuel; whereas, the source term required for the staff's calculation in BTP 11-6 is .12 percent failed fuel.

Comparison of Question 12.02-2's response to Table 11.2-9 did not allow staff to arrive at the conclusion that half the source term provided in 12.02's response was equal to the information in 11.02-9. So, the staff issued an RAI to request clarification.

The Applicant provided a response to discuss the differences in assumptions between the source terms developed for BTP 11-6 and the source terms provided in 12.02-2. This difference in the source term for the 11-6 analysis is based on the ANSI 18.1 standard.

The response to Question 12.2 modified the tank source term methodology in Chapter 12. And so, it is different from the methodology described by ANSI 18.1. Thus, a simple comparison would not be appropriate for the two source terms.

Slide 10, for our conclusion.

The staff reviewed the information provided by the Applicant and determined that the Applicant's response is adequate, given that the staff's guidance for BTP 11-6 specifies the use of NUREG-0017 for the development of the source term in this analysis. NUREG-0017, then, references the ANSI 18.1 standard for the source term. Staff is tracking this RAI as a confirmatory item.

Slide 11, please.

As a followup question received from the last Subcommittee meeting, the staff issued this question to request clarification on the methods used by the Applicant to direct tank gases to the ventilation system.

The Applicant provided a response to describe that the vent for each tank is located near the cubical vent to minimize the transport of gases. In addition, the Applicant provided details on which tanks were directed to floor drains, so that the water overflow would be directed to the appropriate drains before venting.

The inclusion of the updated DCD text allows staff to verify control of radioactive material into the ventilation system. The staff is tracking this RAI as a confirmatory item.

Slide 12, please.

Again, as a followup to a question received from the last Subcommittee meeting, the staff issued this question to request clarification on the Applicant's compliance with NFPA 804, Section 4.8.9.4, which states," Fixed water spray systems shall be provided for charcoal absorber beds containing more than 100 pounds of charcoal." It was found that DCD Section 11.3.2 only contains a description on the use of nitrogen spray for fire suppression.

The Applicant provided a response which

provides DCD changes to Section 9.5A.3.6.4 to describe the fire analysis completed for the charcoal bed in the gaseous radwaste system. The Applicant also states that NFPA 804, Section 8.4.9.4, is not required for the gaseous radwaste system.

The staff reviewed the information provided by the Applicant and determined that the response is acceptable. In Section 9.5 of the staff's SER, the staff discusses how nitrogen has been approved as a means to limit and extinguish fores for charcoal beds. The staff finds the response acceptable because it follows the guidance of Reg Guide 1.189. The staff is tracking this RAI as a confirmatory item.

Slide 13, please.

MEMBER STETKAR: Zach, we haven't seen Chapter 9 of the SER, the finalized SER, yet. So, we'll have a meeting on that sometime later.

As I understand this, you say, well, despite the fact that NFPA 804 says you need water sprays, the staff is okay with them using nitrogen?

MR. GRAN: Yes.

MEMBER STETKAR: You refer to a fire analysis in Section 9. The fire analysis just says it's not realistic to assume that there will be fire damage. To me, that's not a fire analysis; it's just wishing it away.

But, if I understand the staff's conclusion, which, again, you're saying is a Chapter 9 issue --

MR. GRAN: Yes, mostly.

MEMBER STETKAR: But what we're trying to look at is the nexus of 9 and 11, obviously.

MR. GRAN: Right.

MEMBER STETKAR: And you're saying, as far as the staff is concerned, nitrogen is okay as a --

MR. GRAN: Yes, we talked -- as an extinguisher, yes.

MEMBER STETKAR: As you said, as an extinguishing agent.

MR. GRAN: Yes. So, we talked with the fire protection folks and the ventilation folks. Yes, we talked with them both, and they both -- I can't remember the particular standard number that they referred to, but I believe it's in the Reg Guide that specifically states, you know, in place of water spray, you can use nitrogen to extinguish fires.

MEMBER STETKAR: Okay.

MR. GRAN: And so, they rely on the

standard to meet the fire protection requirements.

MEMBER STETKAR: Okay. Thank you.

MR. GRAN: So, slide 13, please.

As another followup to a question received from the last Subcommittee meeting, the staff issued this question to request information on how the Applicant on limiting releases in excess of the release limits in the event that the isolation valve, valve 008, does not close on the receipt of a close signal.

The Applicant provided a response that specified another isolation valve that can be closed remotely at the radwaste control room in the event that valve 008 does not close on the receipt of the close signal. The Applicant also specified that valves 1013 and 1014, which are located before and after valve 008, can be manually closed.

The Applicant also provided DCD markups in response to this question. The DCD markups allow the staff to verify the locations of other valves that can be used to control releases. Therefore, the staff is tracking this RAI as a confirmatory item.

Slide 14, please.

The staff has determined that all open items have been closed in the sense that the confirmatory items listed below meet all applicable regulatory criteria. The six listed confirmatory items are being tracked for incorporation in Rev 2 of the DCD.

The staff concludes, using the information presented in the application, and pending confirmation of the items listed above, that the Applicant has demonstrated compliance with NRC regulations and guidance.

This concludes the staff's presentation on Chapter 11.

MEMBER STETKAR: Zach, I'm back to the charcoal beds.

MR. GRAN: Okay.

MEMBER STETKAR: When I read through there, you refer to Section 11.3.2 of the DCD by saying that nitrogen can be used to extinguish the fires. The discussion there says that nitrogen --

MR. GRAN: More for drying in that section, I believe, right?

MEMBER STETKAR: That's right. It doesn't say anything about any automatic nitrogen. It just says you can line up nitrogen --

MR. GRAN: If it gets wet or something?

MEMBER STETKAR: -- to purge, yes, to try them or to purge the beds before you replace the charcoal. So, apparently, there is a nitrogen pipe with a valve in it somewhere that somebody can open, but it's different from the fire suppression system?

MR. GRAN: Yes, I think that the response to this question details some information about the fire suppression ability. I can't recall specifically, though.

MEMBER POWERS: The inherent difficulty, of course, in using the nitrogen for the suppression fire is it doesn't remove the heat source.

MEMBER STETKAR: Right.

MEMBER POWERS: It addressed excludes the oxygen. So, you have to maintain it, because as soon as it dissipates, it, of course, is back in the fire.

MEMBER STETKAR: Right, and gets swept out. Perhaps they will look at that in Chapter 9, I would imagine. That's the fire protection stuff.

MEMBER POWERS: The fire protection stuff will probably -- I mean, it's just a matter of being able to maintain the exclusion of oxygen. Of course, you may have to dissipate the heat by other mechanisms, which are notoriously slow. Charcoal beds just don't have the thermal conductivity to dissipate to the wall very fast.

MR. GRAN: Yes. Thank you.

MEMBER POWERS: There's enough heat capacity in the system to dissipate the heat. It's just a matter of transport.

MEMBER STETKAR: Yes, well --

(Laughter.)

CHAIRMAN BALLINGER: Thank you.

MS. LAURON: Thank you.

MEMBER REMPE: Ron?

CHAIRMAN BALLINGER: Yes, ma'am?

MEMBER REMPE: During our discussion on Chapter 11 previously, we had brought up an issue with respect to Reg Guide 1.143 might be unnecessarily burdensome. And I wasn't fast enough to bring up this point and unmute my phone when we were discussing slide 7. But the discussion in the updated SE from the staff indicated that they had an RAI and asked for contributions for various isotopes that weren't present or were not significant contributors. And I just was curious if the staff has identified here that there might be some needs for updates to the Reg Guides to make the licensing or the design certification process more efficient in the future.

MR. GRAN: Well, the updates that I know will be coming are the consistent descriptions for the components. So, like the response that we received from KHNP, how they indicated the stop and start points for the components, I know it will be updated. Whether or not the significant contributors, so the radionuclides I'm not 100 percent sure will be updated in the Reg Guide.

MEMBER REMPE: Well, I think that, because it goes through design certification, it is important to keep track of these items that might make the process more efficient in the future. And actually, that also pertains back to the discussion on Chapter 2 where they were indicating that the guidance was a little inconsistent on site boundary and EAD, that if we can find ways to track these things, it might be a good idea.

MR. GRAN: Okay. Thank you.

CHAIRMAN BALLINGER: Thank you again.

Moving on. Go ahead.

MR. LEE: Good morning. My name is Dongsu Lee, who is working as Radiation Protection Leader at KEPCO E&C.

Today I am going to talk about Chapter 12, Radiation Protection. Let's move on to the next page.

This presentation follows the contents as is shown in this slide. It consists of overview, summary of open items, current status, and last, attachments.

Let's move the next page.

Overview of Chapter 12 is shown in this page.

Next page.

The submitted documents related to Chapter 12, the DCD, and no open items are left for this chapter.

A total of 15 open items will be addressed in this presentation. The list of nine is shown on this page, and the next page.

And next page.

On this slide I would like to talk about the summary of open items. First is staff asked to provide additional information on CVCS source terms. Thus, KHNP provided the source term. After that, staff indicated that barium activities of CVCS tanks are incomplete and dose rates of the tanks were not updated.

For these requests, KHNP provided a revised response with the corrected source terms and we performed the shielding calculations results.

And next page.

And the next open item, staff requested to provide: post-accident time-dependent fluid source term outside the containment, and the source term for MCR emergency ventilation filters, and dimensions of the systems containing recirculating fluid and the MCR emergency ventilation filter.

For this request, KHNP provided the responses. Staff reviewed KHNP responses and noted that the one-week source term of the MCR filter was not accurate. So, KHNP corrected the one-week source term data and provided a revised response.

Next page.

And through RAI 8420, staff requested to provide the basis of CVCS yard tank source term, and KHNP provided the information. During the review, staff noted that the source term was based on the continuous gas stripper operation and requested to limit the operation not to exceed Zone 1 criteria around the CVCS yard tank.

For this notice, KHNP provided the Tier 1 markups to include the limitation of gas stripper operation. After that, staff additionally requested to confirm that the dose rate from the tanks comply with 40 CFR 190.

KHNP added a COL item to provide

information to ensure that radiation levels at the site boundary do not exceed the limits of 40 CFR Part 190.

Let's move to the next page.

The next open item is related to the design impacts by daughter nuclides. Staff requested to revise the CVCS and BOP component source terms, shielding, and the zoning, concerned about the buildup of the daughter nuclides; and also requested to provide more information describing how the approach ensures that the shielding for piping areas is adequate.

For those requests, KHNP demonstrated that the conservatisms in KHNP's methodology are substantially larger than those of Westinghouse's methodology, which considered the effect of buildup of daughter products.

KHNP also evaluated the daughter nuclide buildup in BOB systems, and the shielding analyses were performed using updated source terms. As a result, the impacts of the daughter nuclides on the current design were negligible since the civil structure design has sufficient margin to bound the minor increase of the source terms. KHNP provided information about the shielding analysis for the pipe lines with specific examples.

Next page.

In RAI 8420, Question No. 25, staff requested as a followup for additional descriptions for the source terms of the GRS header from CVCS components; correction of the inconsistency in the source dimensions for the header drain tank; provision of justification for the reason that the shielding source terms of the waste gas dryer was significantly lower than the design basis source term, and, also, updating all the component source terms to consider the impact of the daughter nuclide products.

For those requests, KHNP revised the DCD to include the additional description about the determination of the GRS inlet source term and corrected dimensions for the header drain tank and the shielding analysis. KHNP also corrected the dimension of the waste gas dryer and updated the source term and the corresponding shielding analysis.

And KHNP updated the GRS source terms considering the daughter nuclide buildup and the shielding analyses were re-performed using the updated source terms. Accordingly, the shielding thicknesses and the radiation zone drawings were revised based on the updated shielding analyses above.

The next open item is that staff noted the following:

The dose conversion factors in ICRP No. 74 was used for determination of multiplication factors, while ICRP-51 was used for all other shielding calculations. The effects of the radiation backscatter was not considered in the determination of multiplication factors.

For two open items, the KHNP provided related rationales as follows:

The ICRP-74 DCFs are only used to determine the multiplication factors which are the adjustment factors for the multiple pipes that are to be multiplied by the dose rate from a single pipe. Since the dose rate from a single pipe is calculated using ICRP-51 DCFs, the actual shielding calculations for the multiple pipes are based on ICRP-51 DCFs.

KHNP also performed the additional analysis to verify the calculation without considering backscattering, and it does not underestimate the dose rate for the shielding design purpose.

And staff noted that the shielding

thicknesses of the hot pipe way area was insufficient. So, staff requested to provide the shielding thickness for each of the walls in the room.

Accordingly, KHNP provided all information which were required by staff and revised the DCD table and the relevant figures.

Next page.

Through this RAI, staff noted that it was unclear where the collected liquid in the sump of the CCWS structure is routed and if the sump included design features to prevent the release of the radioactive material.

KHNP revised this approach, so that the radioactive material from the CCWS sump is routed either to the LWMS or to the turbine generator building sump.

Staff also requested to provide the location of the CCWS sump monitors and the turbine building sump monitors.

KHNP provided the information of the CCWS sump and the turbine building sump monitors in the revised response to RAI 8088.

And then, the next open items, yes.

Staff also tracked RAI 8254 as an open item. Staff requested the information regarding the access to delay bed rooms.

KHNP provided the means to limit the radiation exposure by isolating and purging the delay bed with nitrogen gas before access to the rooms.

The related information has been provided in the DCD.

Let's move to the next page.

The next open item is that staff noted that the application does not contain enough information to ensure that appropriate design features are in place to limit personnel exposure and the spread of contamination during the cutting and disposal of ICI.

Staff requested information, also, on the temporary filtration and the relevant design supports, such as provision of a power supply.

For the resolution, KHNP clarified that refueling water is purified by the Spent Fuel Pool Cooling and Cleanup System, not by a temporary filtration system, and also indicated that the Spent Fuel Pool Cooling and Cleanup System reduces the concentration level of radioactive material in the refueling pool; and thus, maintains a lower level during the refueling operation, including ICI cutting.

This slide shows the next open item. Staff requested to provide how to degas the pressurizer for the shutdown.

KHNP responded that the gas can be removed by the reactor vessel closure head using the reactor coolant gas vent piping, which connects to the pressurizer vent and, then, is routed to the reactor coolant gas vent system.

Staff noted that it is inconsistent with the information in Section 5.4, which indicates that the piping from the reactor vessel closure head vent goes directly to the reactor coolant gas vent system.

And KHNP corrected the description in Section 5.4 by deleting the sentence to be consistent with the current design.

The next open item is related to the fire protection of the radiological areas. Staff requested to provide the fire protection design features for the areas containing radioactive sources other than containment.

KHNP updated the descriptions in DCD Subsection 9.5 appendix, including the other radioactive sources in the compound building area that are to be considered in fire protection.

Staff noted that there were still

inconsistencies regarding if an area is a radiological area and missing the criteria associated with the fire protection of radiological sources.

KHNP provided the response to address additional radiological sources in the fire areas, including the SWMS, GRS, LWMS, and HVAC systems; and also, updated the DCD to address how the plant complies with the criteria in 10 CFR 50.48 and Reg Guide 1.189.

The next open item was that the area radiation monitor for the Instrument Calibration Facility room, and there were alarm location issues to meet the requirement of ANSI/ANS-HPSSC-6.8.1.

As a resolution, the ICF room area monitor has been deleted from the relevant subsections of DCD Tier 1 and Tier 2, as the room name of ICF was changed to "Future Use".

The first finding section in DCD and the response related to RAIs were revised, and the truck bay area and the waste drum area have area radiation monitors with local alarms. The alarm was located only outside the area.

Upon the request of the NRC staff, KHNP has added a local alarm to the inside truck bay area and the waste drum area to meet the requirement of

ANSI/ANS-HPSSC.

In the revised response, RAI 8496, Question No. 49, the open items have been resolved.

As a last open item, staff requested to confirm that the general shielding, zoning, and EQ design consider the cumulative effects of source term changes which were incorporated through the numerous RAI response.

Staff also requested to ensure that the mission dose rates remain acceptable, even considering the changes in the source terms.

For the last resolution, KHNP has performed the full evaluations of shielding, zoning, and EQ evaluation based on the updated source terms and confirmed that the current design is valid; and also, re-performed the vital area mission dose analysis and confirmed that the results meet the dose limit of 5 rem.

KHNP continues to monitor Chapter 12 to assure any conforming changes are addressed. Fifteen open items that were identified in phase 2 and phase 3 have been resolved with adequate and sufficient discussion with the staff.

Thank you for your attention.

CHAIRMAN BALLINGER: Thank you.

MR. TESFAYE: Good morning, everyone. My name is Getachew Tesfaye. I'm the NRC Project Manager for Chapter 12, Radiation Protection.

To my right is the technical reviewer, and over there is Bill Ward, the Project Manager, and Larry Burkhart, the Technical Branch Chief for this chapter.

The staff has completed its phase 4 Safety Evaluation Report with no open items for Chapter 12 and submitted it for your review about a month ago. That report includes the resolution of 14 open items discussed with you on February 24th, 2017, and the full Committee on June 27th, 2017, during our phase 3 review of the application.

There was an apparent discrepancy on the number of open items that was discussed by KHNP. They had 15; we have 14. I think the discrepancy is due to one of the items being closed before phase 3 was closed. So, it is not open on their part. So, we have 14 open items.

Ed will now discuss in detail the closure of these open items.

Thank you.

MR. STUTZCAGE: Hi. I'm Edward Stutzcage. I am the lead Chapter 12 reviewer.

I will go through the open items, and all the open items were in Section 12.2 and 12.3.

Next slide. Yes, right there.

So, the first open item was Question 12.02-2. That had dealt with various source term issues. They revised some of the source terms in the response for tanks containing liquid radioactive material, except for some of them did not appropriately consider the decay of cesium-137 when they revised the responses. In addition, the contact dose rates for the tanks were not updated based on the revised source terms.

The Applicant updated the source terms considered a barium-137m activity. They considered it the same as cesium-137, which is slightly conservative because they're considering 100 percent branching from cesium-137 to barium-137, and in reality it's about 94.6 percent branching.

So, the Applicant revised the source term. They also revised Table 5 of the response to provide updated contact dose rate information for the outdoor tanks. With the shielding surrounding the tanks, the dose rates are very low. It's radiation zone 1.

So, based on that, we performed a

MicroShield calculation of the dose rates from the tanks and found them to be acceptable. So, therefore, we found it to be consistent with SRP 12.2 and addressed the requirements of Part 20 and GDC 61.

Next slide, please.

The next open item was Question 12,02-16 which asked questions related to accident source terms and doses. The issue that was remaining after the phase 2 SER was post-accident source terms for the main control room filters had to be revised. They revised it in response to update to the appropriate dose conversion factor, but the revised source term provided in the response was in error. It was a clear discrepancy in the source term for the one-week source term. It was off many orders of magnitude.

So, it was a simple fix. They corrected the data. We reviewed it and found it to be acceptable.

Next slide, please.

The next open item was 12.2-22, which asks questions about the holdup tank and boric acid storage tank. We had requests to provide information on how they would perform any maintenance on the tanks and how they would detect leakage of radioactive material. And there were different errors in the source term information and stuff we asked them to correct.

The resolution, the Applicant specified that there was a manway cover at the top and side of the tank for access and maintenance. Also, the Applicant specified that any leakage or overflow from the holdup tank and boric acid storage tank will be collected in a leakage collection sump which is separate from the rainfall sump that's provided in the tank area. The leakage collection sump routes the water to the liquid radioactive waste system for treatment.

The staff determined that the information provided in the response is consistent with Reg Guide 8.8 and sufficient to address the requirements of 10 CFR 20, including 10 CFR 20.1406.

Okay, next slide, please.

The next open item was Question 12.02-23, which was that the Applicant did not appropriately consider daughter product buildup, with the exception of barium-137m, which for most of the source terms was initially considered. And it wasn't clear if many of the plant sources were adequate for use in demonstrating compliance with 10 CFR 20 and other applicable regulations.

The resolution, the Applicant demonstrated that for most components containing radioactivity the impact of not considering daughter products is negligible. This was demonstrated, in part, by comparing the source terms calculated using the KHNP codes to the source terms calculated with codes that account for daughter progeny buildup.

There are a number of components where the error was potentially larger. The Applicant provided information demonstrating that other conservatisms in many of the sources bounded any error in not considering daughter progeny. For example, many of the biggest errors or potential errors were in tanks, and they demonstrated that they had overly considered the volume of the liquid and the gas. So, it comes out to higher activity than would really be in the tank, as the volumes for both the liquid and the gas are basically maximized.

And for several sources, they increased the source terms to adequately consider daughter progeny, to conservatively bound the source terms compared to if the daughter progeny were considered.

Next slide, please.

MEMBER REMPE: Excuse me.

Okay. So, the Applicant stated that they used the Westinghouse code to review these calculations also. And what I'm hearing from you is that there were a lot of adjustments made to the analyses. Did the staff basically do their own evaluations? One, is the Westinghouse code approved? Apparently, even if it is approved, they still dinked with the numbers a bit to make sure that they had a bounding analysis.

So, I guess what I'm kind of asking is, one, was the Westinghouse code even approved by or reviewed by the NRC? And two, did the NRC just basically do their own calcs and that's why they determined that it was acceptable?

MR. STUTZCAGE: The Westinghouse code was used in the AP1000, which was approved. And we reviewed the code, and we didn't review the code in detail, but the code does account for daughter progeny buildup. So, when Westinghouse did their analysis, they came up with maximum percent errors that could occur based on not including it.

We did review; we came up with the same significant isotopes that were creating the errors. And we found that what KHNP and Westinghouse had come up with for possible errors was reasonable. It seemed accurate.

MEMBER REMPE: What method did the staff use?

MR. STUTZCAGE: We do hand calculations for some of the decay stuff. Also, MicroShield has a decay function that we can use to help assist with determining what the daughter nuclide inventories would be. So, that is what we used to come to our conclusion.

MEMBER REMPE: Okay. Thank you.

MR. STUTZCAGE: Yes. No problem.

So, as we discussed, based on our review of the information, the staff determined that for many of the sources the effect, not considering daughter progeny, is negligible. For those sources where it is not negligible, the Applicant either provided sufficient justification that other conservatisms bound, not considering daughter progeny or the Applicant the source terms accordingly. Therefore, the staff determined that the source terms were acceptable to demonstrate compliance with 10 CFR 20 and other applicable regulations.

In addition, another conservatism that they had, as I mentioned earlier, is it is a small conservatism, but over considering the barium-137m activity also is a conservatism they have which takes away some of the non-conservatisms and not considering daughter progeny. Barium-137 is one of the most important nuclides for the gamma activity from the sources.

Open item 5 is related to Question 12.02-25. Part of the question was similar to the previous, which is not appropriately considering daughter progeny. The other part was that some of the gaseous waste management system source terms with the .25 percent failed fuel source term were higher than the 1 percent failed fuel source term for certain radionuclides, which is counterintuitive. So, we asked them to explain that.

The reason for that was the 1 percent source term considered continuous gas stripping, where the .25 percent was extra conservative because it assumed that everything built up over, basically, multiple operating cycles and, then, was sent in through the gaseous waste system all at once. So, it was higher than the 1 percent for some radionuclides because of that.

As discussed, the daughter progeny issue was probably the most significant for the gaseous waste management system source terms. So, they updated those source terms to cover any non-conservatism. Rubidium-88 particularly has an effect on the dose rates. So, they revised the source terms and the shielding and the zoning as necessary. Staff found it to be acceptable.

The next slide, yes.

So, that just goes through what I just said.

The next slide, please.

So, then, going to the 12-03 open items, the first is Question 12.03-8. 12.03-8 initially asked generic shielding questions. However, the issues at the end of the phase 2 review, the remaining open item was they didn't provide enough information for the staff to determine that the shielding and zoning for piping areas was sufficient. Specifically, the calculations to determine multiplication factors for piping areas did not consider backscatter and used ICRP 74, instead of ICRP 51, which was used for the other shielding calculations.

Resolution, the Applicant specified that the multiplication factors for the piping areas are based on conservative assumptions, including basing the multiplication factors on a dose point in the center of the pipes, which bound any non-conservatism in not considering backscatter and in using different dose conversion factors. Assuming a dose point at the center of the pipes would result in a significantly higher dose conversion factor than it would if the dose was calculated all on one side of the pipes or all on the other side of a wall, which would be more realistic for determining shielding from a piping source.

Conclusion: the staff determined that considering the dose point at the center of the pipes provided adequate conservatism for determining the multiplication factors. As a result, the staff found that the multiplication factors are appropriate for determining the shielding and zoning for piping areas. Therefore, the shielding and zoning for these areas meet the requirements of 10 CFR 20 and GDC 61.

Open item 2, that was related to Question 12.03-10. And in that question, the Applicant did not adequately describe the shielding for several irregular-shaped rooms with high-activity radiation sources in the DCD. Most of the rooms are rectangular, cubicle rooms where you can specify north, south, east, west.

Initially, the application had north, south, east, west for these rooms, but they had multiple walls and irregularly-shaped. So, we asked them to provide more information on the shield walls. And these were for piping areas with some of the most significant piping in the plant. Other than the inside containment, they had their resin lines and gaseous waste management system and liquid waste management system piping and stuff.

So, they provided the information. We reviewed the information. We used MicroShield code to check a lot of the walls and floors, and we found them to be acceptable.

Open item 3 related to Question 12.03-11. The issue remaining after the phase 2 review was simply that the Applicant indicated that there were CCW sump monitors and turbine building condenser pit sump monitors to detect leakage, but they didn't include them in the DCD.

The resolution was the Applicant included the monitors in response to Question 11.05-2. The staff reviewed the description and function of the monitors in the DCD. The monitors provide alarms, local alarms and alarms in the main control room. The staff found the monitors to be an appropriate design feature to detect leakage of radioactive material and to ensure that radioactive material is adequately processed and monitored when released, in accordance with 10 CFR 20.1406.

Open item 4 was associated with Question 12.03-13. The staff requested that the Applicant provide additional information regarding the access to the delay bed rooms if it was required to perform maintenance or to replace charcoal, and to provide additional information on how the design of the delay beds and associated equipment ensures that radiation doses will remain below that.

Resolution: the Applicant specified that temperature and humidity instruments are installed at wall-mounted piping racks in a relatively low-dose-rate area and that instrument readings can be remotely monitored from the radwaste control room. Plant operators may need to access the delay bed rooms only if repair work or inspection of the temperature instrumentation at the guard beds or inlet to each delay bed is required. The Applicant also proposed to update the DCD to specify that, if work on the charcoal delay beds is required, the charcoal delay beds located in the room where the work was being performed would be purged and isolated to allow the plant operators to access the room at lower dose rates.

The conclusion: the staff found that the design features to limit the need to access the delay bed room and to minimize dose, if access is required, is consistent with the requirements of 10 CFR 20.1101(b) and is acceptable.

Open item 5 is associated with Question 12.03-26. Yes, this question, we had asked them to provide more information on filtering the refueling pool. At the time I didn't have a good understanding that they could directly connect the spent fuel pool cleaning system to the refueling pool to help clean the pool. I thought that it was only connected to the spent fuel pool.

So, the Applicant clarified that it could be aligned directly to the refueling, the spent fuel pool cleaning system could be aligned directly to the refueling pool during refueling operation to remove contaminants from the spent fuel pool. The APR1400 design also includes detection to assist the operators to ensure that neither the refueling pool nor the spent fuel pooling are being unintentionally drained or overfilled by misaligning the spent fuel pool cleaning system intake or return lines.

The conclusion: aligning the spent fuel pool cleaning system directly to the refueling pool will allow for the pool to be cleaned much more efficiently than cleaning indirectly through the spent fuel pool. It reduces contamination to the refueling pool and the potential for airborne contamination. In addition, the level instruments ensure that misaligning valves would not result in either pool being overfilled or drained.

The staff found these design features to be in accordance with ALARA and 20.1406 and to be acceptable.

Open item 6 was Question 12.03-46. There were numerous inconsistencies and apparent inadequacies in the DCD as it relates to preventing radiological releases and exposures from fires, consistent with the requirements of 10 CFR 50.48 and the guidance of 1.189.

Initially, the DCD would indicate that there was no radioactive sources in the radwaste compound building areas and areas that had stored radioactive material, radioactive sources. And there was other information that was inconsistent.

The resolution: the fire protection analysis in the DCD was updated to consider significant radiation sources and provide additional design features that included specifying that the compound building includes an automatic sprinkler system that would actuate in the event of a fire to minimize the potential for a significant release. In addition, the Applicant specified that the compound building ventilation system's two carbon absorbers are protected with a manually-actuated deluge system and that operators would be alerted of a fire by temperature alarms downstream of the carbon absorbers.

The staff found that the information provided and design features included in the DCD are sufficient to meet the requirements of 10 CFR 50.48 from a radiation perspective and the guidance of 1.189 from a radiation protection perspective.

Next slide, please.

Open item 7 is associated with Question 12.03-49. The issues were that the hot machine shop, waste drum storage area, and truck bay area radiation monitors did not include local audible and visual alarms to alert the operators in the area if there was unusually high radiation levels. SRP 12.3-12.4 provides guidance to the staff and states that area and airborne monitors would have a local audible and visual alarm, which is a design feature to ensure that worker dose will not exceed ALARA.

In addition, the instrument calibration facility described in the application was a high enough activity source to meet the definition of an irradiator in 10 CFR Part 36. However, the design of the instrument calibration facility did not appear to meet or address several of the applicable requirements of 10 CFR Part 36, which is access requirements, and so forth.

Resolution: the Applicant updated the DCD to provide local audible and visual alarms for the hot machine shop, waste drum storage area, and truck bay areas.

The Applicant also removed the instrument calibration facility designation and associated area radiation monitor from the design and included a COL item to specify that the COL applicant will specify how the room will be used and how all applicable regulatory requirements related to the room will be met, including 10 CFR Part 36.

Next slide.

Staff conclusion: including audible and visual alarms for monitors is consistent with the SRP and a design feature to ensure doses are ALARA, in accordance with 10 CFR 20.1101(b).

In addition, calibration activities

requiring high-activity sources can be performed by an offsite contractor at the digression (sic) of the COL licensee. Therefore, it is acceptable for the COL applicant to determine if high-activity calibration will be performed onsite and to address the applicable requirements accordingly.

Next slide, please.

Open item 8 is associated with Question 12.03-53. The issue, there was a small error, approximately 2 percent, in the post-accident recirculating fluid source term. It was due to using the inappropriate volume for the IRWST.

In addition, it was determined that the Applicant had adequately considered all source terms -- it was unclear if the applicant had adequately considered all source terms and design changes made during the review in the radiation shielding and zoning design. There were also questions about the limitations of the MicroShield computer program in the post-accident shielding analysis design, radiation zoning, and mission dose rate calculations.

The Applicant response: the Applicant revised the post-accident mission dose rates based on the corrected source term. Also, the Applicant indicated that the source terms and shielding, including the EQ analysis, were updated to consider all changes and that the mission dose analysis included adequate conservatism to account for any limitations in the MicroShield computer program. For example, the Applicant indicated that the mission dose analysis assumes the use of a half-mask respirator with a protection factor of 10, when during plant operations they specified that respirators with a higher protection factor will likely be available for use.

Staff evaluation: the post-accident mission dose rates had been updated based on the corrected source terms. However, in reviewing the Applicant's response to this RAI, the staff identified numerous areas associated with post-accident zoning in which the staff calculated significantly higher doses than what was provided by the Applicant in the DCD Chapter 12 figures. Many of these areas would likely also impact the mission dose calculations.

In addition, it was unclear how the Applicant was applying the protection factor of 10 in the post-accident mission dose analysis as 10 CFR Part 20, Appendix A, footnote C specifies that a protection factor of 1 should be assigned to sorbent cartridges as protection against radioiodine in air-purifying respirators unless a licensee applies to the Commission to assign a value of greater than 1. Therefore, we closed this RAI, Question 53, as unresolved and issued Question 55 to resolve these issues.

So, we go on to Question 12.03-55. To resolve those issues, the Applicant revised their approach regarding the use of a respirator for post-accident missions. Instead of crediting a half-mask respirator for post-accident vital missions, the Applicant now specified that they would base their post-accident mission dose analysis on the use of a positive pressure self-contained breathing apparatus with a protection factor of 10,000.

The Applicant also proposed adding a new COL item to specify that the COL applicant will provide the respiratory protection program to ensure that the Self-Contained Breathing Apparatuses are available and functional to minimize airborne radiological hazards while performing post-accident vital functions. The COL item also specified that the Self-Contained Breathing Apparatuses will have a minimum rated service life of one hour in the control room and air supply systems in areas where post-accident mission dose may exceed the one-hour timeframe. Finally, the COL item specifies the COL applicant will assess if replenishing the respirators during vital missions will result in any increase to the vital area mission times and doses.

The Applicant also revised many of the minimum required shielding thicknesses associated with post-accident vital area missions and recalculated the post-accident vital mission doses.

Next slide.

Staff conclusion: The staff considers it acceptable for the DCD post-accident vital area analysis to use a protection factor of 10,000 for airborne radioactive material because the COL item specifies that the appropriate equipment will be available, and if any changes are needed to the mission dose analysis, that they will be appropriately addressed.

The staff also re-evaluated the Applicant's mission dose calculations. Staff confirmatory calculations of the highest dose rate areas and areas where the most significant shielding was expected to be needed to ensure vital area mission dose limits were met yielded results consistent with the applicant's results. In addition, the staff did not identify any areas where the shielding did not appear to be adequate.

As a result, the staff finds the Applicant's vital area mission dose calculations, assumptions, and shielding design to be acceptable to address the requirements of 10 CFR 50.34(f)(2)(vii) and 50.34(f)(2)(viii).

Conclusion: staff has determined that all open items associated with Chapter 12 have been adequately addressed and the responses meet all applicable regulatory requirements. The staff concludes, using the information presented in the application, and pending confirmation of the remaining confirmatory items, that the Applicant has demonstrated compliance with NRC regulations and guidance.

Okay. Any questions?

MEMBER KIRCHNER: Yes, Edward, you talked about limitations of the MicroShield code. What, generally, did you find after all this analysis? And how much conservatism? Or, a different way of raising that would be, how much error band uncertainty is in those calculations with MicroShield?

MR. STUTZCAGE: That's a good question. So, let me think about this.

MEMBER KIRCHNER: Do you benchmark MicroShield against MCNP for some of the most difficult calculations?

MR. STUTZCAGE: We do run MCNP in limited cases. In some cases, MicroShield is more conservative than MCNP; in other cases it's not. I know that, as I said, some of the MicroShield calculations are overly conservative because of like multiplication factors of piping, and so on and so forth, that they use.

I'm trying to remember exactly how we came to the conclusion. I have a difficulty off the top of my head. We can get back to you with more information.

I assume that there was, there is some conservatisms in their assumptions. Oh, and for their mission dose access and egress, they added extra conservatisms to the times to enter in egress areas. That added additional dose to the calculations. There are conservatisms in the calculations that make up for any limitations.

MEMBER KIRCHNER: Okay. The use of Self-Contained Breathing Apparatuses under accident conditions for an hour to gain this factor of 10,000 and protection, how realistic is that, in your estimation?

MR. STUTZCAGE: How realistic is the protection factor, the 10,000 --

MEMBER KIRCHNER: Oh, I'm just trying to think through the different scenarios and being in a control room with the Scott Air-Paks on.

MR. STUTZCAGE: No, no, this is for everything except inside the control room.

MEMBER KIRCHNER: Okay. So, this is all activities outside of the control room?

MR. STUTZCAGE: Right. This is for if you have to go outside the control room to align valves, for example, for the containment spray and stuff.

MEMBER KIRCHNER: Okay.

MR. STUTZCAGE: So, this is the limited operation, take samples --

MEMBER KIRCHNER: Okay. Thank you.

MR. STUTZCAGE: Yes. Yes, there's no respirators for inside the control room.

CHAIRMAN BALLINGER: Other questions?

(No response.)

While we're getting the phone lines open, are there any questions from people in the room?

(No response.)

Hearing none, I hear crackling and everything, but I'm not sure what phone line is actually open. It's open? It's on; it's open.

Is there anybody, members of the public out there that would like to make a comment?

(No response.)

Hearing none, then we can go around the table a bit just to make sure if there are any members that have additional questions.

Pete?

MEMBER RICCARDELLA: No, I have nothing.

CHAIRMAN BALLINGER: Walt?

MEMBER KIRCHNER: No, thank you.

CHAIRMAN BALLINGER: Dana?

MEMBER POWERS: No.

CHAIRMAN BALLINGER: Matt?

MEMBER SUNSERI: I don't have any additional comments. I appreciate the staff and KHNP just coming and presenting the "no additional results". It's probably, well, it's helpful to us just to have closure. Thank you.

CHAIRMAN BALLINGER: John?

MEMBER STETKAR: Nothing at all. And I would like to also extend my thanks to KHNP, especially for all the followup they did on the questions that we had during the Subcommittee meetings that made this process a lot less painful.

(Laughter.)

CHAIRMAN BALLINGER: Jose?

MR. MARCH-LEUBA: There were various thoughtful presentations, and I really don't have any comments.

MR. CHARLES BROWN: Nothing further from me.

CHAIRMAN BALLINGER: No?

MR. CHARLES BROWN: I said, nothing further from me.

CHAIRMAN BALLINGER: Well, I would like to thank you again for great presentations. I think the fact that this went so quickly is kind of a testimony to the phase 2 analysis where there were not that many open items to start with. And again reflecting John's comment that the responses were very, very good.

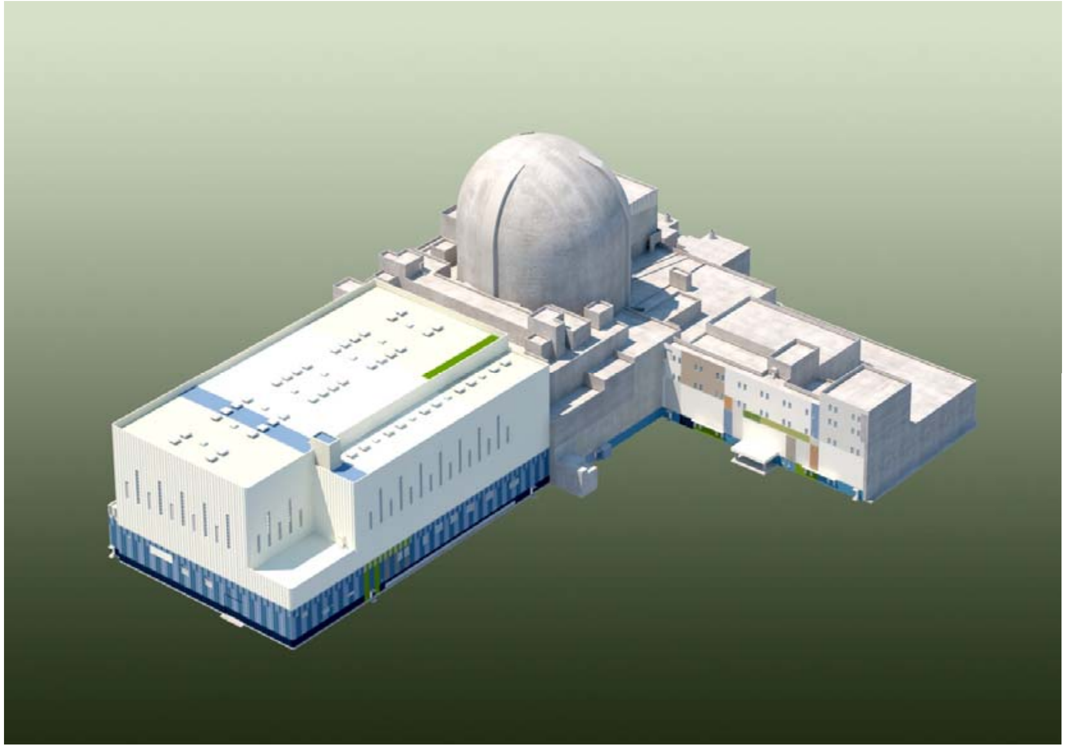
So, I would like to thank both KHNP and the staff for that.

Without any further ado, we are adjourned.

(Whereupon, at 11:28 a.m., the Subcommittee adjourned.)

NON-PROPRIETARY

APR1400 DCA
Chapter 2: Site Characteristics



KEPCO/KHNP

November 14, 2017

ACRS SC Meeting (Nov. 14, 2017)

Contents

Overview of Chapter 2

Section	Title	Major Contents
2.0	Site Characteristics	• Postulated Site Parameters
2.1	Geography and Demography	• Site Location and Description • Exclusion Area Authority and Control • Population Distribution
2.2	Nearby Industrial, Transportation, and Military Facilities	• Locations and Routes • Descriptions • Evaluation of Potential Accidents
2.3	Meteorology	• Regional Climatology • Local Meteorology • Onsite Meteorological Measurements Program • Short-Term Atmospheric Dispersion Estimates for Accident Releases • Long-Term Atmospheric Dispersion Estimates for Routine Releases

* Note: Subsection 2.5 Geology, Seismology, and Geotechnical Engineering is not included in this presentation.

NON-PROPRIETARY

Overview of Chapter 2

Section	Title	Major Contents
2.4	Hydrologic Engineering	• Hydrologic Description • Floods • Probable Maximum Flood on Streams and Rivers • Potential Dam Failures • Probable Maximum Surge and Seiche Flooding • Probable Maximum Tsunami Hazards • Ice Effects • Cooling Water Canals and Reservoirs • Channel Diversions • Flooding Protection Requirements • Low Water Considerations • Groundwater • Accidental Releases of Radioactive Liquid Effluents in Ground and Surface Waters • Technical Specification and Emergency Operation Requirements

* Note: Subsection 2.5 Geology, Seismology, and Geotechnical Engineering is not included in this presentation.

NON-PROPRIETARY

Overview of Chapter 2

❖ List of Submitted Documents for Site Characteristics

Document No.	Title	Revision	Type	ADAMS Accession No.
APR1400-K-X-FS-14002 -P & NP	APR1400 Design Control Document Tier 2: Chapter 2 Site Characteristics	0	DCD	ML15006A041
		1 (03/10/17)	DCD	-
APR1400-K-X-IT-14001 -P & NP	APR1400 Design Control Document Tier 1	0	DCD	ML15006A039
		1 (03/10/17)	DCD	-

❖ Summary of RAIs

No. of Questions	No. of Responses	Not Responded	No. of OI
33	33	0	0

NON-PROPRIETARY

Response to the ACRS Subcommittee Questions

❖ Question

- Staff Draft SE (p 2-45): KHNP used the terms “exclusion area boundary” and “site boundary” interchangeably, although these terms are not necessarily the same for all facilities - if KHNP is aware of this and if there is any impact of this.

❖ Response

- The revisions to SER Subsection 2.3.5.4 (Para. 4) note that the terminology “EAB Site Boundary (m)” in one of the column headings of SER Table 2.3.5-1 (Applicant’s Comparison of APR1400 Annual Average χ /Q and D/Q Values with Other U.S. Nuclear Power Plant and DC Applications) is directly based on the Applicant’s response to RAI 7913, Question 02.03.05-1 (ADAMS Accession No. ML15182A395). The Staff also notes that the (routine release-related) annual average χ/Q and D/Q values postulated for the APR1400 design, as listed in DCD Tier 1, Table 2.1-1 and DCD Tier 2, Table 2.0-1, appropriately associate these values with the “site boundary”. The context for the SER discussion is the Staff’s evaluation of these postulated site parameter values for reasonability by comparison to not only the χ /Q and D/Q values provided by the Applicant in the referenced RAI response but to other χ /Q and D/Q values identified by the Staff in SER Table 2.3.5-3, many of which are reported for different downwind distances applicable to each facility.

Response to the ACRS Subcommittee Questions

❖ Question

- Design basis flood and max ground water level – which bldgs. Outside nuclear island need to be protected water level limits of 1' and 2' below grade level, is part of TG bldg. below these levels? How would a COL applicant know (no COL info item in Ch. 2)?

❖ Response

- The buildings important to safety include the below listed buildings.

  - Buildings in the nuclear island : RCB, AB

  - Buildings outside the nuclear island : Compound Building, ESW / CCW Heat Exchanger Building with Cooling Tower, AAC Gas Turbine Generator Building, Emergency Diesel Generator Building and Diesel Fuel Oil Tank, and Turbine Building

- Maximum flood elevation (1 ft below plant grade) and maximum groundwater elevation (2 ft below plant grade) are addressed in DCD Tier 2, Table 2.0-1 and applied to the design of these buildings.

- COL 2.4(1) states that COL applicant is to provide the site-specific information on flood protection requirements.

Response to the ACRS Subcommittee Questions

❖ Question

- Section 2.4.4.2 on dam failures – “artificially large floods” – means what?

❖ Response

- As stated in DCD Tier 2 Subsection 2.4.4, artificially large floods means the floods to safety-related facilities of nuclear power plant due to the failure of upstream and downstream water control structures such as dam, reservoir and levee.

Response to the ACRS Subcommittee Questions

❖ **Question**

- Section 2.4.11, Low water – downstream dam, impoundment of cooling water dikes etc. not addressed, why?

❖ **Response**

- Downstream water control structures such as downstream dam, impoundment of cooling water dikes etc. are addressed in DCD Tier 2 Subsection 2.4.4. According to COL 2.4(1), the COL applicant is to provide site-specific hydrologic information addressed in DCD Section 2.4. The plant requirements of minimum safety-related cooling water flow in low water consideration are described in Subsection 2.4.11.5 and any potential failures such as downstream dam, impoundment of cooling water dikes, etc. should meet the requirements..

Current Status

- Chapter 2 (Revision 1, March 2017) is completed with no open items.
  - KHNP continues to monitor Chapter 2 to assure any conforming changes are addressed.

Attachment: Acronyms

- AAC: Alternate Alternating Current
- AB: Auxiliary Building
- ACRS: Advisory Committee on Reactor Safeguards
- CFR: Codes of Federal Regulations
- COL / COLA: Combined License / Combined License Applicant
- CCW: Component Cooling Water
- DCA: Design Certification Application
- DCD: Design Control Document
- ESW: Essential Service Water
- KEPCO: Korea Electric Power Corporation
- KHNP: Korea Hydro & Nuclear Power
- NRC: U.S. Nuclear Regulatory Commission
- OI: Open Item
- PMP: Probable Maximum Precipitation
- PMF: Probable Maximum Flood
- RCB: Reactor Containment Building
- RAI: Request for Additional Information
- RG: Regulatory Guide
- SE: Safety Evaluation
- SSC: Structure, System, or Component
- TG: Turbine Generator

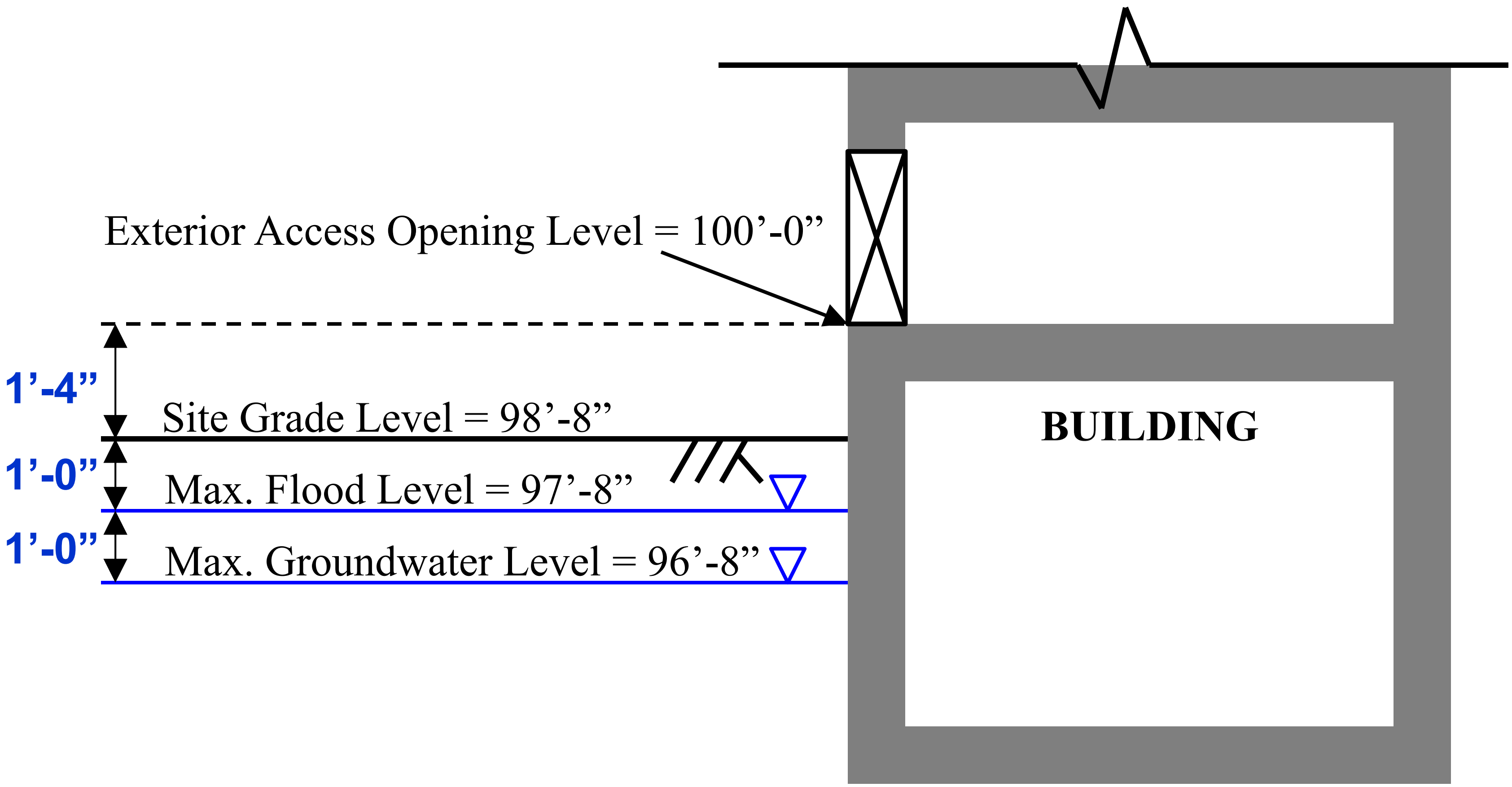
Attachment: List of COL Items

❖ **List of COL Items related to ACRS subcommittee questions**

COL No.	Description
COL 2.4(1)	The COL applicant is to provide the site-specific hydrologic information on probable maximum precipitation (PMP), probable maximum flood (PMF) of streams and rivers, potential dam failures, probable maximum surge and seiche flooding, probable maximum tsunami hazards, ice effects, cooling water canals and reservoirs, channel diversions, flood protection requirements, low water considerations, groundwater, potential accidental release of liquid effluents in ground and surface water, and Technical Specifications and emergency operation requirements in accordance with NRC RG 1.206, NRC RG 1.59, and NRC JLD-ISG-2012-06.

NON-PROPRIETARY

Reference: Elevations against External Flood



United States Nuclear Regulatory Commission
Protecting People and the Environment

United States Nuclear Regulatory Commission
Protecting People and the Environment

Presentation to the ACRS Subcommittee

Korea Hydro & Nuclear Power Co., Ltd (KHNP)
APR1400 Design Certification Application Review

Safety Evaluation with No Open Items:

Chapter 2 SITE CHARACTERISTICS

Sections 2.1 – 2.4

NOVEMBER 14, 2017

Staff Review Team

- **Technical Staff**
  - Seshagiri (Rao) Tammara, Michael Mazaika, Jason White, Kevin Quinlan, Michael Lee
- **Project Managers**
  - Bill Ward – Lead Project Manager
  - Carolyn Lauron – Project Manager

Technical Topics - Overview Chapter 2, Site Characteristics Sections 2.1 – 2.4

- No Open Items

Technical Topics
Chapter 2 – Site Characteristics

U.S.NRC
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Protecting People and the Environment

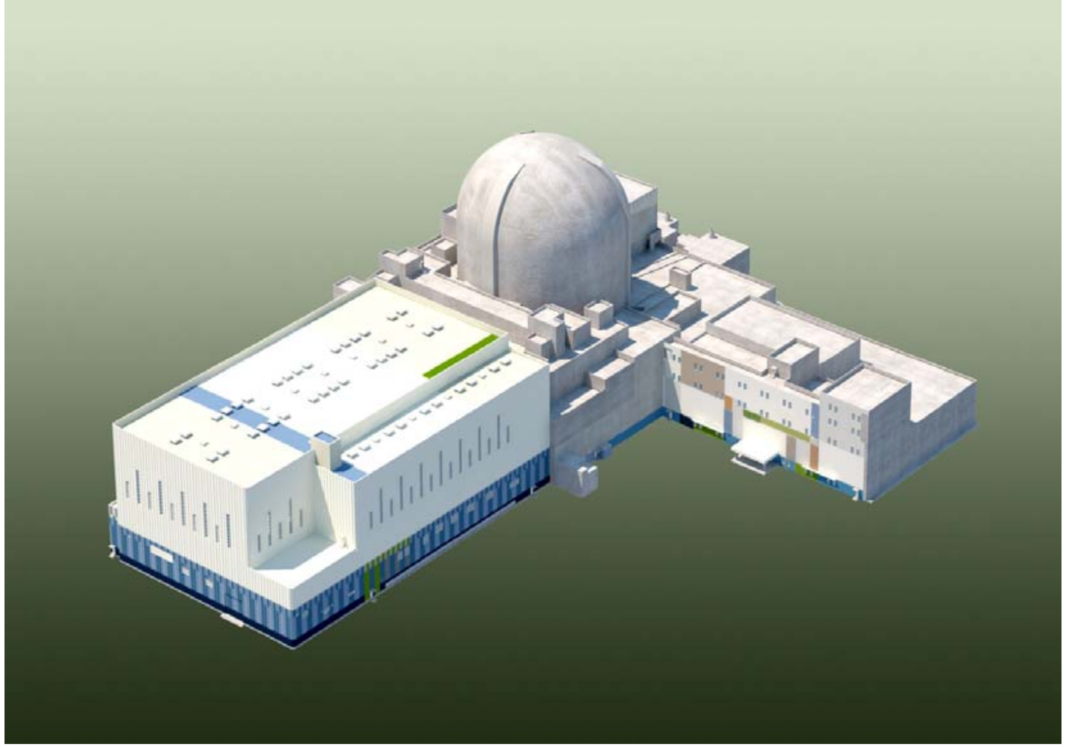
- The APR1400 design assumes a site envelope that describes the geography and demography, nearby facilities, and postulated site parameters for the design, including meteorology, hydrology, geology, seismology, and geotechnical parameters.

- This presentation covers the site characteristics related to:
  - Geography and demography
  - Meteorology
  - Hydrology
  - Geology

- A future ACRS presentation will discuss the site characteristics related to seismology and geotechnical parameters.

- There were no open items previously identified. We expect all confirmatory items to be closed with DCD Revision 2.

APR1400 DCA
Chapter 5: Reactor Coolant System and Connecting Systems



KEPCO/KHNP
November 14, 2017

Contents

NON-PROPRIETARY

Overview of Chapter 5

Sections	Major Contents
5.1 Summary Description	• Design Features of the Reactor Coolant System (RCS)
5.2 Integrity of Reactor Coolant Boundary (RCPB)	• Describes the measures that provide and maintain the integrity of the RCPB throughout the facilities design life
5.3 Reactor Vessel	• Describes Reactor Vessel Material Issues
5.4 RCS Component and Subsystem Design	• Describes the Reactor System Components

NON-PROPRIETARY

Overview of Chapter 5

● List of Submitted Documents

Document No.	Title	Revision	Type	ADAMS Accession No.
APR1400-K-X-FS-14002 -P & NP	APR1400 Design Control Document Tier 2: Chapter 5 Reactor Coolant System and Connecting Systems	1 (03/10/17)	DCD	-
APR1400-K-X-IT-14001 -P & NP	APR1400 Design Control Document Tier 1	1 (03/10/17)	DCD	-
APR1400-Z-A-NR-14015 -P & NP	Neutron Fluence Calculation Methodology for Reactor Vessel	1	TER	ML17094A158
APR1400-Z-M-NR-14008 -P & NP	Pressure-Temperature Limits Methodology for RCS Heatup and Cooldown	0	TER	ML15009A125
APR1400-A-M-NR-14001 -P & NP	KHNP APR1400 Flywheel Integrity Report	3	TER	-
APR1400-E-N-NR-14005 -P & NP	Shutdown Evaluation Report	0	TER	ML15128A285

● RAI Summary

No. of Questions	No. of Responses*	Not Responded	No. of Open Items
78	78	0	0

Overview of Chapter 5

● List of Open Items

Open Item Number	Related RAI	Title	ADAMS Accession #
05.02.02-1	RAI 8244	POSRV sizing	ML15348A083
05.02.02-7	RAI 8609	LTOP analysis	ML16161B241
05.04.01.01-7	RAI 8641	RCP Motor flywheel Integrity	ML16256A805
05.04.01.01-8	RAI 8641	RCP Motor flywheel Integrity	ML16256A805
05.04.01.01-9	RAI 8641	RCP Motor flywheel Integrity	ML16256A805
05.04.01.01-10	RAI 8641	RCP Motor flywheel Integrity	ML16256A805
05.04.01.01-11	RAI 8641	RCP Motor flywheel Integrity	ML16256A805
05.04.01.01-12	RAI 8641	RCP Motor flywheel Integrity	ML16256A805
05.04.07-4	RAI 8614	Prevention of potential gas accumulation	ML16190A320

Summary of Open Items

Open Item: POSRV sizing

- Related RAIs
  - RAI 233-8244 (05.02.02-1)
- Description of issue
  - The staff is unable to locate the referenced sensitivity study containing assumptions used for the POSRV sizing study.
  - KHNP was requested to provide additional POSRV capacity details, the basis for Figure 5.2.2-1 and to provide access to the analysis referenced in the DCD which contains an assessment describing the basis for POSRV sizing.
- Resolution:
  - KHNP provided the response in Dec. 2015 with detailed capacity basis and sizing analysis of POSRV.

Summary of Open Items

Open Item: LTOP analysis

- Related RAIs
  - RAI 233-8244 (05.02.02-1) and RAI 487-8609 (05.02.02-7)
- Description of issue
  - The APR1400 does not contain the analysis demonstrating the adequacy of the LTOP design. The staff is unable to confirm that the use of either SCS relief valve will provide sufficient pressure relief capacity to mitigate the most limiting LTOP events.
  - KHNP was requested to provide description of the analysis and, more specifically provide the mass and energy addition transient results.
  - KHNP was requested to address the analysis assumptions, evaluation model, methodology, computer codes and input parameters used to analyze the limiting LTOP events.

Summary of Open Items

- Resolution:
  - In response to RAI 233-8244, the KHNP provided a discussion of the analysis of mass and energy limiting events.

    However, staff identified additional questions (RAI 487-8609) regarding the analysis of the limiting events where LTOP applied.

  - In response to RAI 487-8609, KHNP provided:
    - ✓ method of analysis, basic data, assumptions, input parameters and the conservatism of input data for mass and energy transients.

Summary of Open Items

Open Item: RCP Motor Flywheel Integrity

- Related RAIs
  - RAI 341-8410 (05.04.01.01-1) and 503-8641 (05.04.01.01-7)
- Description of issue
  - KHNP was requested to document an acceptable approach for determining the fracture toughness of the RCP flywheel materials used in the APR1400 design.
  - An example of an acceptable approach discussed in a public meeting June 29, 2016, is to specify the direct method of determining fracture toughness, and provide either the fracture toughness value using the direct method or include fracture toughness as an ITAAC.
- Resolution:
  - KHNP revised DCD to state fracture toughness of at least 150 ksi√in (to specify the direct method of determining fracture toughness).

Summary of Open Items

Open Item: RCP Motor Flywheel Integrity

- Related RAIs
  - RAI 341-8410 (05.04.01.01-1) and 503-8641 (05.04.01.01-8)
- Description of issue
  - KHNP provided operating experience of the flywheel material. However, the operating experience cited for the material includes spare flywheels that have not seen service or plants that have not been operated.
  - The staff requested to clarify how this information is relevant to demonstrating the performance of the proposed flywheel material under the APR1400 operating conditions.
- Resolution:
  - KHNP revised the operating experience table with only relevant flywheels.

Summary of Open Items

Open Item: RCP Motor Flywheel Integrity

- Related RAIs
  - RAI 341-8410 (05.04.01.01-3) and 503-8641 (05.04.01.01-9)
- Description of issue
  - KHNP was requested to apply a RCP flywheel stress limit of one-third of the yield strength of the material or provide technical justification for use of one-third of ultimate strength.
- Resolution:
  - RCP flywheel stress limit of one-third of the yield strength of the material according to the SRP 5.4.1.1 is applied in the TeR (APR1400-A-M-NR-14001-P & NP, KHNP APR1400 Flywheel Integrity Report, Rev.3).
  - The TeR was made available for staff's audit.

Summary of Open Items

Open Item: RCP Motor Flywheel Integrity

- Related RAIs
  - RAI 341-8410 (05.04.01.01-3) and 503-8641 (05.04.01.01-10)
- Description of issue
  - KHNP was requested to revise the technical report to include an analysis of the hub and provide the appropriate fatigue crack growth rates.
- Resolution:
  - A separate stress plot of the hub is added in the TeR (APR1400-A-M-NR-14001-P & NP, KHNP APR1400 Flywheel Integrity Report, Rev.3).
  - The TeR was made available for staff's audit.

Summary of Open Items

Open Item: RCP Motor Flywheel Integrity

- Related RAIs
  - RAI 341-8410 (05.04.01.01-4) and 503-8641 (05.04.01.01-11)
- Description of issue
  - KHNP was requested to specify maximum flaw size used as the acceptance criteria and that it is bounding in determining the critical flaw size.
- Resolution:
  - KHNP revised DCD to include inspection acceptance criteria of less than 0.5 inch (12.7mm).

Summary of Open Items

Open Item: RCP Motor Flywheel Integrity

- Related RAIs
  - RAI 341-8410 (05.04.01.01-5 and 6) and 503-8641 (05.04.01.01-12)
- Description of issue
  - Tests and inspections proposed for the flywheel also apply to the hub.
  - KHNP was requested to revise DCD to state that the hub will be inspected for both PSI and ISI in the same manner. In addition, it was requested to provide a discussion on the extent and acceptance criteria of UT inspections that could be performed or other alternatives of performing in-service inspections given these geometric interferences (oil channels).
- Resolution:
  - The hub has oil channels that would make it difficult to perform UT inspection. Dye penetration or magnetic particle test instead of UT is added to the DCD for ISI instructions.

Summary of Open Items

Open Item: Prevention of potential gas accumulation

- Related RAIs
  - RAI 492-8614 (05.04.07-04) , RAI 42-7945 (19-2)
- Description of issue
  - GL 2008-01 requests to prevent potential gas accumulation in safety related systems, including emergency core cooling systems. This includes, but is not limited to the Shutdown Cooling System(SCS), including potential gas entrainment during mid-loop operations from vortexing, the containment spray system(CSS), and the safety injection system(SIS).
  - ITAACs previously submitted in response to RAI 42-7945 Question 19-2 do not adequately address the provisions in these documents.
  - KHNP was requested to address GL 2008-01 and NEI 09-10, Revision 1a-A as they relate to SCS, SIS and CSS or provide and justify an alternate approach to managing gas accumulation.

Summary of Open Items

- Resolution:
  - KHNP provided markup of ITAAC with respect to potential air ingestion and/or vortexing during refueling conditions and gas accumulation during power operation.
    - ✓ ITAAC for gas accumulation (DCD Tier 1 Subsection 2.4.3.1 and Table 2.4.3-4 for SIS, 2.4.4.1 and Table 2.4.4-4 for SCS, 2.11.2.1 and Table 2.11.2-4 for CSS)
    - ✓ ITAAC for air entrainment during mid-loop operations (DCD Tier 1 Subsection 2.4.1.1 and Table 2.4.1-4)

Current Status

- Chapter 5 is complete.
  - KHNP continues to monitor Chapter 5 to assure any conforming changes are addressed.
- 9 open items, that were identified in Phase 2 and 3, have been resolved with adequate and sufficient discussion with the staff.
- Change in Chapter 5 as reviewed and marked-up in response to the RAIs will be incorporated into the next revision (Rev.2) of the DCD.

Attachment : Acronyms

- ASME: American Society of Mechanical Engineers
- KHNP: Korea Hydro & Nuclear Power
- IRWST: In-containment Refueling Water Storage Tank
- ISI: Inservice Inspection
- IST: Inservice Testing
- LTOP: Low Temperature Overpressure Protection
- POSRV: Pilot-operated Safety Relief Valve
- RCP: Reactor Coolant Pump
- RCPB: Reactor Coolant Pressure Boundary
- RCS: Reactor Coolant System
- RG: Regulatory Guide
- SIS: Safety Injection System
- CSS: Containment Spray System
- SCS: Shutdown Cooling System

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Presentation to the ACRS Subcommittee

Korea Hydro & Nuclear Power Co., Ltd (KHNP)
APR1400 Design Certification Application Review

Safety Evaluation with No Open Items:

Chapter 5 REACTOR COOLANT SYSTEM AND RELATED SYSTEMS

NOVEMBER 14, 2017

Staff Review Team

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  - Chang Li
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- **Project Managers**
  - Bill Ward – Lead Project Manager
  - Jessica Umaña – Project Manager

Technical Topics

Chapter 5 – Reactor Coolant System and Related Systems

Technical Topics

- The reactor coolant systems circulates water in a closed cycle, removing heat from the reactor core and internals and transferring it to a secondary system.

- The RCS includes the following:
  - reactor vessel
  - SG
  - RCPs
  - pressurizer
  - associated piping

Technical Topics - Overview
Chapter 5, Reactor Coolant System and Related Systems
Sections with Open Items

- 5.2.2 - Overpressure Protection
- 5.4.1.1 - RCP Flywheel Integrity
- 5.4.7 - Residual Heat Removal System

Open Item, RAI 8244, Question 05.02.02-1

Issue: The DCD referenced a sensitivity study that contained the assumptions, inputs, and results used for the design of the POSRV capacity during worst case loss-of-load transient and to develop the optimized POSRV capacity shown in Figure 5.2.2-1.

Resolution: Part V of the response provided the sensitivity study used to define the POSRV design during worst case loss-of-load transient and develop optimized POSRV capacity shown in Figure 5.2.2-1.

Staff Conclusion
The staff determined the sensitivity study's assumptions, inputs, and results were reasonable and conservative. The staff concludes that the applicant design of the POSRV capacity is consistent with GDC15.

Technical Topics

Chapter 5 – Reactor Coolant System and Related Systems

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Open Item, RAI 8609, Question 05.02.02-7

Issue: DCD lacked sufficient information of the methodology for the analysis of the limiting events where LTOP is utilized.

Resolution: Responses to RAI 8244, Question 05.02.02-1, Part V, and follow-up RAI 8609 Question 05.02.02-7, provided a description of the analysis methodology, computer codes used to analyze the limiting LTOP event(s) including the input parameters and assumptions.

Staff Conclusion

The staff determined the analysis methodology and computer codes including the input parameters and assumptions used to analyze the limiting LTOP event(s) were reasonable and conservative. The staff concludes that the applicant design of the POSRV capacity is consistent with GDC15.

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Open Items, RAI 8641, Questions 05.04.01.01-7 and 05.04.01.01-8

Issue: Flywheel Material, including fracture toughness determination and operating experience of the RCP flywheel material used in the APR1400 design.

Resolution: The as-built fracture toughness will be determined using the direct method in NUREG-0800, Section 5.4.1.1, and has satisfactory operating experience.

Staff Conclusion
The staff found the operating experience and determination of mechanical properties for the RCP flywheel acceptable to maintain its toughness to resist brittle fracture, thereby maintaining its structural integrity consistent with the requirements of 10 CFR 50.55a and GDC 1 of Appendix A to 10 CFR Part 50.

Open Items, RAI 8641, Questions 05.04.01.01-9 and 05.04.01.01-10

Issue: Flywheel analysis. The original submittal based the flywheel on the design criteria meeting one-third of the ultimate strength of the material.

Resolution: The analysis was modified extensively (by optimizing the shrink-fit stresses) to demonstrate that the design stress of the flywheel at design speed does not exceed one-third of the yield strength of that material, consistent with NUREG-0800, Section 5.4.1.1. The applicant used reference crack growth rates applicable to the flywheel material. An analysis of the hub was provided that demonstrates the hub is in compression; therefore, fatigue is not a concern.

Staff Conclusion

The staff found the flywheel analysis demonstrates that the flywheel and hub are designed to withstand overspeed conditions thereby minimizing the potential of generating missiles consistent with the requirements of GDC 4 of Appendix A to 10 CFR Part 50.

Open Items, RAI 8641, Questions 05.04.01.01-11 and 05.04.01.01-12

Issue: Applicable Inspection (PSI and ISI) – Whether the inspection acceptance criteria for the PSI is bounded by the flaw size used in the analysis for determining the critical flaw size, and the what PSI and ISI of hub.

Resolution: Applicant confirmed inspection acceptance criteria for the PSI is bounded by the flaw size used in the analysis for determining the critical flaw size. The applicant revised the APR1400 DCD to include the extent and acceptance criteria for the PSI and the ISI of the hub. Ultrasonic and surface inspection of the hub will be performed for PSI. Surface inspection will be performed for the hub during ISI.

Staff Conclusion

The staff concludes that the applicable PSI and ISI of the hub is acceptable, since it will ensure that the flywheel integrity is maintained to preclude the generation of missiles, as required GDCs 1 and 4 of Appendix A to 10 CFR Part 50.

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Open Item, RAI 8614, Question 05.04.07-4

Issue: DCD lacked sufficient ITACC information to support that the SCS, SIS, and CSS designs to comply with GL 2008-01, DC/COL-ISG-019, and NEI 09-10, Revision 1a-A with respect to potential air ingestion and/or vortexing during refueling conditions and gas accumulation during power operations.

Resolution: RAI 8614, Question 05.04.07-4 response included ITAACs that addressed the conditions that would satisfy requirements in the above documents.

DCD Tier 1 Subsection 2.4.3.1, Table 2.4.3-4 for SIS, Subsection 2.4.4.1, Table 2.4.4-4 for SCS, Subsection 2.11.2.1, Table 2.11.2-4 for CSS were revised to include ITAAC.

Staff Conclusion

The staff reviewed the revised ITAAC information provided by the applicant and determined that the revised ITAACs are sufficient to identify potential air ingestion (and/or vortexing) during mid-loop operation and pathways for gas accumulation during power operations satisfy 10 CFR 52.47(b)(1).

Technical Topics

Chapter 5 – Reactor Coolant System and Related Systems

Conclusion

The staff has determined that all open items are resolved, besides the confirmatory items listed in the SE, and that DCD Chapter 5 meets all applicable regulatory criteria. As identified within the Chapter 5 SE with no open items, the staff has 6 confirmatory items awaiting incorporation in Revision 2 of the DCD.

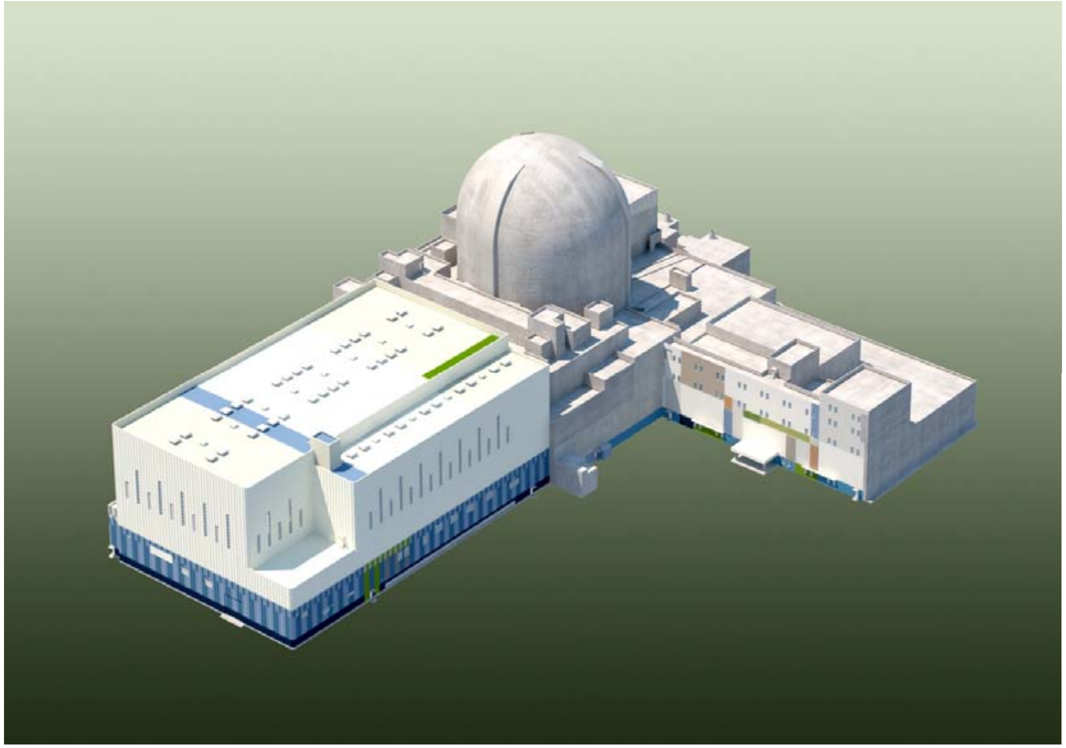
The staff concludes, using the information presented in the application, and pending confirmation of the confirmatory items above, that the applicant has demonstrated compliance with NRC regulations and guidance.

ACRONYMS

10 CFR – Title 10 of the Code of Federal Regulations
CSS – containment spray system
ISI – inservice inspection
LTOP – low pressure temperature overpressure
POSRV – pilot-operated safety relief valve
PSI – preservice inspection
PTLR – Pressure – Temperature Limits Report
RAI – request for additional information
RCP – reactor coolant pump
RCS – reactor coolant system
RCP – reactor coolant pump
RG – Regulatory Guide
SCS – shutdown cooling system
SG – steam generator
SIS – safety injection system
SRP – Standard Review Plan
SRV – safety relief valve

NON-PROPRIETARY

APR1400 DCA
Chapter 11: Radioactive Waste Management



KEPCO/KHNP

November 14, 2017

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- **Overview of Chapter 11**
  - Section Overview
  - List of Submitted Documents and Summary of RAIs
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- **Current Status**
- **Attachments:**
  - Acronyms
  - List of COL Items related to Open Items

Overview of Chapter 11

Section	Title	Major Contents
11.1	Source Terms	• Design Basis Source Term • Expected Source Term • Neutron Activation Products • Tritium Production in Reactor Coolant • Leakage Sources
11.2	Liquid Waste Management System	• Design Bases • System Description • Radioactive Effluent Releases • Testing and Inspection Requirements
11.3	Gaseous Waste Management System	• Design Bases • System Description • Radioactive Effluent Releases • Testing and Inspection Requirements • Instrumentation Requirements
11.4	Solid Waste Management System	• Design Bases • System Description • Radioactive Effluent Releases • Process Control Program • Component Descriptions • Malfunction Analysis • Testing and Inspection Requirements • Instrumentation Requirements
11.5	Process and Effluent Radiation Monitoring and Sampling Systems	• Design Bases • System Description

NON-PROPRIETARY

Overview of Chapter 11

❖ List of Submitted Documents for Chapter 11

Document No.	Title	Revision	Type	ADAMS Accession No.
APR1400-K-X-FS-14002 -P & NP	APR1400 Design Control Document Tier 2: Chapter 11 Radioactive Waste Management	1	DCD	ML15006A044
APR1400-K-X-IT-14001 -P & NP	APR1400 Design Control Document Tier 1	1	DCD	ML15006A039

❖ Summary of RAIs

No. of Questions	No. of Responses	No. of OI
38	38	0

Overview of Chapter 11

❖ List of Open Items

No.	Related RAI	Topic	ADAMS Accession #
1	RAI 230-8201 (Q 11.02-6)	Control of radioactive release to environment	ML16256A811
2	RAI 254-8270 (Q 11.02-07)	Radwaste classification of SGBS	ML16188A395
3	RAI 543-8731 (Q 11.02-11)	Liquid Tank Failure Analysis	ML17214A580
4	RAI 538-8720 (Q 11.03-11)	BTP 11-6 liquid tank failure analysis	ML17082A422
5	RAI 538-8731 (Q 11.03-12)	SWMS tank vents	ML17076A138
6	RAI 538-8720 (Q 11.03-13)	NFPA 804 compliance for delay beds	ML17076A138
7	RAI 131-8087 (Q 11.05-1)	Description of PERMSS monitors	ML17230A231
8	RAI 132-8088 (Q 11.05-2)	Description of PERMSS monitors	ML17223A081
9	RAI 222-8203 (Q 11.05-3)	Primary-to-secondary leakage detection	ML16174A118

Summary of Open Items

❖ Open Item: Control of radioactive release to environment

- Related RAIs : 230-8201 (Q 11.02-6)
- Description of issue
  - Staff requested to provide the followings:
    - ✓ Overall details for operator initiation and termination of the LWMS process operations to achieve treatment objectives and effluent specifications.
    - ✓ Liquid radwaste system P&ID to clarify how the system is designed to control the releases of radioactive material to the environment.
    - ✓ Modification of DCD text to clarify liquid waste input streams.
    - ✓ Details for operator actions once the LWMS tank leakage is detected.

Summary of Open Items

- Resolution:
  - KHNP provide the followings:
    - ✓ The operator can initiate treatment using one of two LWMS trains. Some components are equipped with cross-ties to add flexibility of treatment operation. The treated effluent in the monitor tanks can be recycled for further treatment when the release exceeds a radiological setpoint. The internal components inside R/O and ion exchanger module are arranged as predetermined treatment process in order to meet regulatory limits.
    - ✓ P&ID showing the release of processed liquid.
    - ✓ DCD descriptions which are modified to clarify liquid waste input streams.
    - ✓ The operator will investigate the cause of leakage to determine mitigation actions. The mitigation actions may include termination of liquid waste collection, decontamination for contaminated area, and repair work as required. The associated program and procedures will be developed by COL applicant.

Summary of Open Items

❖ Open Item: Radwaste classification of SGBS

- Related RAIs : 254-8270 (Q 11.02-07)
- Description of issue
  - Staff noted that there was a lack of information available to make any kind of determination for the radwaste classification of the steam generator blowdown (SGBS) demineralizer, which should be a different radwaste safety class (possibly RW-IIa).
- Resolution:
  - KHNP responded that the radwaste classification of the SGBS components were based on the 1% fuel defect and the SG leakage rate of 75 lb/day.
  - KHNP added the source term data and the corresponding radwaste classification for the SGBS in the revised response.

Summary of Open Items

❖ Open Item: BTP 11-6 liquid tank failure analysis

- Related RAIs : 254-8731 (Q 11.02-11)

- Description of issue
  - Staff requested to justify the CVCS yard tank source terms used for the BTP 11-6 in DCD Table 11.2-9 are not consistent with the those provided in the response to RAI 13-7856 Question 12.02-2.

- Resolution:
  - KHNP provided a response that the source terms for the BTP 11-6 are calculated in accordance with ANSI/ANS 18.1, not by assuming an fuel defect rate of 0.12%.
  - KHNP also addressed that since the CVCS yard tank source term calculation method was changed in RAI 7856 Question 12.02-2 to consider 95 % of the tank volume, the expected source terms in Table 11.2-9 also were changed.
  - KHNP re-performed the BTP 11-6 analysis and updated the results in the DCD.

Summary of Open Items

❖ Open Item: SWMS tank vents

- Related RAIs : 254-8720 (Q 11.03-11)
- Description of issue
  - Staff requested to address means to direct the SWMS tank gases to the ventilation system and the basis for providing this set up from a radiation protection perspective
- Resolution:
  - KHNP provided a response as follows:
    - The gaseous effluents from the SWMS are processed through the Compound Building controlled area HVAC system. The system includes HEPA and carbon filters to ensure that the releases do not exceed the regulatory limits.
    - For the SRLST, the tank vent is directed to the cubicle vent to minimize the transport of radionuclides to the room. The tank vent is separated from ventilation duct and equipped with screens to prevent discharge of any fluid and solids into the ventilation system.
    - For the LASRT, the tank vent is routed to the proximity of the floor drain inside the tank room. The gases from the tank are vented to the room atmosphere for collection by the ventilation system and treated within the ventilation system prior to release to the environment. The gases are vented only during the resin transfer process or tank depressurization.
  - KHNP updated the DCD to include the above information.

Summary of Open Items

❖ Open Item: NFPA 804 compliance for delay beds

- Related RAIs : 254-8720 (Q 11.03-12)
- Description of issue
  - Staff requested to provide description how the design complies with NFPA 804 and the details of the fixed water spray systems for the charcoal adsorber beds that contain more than 100 lbs of charcoal.
- Resolution:
  - KHNP provided a response as follows:
    - The gaseous radwaste system is designed to prevent the formation of an explosive mixture by controlling the hydrogen and oxygen concentration. The charcoal delay beds are located inside a shielded cubicle, which also acts as a fire barrier; and there is no additional combustible material that could cause fire or the spread of fire.
    - These design features help to preclude a fire condition. Hence a fixed water spray system for charcoal delay beds is not required to be provided for gaseous radwaste system. The associated information and conclusion has been included in fire hazard analysis report for the charcoal delay bed area (DCD section 9.5A.3.6.4).
  - KHNP updated the DCD to include the above information.

NON-PROPRIETARY

Summary of Open Items

❖ Open Item: Prevention of release from GRS

- Related RAIs : 254-8720 (Q 11.03-13)
- Description of issue
  - Staff requested to justify how would the gaseous effluent discharge be terminated if the isolation valve did not close.
  - Staff requested to provide the function of manual valve located at gaseous effluent bypass line from gaseous radwaste system
- Resolution:
  - KHNP responded as follows:
    - Another isolation valve in the GRS package can be closed remotely when the main isolation valve fails to close. The vendor for GRS package is required to provide the isolation valve in the effluent discharge line. And also the two manual valves located at both sides of the main isolation valve can be closed for limiting the release of discharge flow.
    - The full flow bypass line around the main isolation valve is provided to maintain the continuous GRS process flow. When the main discharge line is isolated due to fail position or maintenance of main isolation valve, the valve located at the bypass line is opened for continuous process flow until the main isolation valve is fixed.
  - KHNP updated the DCD to include the above information.

Summary of Open Items

❖ Open Item: Description of PERMSS monitors

- Related RAIs : 131-8087 (Q 11.05-1), 132-8088 (Q 11.05-2)
- Description of issue
  - Text description to be added to DCD for the following information :
    - ✓ Purpose of monitor for each monitor, i.e., ODCM and REMP
    - ✓ Setpoint determination for each of gaseous monitor channels (particulate, iodine, or gaseous)
    - ✓ QA commitment and calibration procedure
    - ✓ Line loss calculation of sample line for containment air monitors
    - ✓ H-3 and noble gas sampling capability
  - Condenser pit sump monitor and CCWS HX building sump monitor

Summary of Open Items

- Resolution:
  - In the revised response and DCD markup, clarification on the RMS with relation to ODCM and REMP has been provided.
  - The set-points of each channel are to be determined not to exceed the design criteria, i.e., 10 CFR 20, Appendix B. Hence if any of the three channels indicated that the set-point is exceeded, then the RMS initiates required actions. Since the characteristics of the leakage may vary depending on many other situations, the required action would be initiated when one channel of the three channels will exceed the set-point first.
  - QA program conformance with regulatory position C.7 of RG 1.143 has been discussed in the DCD markup. The calibration procedures in accordance with RG 1.33 and RG 4.15 will be developed by COL applicant. The methodology of the calibration methods and frequency is provided by the ODCM based on plant procedures.

Summary of Open Items

- Resolution:
  - The COL applicant designs the sample nozzle location, sample line size, line routing/configuration/length, and monitor location to minimize the line loss in accordance with ANSI-N13.1. This is verified to ensure the particle penetration factor is not less than 50% using CFD methodology and particle penetration analysis.
  - Description has been added that the RMS has capability to obtain grab samples for particulates, iodine, gases and H-3.
  - Text description and table information have been added to DCD 11.5 to discuss function, interlock, measurement range, compliance to regulation, installed location , and safety classification of four monitors. (Condenser pit sump monitor and CCW HX building sump monitor)
  - All of the above open items have been resolved through the revised response to RAIs 8087, Q.11.05-1 and 8088, Q.11.05-2.

Summary of Open Items

❖ Open Item: Primary-to-secondary leakage detection

- Related RAIs : 222-8203 (Q 11.05-3)
- Description of issue
  - The ITAAC should address the sensitivity, response time, and alarm limit for the primary-to-secondary leakage detection instrumentation.
  - Provide additional information relating to the steam line effluent monitors.
- Resolution:
  - The information of main steam line monitors for detecting primary-to-secondary leakage is provided in the Table 2.7.6.4-1 and corresponding ITAAC.
  - A calculation to demonstrate the ability to monitor N-16 activity in the main steam line is provided.
  - Details in Appendix 11B shows compliance with monitoring SG tube leakage.
  - The revised response to the RAI has been submitted and the open item resolved.

Current Status

❖ **Chapter 11 is complete**

- KHNP continues to monitor Chapter 11 to assure any conforming changes are addressed.
- 9 open items, that were identified in Phase 2 and 3, have been resolved with adequate and sufficient discussion with the staff.

❖ **Changes in Chapter 11 as reviewed and marked-up in response to the RAIs will be incorporated into the next revision (Rev.2) of the DCD**

NON-PROPRIETARY

Attachment: Acronyms

BTP	Branch Technical Position
CCWS	Component Cooling Water System
CFD	Computational Fluid Dynamics
CFR	Code of Federal Regulation
COL	Combined Operation License
COL	Combined Operation License
DCD	Design Control Document
HEPA	High Efficiency Particulate Air
ITAAC	Inspection, Test and Acceptance Criteria
KHNP	Korea Hydro and Nuclear Power Co.
LASRT	Low Activity Spent Resin Tank
LWMS	Liquiud Radwaste Mangement System
NFPA	National Fire Protection Association
ODCM	Offsite Dose Calculation Manual
P&ID	Piping and Instrument Diagram
QA	Quality Assurance
R/O	Reverse Osmosis
RAI	Request for Additional Information
REMP	Radiological and Environmental Monitoring Program
RG	Regulatory Guide
RMS	Radiation Monitoring System
SGBS	Steam Generator Blowdown System
SRLST	Spent Resin Long Term Storage Tank
SWMS	Solid Waste Management System

Attachment : List of COL Item related to OIs

COL Identifier	Description
COL 11.5(1)	The COL applicant is to determine the WARN and ALARM setpoints of the PERMSS based on the site-specific conditions and operational requirements.
COL 11.5(4)	The COL applicant is to prepare an offsite dose calculation manual (ODCM) that contains a description of the methodology and parameters for the calculation of the offsite doses for th e gaseous and liquid effluents.
COL 11.5(5)	The COL applicant is to provide analytical procedures and sensitivity for selected radio-anal ytical methods and types of sampling media for site specific applications.
COL 11.5(6)	The COL applicant is also to develop operational procedures in accordance with NRC RG 1.33 and NRC RG 4.15.
COL 11.5(7)	The COL applicant is to develop a radiological and environmental monitoring program (REMP) in accordance with NUREG-1301 and NUREG-0133, and NRC RG 4.1, which describes the scope of the program, taking into account local and land use census data in identifying all potential radiation exposure pathways, associated radioactive materials present in liquid and gaseous effluent, and direct external radiation from SSCs.
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 safety class and installed location of the RE-165, RE -166, RE-166, and RE-167.
COL 11.5 (11)	The COL applicant is to design the sample nozzle location, sample line size, line routing/co nfiguration/length, and monitor location to minimize the line loss in accordance with ANSI/H PS N13.1.

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Presentation to the ACRS Subcommittee

Korea Hydro & Nuclear Power Co., Ltd (KHNP)
APR1400 Design Certification Application Review

Safety Evaluation with No Open Items:

Chapter 11 RADIOACTIVE WASTE MANAGEMENT

NOVEMBER 14, 2017

Staff Review Team

- **Technical Staff**
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- **Project Managers**
  - Bill Ward – Lead Project Manager
  - Carolyn Lauron – Project Manager

Technical Topics - Overview
Chapter 11, Radioactive Waste Management
Sections with Open Items

- 11.2 - Liquid Waste Management System
- 11.5 - Process and Effluent Radiation Monitoring and Sampling System

Technical Topics

United States Nuclear Regulatory Commission
Protecting People and the Environment

Chapter 11 – Radioactive Waste Management

Technical Topics

- The APR1400 design monitors and controls releases of radioactive effluents and wastes through the Radioactive Waste Management System. The systems are designed for normal operations, including refueling outages, containment purging, routine maintenance, and anticipated operational occurrences.

- The Radioactive Waste Management System comprises of the following sections:
  - coolant source terms
  - liquid waste management system (LWMS)
  - gaseous waste management system (GWMS)
  - solid waste management system (SWMS)
  - process and effluent radiological monitoring and sampling system (PERMSS)

- Regulatory Requirements and Guidance:
  - 10 CFR Part 20, Appendix B; 10 CFR 50.34a; 10 CFR Part 50 Appendix I; 10 CFR Part 50, Appendix A, GDC 3, 13, 60, 61, 63, and 64,
  - NUREG-0800, RG 1.143

Technical Topics
Chapter 11 – Radioactive Waste Management

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Open Item - #1 (RAI 8201, Question 11.02-6)

Issue: DCD lacked sufficient information on liquid effluent tracking process for detergent radwaste tank liquid effluent releases.

Resolution: The applicant provided a revised RAI response that revised DCD section 11.2.1.3 to explain the operator actions to limit doses. The applicant also revised the DCD to include the P&IDs for the liquid radwaste system.

Staff Conclusion on Open Item #1
The staff reviewed the information provided by the applicant and determined that the applicant has adequately modified the DCD section 11.2 to explain the actions an operator can take to limit worker doses. The applicant has also provided the P&IDs necessary to understand the inputs into each waste system and has allowed staff verify the monitored release point for the liquid waste management system and to verify the descriptions for waste inputs into each liquid waste subsystem.

Staff considers RAI 8201, Question 11.02-6 resolved and closed.

Technical Topics

Chapter 11 – Radioactive Waste Management

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Open Item - #2 (RAI 8270, Question 11.02-7)

Issue: The staff requested consistent changes throughout sections 11.2, 11.3, 11.4 and 10.4.8 to address radwaste seismic classifications. In addition, the staff requested the applicant include the system source terms for the components described in DCD section 10.4.8.

Resolution: The applicant provided a revised response that describes the start and end points for radwaste seismic classifications. In addition the applicant provided the radioactive source terms for the steam generator blowdown system (SGBS) components.

Staff Conclusion on Open Item #2

The staff reviewed the information provided by the applicant and determined that the applicant has adequately modified the DCD to clearly state the start and stop points for the radwaste seismic classifications for components, and has also made these classifications consistent with the information contained in DCD sections 11.2, 11.3 and 11.4. Also the applicant has provided the source term information for the SGBS components in the DCD. This allowed the staff to confirm the radwaste seismic classifications stated in the DCD.

Staff considers RAI 8270, Question 11.02-7 resolved and closed.

Technical Topics

Chapter 11 – Radioactive Waste Management

Open Item - #3 and #4 (RAI 8087, Question 11.05-1 and RAI 8088, Question 11.05-2)

Issue: DCD lacked sufficient information to describe the monitors for the LWMS and the GWMS.

Resolution: The applicant provided a revised response that included the staffs request to provide additional details in the DCD.

Staff Conclusion on Open Items #3 and #4

The staff reviewed the information provided by the applicant and determined that the staff's request to provide specific monitor details was adequately addressed as markups to the DCD. The staff confirmed the following information is addressed in DCD markups to DCD section 11.5:

1. Description of each monitor's function
2. Description of each monitor's detection ranges
3. Description of the process configuration of each monitor
4. Description of the location of each monitor.
5. Description of applicable Regulatory Guides for each monitor.
6. Description of the alarms and interlocks as appropriate for each monitor
7. Description of the sampling stations and sampling methods, if applicable, for each monitor.
8. Description of each monitor's safety classification, if applicable.
9. Description of the each monitor's calibration requirements and quality assurance program requirements

The staff is tracking RAI 8087, Question 11.05-1 and RAI 8088, Question 11.05-2 as confirmatory items.

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Open Item - #5 (RAI 8203, Question 11.05-3)

Issue: Staff required clarification on the primary to secondary leak detection calculation provided in DCD appendix 11B.

Resolution: The applicant provided the staff with a response that included DCD text inserts for section 11.5 on the main steam line effluent monitors and the N-16 monitors. In addition the applicant provided clarifying text in DCD Appendix 11B to aid the staff in performing a confirmatory calculation.

Staff Conclusion on Open Item #5
The staff reviewed the information provided by the applicant and determined that the applicant's response, and subsequent DCD inserts, provided the staff with enough information to verify the applicant's ability to detect primary to secondary leakage. In addition, the staff was able to perform a confirmatory calculation to verify the applicant's low range set point to detect primary to secondary leakage.

Staff considers RAI 8203, Question 11.05-3 resolved and closed.

RAI 8731, Question 11.02-11

Issue: In review of a response to RAI 7856, Question 12.02-2, the staff observed an updated source term for the liquid waste tanks relating to the staff's BTP 11-6 "Liquid Tank Failure Analysis." The response to Question 12.02-2 provided a source term equivalent to 0.25% failed fuel whereas the source term required for the calculation for BTP 11-6 is 0.12% failed fuel. Comparison of question 12.02-2's response to Table 11.2-9 did not allow staff to arrive at the conclusion that half of the source term provided in question 12.02-2's response was equal to the information provided in Table 11.2-9. The staff issued this RAI to request clarification on the discrepancy.

Resolution: The applicant provided a response to discuss the difference in assumptions between the source term developed for BTP 11-6's analysis and the source terms provided in Question 12.02-2. This difference is that the source term for the BTP 11-6 analysis is based on the ANS/ANSI 18.1 standard. The response to Question 12.02-2 modified the tank source term methodology in chapter 12 and is different from the methodology described by the ANS/ANSI 18.1 standard. Thus a simple comparison would not be appropriate for the two source terms.

Technical Topics

Chapter 11 – Radioactive Waste Management

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RAI 8731, Question 11.02-11 (continued)

Staff Conclusion

The staff reviewed the information provided by the applicant and determined that the applicant's response is adequate given that the staff's guidance for BTP 11-6 specifies the use of NUREG-0017 for the development of the source term in this analysis. NUREG-0017 then references the ANS/ANSI 18.1 standard for the source term.

The staff is tracking RAI 8731, Question 11.02-11 as a confirmatory item.

Technical Topics
Chapter 11 – Radioactive Waste Management

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RAI 8720, Question 11.03-11

Issue: As a follow-up to a question received from the last subcommittee meeting the staff issued this question to request clarification on the methods used by the applicant to direct tank gases to the ventilation system.

Resolution: The applicant provided a response to described that the vent for each tank is located near each cubical vent to minimize the transport of gases. In addition, the applicant provided details on which tank vents were directed to floor drains so that water overflow would be directed to the appropriate drains before venting.

Staff Conclusion

The staff reviewed the information provided by the applicant and determined that the response was acceptable because the applicant provided information to describe the control of radioactive material in the event of tank venting. In addition the applicant has provided DCD markups to describe plans to prevent water from entering the ventilation system through the use of vent nozzles and tank vent lines that are directed to cubicle floor drains.

The staff is tracking RAI 8720, Question 11.03-11 as a confirmatory item.

RAI 8720, Question 11.03-12

Issue: As a follow-up to a question received from the last subcommittee meeting the staff issued this question to request clarification on the applicant's compliance with NFPA 804, section 8.4.9.4, which states: "Fixed water spray systems shall be provided for charcoal adsorber beds containing more than 100 lb (45.4 kg) of charcoal." It was found that DCD section 11.3.2 only contains a description on the use of nitrogen spray for fire suppression.

Resolution: The applicant provided a response which provides DCD changes to section 9.5A.3.6.4 to describe the fire analysis completed for the charcoal bed in the gaseous radwaste system. The applicant also states that NFPA 804 section 8.4.9.4 is not required for the gaseous radwaste system.

Staff Conclusion

The staff reviewed the information provided by the applicant and determined that the response is acceptable. In section 9.5 of the staff's SER, the staff discusses how nitrogen has been approved as a means to limit and extinguish fire events for charcoal beds. The staff finds the response acceptable because it follows the guidance in RG 1.189.

The staff is tracking RAI 8720, Question 11.03-12 as a confirmatory item.

RAI 8720, Question 11.03-13

Issue: As a follow-up to a question received from the last subcommittee meeting the staff issued this question to request information on how the applicant planned on limiting releases in excess of the release limits in the event that the isolation valve, valve 008, does not close on the receipt of a close signal.

Resolution: The applicant provided a response that specified another isolation valve that can be closed remotely at the radwaste control room in the event valve 008 does not close on receipt of a close signal. The applicant also specified that valves 1013 and 1014, which are located before and after valve 008, and can be manually closed. The applicant also provided DCD markups in response to this question.

Staff Conclusion

The staff reviewed the information provided by the applicant and determined that the response is acceptable since the applicant has specified other valves that operations can use to control releases to the environment.

The staff is tracking RAI 8720, Question 11.03-13 as a confirmatory item.

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Chapter 11 – Radioactive Waste Management

<u>Conclusion</u>

The staff has determined that all open items have been closed. The confirmatory items listed below meet all applicable regulatory criteria. The following six confirmatory items are being tracked for incorporation in Revision 2 of the DCD:

RAI 542-8731, Question 11.02-11

RAI 538-8720, Question 11.03-11

RAI 538-8720, Question 11.03-12

RAI 538-8720, Question 11.03-13

RAI 131-8087, Question 11.05-1, and RAI 132-8088, Question 11.05-2

The staff concludes, using the information presented in the application, and pending confirmation of the items listed above, that the applicant has demonstrated compliance with NRC regulations and guidance.

Presentation to the ACRS Subcommittee

Korea Hydro & Nuclear Power Co., Ltd (KHNP)
APR1400 Design Certification Application Review

Safety Evaluation with No Open Items:

Chapter 12 RADIATION PROTECTION

November 14, 2017

Staff Review Team

- **Technical Staff**
  - Ed Stutzcage – DCD Chapter 12 Reviewer Radiation Protection and Accident Consequences Branch
- **Project Managers**
  - Bill Ward – Lead Project Manager
  - Getachew Tesfaye – Project Manager

Technical Topics - Overview Chapter 12, Radiation Protection Sections with Open Items

- 12.2 - Radiation Sources

- 12.3 - Radiation Protection Design Features

Technical Topics

Section 12.2 – Radiation Sources

Open Item 1 (RAI 7856, Question 12.02-2)

Issue: Revised source terms for tanks containing liquid radioactive material did not appropriately consider the decay of Cs-137. In addition, the contact dose rates for the outdoor tanks were not updated based on the revised source terms.

Resolution: The applicant updated the Ba-137m activity to the same activity of Cs-137, in all of the revised source terms. The applicant also revised Table 5 of the response to provide updated contact dose rate information for the outdoor tanks, as well as make several other proposed updates and corrections to source terms.

Staff Conclusions on Open Item #1: Ba-137m would be in equilibrium with Cs-137. Ba-137m activity would be expected to be slightly lower than Cs-137 activity. Assuming that they are the same is slightly conservative and therefore acceptable.

In addition, the staff performed confirmatory MicroShield calculations and found the dose rates calculated by the applicant to be comparable to dose rates calculated by the staff.

Therefore, the staff found the source terms to be consistent with SRP Section 12.2 and therefore appropriate for addressing 10 CFR Part 20 requirements and GDC 61.

Technical Topics
Section 12.2 – Radiation Sources

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Open Item 2 (RAI 8247, Question 12.02-16)

Issue: The applicant revised the post-accident source term for the main control room (MCR) filters because the original source term was based on an incorrect atmospheric dispersion assumptions but the revised source term provided in the response was in error.

Resolution: The applicant replaced the erroneous source term information with correct data.

Staff Conclusions on Open Item #2: Staff reviewed the revised source term, which was conservative as it did not consider radioactive decay. The source was determined to be acceptable for use in determining the dose to MCR operators from the MCR emergency filters, in accordance with GDC 19.

Technical Topics

Section 12.2 – Radiation Sources

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Open Item 3 (RAI 8420, Question 12.02-22)

Issue: The holdup tank and boric acid storage tank are outdoors and surrounded by concrete and it was unclear how maintenance would be performed on the tanks and how leakage of radioactive material would be collected and controlled. In addition, there were numerous other miscellaneous apparent errors and concerns with the tank source terms and design features.

Resolution: The applicant specified that there is a manway cover at the top and side of the tank for access and maintenance. Also the applicant specified that any leakage or overflow from the holdup tank and boric acid storage tank will be collected in a leakage collection sump, which routes the water to the liquid radioactive waste system for treatment. The applicant also corrected other errors and inconsistencies in the response and addressed other staff concerns.

Staff Conclusions on Open Item #3: The staff determined that the information provided in the response was consistent with RG 8.8 and sufficient to address the requirements of 10 CFR Part 20, including 10 CFR 20.1406

Technical Topics
Section 12.2 – Radiation Sources

U.S.NRC
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Open Item 4 (RAI 8420, Question 12.02-23)

Issue: For most of the radiation source terms in the plant the applicant appeared to not sufficiently consider the buildup of daughter progeny (with the exception of Ba-137m which is assumed to have the same activity as Cs-137). It was unclear if many of the plant sources were adequate for use in demonstrating compliance with 10 CFR Part 20 and other applicable regulations.

Resolution: The applicant demonstrated that for most components containing radioactivity, the impact of not considering daughter products is negligible (less than 1%). This was demonstrated in part by comparing the source terms calculated using the KHNP codes (DAMSAM and Shield-APR) to the source terms calculated with codes that account for daughter progeny buildup. There were a number of components where the error was potentially larger. The applicant provided information demonstrating that other conservatisms in many of these sources bounded any error in not considering daughter progeny. For example, using conservative liquid and/or vapor source terms for tanks. For several sources the applicant increased the source terms to adequately consider daughter progeny or to conservatively bound the source term compared to if daughter progeny were considered.

Technical Topics

Section 12.2 – Radiation Sources

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Open Item 4 (RAI 8420, Question 12.02-23) continued

Staff Conclusions on Open Item #4: Based on a review of the information the staff determined that for many sources the effect of not considering daughter progeny (besides Ba-137m, which was considered) is negligible. For those sources where it is not negligible, the applicant either provided sufficient justification that other conservatisms bound not considering daughter progeny or the applicant updated the source terms accordingly. Therefore, the staff determined that the source terms were acceptable to demonstrate compliance with 10 CFR Part 20 and other applicable regulations.

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Open Item 5 (RAI 8420, Question 12.02-25)

Issue: Daughter progeny were not adequately considered in the gaseous waste management system sources. In addition, for some source terms in the gaseous waste management system the 0.25% failed fuel source term was higher than the 1% failed fuel source term, for certain radionuclides (which is counterintuitive).

Resolution: The applicant updated the gaseous waste management system sources and minimum required shielding to adequately consider all important daughter progeny, with extra conservatism (daughter products were assumed to be the same activity as the parents, which over estimates the activity).

The applicant also explained why for the gaseous radwaste management system components, some radionuclides included a higher 0.25% source term than a 1% source term. This is because the 0.25% source term considered processing RCS activity which continually built up in the RCS before gas stripping, while the 1% source term was based on continuous gas stripping of the RCS. Allowing the 0.25% source term RCS activity to build up over time resulted in a significantly higher source term in the gaseous radwaste management system for some components.

Open Item 5 (RAI 8420, Question 12.02-25) continued

Staff Conclusions on Open Item #5: The staff reviewed the revised gaseous waste management system source terms, shielding, and zoning and found the revisions to adequately consider daughter progeny and to be in accordance with requirements on 10 CFR 20 and GDC 61.

In addition, the staff determined that it was acceptable to assume that the gas stripper would be operated if significant fuel failure occurred and, therefore, both the 0.25% and 1% failed fuel source terms were acceptable.

Technical Topics

Section 12.3 – Radiation Protection Design Features

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Open Item 1 (RAI 8098, Question 12.03-8)

Issue: The applicant did not initially provide enough information for the staff to determine that the shielding and zoning for piping areas was sufficient. Specifically, the calculations to determine multiplication factors for piping areas did not consider backscatter and used ICRP 74, instead of ICRP 51, which was used for most other shielding calculations.

Resolution: The applicant specified that the multiplication factor for the piping areas are based on conservative assumptions, including basing the multiplication factors on a dose point in the center of the pipes, which bound any non-conservatism in not considering backscatter and in using different dose conversion factors. Assuming a dose point at the center of the pipes would result in a significantly higher dose conversion factor than if the dose point was calculated all on one side of the pipes or all on the other side of a wall, which would be more realistic for determining shielding from a piping area.

Staff Conclusions on Open Item #1: The staff determined that considering the dose point at the center of the pipes provided adequate conservatism for determining the multiplication factors. As a result, the staff found that the multiplication factors were appropriate for determining the shielding and zoning for piping areas. Therefore, the shielding and zoning for these areas meets the requirements of 10 CFR Part 20 and GDC 61.

Technical Topics

Section 12.3 – Radiation Protection Design Features

U.S.NRC
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Open Item 2 (RAI 8098, Question 12.03-10)

Issue: The application did not adequately describe the shielding for several irregular shaped rooms with high activity radiation sources in the DCD (rooms 077-P01, 068-A07A, and 068-A10A).

Resolution: The applicant provided the missing radiation shielding information for the irregularly shaped rooms in the DCD.

Staff Conclusions on Open Item #2: The staff evaluated the revised shielding information for the irregularly shaped rooms and found it to be complete. In addition, the staff performed confirmatory calculations for the shielding thicknesses of selected walls using the MicroShield computer program and found the shielding to be adequate. Therefore, the staff determined that the shielding and zoning associated with these areas meets the requirements of 10 CFR Part 20 and GDC 61.

Open Item 3 (RAI 8254, Question 12.03-11)

Issue: The applicant indicated that the design included CCW sump monitors and Turbine Building condenser pit sump monitors but they were not included in the DCD.

Resolution: The applicant included the Turbine Building sump (condenser pit sump water) monitors and CCW heat exchanger building sump monitors in the response to RAI 8088, Question 11.05-2.

Staff Conclusions on Open Item #3: The staff reviewed the description and function of the monitors in the DCD. The monitors provide local alarms and alarms in the MCR. The staff found the monitors to be an appropriate design feature to detect leakage of radioactive material and ensure that radioactive material is adequately processed and monitored when released, in accordance with 10 CFR 20.1406.

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Open Item 4 (RAI 8098, Question 12.03-13)

Issue: The staff requested that the applicant provide additional information regarding when access to the delay bed rooms is required (for example, to perform maintenance on instrumentation or to replace charcoal) and to provide additional information on how the design of the delay beds and associated equipment ensures that radiation doses will remain as low as is reasonably achievable (ALARA).

Resolution: The applicant specified that the temperature and humidity instruments are installed at wall mounted piping racks in a relatively low radiation area and that instrument readings can be remotely monitored from the radwaste control room. Plant operators may need to access the bed rooms only if repair work or inspection of the temperature instrumentation at the guard beds or inlet to each delay bed is required. The applicant also proposed to update the DCD to specify that if work on the charcoal delay beds is required, the charcoal delay beds located in the room where work was being performed (there are four charcoal delay beds, two in room 096-P01 and 096-P02) would be purged and isolated to allow plant operators to access the room at lower dose rates.

Staff Conclusions on Open Item #4: The staff finds that the design features to limit the need to access the delay bed room and to minimize dose if access is required is consistent with the requirements of 10 CFR 20.1101(b) and is acceptable.

Open Item 5 (RAI 8275, Question 12.03-26)

Issue: It was unclear if the design included appropriate features to clean the refueling pool in order to minimize the dose to workers and the spread of contamination in accordance with 10 CFR 20.1101(b) and 10 CFR 20.1406.

Resolution: The applicant clarified that the spent fuel pool cooling system could be aligned directly to the refueling pool during refueling operation to remove contaminants from the spent fuel pool. The APR1400 design also includes level detection instrumentation to assist the operators (along with visual observation) to ensure that neither the refueling pool nor the spent fuel pool are being unintentionally drained or overfilled by misaligning the spent fuel pool cleaning system intake or return lines.

Staff Conclusions on Open Item #5: Aligning the spent fuel pool cleaning system directly to the refueling pool will allow for the pool to be cleaned much more efficiently than cleaning indirectly through the spent fuel pool. This will reduce contamination of the refueling pool and the potential for airborne contamination when the pool is drained. In addition the level instruments provide assurance that misaligning valves would not result in either pool being overfilled or drained. The staff finds these design features to be in accordance with 10 CFR 20.1101(b) and 10 CFR 20.1406 and to be acceptable.

Technical Topics

Section 12.3 – Radiation Protection Design Features

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Open Item 6 (RAI 8275, Question 12.03-46)

Issue: There were numerous inconsistencies and apparent inadequacies in the DCD as it relates to preventing radiological release and exposure from fires, consistent with the requirements of 10 CFR 50.48 and guidance of RG 1.189. Examples included not adequately considering significant radiation sources in the fire protection analysis and not providing information on the protection of the Compound Building ventilation system carbon adsorbers from fires.

Resolution: The fire protection analysis in the DCD was updated to consider significant radiation sources and provide additional design features, including specifying that the Compound Building includes an automatic sprinkler system that would actuate in the event of a fire to minimize the potential for a significant release. In addition, the applicant specified that the Compound Building ventilation system's two carbon adsorbers are protected with a manually acutated deluge system and that operators would be alerted of a fire by temperature alarms downstream of the carbon adsorbers.

Staff Conclusions on Open Item #6: The staff found that the information provided and design features included in the DCD were sufficient to meet the requirement of 10 CFR 50.48 and was consistent with the guidance of RG 1.189.

Technical Topics

Section 12.3 – Radiation Protection Design Features

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Open Item 7 (RAI 8496, Question 12.03-49)

Issue: The hot machine shop, waste drum storage area, and truck bay area radiation monitors did not include local audible and visual alarms. SRP 12.3-12.4 provides guidance to the staff and states that area and airborne monitors should have a local audible and visual alarm, which is a design feature to ensure worker dose limits will not be exceeded and that the dose to workers is kept ALARA in accordance with 10 CFR 20.1101(b).

In addition, the instrument calibration facility described in the application met the definition of an irradiator in 10 CFR Part 36. However, the design of the instrument calibration facility did not appear to meet or address several of the applicable requirements of 10 CFR Part 36.

Resolution: The applicant updated the DCD to provide local audible and visual alarms for the hot machine shop, waste drum storage area, and truck bay areas.

The applicant removed the instrument calibration facility and associated area radiation monitor from the design and included a COL item specifying that the COL applicant will specify how the room will be used and how all applicable regulatory requirements related to the room will be met, including 10 CFR Part 36.

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Open Item 7 (RAI 8496, Question 12.03-49) continued

Staff Conclusions on Open Item #7: Including audible and visual alarms for monitors is consistent with the SRP and a design feature to ensure doses are ALARA, in accordance with 10 CFR 20.1101(b).

In addition, calibration activities requiring high activity sources can be performed by an offsite contractor at the digression of the COL licensee. Therefore, it is acceptable for the COL applicant to determine if high activity calibrations will be performed onsite and to address the applicable requirements accordingly.

Technical Topics

Section 12.3 – Radiation Protection Design Features

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Open Item 8 (RAI 8599, Question 12.03-53)

Issue: There was a small error (approximately 2%) in the post-accident recirculating fluid source term. In addition, it was unclear if the applicant had adequately considered all source term and design changes made during the review in the radiation shielding and zoning design. There were also questions about the limitations of the Microshield computer program in the post-accident radiation shielding design, radiation zoning, and mission dose rate calculations.

Applicant Response: The applicant revised the post-accident mission dose rates based on the corrected source term. Also, the applicant indicated that the source terms and shielding, including the EQ analysis were updated to consider all changes and that the mission dose analysis included adequate conservatism to account for any limitations in the Microshield computer program. For example, the applicant indicated that the mission dose analysis assumes the use of a half mask respirator with a protection factor of 10, when during plant operation they specified that respirators with a higher protection factor will likely be available for use.

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Open Item 8 (RAI 8599, Question 12.03-53) continued

Staff Evaluation of Open Item #8: The post-accident mission dose rates had been updated based on the corrected source terms. However, in reviewing the applicant's response to RAI 8599, Question 12.03-53 the staff identified numerous areas associated with post-accident zoning in which the staff calculated significantly higher doses than what was provided by the applicant in the DCD Chapter 12 figures, many of these areas would likely also impact the 10 CFR 50.34(f)(2)(vii) mission dose calculations. In addition, it was unclear how the applicant was applying the protection factor of 10 in the post-accident mission dose analysis as 10 CFR Part 20, Appendix A, Footnote c specifies that a protection factor of 1 should be assigned to sorbent cartridges as protection against radioiodine in air purifying respirators unless a licensee applies to the Commission to assign a value of greater than 1. Therefore, the staff closed RAI 8599, Question 12.03-53 as an unresolved item and issued RAI 8756, Question 12.03-55 to resolve these issues.

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Open Item 9 (RAI 8756, Question 12.03-55)

Issue: Please see previous slide. This is a follow-up to RAI 8599, Question 12.03-53.

Resolution: The applicant revised their approach regarding the use of a respirator for post-accident missions. Instead of crediting a half mask respirator for post-accident vital missions, the applicant now specified that they would base their post-accident mission dose analysis on the use of a positive pressure self-contained breathing apparatus (SCBA), with a protection factor of 10,000. The applicant also proposed adding a new COL information item to specify that the COL applicant will provide the respiratory protection program to ensure that the SCBAs are available and functional to minimize airborne radiological hazards while performing post-accident vital functions. The COL item also specified that the SCBAs will have a minimum rated service life of 1-hour in the control room and air supply systems in areas where post-accident missions may exceed the 1-hour time frame. Finally, the COL item specifies that the COL applicant will assess if replenishing the respirators during vital missions will result in any increase to the vital area mission times and doses.

The applicant also revised many of the minimum required shielding thicknesses associated with post-accident vital area missions and re-calculated the post-accident vital mission doses.

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Open Item 9 (RAI 8756, Question 12.03-55) continued

Staff Conclusions on Open Item #9: The staff considers it acceptable for the DCD post-accident vital area analysis to use a protection factor of 10,000 for airborne radioactive material, because the COL item specifies that the appropriate equipment will be provided and if any changes are needed to the mission dose analysis that they will be appropriately assessed.

The staff also re-evaluated the applicant's mission dose calculations. Staff confirmatory calculations of the highest dose rate areas and areas where the most significant shielding was expected to be needed to ensure vital area mission dose limits were met yielded results consistent with the applicant's results. In addition, the staff did not identify any areas where the shielding did not appear to be adequate.

As a result, the staff finds the applicant's vital area mission dose calculations, assumptions, and shielding design to be acceptable to address the requirements of 10 CFR 50.34(f)(2)(vii) and 10 CFR 50.34(f)(2)(viii).

Technical Topics

Chapter 12 – Radiation Protection

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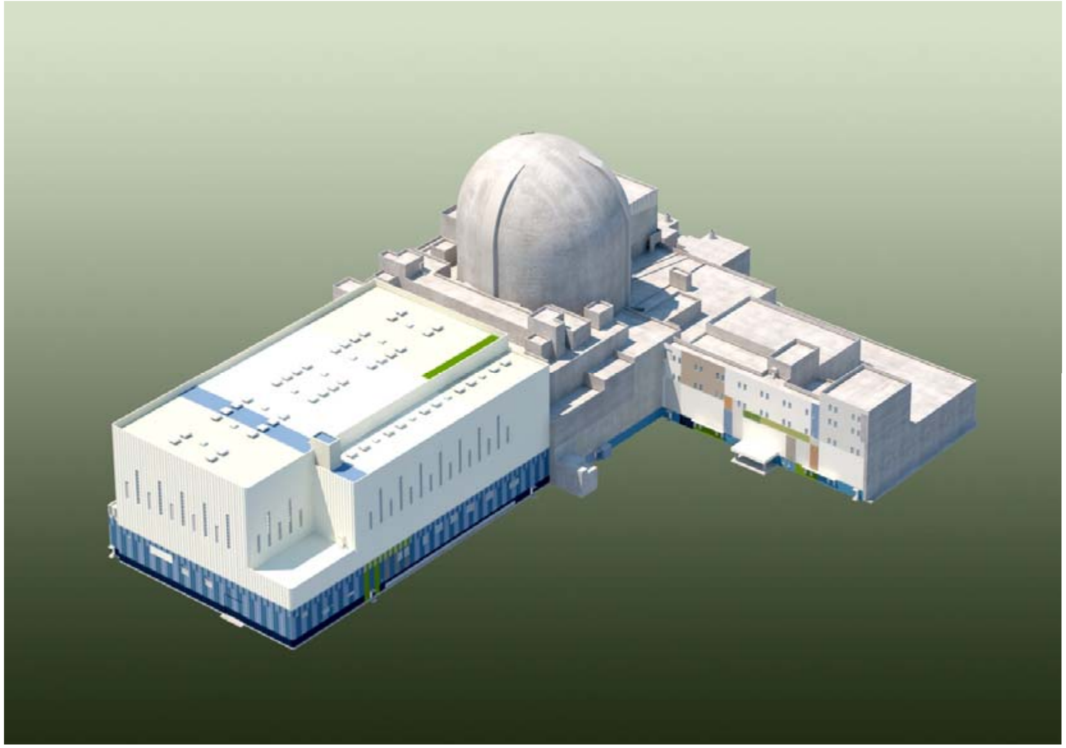
Conclusion

The staff has determined that all open items associated with Chapter 12 have been adequately addressed and the responses meet all applicable regulatory criteria.

The staff concludes, using the information presented in the application, and pending confirmation of the remaining confirmatory items, that the applicant has demonstrated compliance with NRC regulations and guidance.

NON-PROPRIETARY

APR1400 DCA
Chapter 12: Radiation Protection



KEPCO/KHNP

November 14, 2017

ACRS SC Meeting (Nov.14, 2017)

NON-PROPRIETARY

Contents

NON-PROPRIETARY

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Overview of Chapter 12

❖ List of Submitted Documents for Radiation Protection

Document No.	Title	Revision	Type	ADAMS Accession No.
APR1400-K-X-FS-14002-P/NP	APR1400 Design Control Document Tier 2: Chapter 12 Radioactive Waste Management	1 (March.10.2017)	DCD	-
APR1400-K-X-IT-14001-P/NP	APR1400 Design Control Document Tier 1	1 (March.10.2017)	DCD	-

❖ Summary of RAIs

No. of Questions	No. of Responses	Pending Response
84	84	0

NON-PROPRIETARY

Overview of Chapter 12

❖ List of Open Items (1/2)

No.	Related RAI	Title	ADAMS Accession #
1	13-7856 (Q.12.02-02)	CVCS tank source terms	ML17093A969
2	207-8247 (Q.12.02-16)	Major post-accident source terms	ML16306A454
3	343-8420 (Q.12.02-22)	Source terms and shielding for CVCS tanks	ML17214A623
4	343-8420 (Q.12.02-23)	Design impacts by daughter nuclides (1)	ML17068A168
5	343-8420 (Q.12.02-25)	Design impacts by daughter nuclides (2)	ML17152A390
6	141-8098 (Q.12.03-08)	Dose conversion factors and backscattering	ML17152A038
7	141-8098 (Q.12.03-10)	Shielding information on pipe way	ML17163A063

NON-PROPRIETARY

Overview of Chapter 12

❖ List of Open Items (2/2)

No.	Related RAI	Title	ADAMS Accession #
8	225-8254 (Q.12.03-11)	CCW and trubine building sump monitors	ML16211A139
9	225-8254 (Q.12.03-13)	Access control to GRS delay bed rooms	ML17102B007
10	235-8275 (Q.12.03-26)	Purification system for the refueling pool	ML17152A027
11	235-8275 (Q.12.03-43)	Reactor vessel closure head vent	ML17114A506
12	235-8275 (Q.12.03-46)	Fire protection of radiological areas	ML17172A747
13	376-8496 (Q.12.03-49)	Area radiation monitor	ML17095B053
14	490-8599 (Q.12.03-53)	Cumulative impact of source term changes	ML17052A829
15	544-8756 (Q.12.03-55)	Post-accident vital mission doses	ML17160A157

Summary of Open Items

❖ Open Item: CVCS tank source terms

- Related RAIs : 13-7856 (Q.12.02-02)
- Open item reference: N/A
- Description of issue
  - Staff requested to provide additional information on CVCS source terms.
  - Indicated that Ba-137m activities of CVCS tanks in the applicant's response are incomplete.
  - While the source terms of the holdup tank and BAST were modified, the dose rates of the tanks were not updated.
- Resolution
  - KHNP provided the revised response to :
    - ✓ Modify the Ba-137m activities in the CVCS tanks
    - ✓ Include dose rates of the tanks by performing the shielding calculations using updated source term

Summary of Open Items

❖ Open Item: Major Post-accident Source Terms

- Related RAIs : 207-8247 (Q.12.02-16)
- Open item reference: N/A
- Description of issue
  - Staff requested to provide:
    - ✓ Post-accident time-depend fluid source term outside containment,
    - ✓ Source term for MCR emergency ventilation filter, and
    - ✓ Dimensions of the systems containing recirculating fluid and the MCR emergency ventilation filter during post-accident conditions
  - Staff reviewed KHNP response which include all the requested information and noted that the 1-week source term of the MCR filter was not accurate
- Resolution
  - KHNP corrected the 1-week source term data and provided revised response

Summary of Open Items

❖ Open Item: Source terms and shielding for CVCS tanks

- Related RAIs : 343-8420 (Q. 12.02-22)
- Open item reference: 12.02-1, RAI 308-8339, Question 12.02-19
- Description of issue
  - Staff requested to provide the basis of CVCS yard tank source term and KHNP provided the information.
  - Staff noted that the source term was based on continous gas stripper operation and requested to limit the operation not to exceed the Zone 1 criteria
  - KHNP provided the Tier 1 markups to include limitation of gas stripper operation
  - Staff additionally requested to confirm that the dose rate from the tanks comply with 40 CFR 190
- Resolution
  - KHNP added a COL item 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 in DCD.

Summary of Open Items

❖ Open Item: Design impacts by daughter nuclides (1)

- Related RAIs : 343-8420 (Q.12.02-23)
- Open item reference: 12.02-4
- Description of issue
  - Staff requested to revise the CVCS and BOP component source terms, shielding, and zoning, as appropriate, to consider the buildup of radioactive daughters, for those radionuclides listed in ANSI/ANS 18.1 (consistent with SRP Section 12.2) or provide additional justification for why the current source terms are acceptable.
  - Staff also requested to provide more information describing how the approach ensures that the shielding for piping areas is adequate

Summary of Open Items

- Resolution
  - KHNP demonstrated that the conservatisms in the results of methodology (DAMSAM/SHIELD-APR code) are substantially larger than the effect of the non-modeled contribution of daughter products by using Westinghouse methodology (FIPCO/SSP code) which considered the effect of buildup of daughter products.
  - KHNP also evaluated the daughter nuclide build-up in BOP systems (SGBS, CPS, SFPCCS and SWMS) and the shielding analyses were performed using the updated source terms. As a results, the impacts of the daughters on the current design were negligible since the civil structure design has sufficient margin to bound the minor increase of the source terms.
  - KHNP provided the information about the shielding analysis for pipe lines with specific examples.

Summary of Open Items

❖ Open Item: Design impacts by daughter nuclides (2)

- Related RAIs : 343-8420 (Q.12.02-25)
- Open item reference: 12.02-5
- Description of issue
  - Staff requested to :
    - Provide additional descriptions about the determination of the inlet source to the GRS header from CVCS components.
    - Correct the inconsistency in the dimensions provided for the header drain tank
    - Provide justification for the reason that the 0.25 percent fuel defect waste gas dryer source term was significantly lower than that for the 1 percent failed fuel percent source term.
    - Update all component source terms to include the expected contribution from the daughter nuclide products

Summary of Open Items

- Resolution
  - KHNP revised DCD to include additional descriptions about the determination of the inlet source to GRS header.
  - Incorrect dimensions for the header drain tank were revised and the shielding analysis was re-evaluated based on the corrected dimensions with the source term considering daughter nuclide build-up.
  - KHNP corrected dimension of the waste gas dryer and updated the source term and the corresponding shielding analysis.
  - KHNP updated the GRS source terms considering daughter nuclide build-up and the shielding analyses were re-performed using the updated source terms. Accordingly, the shielding thicknesses and radiation zone drawings were revised based on the revised shielding analyses.

Summary of Open Items

❖ Open Item: Dose coversion factors and backscattering

- Related RAIs : 141-8098 (Q.12.03-08)
- Description of issue
  - Staff noted the followings:
    - ✓ The dose conversion factors (DCF) in ICRP-74 was used for determination of multiplication factors used for multiple piping, while ICRP-51 was used for all other shielding calculations. Use of the ICRP-74 DCF would result in a lower dose rate from the piping than ICRP-51.
    - ✓ The effects of radiation backscatter was not considered in determination of multiplicatioin factors.

Summary of Open Items

- Resolution
  - KHNP provided the related rationales as follows;
    - ✓ The ICRP-74 DCFs are only used to determine the MFs which are the adjustment factors for the multiple pipes that are to be multiplied by the dose rate from a single pipe
    - ✓ Since the dose rate from a single pipe is calculated using the ICRP-51 DCFs, the actual shielding calculations for the multiple pipe are based on the ICRP-51 DCFs.
    - ✓ KHNP performed additional analysis to verify that the calculation without considering backscattering does not underestimate the dose rate for shielding design purpose

Summary of Open Items

❖ Open Item: Shielding information on pipe way

- Related RAIs : 141-8098 (Q.12.03-10)
- Description of issue
  - Staff noted that the shielding thicknesses of hot pipe way area, which has abnormally shaped room with many different walls, was insufficient.
  - Staff requested to provided the shielding thickness for each of the walls in the room, including for the stairwell and elevator that run through the room.
- Resolution
  - KHNP provided all information which were required by Staff and revised the DCD Table 12.3-4 and relevant figures.

NON-PROPRIETARY

Summary of Open Items

❖ Open Item: CCWS and Turbine Building sump monitors

- Related RAIs : 225-8254 (Q.12.03-11)
- Description of issue
  - Staff noted that it was unclear where the collected liquid in the sump of the CCWS structure is routed to (for example, to the LWMS) and if the sump included design features to prevent the release of radioactive material.
  - KHNP revised the approach so that the radioactive material from the CCWS sump is routed either to the LWMS or to the turbine generator building sump where it will then be sent for treatment and release.
  - Staff also requested to provide the location of the CCWS sump monitors and turbine building sump monitors.
- Resolution
  - KHNP provided the information of the CCWS sump and Turbine building sump monitors in the revised response to the RAI 132-8088, Question 11.05-2.

Summary of Open Items

❖ Open Item: Access control to GRS delay bed rooms

- Related RAIs : 225-8254 (Q.12.02-13)
- Open item reference: 12.03-4
- Description of issue
  - Staff requested the need to access the delay bed rooms in order to ensure that the design uses engineering controls to the extent practicable to limit radiation exposure.
- Resolution
  - KHNP provided the information for limiting radiation exposure by purging the delay bed with nitrogen gas and subsequently isolating the delay bed before access to the delay bed rooms.
  - KHNP also provided the associated information and flow diagram including functional arrangement for the purge operation and isolation of the beds.

Summary of Open Items

❖ Open Item: Purification system for the refueling pool

- Related RAIs : 235-8275 (Q.12.03-26)
- Open item reference: N/A
- Description of issue
  - Staff noted that the application does not contain enough information to ensure that appropriate design features are in place to limit personnel exposure and the spread of contamination during the cutting and disposal of in-core instrumentation
  - Staff requested information on the temporary filtration and the relevant design supports, such as provision of a power supply.
- Resolutions
  - KHNP clarified that the refueling water is purified by Spent Fuel Pool Cooling and Cleanup System (SFPCCS) not by temporary filtration system.
  - KHNP also indicated that the SFPCCS reduces the concentration level of radioactivity in the refueling pool and thus maintain the lower level during refueling operation including ICI cutting.

Summary of Open Items

❖ Open Item: Reactor vessel closure head vent

- Related RAIs : 235-8275 (Q.12.03-43)
- Description of issue
  - Staff requested to provide how to degas the pressurizer for shutdown.
  - KHNP responsed that the gas can be removed by the reactor vessel closure head using the reactor coolant gas vent piping, which connects to the pressurizer vent and then routed to the reactor coolant gas vent system.
  - Staff noted that it is inconsistent with the information in Section 5.4 which indicates that the piping from the reactor vessel closure head vent goes directly to the reactor coolant gas vent system.
- Resolution
  - KHNP corrected the description in Section 5.4 by deleting the sentence "Piping from the reactor vessel is routed directly to the RCGVS piping" to be consistent with the current design.

Summary of Open Items

❖ Open Item: Fire protection of radiological areas

- Related RAIs : 235-8275 (Q.12.03-46)
- Description of issue
  - Staff requested to provide fire protection design features for the areas containing radioactive source other than containment (e.g., charcoal delay beds and spent resin long-term storage tank)
  - KHNP updated the descriptions in DCD Subsection 9.5A including the other radioactive sources in Compound building area that are to be considered in fire protection.
  - Staff noted that there were still inconsistencies regarding if an area is a radiological area and missing criteria associate with fire protection of radiological sources.
- Resolution
  - KHNP provided response to address additional radiological sources in fire areas including SWMS, GRS, LWMS and HVAC systems.
  - KHNP also updated the DCD to address how the plant comply with the criteria in 10 CFR 50.48 and RG 1.189.

Summary of Open Items

❖ Open Item: Area radiation monitor

- Related RAIs : 376-8496 (Q.12.03-49)
- Open item reference: 12.03-8
- Description of issue
  - Area radiation monitor for Instrument calibration facility (ICF) room
  - Locations of alarms in truck bays and waste drum area are not consistent with ANSI/ANS-HPSSC-6.8.1.
- Resolution
  - The ICF room area monitor has been deleted from relevant subsections of DCD Tier 1 and Tier 2 as the room name of ICF was changed to "FUTURE USE."
  - The local alarms have been added to the inside of truck bay area and waste drum area. The alarm inside the area alert the crew to exit the area and the alarm outside the area warns the crew outside to limit access to the area.
  - The open items have been resolved through the revised response to the RAI.

Summary of Open Items

❖ Open Item: Cumulative impact of source term changes and post-accident vital mission doses

- Related RAIs : 490-8599 (Q.12.03-53), 544-8756 (Q.12.03-55)
- Description of issue
  - Staff requested to confirm that the general shielding, zoning and EQ design considering the cumulative effects of source term changes which were incorporated through the numerous RAI responses
  - Staff also requested to ensure that the mission dose rates remain acceptable even considering the changes in the source terms.
- Resolution
  - KHNP has performed full evaluations of shielding, zoning and EQ evaluation based on the updated source term and confirmed that the re-performed design.
  - KHNP also re-performed the vital area mission dose analysis, and confirmed that the results meet the dose limit of 5rem (50 mSv).

Current Status

- **Chapter 12 is complete.**
  - KHNP continues to monitor Chapter 12 to assure any conforming changes are addressed.
  - 15 open items, that were identified in Phase 2 and 3, have been resolved with adequate and sufficient discussion with the staff.

- **Changes in Chapter 12 as reviewed and marked-up in response to the RAIs will be incorporated into the next revision (Rev.2) of the DCD.**

Attachment: Acronyms (1/1)

BAST	Boric Acid Storage Tank
BOP	Balance of Plant
CCWS	Component Cooling Water System
CFR	Code of Federal Regulation
COL	Combined Operation License
CPS	Condensate Polishing System
CVCS	Chemical and Volume Control System
DCD	Design Control Document
DCF	Dose Conversion Factor
EQ	Equipment Qualification
GRS	Gaseous Radwaste System
HVAC	Heating Venting and Air Conditioning
ICI	In-Core Instrumentation
ICRP	International Commission on Radiological Protection
KHNP	Korea Hydro and Nuclear Power Co.
LWMS	Liquiud Radwaste Mangement System
MCR	Main Control Room
RAI	Request for Additional Information
SFPCCS	Spent Fuel Pool Cooling and Cleanup System
SGBS	Steam Generator Blowdown System
SWMS	Solid Radwaste Management System

NON-PROPRIETARY

Attachment : List of COL Item related to OIs

COL Identifier	Description
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 12.4(4)	The COL applicant is to provide a respiratory protection program to minimize airborne radiological hazards while performing post-accident vital functions. The respiratory protection program should include the provisions of the positive pressure self-contained breathing apparatus (SCBA) with a minimum rated service life of 1 hour in the control room and air supply systems in areas where post -accident mission times may exceed the 1-hour SCBA supply and where necessary to account for uncertainty in respirator service life in performing post-accident missions. The COL applicant will also assess if replenishing the respirators during vital missions will result in any increase to the vital area mission times and doses