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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

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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REGULATORY POLICIES AND PRACTICES SUBCOMMITTEE

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WEDNESDAY

NOVEMBER 14, 2018

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear Regulatory Commission, Three White Flint North, Room 1C3 & 1C5, 11601 Landsdown Street, at 8:30 a.m., Walter L. Kirchner, Chairman, presiding.

COMMITTEE MEMBERS:

WALTER KIRCHNER, Chairman

RONALD G. BALLINGER, Member

DENNIS C. BLEY, Member*

CHARLES H. BROWN, JR., Member

MICHAEL L. CORRADINI, Member

PETER C. RICCARDELLA, Member

MATTHEW W. SUNSERI, Member

DESIGNATED FEDERAL OFFICIAL:

QUYNH NGUYEN

ALSO PRESENT:

ANDY CAMPBELL, DLSE

YUAN CHENG, NRO

RICHARD CLEMENT, NRO

MICHELLE CONNER, TVA

ALLEN FETTER, NRO

JOSEPH GIACINTO, NRO

HILLOL GUHA, TVA

STU HENRY, TVA

JOHN HOLCOMB, TVA

KEVIN QUINLAN, NRO

NICHOLAS SAVWOIR, NRO

RAYMOND SCHIELE, TVA

MALLECIA SUTTON, NRO

ALEX YOUNG, TVA

*Present via telephone

A G E N D A

P R O C E E D I N G S

8:30 a.m.

CHAIRMAN KIRCHNER: The meeting will now come to order. This is a meeting of the Regulatory Policies and Practices Subcommittee of the Advisory Committee on Reactor Safeguards.

I am Walt Kirchner, Chairman of this Subcommittee meeting. ACRS members in the room are: Mike Corradini, Pete Riccardella, Matt Sunseri, Ron Ballinger, Charlie Brown, and I think we'll see if others join us. Quynh Nguyen of the ACRS staff is the Designated Federal Official for this meeting.

The Subcommittee will hear from representatives of TVA and the staff regarding the following sections of the Clinch River early site permit application and the corresponding Safety Evaluation: Meteorology, 2.3; Hydrologic Engineering, 2.4; Radioactive Waste Management, 11; and Quality Assurance, Chapter 17.

The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full Committee.

The ACRS was established by statute and is governed by the Federal Advisory Committee Act, FACA.

This 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 also set aside some time for spur of the moment comments from members of the public attending or listening to our meetings. Written comments are also welcome.

In regard to early site permits, 10 CFR 52.23 provides that the Commission shall refer a copy of the application to the ACRS and the Committee shall report on those portions which concern safety.

The ACRS section of the US NRC public website provides our charter, bylaws, letter reports, and full transcripts of all full and Subcommittee meetings, including slides presented at those meetings.

The rules for participation in today's meeting were previously announced in the Federal Register. We have received no written comments or requests for time to make oral statements from the members of the public regarding today's meeting.

We have a bridge line established for

interested members of the public to listen in. To preclude interruption of the meeting, the phone bridge will be placed in a listen-in mode during the presentations and Committee discussions.

We will unmute the bridge line at a designated time to afford the public an opportunity to make a statement or provide comments.

At this time, I request that meeting attendees and participants silence cell phones and any other electronic devices that are audible.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice. Therefore, we request that participants in this meeting use the microphones located throughout the meeting room when addressing the Subcommittee.

The participants should first identify themselves and speak with sufficient clarity and volume so that they may be readily heard. Make sure that the green light at the base of the microphone is on before speaking and off when not in use.

We will now proceed with the meeting and I call upon Andy Campbell of the NRO Management to begin. Please, Andy?

MR. CAMPBELL: Thank you, Mr. Chairman.

It's a pleasure to be here today. I'm Andy Campbell, I'm the Deputy Director of the Division of Siting, Licensing, and Environmental Analysis in the New Reactors Office at NRC.

I want to just make a couple very quick points and then, welcome everybody here. First, this is the fourth and final ACRS Subcommittee meeting on the Safety Evaluations with no open items for the Clinch River ESP review.

Second, the first ESP for an SMR plant design, that's what we've been reviewing and that's what this is focused on. Project review has been progressing consistent with the schedule, we're on or ahead of schedule right now.

We're looking forward to a fruitful dialogue today and then, with the full ACRS Committee on December 5 of this year. So, with that, I'll turn it back to you.

CHAIRMAN KIRCHNER: Thank you, Andy. Now, we'll turn to -- Ray, are you going to start? Please proceed.

MR. SCHIELE: Good morning. My name is Ray Schiele, currently the Licensing Manager for the TVA Clinch River early site permit application.

I have over 44 years in the nuclear

industry, including service in the United States Navy, commercial plant operations and licensing, and most recently, since 2016, Licensing Manager supporting the Clinch River early site permit application.

Chairman Kirchner, before we get started, TVA would again like to thank you and your Subcommittee for the review of this application.

Acknowledgment and disclaimer. This slide represents the acknowledgment of the relationship between DOE and TVA. DOE funding is sharing in half the project costs. DOE support is gratefully appreciated by TVA. However, the work and view expressed in the application and this presentation are TVA's alone.

TVA's mission. TVA's mission is serving the people of the Tennessee Valley. Currently, TVA is partnering with 154 local power companies serving more than nine million customers in parts of seven states. They directly serve 56 large industries and federal installations.

A quick review of the schedule and where we are. This Gant chart is broken into three sections. The top piece is the safety review. As you can see, this meeting today is the fourth Subcommittee meeting, with the full Committee scheduled on December 5. We anticipate that FSER to be issued on or ahead of schedule.

The next row is the status on the Environmental Review. Again, the Environmental Review is on or ahead of schedule, with the FEIS scheduled to be issued on June of 2019.

Hearings. The -- in July of 2018, the ASLB dismissed the last remaining admitted contention, rejected the two new proposed contentions, and terminated the contested hearing.

Considering the progress made in both the Safety Review and Environmental Review, the Commission mandatory hearing could be as early as late Fiscal Year 2019.

Quick review of a Plant Parameter Envelope. The Plant Parameter Envelope, PPE, is an approach the provides sufficient design detail to support the NRC review of the early site permit application, while allowing sufficient flexibility for technical developments in new reactor technologies.

The actual design selected for the Clinch River Site would be reviewed with a Combined License Application to demonstrate that the design is bounded by the PPE and differences would be reviewed for acceptability in the Combined License Application.

The PPE that was developed in support of the Clinch River Site early site permit application is based on data from the four SMR designs under evaluation by TVA. Those being: BWXT, NuScale, Holtec, and Westinghouse.

PPE use considerations. The site characteristics, which have been determined in the analyses presented throughout the SSAR are those necessary to establish findings required by 10 CFR 52 and 10 CFR 100, regarding suitability of the proposed site.

Site-related design parameters are those that are related to the design of an SMR that may be constructed on the CRN Site in the future. In some cases, it is necessary to assume values for certain site-related design parameters in order to analyze the associated site characteristics.

The values selected for the different site-related design parameters represent the bounding values and include engineering, safety, and environmental conservatisms, as appropriate.

An outline of today's presentation. Today's presentation will follow the following sections. Section 11, Radioactive Waste Management, will be presented by Alex Young. Section 2.3, Meteorology, presented by Alex Young.

Section 17, Quality Assurance, presented by Michelle Conner. And the last presentation, Section 2.4, Hydrology, will be presented by John Holcomb, assisted by Stu Henry, and Hillol Guha.

Right now, I'd like to introduce Alex Young to present Section 11. Alex?

MR. YOUNG: Thank you, Ray. My name's Alex Young, Design Engineer for the SMR project for TVA. I've been working on this project since September of 2014.

I'd like to start off talking about some key NRC interactions associated with the Chapter 11 review. This piece consisted of one two-part audit.

The first part of that audit was conducted at the Bechtel offices in Reston, Virginia in April of 2017.

And the second part, taking place at the TVA corporate offices in Knoxville, Tennessee. That second part, later in April of 2017, consisted of a site tour of the Clinch River Site and the surrounding areas.

After the audit, TVA submitted a supplemental letter in June of 2017, CNL-17-075, for supplementary information regarding source term development. Okay, next slide.

So, Chapter 11 is broken down into Subsections 11.2, for liquid release, and 11.3, for gaseous release. But for each of these subsections, the release source terms were developed using the same approach.

TVA utilized the Plant Parameter Envelope approach using the guidance of NEI 10-01 to develop the source terms. Each of the four vendors submitted annual release, releases for individual reactor units, and those were reviewed by TVA.

The site release annual activities were developed by multiplying each vendor's values by their respective number of units considered for the CRN Site.

Then, for both unit and site-basis values, TVA developed composite tables utilizing the highest annual activity for each isotope from any of the vendors.

It was identified that some of the annual activity in the composite table included excessive conservatisms. We adjusted those isotopic activities.

The composite source terms were then assessed for reasonableness by comparing to previously approved source terms, scaled by reactor thermal power. This comparison showed that the composite source term was not unreasonable for use in the ESPA. Next slide.

So, for Section 11.2, the liquid rad releases. To calculate the doses for those releases, TVA implemented Regulatory Guidance 1.109 for the exposure pathways considered and analytical methods used.

LADTAP II was used to calculate the doses with input parameters specific to the Clinch River Site.

TVA concluded that the effluent concentrations are within the effluent concentration limits of 10 CFR 20, Appendix B, Table 2, Column 2, and that the doses are within the design objectives of 10 CFR 50, Appendix I, and the environmental standards of 40 CFR 190, and the limits of 10 CFR 20.1301. Next slide.

To calculate the doses for the gaseous radioactive release, TVA implemented Regulatory Guidance 1.109 and 1.111 for the exposure pathways considered and analytical methods used. GASPAR II was used to calculate the doses with input parameters specific to the Clinch River Site.

TVA concluded that the effluent concentrations are within the effluent concentration limits of 10 CFR 20, Appendix B, Table 2, Column 1, and that the doses are within the design objectives of 10 CFR 50, Appendix India, and the environmental standards of 40 C FR 190, and the limits of 10 CFR 20.1301. Thank you.

MR. SCHIELE: Chairman, this concludes the presentation on Section 11. Do you want us to turn it over to the staff?

CHAIRMAN KIRCHNER: So, could you just -- there are lots of numbers, lots of tables. When you -- with your Plant Parameter Envelope, did you basically conclude that, since these designs are LWR derivative, essentially, it was a case of thermal power dominating the source term, the liquid waste, and the gaseous effluence?

MR. YOUNG: Sure. So, for that question, the SMR designs and the information we were able to review for the SMR designs currently are typical, standard, LWR fuel that we see in our conventional fleet.

And the rad waste management systems don't provide greatly different methodologies or system designs from what we see at our operational fleet. So, we were able to justify that the general change is going to be the fission products that come out of the core, those driven primarily by core power.

CHAIRMAN KIRCHNER: Thank you.

MR. SCHIELE: So, that concludes our presentation on Section 11. We'd like to turn over to the staff now for their presentation on Section 11.

CHAIRMAN KIRCHNER: Quick moment while we change out.

MR. CAMPBELL: So, presenting for the staff will be Rich Clement and Mallecia Sutton. Please.

MS. SUTTON: Okay. Thank you. Good morning. Again, my name is Mallecia Sutton. I'm one of the Safety Project Managers for the Clinch River early site permit application.

To my right, I have my cohort, Allen Fetter, who is seated to the right of the table. Mr. Fetter and I will be at the table for December 5, 2018, ACRS full Committee meeting on all the Clinch River early site permit evaluation covered by ACRS Subcommittee meetings.

I've been with NRC since 2007, where I started working as a Project Manager in the Office of New Reactors. Prior to taking over as the Safety Project Manager with Clinch River early site permit review in January 2016, I was an Environmental Project Manager for Bellefonte, Vogtle, Fermi, and Levy COL reviews.

Today's ACRS Subcommittee meeting is the fourth and final Subcommittee meeting for the Clinch River application.

Today, NRC technical reviewers will be presenting on the Safety Evaluations for Section 2.3, Meteorology, 2.4, Hydrology, Radiological Management, Section 11, and Quality Assurance, Section 17.5.

ACRS members will have an opportunity to ask questions and provide comments between each presentation for the sections discussed today.

In addition to staff's review of the TVA's application, staff conducted four audits, one inspection, one site visit, issued two RAIs comprising of ten questions to the application in order to obtain additional information to support NRC's findings.

The first technical staff you will hear from today is Dr. Richard Clement. Today, he will be presenting the review of the Site Safety Evaluation Report, Section 11, Radiological Waste Management.

Dr. Richard Clement is a Senior Health Physicist in the Division of Licensing, Siting, and Environmental Analysis in the Office of New Reactors. He has been involved in design certification, combined license, and early site permit applications.

Rich has over 25 years of applied health physics and operational experience, which includes about 20 years of federal service.

At the NRC, Rich has also worked in the Office of New Reactors, Nuclear Material Safety and Safeguards, and Office of New Reactor and Regulation as a technical reviewer. Now, I'll turn it over to Rich.

MR. CLEMENT: Thank you, Mallecia. As she mentioned, my name is Rich Clement, the Health Physics Technical Reviewer for the Site Safety Analysis Report, Chapter 11, Radioactive Waste Management, of the TVA Clinch River early site permit application. Next slide, please.

The staff's review involves source term information on normal gaseous and liquid effluent releases and the subsequent offsite doses described in Section 11.2.3, Liquid Radioactive Releases, and Section 11.3.3, Gaseous Radioactive Releases, of the TVA Site Safety Analysis Report.

These sections also share review interfaces with hydrology on the accidental liquid source term and offsite dose from an postulated accidental liquid release to the groundwater, evaluated by staff in Section 2.4.13 of the Safety Evaluation, and with meteorology on the atmospheric dispersion and deposition factors for estimating an offsite dose from gaseous effluent releases evaluated by the staff in Section 2.3.5 of the Safety Evaluation that will be presented to you later today. Next slide, please.

The staff participated in the pre-application readiness assessment and acceptance review of TVA's early site permit application.

The staff identified information that it needed to understand development of the Plant Parameter Envelope, or PPE, source terms and offsite doses from normal effluent releases and the accident liquid source term and offsite dose. As a result, TVA supplemented its application.

The staff then conducted a face-to-face audit with TVA to discuss and clarify the supplemental information, which is described in the NRC Hydrology and Health Physics Audit Report.

During the audit, the staff walked the Clinch River Nuclear Site and visited the current receptor locations for the assessment of offsite doses.

In addition, the staff conducted a virtual audit of TVA's voluntary submittal involving meteorology, which is described in the NRC Meteorology and Health Physics Audit Report, also documented under the ADAMS accession number shown. Next slide, please.

The staff reviewed TVA's PPE normal

effluent source term based on four small modular reactor, or SMR, designs, which included: Generation mPower, NuScale Power, Holtec, and Westinghouse.

The staff reviewed TVA's evaluation of composite source terms in the surrogate plant used to develop the normal PPE effluent source terms, performed confirmatory calculations on unit and site effluent release rates for each vendor, and reviewed adjustments made to these effluent release rates and found them reasonable.

The staff confirmed that the unity rule applied in 10 CFR 20, Appendix B, Table 2, Columns 1 and 2, for the mixture of radionuclide concentrations at the site boundary was met.

Based on the review, the staff found TVA's methodology to develop the normal PPE effluent source terms for use in calculating offsite doses reasonable. Next slide, please.

CHAIRMAN KIRCHNER: May I stop you here?

MR. CLEMENT: Yes.

CHAIRMAN KIRCHNER: So, maybe this is a place to ask about uncertainty in the application, particularly the meteorology impacts on gaseous or releases.

How -- let me see if I can -- how confident are you in -- you did independent analyses of their estimates, is that correct?

MR. CLEMENT: Confirmatory analysis. So, we --

CHAIRMAN KIRCHNER: Confirmatory analysis.

MR. CLEMENT: -- reviewed the information that was provided in the application, that was supplemented. So, it was a listing of release rates for each vendor. And if you follow the guidance in NEI 10-01, you typically choose the highest release rate for each vendor.

But due to the limited fuel development and rad waste system designs, there were some adjustments made for each vendor, based on the amount of conservatism in information that was provided from the vendor at that time.

CHAIRMAN KIRCHNER: Okay. And -- but when you did your confirmatory analyses, how well did they compare, in a general sense, with what the applicant supplied?

MR. CLEMENT: The confirmatory analysis that I did consists of taking the effluent release rates from each vendor and comparing those release rates for each respective vendor to see what the highest release rate was determined.

And during that process, we found a couple radionuclides where the highest release rates were not selected and, therefore, they were corrected by TVA. So, we took the release rates pretty much at face value, because of the preliminary nature of the information.

And the confirmatory analysis looked at across for each vendor, what was the release rate that was selected for a composite unit plant and also, for the site composite?

CHAIRMAN KIRCHNER: So, at the respective boundaries, you have confidence that there is conservatism in these calculations that you've confirmed?

MR. CLEMENT: If you look at the release rates across for each vendor, understanding that these SMR designs have not yet been approved by the NRC, if you look at the face value of those values, you can see that there were several orders of magnitude difference in the release rates.

And I think that was primarily driven by the maturity of the source term information that was available from the vendor at that time.

So, there was discussion in the application to justify the adjustments that were made to those release rates in order to come up with composite source terms.

CHAIRMAN KIRCHNER: I'm asking, I guess, a leading indirect question. I just want to probe how much margin there is, how much confidence we have at the exclusionary boundary and such for these releases, in terms of 10 CFR 20 and the other appropriate requirements.

MR. CLEMENT: I would say, given the information that was provided on the docket and the information that the staff reviewed, the COL action item that is proposed at the end --

CHAIRMAN KIRCHNER: Right.

MR. CLEMENT: -- will pretty much be the catchall for anything like that.

MEMBER CORRADINI: So, they've got to come back with the chosen design and show that they're within the bound?

MR. CLEMENT: Absolutely. And that's one staff-identified COL action items that will ensure that the PPE source term is bounded and the doses are bounded.

MEMBER BALLINGER: How do these release rates compare with a typical large PWR in the fleet?

MR. CLEMENT: Well, there was --

MEMBER BALLINGER: Or, it should be, in your case, BWR?

MR. CLEMENT: One of the issues that was identified by TVA is that there was a scaling power level ratio done with Public Service Enterprise Group, PSEG, the ESP was approved by the NRC, included in one of the designs, the advance boiling water reactor design. So, obviously, the release rates are a little bit different.

So, considering that not one plant would contain the highest effluent release rates, there was considerations made in adjusting those release rates. But many of the release rates were scaled by thermal power.

MEMBER BALLINGER: So, it's just strictly scaled by thermal power?

MEMBER RICCARDELLA: So, I have a general question on source terms, when it comes to small modular reactors, when we're considering multiple units, and maybe it's a little too general for this consideration.

But when you have multiple units, is the source term simply the multiple of the source term per reactor times the number of reactors?

Or is there some consideration of the risks of single-reactor versus multiple-reactor events? Where do you think NRO is going to come down on that question?

MR. CLEMENT: For the source terms, essentially, the unit release rates were multiplied by the number of units for that design. So, it was just considered multiplicative.

MEMBER RICCARDELLA: I understand that in this particular case, but is that going to be a generic approach to SMRs, the licensing of SMRs?

MR. CAMPBELL: This is Andy Campbell. There's no reason to believe otherwise, for routine radioactive waste, that you can't just scale it to the overall thermal power for each unit and multiply those by the number of units.

It's -- fission is going to produce the waste, as well as the neutron flux, and with that, you're just essentially dealing with fission products, as well as neutron activation products, in the radioactive waste.

It's not a very -- I mean, it's very complicated, but it's not fundamentally different when you have 12 units of the same type.

MEMBER RICCARDELLA: I guess that's for considerations with the nuclear waste, but when we get into considerations for severe accidents, it would seem that it might be --

MR. CAMPBELL: This is not a severe accident scenario.

MEMBER RICCARDELLA: I understand.

MR. CAMPBELL: That would be a whole --

MEMBER RICCARDELLA: Okay.

MR. CAMPBELL: -- different discussion.

MEMBER RICCARDELLA: I'll raise that question in a different forum, then.

MR. CAMPBELL: Okay.

MR. CLEMENT: All right. Next slide, please. For the dose evaluation, the staff verified TVA's input parameters and assumptions in the exposure pathway dose analysis, which included the normal PP effluent source terms:

Internal exposure from ingestion of contaminated milk, meat, and vegetables and inhalation of airborne activity. And external exposure from recreation activities, ground contamination, and submersion in an airborne plume.

The staff confirmed that the exposure pathway dose calculations to the maximally exposed individual who is a member of the public to receive the maximum possible dose meets the design objectives in 10 CFR 50, Appendix I, the Environmental Protection Agency's radiation standards in 40 CFR 190, and the public dose limit in 10 CFR 20.

Because the reactor design that may be constructed at the Clinch River Nuclear site is not known at the early site permit stage, the staff identified combined license, or a COL, action item 11.1-1 for the COL or construction permit applicant to evaluate and justify any changes in the PPE source term used for normal effluent releases and verify that the calculated dose evaluated in the early site permit is bounded. Next slide, please.

Based on the staff's review of TVA's early site permit application, subject to the staff-identified COL action item, the staff concludes that the normal PPE effluent source terms and offsite doses meet the applicable regulatory requirements and that there is no undue risk to public health and safety.

Thank you. At this point, I will take any question or comments you may have.

CHAIRMAN KIRCHNER: Okay. Members, any questions at this point? Okay. Let's then proceed on. Although, we have a break scheduled, I propose we go next to TVA and Section 2.3 on Meteorology.

MR. SCHIELE: Mr. Chairman, TVA will continue with Section 2.3 and we have some folks on the phone to assist the conversation if necessary. Presenting 2.3 will be Alex Young. Alex?

MR. YOUNG: Good morning. Thanks, Ray. All right. Can we just confirm that those people are available on the phone? I'm looking for Ken Westrick and Marvin Morris. You guys on the line? Hearing none, okay. We'll continue on with the presentation.

First, I'd like to note some key NRC interactions related to SSAR Section 2.3, Meteorological Information. There were two audits that were conducted as a part of this.

The first being in May of 2017, included with the environmental audit in the corporate offices in Knoxville, Tennessee. And this included a site tour and a tour of the former location of the met tower that was on the site.

Also, in May of 2018, there was an audit conducted via the TVA Electronic Reading Room that supported an April 2018 supplemental letter to the staff.

This supplemental letter compares the results utilizing vector versus scalar average wind directions, which we'll talk about in a little more detail later in the presentation.

So, SSAR Section 2.3 is broken down into five subsections, the first of which is Subsection 2.3.1 on Regional Climatology.

This section establishes the Clinch River Site characteristics that are provided in Table 2.0-1 of the Site Safety Analysis Report. The information presented in these first three slides presents those site characteristics provided in Table 2.0-1.

TVA utilized a variety of data sources, including the National Oceanic and Atmospheric Administration, the National Climatological Data Center Storm Events Database and Local Climatological Data Summaries, the National Weather Service records, and observations from TVA Sequoyah and Watts Bar Nuclear Plants.

The winter precipitation events presented here were determined utilizing a variety of sources, as suggested in Interim Staff Guidance Number 7, including American Society of Civil Engineers Standard Number 7-05, National Weather Service data, and Hydrometeorological Report Number 53.

The maximum rainfall rate provided is based on Hydrometeorological Report Number 52.

The basic wind speed is provided based on the American Society of Civil Engineers Standard Number 7-05, with historical maximum based on local climatological data.

And hurricane wind speeds were determined utilizing the speed contours in Regulatory Guidance 1.221 and NUREG-7005. Next slide.

Presented here are the tornado-related site characteristics presented in Table 2.0-1. These were determined using Reg Guide 1.76. Next slide.

Here, we've presented the ambient air temperatures presented in SSAR Table 2.0-1 that were determined using local data from the National Oceanic and Atmospheric Administration and utilizing ASHRAE equations and calculations. Next slide. All right.

SSAR Subsection 2.3.2, on Local Meteorology, compared recent and historical local and regional data.

It was identified that topography around the site strongly influences the local climate and established the predominant valley-ridge access shown in the figure.

The predominant up-valley/down-valley flow depicted is readily apparently at all three meteorological towers shown in the figure.

Comparisons of temperature, precipitation, and moisture data confirmed that the Clinch River Site conditions are consistent with regional conditions. Next slide. Okay.

SSAR Subsection 2.3.3 described the onsite meteorological monitoring program utilized to collect onsite data for use in the Clinch River early site permit application.

The onsite meteorological measurement program was conducted utilizing three different meteorological towers, and their locations, as shown in the previous slide.

MEMBER CORRADINI: Can I ask a general question?

MR. YOUNG: Sure.

MEMBER CORRADINI: This is too detailed for me, so I'm going to take you back to something broader. So, in these data, this is recent data or do you look at it historically?

Where I'm going with that is, for Clinch River, in the prior application for the fast reactor, they probably had to do a similar thing. Did you look at the delta change in the meteorological data from the 1970s to now?

MR. YOUNG: Yes, we did. Well, as we continue on the presentation, I'll describe some of the data we used and I'll make sure to note the comparisons --

MEMBER CORRADINI: Thank you.

MR. YOUNG: -- that we did.

MEMBER CORRADINI: Okay, thank you very much.

MR. YOUNG: So, the onsite meteorological measurement program was conducted using three meteorological towers and their locations, as shown on the previous figure.

This figure shows the latest tower, the primary meteorological tower that was onsite at one point in time. The primary meteorological tower was a 110-meter tower originally constructed for the Clinch River Breeder Reactor Project.

This tower was then reactivated from 2011 to 2013, at the ten-meter and 60-meter elevations, to collect pre-application data for the Clinch River early site permit application.

The supplemental tower was a ten-meter tower utilized during the Clinch River Breeder Reactor Project. And the temporary tower was a 61-meter tower utilized to collect the pre-application data for the Clinch River Breeder Reactor Project.

You asked specifically about the comparisons of some of the historical data versus modern data. And as we've described, there's multiple towers and they were used at different times.

On the previous slide, on 2.3.2, we

mentioned that we see very similar influences for all three met towers, which were at different times, for similar wind conditions. All right.

Continuing on, 2.3.3, Onsite Meteorological Measurement Program. Data collected for the early site permit application satisfied the guidance provided in Regulatory Guide 1.23.

However, the ANSI Standard 3.11-2005 is a reference of Regulatory Guide 1.23, and it states that the transport wind direction for straight-line Gaussian models should be based on the scalar mean wind direction.

TVA has evaluated the use of both vector and scalar wind direction for the Clinch River Site. There were several differences between the approaches, with some sectors identifying larger atmospheric dispersion values and others identifying smaller values.

TVA considered both the Chapter 15 and Chapter 11 dose consequences utilizing both vector and scalar wind direction atmospheric dispersion values and concluded that the vector wind direction was more conservative and was utilized as the basis for the following Subsections SSAR 2.3.4, 2.3.5, and their associated Chapter 15 and Chapter 11 analyses.

CHAIRMAN KIRCHNER: So, Alex, for the record, for the public, could you explain why vector was bounding for Chapter 15 and 11, versus the scalar approach?

MR. YOUNG: Absolutely. So, it's slightly different for Chapter 15 versus Chapter 11. The Chapter 15 analysis conducted for the ESPA is based on the single limiting sector and single limiting values.

So, when we compared vector versus scalar results for the Chapter 15 analysis, we noticed that both of them are driven by the same sector and that the vector wind direction was a more conservative value for that same wind direction sector.

For the Chapter 11 piece, which includes a multitude of sectors, multitude of X/Q values and D/Q values, we ran a sensitivity case of dose analyses utilizing -- one case utilizing the vector, one case utilizing the scalar results, and the vector results showed to have more limiting dose consequences.

CHAIRMAN KIRCHNER: And physically, can you explain for the record why that is so?

MR. YOUNG: Physically, it comes down to vector averaging and the mathematics. It's noted that we don't necessary see this for all cases, this was a case specific to the data we analyzed and for the Clinch River Site. So, for other sites, that may not be the case.

CHAIRMAN KIRCHNER: But again, I'm probing a little further, physically, why is it so that the vector approach gives you a more bounding conservative versus the scalar? Is it just the plume dispersion?

MR. YOUNG: Yes. So, it's based on the X/Qs, D/Qs. So, those results that we get --

CHAIRMAN KIRCHNER: You're talking Greek, could you --

MR. YOUNG: Okay.

CHAIRMAN KIRCHNER: -- get out of the physics space --

MR. YOUNG: Sure.

CHAIRMAN KIRCHNER: -- and say what's happening?

MR. YOUNG: So, X/Qs were -- we think of it as a smoke cloud, you're releasing contamination. It propagates through the air and lands and disperses. So, we found that utilizing the vector results, there was less of that dispersion. It was more concentrated, therefore, there was more absorption in dose. All right.

Moving on to the next slide, Section 2.3.4.

So, SSAR Subsection 2.3.4 addresses the development of the short-term diffusion estimates utilized for the accident evaluations in Chapter 15 of the SSAR.

These atmospheric dispersion calculations were performed utilizing the PAVAN code and met the requirements of Regulatory Guidance 1.145 and 1.23. These calculations utilized the meteorological data from June 1, 2011 through May 31, 2013.

TVA also made conservative assumptions considering the use of the Plant Parameter Envelope and gave no credit for building wake effects and assumed a ground level release.

As depicted in the figure, atmospheric dispersion values for the exclusionary boundary were calculated at an 1,100-foot distance from the effluent release boundary, for any proposed reactor location onsite.

The low population zone atmospheric dispersion values were calculated at a one-mile distance from the site center point. Next slide.

SSAR Subsection 2.3.5 addresses the development of long-term diffusion estimates utilized for the normal release evaluations in Chapter 11 of the SSAR.

These atmospheric dispersion calculations were performed using the XOQDOQ code. These calculations utilized the same meteorological data from that June 1, 2011 through May 31, 2013 period, and again, gave no credit for building wake effects and assumed ground level releases.

Values were calculated for each of the 16 wind direction sectors at different distances out to 50 miles and for the nearest residents, vegetable garden, and beef animal in each sector.

This figure depicts the sensitive receptors identified within the surrounding area. Next slide, please. Okay.

SSAR 2.3.5, Complex Terrain. As mentioned previously, the topography at the site has a strong influence on the local climate.

To evaluate the complex terrain surrounding the site, TVA made a comparison of the results with a variable trajectory model called CALPUFF. This model utilized similar data and assumptions as the other calculations.

We used the same meteorological data from the June 1, 2011 through May 31, 2013 period and we assumed ground level releases and gave no credit for building wake effects.

The conclusion of this evaluation was that the XOQDOQ model, previously described in the previous slide, was bounding for the assessment of long-term diffusion estimates.

CHAIRMAN KIRCHNER: When you make the assumption of ground level release, then in effect, that's like a release when you are having an inversion?

MR. YOUNG: So, that's the -- opposed to having a stack that would release it higher in the atmosphere versus low. We reduce it lower, which limits the amount of dispersion that there is the potential to happen as it approaches that boundary.

CHAIRMAN KIRCHNER: I'm just thinking, I've driven on I-40, south of the site, under conditions were essentially it was like an inversion, it was heavy fog, cloud cover, very low sitting in those valleys. Okay. So, this -- by making a ground level release assumption, you are probably in effect --

MR. YOUNG: You would have more of that effect --

CHAIRMAN KIRCHNER: -- simulating that --

MR. YOUNG: -- opposed to a greater dispersion.

CHAIRMAN KIRCHNER: -- condition for the release?

MR. YOUNG: Yes. You would have more of

that type of effect, opposed to a greater dispersion at higher elevations in the atmosphere.

CHAIRMAN KIRCHNER: So, let me ask Walt's question differently, because, again, this is an area that I know you follow the guides, but I'm curious, is the X/Q -- let me not do that.

Is the way in which you treat the meteorology here regionally-dependent, so that if I were to look at this in Illinois or Wisconsin or Minnesota, it would be a different set of X/Qs? Or are you looking for a bounding X/Q regardless of site, in terms of the guide?

That's what I was kind of curious about, kind of going with his question about hills and valleys here, catching it differently, and you having a different terrain.

MR. YOUNG: Sure. So, because of the topography around our site, this is very specific to the Clinch River Site --

MEMBER CORRADINI: Okay.

MR. YOUNG: -- based on the topography and how winds flow through the area.

MEMBER CORRADINI: Okay.

MR. YOUNG: And that concludes the presentation on 2.3.

CHAIRMAN KIRCHNER: Okay, thank you. Let us turn to the NRC staff at this point.

MR. CAMPBELL: This is Andy Campbell, again. Presenting for the NRC is Kevin Quinlan, for the meteorology, and Mallecia Sutton.

CHAIRMAN KIRCHNER: Okay.

MR. CAMPBELL: And I will add, stepping into an area that I don't know much about, all X/Q, D/Qs are site-specific. There really are no generic ones, you really have to look at each and every site to make that determination.

MEMBER CORRADINI: Andy, since you brought that up, how local do you get, in terms of distance? You go out ten -- you look at some sort of averaging over, like, a ten-mile radius?

MR. CAMPBELL: Now, you're talking in Kevin's talk, so I'm going to --

MEMBER CORRADINI: Well, that's all right. He can wait, when the time comes, but I was kind of curious. That's fine.

MR. CAMPBELL: It'll look at a variety of differences, and he's nodding his head yes, so I answered that correctly.

(Laughter.)

MR. CAMPBELL: And that's the extent of my knowledge.

CHAIRMAN KIRCHNER: Okay. Proceed.

MS. SUTTON: Kevin Quinlan graduated from Millersville University of Pennsylvania in 2006 with a bachelor's of science in meteorology. He then went on to earn his masters of science degree from the University of Alabama in Huntsville, atmospheric science.

Mr. Quinlan has been working in the Office of New Reactors since July 2008. He is or has been the lead NRC Meteorology Reviewer on 12 new reactor applications and design reviewed by the NRC. Now, I'll turn the presentation over to Kevin.

MR. QUINLAN: Good morning. My name is Kevin Quinlan and I'm a meteorologist in the Office of New Reactors, Division of Licensing, Siting, and Environmental Analysis.

Section 2.3, Meteorology, discusses the site-specific information related to regional climatology, local meteorology, the onsite meteorological measurements program, short-term atmospheric dispersion estimates for accidental releases, and long-term atmospheric dispersion estimates for routine releases.

I'd like to note that this section included technical input from other staff meteorologists, notably Mike Mazaika, Jason White, and the Meteorological Team Leader, Brad Harvey. Next slide, please.

Section 2.3.1, Regional Climatology, provides information related to the regional climatology that could potentially influence the design and operating basis of safety and non-safety-related structures, systems, and components.

Section 2.3.1 is where most of the meteorological site characteristics are developed and reviewed.

Staff performed a review and analysis of the following site characteristics: the tornado and hurricane wind speeds and associated missiles; the 100-year return period wind speed for three-second gusts; the maximum winter precipitation; ambient air temperature and humidity.

And staff concluded that the identification and consideration of the climatic site characteristics are acceptable at the Clinch River Site. Next slide, please.

Section 2.3.2 discusses the local meteorology in the area surrounding the site. This section provides summaries of local meteorological conditions, an assessment of the potential influences of the plant on the local meteorological conditions, and a topographical description of the site and its surroundings.

Staff reviewed the Clinch River analysis of the onsite wind speed and direction summaries, atmospheric stability, and ambient air temperature and humidity.

Staff also confirmed meteorological information related to precipitation, fog, and potential changes in air quality near the site. Staff reviewed and verified that the local meteorological data provided by TVA are representative of the site area as impacted by the local topography.

Section 2.3.3 discusses the onsite meteorological measurements program, in support of the early site permit application. NRC staff visited the site and reviewed the onsite meteorological measurements program during an environmental site audit conducted in May of 2017.

The audit topics were related to the meteorological monitoring. They included location and exposure of previously sited meteorological instrumentation and the tower, instrument maintenance, and the data quality assurance program.

NRC staff completed a quality assurance review of the onsite meteorological database submitted by TVA as part of the early site permit application and staff confirmed that the TVA meteorological tower conformed to Regulatory Guide 1.23 criteria for siting of the tower in relation to the proposed Clinch River Site.

One concern that the staff had with the onsite meteorological measurements program, and this was just previously discussed in TVA's presentation was related to TVA's use of the vector average wind direction and scalar average wind speed data as input to the atmospheric dispersion models.

TVA chose an alternative method to the best practice cited in Regulatory Guide 1.23 and ANSI Standard 3.11-2005, Determining Meteorological Information at Nuclear Facilities, which states that the transport wind direction for straight-line Gaussian models should be based on the scalar mean or unit vector wind direction.

TVA voluntarily provided a submittal that evaluated the effects of using vector average wind directions rather than the suggested scalar average wind directions for the atmospheric dispersion estimates.

The analysis showed that the dose modeling results were bounding, based on the average of the vector average wind directions, as provided in the SSAR.

However, TVA acknowledged the atmospheric dispersion and deposition factors for routine radiological releases were greater in some directions and lower in others, when compared to using the scalar average wind directions. Okay.

MEMBER SUNSERI: I have a question about that.

MR. QUINLAN: Sure.

MEMBER SUNSERI: So, is there a suggestion there that the scalar method that's referenced in the Reg Guide is non-conservative, or not as conservative, as using the vector?

MR. QUINLAN: It likely varies site-by-site. However, the ANSI 3.11 standard, as referenced in the Regulatory Guide, suggests the use of the scalar average wind direction, just as a best practice.

However, in this case, some areas were -- some directions were a little more conservative or a little higher and some were lower.

MEMBER SUNSERI: So, based on the TVA experience, would you anticipate updated the Regulatory

Guidance?

MR. QUINLAN: When we get to updating the guidance, it may be an area to take an additional, a closer look at, and maybe compare some other sites as well.

MEMBER SUNSERI: Okay, thank you.

MR. QUINLAN: Based on the aforementioned analysis, TVA concluded that for normal and accident gaseous release dose assessments, the existing dose analysis in the SSAR is conservative and remains the basis for the ESP application.

NRC staff conducted an audit of the submittal and agreed with the applicant's conclusion that the SSAR dose analysis is bounding.

The staff concluded that the onsite meteorological monitoring system provides adequate data to represent the onsite meteorological conditions at the Clinch River Site during the time frame in which it was collected. Next slide, please.

The staff identified and has proposed three COL action items related to the onsite meteorological measurements program.

COL Action 2.3-2 states that an applicant referencing this early site permit should demonstrate the onsite meteorological measurement program continues to meet the guidance provided in Regulatory Guide 1.23. This was necessary, since the system that recorded the meteorological data for the early site permit application has since been removed.

COL Actions items 2.3-3 and 2.3-4 are related to the collection and use of vector and scalar average wind data averaging for COL or a CP referencing this early site permit.

MEMBER CORRADINI: So, can you -- 2.3-3, so the way I read that is, they've got to go back and check to make sure which one is bounding? That's how I read that. Am I misreading it?

MR. QUINLAN: I believe the intent of this one was, because we're granting a finality on the X/Q values and the onsite data that was collected for use in the early site permit, but the tower and the system that recorded the meteorology data has since been removed, when they come in for a COL or CP and they build a new tower, that it remains the same as what the early site permit assumed. And if not, then a comparison can be --

MEMBER CORRADINI: I think you're answering 2.3-2, I was asking about 2.3-3. I think I understand the first one.

2.3-3 leads me to believe that they're

going to have to come back, whoever -- if they decide to go forward and if they pick one of the four, that design is going to have to compare scalar to vector and pick the bounding of the two. Am I misunderstanding that?

MR. QUINLAN: It says that it should verify whether the operational phase of the onsite meteorological measurement program will include wind data averaging on the basis of scalar or vector averages.

So, I think they need to say at that time which program they're going to be using, or which averaging type they'll be using going forward.

MEMBER CORRADINI: And either one would then be -- I'm still back to Matt's question about either one would be acceptable. But in this case, because of this locale and this weather, it turns out vector averaging was more bounding?

MR. QUINLAN: In this case, yes.

MEMBER CORRADINI: Okay.

MEMBER SUNSERI: So, you would think that that would be more specific, since the regulatory best practice is to use the scalar, that the COL item should reference using vector.

MR. QUINLAN: Well, it would be up to them to -- if they change the averaging type, then they could take a departure from the early site permit.

So, it's really up to TVA at that point to decide which they would want to use. If it's inconsistent with the ESP, then they could always take a departure. However, it is up to them for how they set up their system.

MEMBER CORRADINI: So, this is kind of in the weeds, so let me say it back to you so I get it. I think I get it now. Your point is, they can do either.

If they choose to do vector, they're in compliance and consistent with the ESP. If they choose to do scalar, they've got to essentially say why and ask for an exemption.

MR. QUINLAN: I believe that's correct.

MEMBER CORRADINI: Okay, I got it.

MR. QUINLAN: Okay. Section 2.3.4 relates to the short-term atmospheric dispersion estimates used to determine the amount of airborne radioactive materials expected to reach a specific location during an accident situation.

These atmospheric dispersion factors, or X/Q values, estimate the relevant concentrations at the exclusion area boundary, the EAB, and at the outer boundary of the low population zone, or LPZ, for postulated design-basis accidental radioactive airborne releases.

As part of the review, staff performed an independent verification of the applicant's accident diffusion estimates.

Staff created a joint frequency distribution from wind speed, wind direction, and atmospheric stability data collected as part of the onsite meteorological data, and used for input to the PAVAN atmospheric dispersion computer model.

Staff then executed the model and generated offsite X/Q values for all sectors along the uniform analytical EAB and LPZ boundaries. Next slide, please.

As described in SSAR Section 2.3.4.2, the nuclear island effluent release boundary, or the small green and blue circles on the figure on the screen, are used to conservatively enclose all possible release points for the selected reactor technologies.

The distance from the outer edge of the power block area to the exclusion area boundary is 335 meters, or 1,100 feet, as shown in the figure on the slide.

To account for the potential of multiple units on the site, nuclear islands are positioned at multiple locations within the power block, with associated effluent release boundaries and exclusion area boundaries as shown in the figure.

A circular analytical EAB is established 1,100 feet from the effluent release boundary, as denoted by the yellow circles.

All of the potential nuclear island sites are bounded by the red ellipse that encompasses all of the analytical effluent release boundaries and is completely contained within the Clinch River Site.

Since the distance from the outer edge of the power block to the effluent release boundary is less than the actual distance from the nuclear island to the EAB, and will result in higher or more conservative X/Q values, the NRC staff considers the assumptions in the dispersion analysis to be reasonable.

Through this confirmatory analysis, the staff found the applicant's EAB and LPZ site characteristic X/Q values to be acceptable.

CHAIRMAN KIRCHNER: Let me explore with you, yes, they were acceptable, so I'm not looking to change what the requirements are.

I wanted to explore more, how close were their X/Q values to yours, after you did your confirmatory analysis? And what I'm looking at is uncertainty sensitivity, as might impact the analysis of Chapter 15 analyses.

MR. QUINLAN: Sure. I'm opening up the SER to see if we provided an exact number for how close they were. But we did use the same two-year onsite meteorological dataset as TVA. And we created our own joint frequency distribution, used the same distances --

CHAIRMAN KIRCHNER: Right.

MR. QUINLAN: -- for each direction. So, they were very close. I don't have an exact number for you, but usually, if it's any more than a couple of percent, maybe two to four percent difference, then we start to explore a reason why we have a larger difference.

In this case, I remember the results being very close, either right on, the exact same, or just within one or two percent.

CHAIRMAN KIRCHNER: Okay, thank you.

MR. QUINLAN: You're welcome.

MR. CAMPBELL: This is Andy Campbell. Just, if you want to pursue that, we can point you to the specific area of the SER where the numbers are compared.

CHAIRMAN KIRCHNER: To the point, Andy, I was trying to integrate that. So, yes, I know where the numbers are in the SER, I'm trying to really have a feeling of margin and confidence when it comes to issues like the emergency planning topic. So, that's why I'm pushing on this.

I would hope that a slight change in the weather wouldn't put them over any of the requirements that have to be met here with a much smaller emergency planning zone.

That's the one in particularly I'm looking at, because, in effect here, we're ahead of the rulemaking, with what the applicant is proposing, so I'm pushing to understand and have confidence that the analyses that had been done and the confirmatory analyses done across the board by the staff show that we have reasonable confidence on this official issue.

MR. CAMPBELL: And that there's sufficient margin --

CHAIRMAN KIRCHNER: Yes.

MR. CAMPBELL: -- between these analyses and what the site boundary could be. And I think Kevin can speak to the conservatisms that are inherent in these types of analyses, in terms of that margin.

CHAIRMAN KIRCHNER: Thank you.

MR. QUINLAN: If there are no further questions on this slide, I can -- okay to move on?

CHAIRMAN KIRCHNER: Yes.

MR. QUINLAN: Okay. Section 2.3.5 relates to the long-term dispersion estimates that are used to determine the amount of airborne radioactive materials expected to reach a specific location during normal operations.

These dispersion estimates address the requirement concerning atmospheric dispersion and dry deposition estimates for routine releases of radiologic effluents to the atmosphere.

For the review, the staff performed an independent verification of the applicant's routine release diffusion estimates.

As with Section 2.3.4, discussed previously, staff created a joint frequency distribution from the onsite meteorological data for use as part of the input to the XOQDOQ atmospheric dispersion computer model.

Staff then executed the XOQDOQ computer model and generated X/Q and D/Q values for receptors of interest. Based on the XOQDOQ results, the staff concluded that representative atmospheric dispersion and deposition conditions have been calculated for the receptors of interest.

In conclusion, all regulatory requirements for Section 2.3, Meteorology, have been satisfied. In this section, we have no open items and we do have three confirmatory items, which are expected to be closed at the next revision of the SSAR. And I'll take any questions that you may have.

CHAIRMAN KIRCHNER: Okay, thank you. Members?

MEMBER BROWN: I've got one, I'm not a meteorology person either, but back on Slide 3 -- I'm going to get it right sooner or later if I say it often enough -- you noted you did your review of the original climatology.

MR. QUINLAN: Yes.

MEMBER BROWN: And in an earlier discussion, we talked and it was mentioned that Clinch River Breeder Reactor also had a similar type of analysis that was done. And that was, what?, 30?, how many years ago?

MR. QUINLAN: Yes, I believe mid-1970s.

MEMBER BROWN: Mid-1970s?

MR. QUINLAN: Forty years ago.

MEMBER BROWN: Thirty-five, 40 years ago? Okay. Was there any comparison or look back and see what the results were there? Were these more severe than they were then?

MR. QUINLAN: There was a comparison of the wind speed and wind directions for the dataset that they collected for an early site permit from 2011 to 2013, compared to the 1970s data, there were two separate datasets collected in the 1970s.

There was a comparison in the SSAR, that compared the -- it was a wind rose as well as, I believe, wind speeds and wind directions. So, there was a comparison done.

The staff, we compared the data that they provided for the early site permit, we did our own internal analysis and quality check of the data, and compared it against what they provided in the SSAR, to make sure that we were arriving at the same results. We did not independently do a verification of the 1970s data, but --

MEMBER BROWN: Well, I wasn't looking for that --

MR. QUINLAN: Sure.

MEMBER BROWN: -- it just was the end result. I mean, you confirmed that their characteristic values now were appropriately derived from the Reg Guides.

They were also probably appropriately derived from whatever the Regulatory Guides were at that time.

MR. QUINLAN: Yes.

MEMBER BROWN: And I'm just wondering, were the conditions more severe now, predicted to be more severe now than they were then? In other words, was there a change in the severity of the wind speeds, 100-year return, et cetera?

MR. QUINLAN: You always expect at least a small variation from year-to-year.

MEMBER BROWN: I don't --

MR. QUINLAN: But the --

MEMBER BROWN: -- disagree with that.

MR. QUINLAN: -- comparisons were very close, between the more recent dataset and the 1970s dataset.

MEMBER BROWN: Okay. That's -- thank you.

MR. QUINLAN: Yes, you're welcome.

CHAIRMAN KIRCHNER: Okay. Thank you.

MR. QUINLAN: Thank you.

CHAIRMAN KIRCHNER: It seems that, according to the agenda, we are at lunch.

(Laughter.)

CHAIRMAN KIRCHNER: So, I'm going to try and reorganize here a bit. What I would propose is to take a 15 minute break at this juncture.

But I want to check with both the applicant and the staff, whether we have the necessary people on-hand if we take up Quality Assurance and Hydrology after the break.

MR. SCHIELE: TVA can support it.

CHAIRMAN KIRCHNER: Okay.

MR. CAMPBELL: And the staff can --

MS. SUTTON: The staff, yes.

MR. CAMPBELL: -- support that as well.

CHAIRMAN KIRCHNER: Excellent, okay. Then, we will recess for 15 minutes. Let's use the clock up there and return at five minutes of 10:00.

(Whereupon, the above-entitled matter went off the record at 9:38 a.m. and resumed at 9:54 a.m.)

CHAIRMAN KIRCHNER: Let's reconvene. Let me, for the record, mention that Dennis Bley, a member, is on the phone line. And with that, we're going to turn to Quality Assurance. Ray, would you proceed?

MR. SCHIELE: Thank you, Mr. Chairman. I'd like to introduce Michelle Conner, who will be presenting SSAR Section 17, Quality Assurance.

MS. CONNER: Thank you, Ray. My name is Michelle Conner, I'm the TVA SMR Senior Project Manager for Operations, Training, and Programs, with 19 years of experience in nuclear regulatory affairs and operations. I held an NRC license as a Reactor Operator and a Senior Reactor Operator for 12 of those years.

This presentation is for the ESPA Site Safety Analysis Report Section 17.5, Quality Assurance Program Description.

We'll go through the chronology, the Clinch River ESPA activities, the program description, quality assurance implementation, and then, a conclusion.

So, first, the chronology. The ESPA Rev 1 was submitted to the NRC in December of 2017. The NRC issued an RAI on QA on March 9, 2018. TVA provided our RAI response on April 9 and the NRC Quality Assurance Inspection was on April 16-20.

TVA issued the NQAP Rev 36 subsequent to that inspection on May 8, 2018. NRC issued the QA Inspection Report on June 1, 2018. And we'll talk about each of those activities in more detail.

So, first, the TVA Nuclear Quality Assurance Plan Description. The TVA NQAP is the top level document that defines the Quality Assurance policy and assigns major functional responsibilities.

Section 17.5 of the application provides a summary of the TVA Clinch River QA Plan attributes. It is a separately controlled document and is included in Part 8 of the ESPA.

The activities performed during the ESPA development for Clinch River using the TVA Fleet Nuclear Quality Assurance Plan. The NQAP is an NRC approved 10 CFR 50, Appendix B, Quality Assurance Plan that is used by the three operating sites for TVA.

The TVA NQAP was based on an early set of standards endorsed by the NRC. The early standards were the foundation of the subsequent development of the NQA-1 standards, which are endorsed by Reg Guide 1.28 Rev 4, the Quality Assurance Program Requirements for Design and Construction.

The NRC issued an RAI to TVA to clarify conformance to SRP 17.5 Rev 1, and to provide clarification of that conformance to proposed alternatives to some of the 17.5 acceptance criteria and commitments.

So, TVA developed a conformance matrix that provided those requirements with a TVA QA Plan. Where conformance was not provided, commitments were added to the TVA QA Plan and where the existing TVA QA Plan had an acceptable alternative, that alternative was submitted.

In most cases, the previous commitments to N-45 standards provided the appropriate controls for activities related to the ESP application.

Following the inspection, TVA did revise the Fleet NQAP to show conformance with 17.5.

The revision clarified or included requirements for certain site-specific activities occurring at various stages of facility life. Work activities include, but are not limited to: management, planning, site investigation, design, and procurement. Next slide.

As I mentioned, the NRC came and did an inspection between April 16 and April 20. Areas inspected included 10 CFR 21, corrective actions, QA records, internal audits, organization, design control, procurement, document control, and control of purchased materials, equipment, and services.

The conclusion in the NRC Inspection Report was of no violations or non-conformances being identified.

So, based on that information, TVA concludes that the TVA Quality Assurance Plan meets the requirements of 10 CFR 50, Appendix B, and 10 CFR 52.17. That concludes my presentation.

CHAIRMAN KIRCHNER: Thank you, Michelle. Any questions from members? We're missing Dick Skillman, he usually has a very pointed question to ask, this is with license renewals, about commitment of the organization to its QA Program.

So, Ray, I'm going to ask you about that. So, how does the management stand behind this application? I mean, pretty much, right now, we're talking about paper. But where are you in terms of an actual implemented program?

MR. SCHIELE: So, right now, we are using, taking credit for, the TVA program, which is fully implemented and used at all three sites. So, we are part of that program right now.

It is the plan to eventually transition to a full standalone NQA-1 program for the project, should it decide to move forward. But right now, we are part of the fleet, fully implemented, NQA Program.

CHAIRMAN KIRCHNER: Thank you.

MR. SCHIELE: Yes.

CHAIRMAN KIRCHNER: Anyone else? Okay. With that, then I believe we would turn here to the staff. Thank you, Michelle. Okay. Allen, are we set?

MR. FETTER: Okay. Good morning. Allen Fetter. As Mallecia said, I'm the other Safety Project Manager on this review.

Mr. Nicholas Savwoir is from the Office of New Reactors, in the Division of Construction, Inspection, and Operational Programs, under the Quality Vendor Inspection Branch I.

He has four years of quality assurance experience at the NRC and has an electrical engineering degree from North Carolina's A&T State University.

Prior to the NRC, he performed ship alterations and troubleshooting on analog and digital instrumentation and control systems for submarines and aircraft carriers under NAVSEA's Nuclear Propulsion and Planning Department at Norfolk Naval Shipyard.

Today, his first presentation before the ACRS, he will be presenting the review of the Site Safety Evaluation Report, Section 17.5, Quality Assurance Program Description. Okay. Go ahead, Nick.

MR. SAVWOIR: Good morning, ACRS. Again, my name is Nicholas Savwoir, I'm part of the Division of Construction, Inspection, and Operational Programs under the Quality Vendor Inspection Branch I. And good afternoon, good morning. Next slide.

The Chapter 17.5 regulations which pertain to the early site permit consist of the 18 quality assurance criteria of 10 CFR 50, Appendix B, and also, 10 CFR 52.17(a)(1)(xi) and (a)(1)(xii).

(a)(1)(xi) specifically requires the ESP applicants to provide a description of the Quality

Assurance Plan applied to the site-related activities.

And (a)(1)(xii) requires the ESP applicants to include an evaluation against the NRC's most current quality assurance guidance six months prior to the docketed date. Next slide.

I guess I'll start a little bit with the background history, and, basically, some of the information, to summarize the application, which led to my review.

So, as required by 10 CFR 52.17, an applicant is to provide a description of the Quality Assurance Plan applied to site-relate activities. And as a result, TVA, they submitted their operating NQAP, which was Revision 32.

TVA's NQAP, it commits to the ANSI N45.2-1971, as endorsed by the NRC's Reg Guide 1.28 Rev 3. However, at the time, six months prior to the docketed date, NQA-1-2008 was in effect and endorsed by NRC's Regulatory Guide 1.28 Rev 4.

And because we evaluate submittals using the current regulatory framework, we conducted multiple public meetings and clarification calls to resolve any differences with the operating fleet's NQAP and a submittal, in accordance with the regulations, which is 10 CFR 52.17 stated, as earlier.

From the staff's review, we issued one RAI with eight questions, and as a result of the staff's review, TVA did revise the submittal, the NQAP Revision 32 to Revision 26, to address the staff's questions. Next slide.

So, as a part of my review, I reviewed all the 18 criteria of Appendix B, 10 CFR 50, and also, I performed my own gap analysis for my review against the Reg Guide 1.28. And also indicated by my SE, you can see that in my gap analysis.

So, for this presentation, I would just like to summarize this into -- summarize my review and the RAIs into three overall key areas.

The first area is for the Quality Assurance Program Description, which is in accordance with Criterion I for Organization, and also Criterion II for Quality Assurance Program.

The second key review area is for the Quality Assurance Gap Analysis, in accordance with Criterion XVII, which is QA Records, Criterion VII for Control of Purchased Material, Equipment, and Services, and Criterion XV for Nonconforming Materials, Parts, or Components.

And last but not least, the third key review area is for the QA Implementation and Inspection. That was conducted April 16-20 of this year at TVA Headquarters in Chattanooga. Next slide.

So, the first key review area is for the Quality Assurance Program Description, specifically, at the Clinch River Nuclear Site.

And as a result of my interactions with TVA, the NRC staff identified the need for additional information for the small modular reactor organization for the Clint River Nuclear Site, and also, the independent assessments that would be conducted at the Clinch River Nuclear Site, in addition to the reference or the commitment of 10 CFR 52, because inside their NQAP that was submitted, there was no indication of that at all.

So, as a result of the staff's review, TVA, they revised the NQAP to Revision 36, which basically added the Appendix K, which addressed the roles and responsibilities, and also the authorities.

Also, they added Appendix L, which is an organization chart specific for the small modular reactor or organization which, in their Appendix I, didn't address at all. And also, they added 10 CFR 52 to the NQAP Revision 36 that I'll talk about later. Next slide.

So, my second key review area --

MEMBER RICCARDELLA: Why is it Revision 36?

MR. SAVWOIR: So, there were several iterations of the revisions. From my knowledge and experience, they revise it, I believe, every Christmas. And so, basically, after this two-year period, there were internal revisions and things of that nature.

MEMBER RICCARDELLA: Thank you.

MR. SAVWOIR: Yes. So, my second key review area is for the gap analysis, and also, the Criterion XVII for the Quality Assurance Records.

So, as a result of my interactions with TVA, the NRC staff, we identified the need for additional information for the gap analysis, which was the difference between Revision 3 and Revision 4 of Reg Guide 1.28.

And also, the Clinch River Nuclear Quality Assurance Records and also, the Clinch River Nuclear Electronic Records Controls.

So, as a result of the staff's review and the RAIs, we -- the RAI I generated with the eight questions, TVA, they revised the NQAP to Revision 36.

TVA, they submitted a gap analysis evaluation during the inspection that was conducted this April and they also added Appendix M to address the Clinch River Nuclear Commitments and Clarifications for the ESP QA Program.

They also committed Reg Guide 1.28 Rev 4. And they also identified the documents that are considered QA Records per Criterion XVII of the regulations. They also added the Electronic Records per RIS 2000-18 and the NIRMA guidance. Next slide.

MEMBER RICCARDELLA: Excuse me?

MR. SAVWOIR: Yes.

MEMBER RICCARDELLA: Could you just give me a description as to what a gap analysis is? It's a new term for me.

MR. SAVWOIR: Yes. So, I guess, in essence, what a gap analysis is, it's basically an evaluation.

An evaluation as the regulations require, per 10 CFR 52.17, in which -- as TVA indicated earlier, they did a full matrix, which is a chart that went through all the criterion of the Quality Assurance Criterion of Appendix B and they did an evaluation and opened corrective actions, if there was any discrepancies between the two, or addressed them in the revision.

MEMBER BALLINGER: Why did you pick Revision 3 and 4? Because there is a Revision 5.

MR. SAVWOIR: So, the regulations require that it's six months prior to the docketed date.

MEMBER BALLINGER: Okay.

MR. SAVWOIR: And at the time, Revision 4 was the -- so, yes, same slide. Oh, next slide. Yes. Okay.

So, to continue with the second key review area for the gap analysis, which addresses the Criterion VII, which is the Control of Purchased Materials, Parts, and Equipment, and Services, and Criterion XV, which is Nonconforming Materials.

So, as a result of the staff's interactions with TVA, the staff, we identified the need for additional information, because there was an incorrect exemption for the use of accreditation in lieu of commercial grade surveys for procurement of laboratory calibration and test services.

And also, TVA, they did not address the notification of affected organizations for nonconforming material and parts and components within this NQAP they submitted.

So, as result of the staff's review and the RAI generated, TVA, they revised the NQAP. They revised the ILAC conditions per the NEI 14-05 guidance, which is the guidelines for the use of accreditation in lieu of commercial grade surveys for procurement of laboratory calibration and test services.

And also, they added an Appendix M and the commitments to address the notification of affected organizations. Next slide.

So, my last, but not least, my third key review area was for the Quality Assurance implementation, that I was a part of, and also, Greg Galletti, who's sitting over there on the side, that was conducted April 16-20 of this year, 2018. And we used the Inspection Procedure 350117, which is the QA Implementation Inspection.

And, basically, this inspection assessed the aspects of TVA's process, their procedures, and their implementation of the Quality Assurance activities used for the Clinch River Nuclear early site permit application, which also included the organization, the Quality Assurance Program, the QA Records, the design control, corrective actions, audits, oversight of contractor activities, and also, 10 CFR 21.

And based upon, at this inspection, we actually -- this was the initial review, where we were able to look at the Revised 36. So, basically, the draft, what it would look like and what it would contain, as far as addressing the RAIs.

At the time, there were no findings of

significance were identified and the qualification and the Quality Assurance Inspection Report is publicly available at the accession number here on the slide.

So, in conclusion, on the basis of the staff's review of Chapter 17.5 of the Clinch River Nuclear Site early site permit application and the NQAP Revision 36, the staff concludes the applicant's QAP Description for the Clinch River Nuclear Site early site permit meets the regulatory requirements of 10 CFR 50, Appendix B, and also, 10 CFR 52.17. Any questions?

CHAIRMAN KIRCHNER: Thank you. Members, any further questions at this point? Okay. Thank you, Nicholas. We let you get off easily this time.

(Laughter.)

CHAIRMAN KIRCHNER: But, welcome.

MR. SAVWOIR: Thank you.

CHAIRMAN KIRCHNER: Okay. Let's move on to Hydrology. I know we're showing a break, but I think we can push on and probably get this done before lunch. So, are we ready? Okay, Ray, you're ready? Please proceed.

MR. SCHIELE: Yes, Mr. Chairman, we'd like to continue our presentation with Section 2.4, Hydrology. I'd like to introduce John Holcomb, who'll be presenting. John?

MR. HOLCOMB: Thank you, Ray. Good morning. My name is John Holcomb, I'm a civil engineer. I've been with TVA for nine years, on various construction operations and licensing projects. I'm currently service as the TVA SMR Engineering Manager.

The presentation for ESPA Site Safety Analysis Report Section 2.4, Hydrologic Engineering, has been divided into three areas. There will be a brief description of the NRC interactions related to Section 2.4.

We'll present an overview of the Tennessee River System and the Clinch River Watershed, prior to the technical presentations. We will also have an overview of each of the 14 sections of 2.4. Next slide.

In April of 2017, the NRC conducted an audit to review the site hydrologic engineering information presented in Site Safety Analysis Report Section 2.4 of the ESPA.

The audit consisted of an office visit, with a general presentation of the Clinch River Site. The staff provided 40 audit information needs to TVA prior to the audit. And TVA's responses were presented and discussed during the audit.

Following the audit, TVA docketed their

responses to the NRC. These responses have been incorporated into Revision 1 of the early site permit application.

The audit also consisted of a site tour, including site hydrologic engineering features in terms of four TVA dams upstream of the Clinch River Site. We'll discuss more of these dams later in the presentation. Next slide.

Before we get into technical details of the presentation, I would like to give an overview of the Clinch River Site as it relates to the hydrologic characteristics of the site.

Details of the Clinch River Site hydrologic description are provided in SSAR Section 2.4.1, Hydrologic Description of the ESPA. Next slide.

On this slide, you'll get a perspective for the spatial relationship between the significant dams near the Clinch River Site. The Clinch River Site is shown by the red circle on the left of the map, and I'll also use the pointer here.

One of the most important dams relative to flooding of the Clinch River Site is Norris Dam. As shown here in the map, Norris Dam is located 52 miles above the site on the Clinch River.

Melton Hill Dam is located approximately five miles upstream of the Clinch River, as shown here on the map, and has a small amount of storage capacity.

The Watts Bar Dam backwater is a primary factor in the water elevation at the Clinch River Site. The Watts Bar Dam is located about 50 miles downstream of the site, and that's shown here on the map.

Because of the importance of the Watts Bar Dam backwater on the site elevation, we also show on this map the key dams above Watts Bar, on the Tennessee River and its main tributaries.

The most important of these are the Cherokee Dam, the Douglas Dam, the Fontana Dam, and the Fort Loudoun/Tellico Dam Complex. Next slide. Go ahead.

MEMBER CORRADINI: Is this the same information, just shown differently? The one you just flipped to?

MR. HOLCOMB: That one right there?

MEMBER CORRADINI: Yes.

MR. HOLCOMB: Yes. This is so you can get an idea of the hydraulic flow of the dams, this is --

MEMBER CORRADINI: Okay.

MR. HOLCOMB: Yes.

MEMBER CORRADINI: All right.

MR. HOLCOMB: The other one gives you a

spatial --

MEMBER CORRADINI: Because the other one, I didn't catch. This one --

MR. HOLCOMB: Yes, this is just a pictorial to easily show all the dams on one slide.

MEMBER CORRADINI: Okay.

MR. HOLCOMB: The other one is for spatial description.

MEMBER CORRADINI: Sure.

MR. HOLCOMB: All right.

MEMBER CORRADINI: So, the site is the red dot and water flows up the screen?

MR. HOLCOMB: So, the -- yes.

MEMBER CORRADINI: Or water flows down the screen?

MR. HOLCOMB: Water flows down the screen.

MEMBER CORRADINI: Down the screen?

MR. HOLCOMB: Yes.

MEMBER CORRADINI: Okay.

MR. HOLCOMB: All right. The TVA water control system is large and diverse, as you can see in this diagram.

Unlike many utilities that have dams affecting flooding at their site which are under control by external entities, such as the Army Corps of

Engineers, the Tennessee River System is controlled by TVA.

The exceptions are small dams controlled by the Corps of Engineers and other power generation entities.

MEMBER CORRADINI: So, what -- all of the ones we see here are controlled by TVA?

MR. HOLCOMB: Except for two or three smaller ones on here, but --

MEMBER CORRADINI: Can you just kind of --

MR. HOLCOMB: -- TVA's River --

MEMBER CORRADINI: -- highlight where those are? I'm sorry.

MR. HOLCOMB: Stu, do you mind pointing those out?

MR. HENRY: Yes. The ones that are not controlled by TVA are up here on the Little Tennessee: Chilhowee, Cheoah, Santeetlah, Thorpe. I think TVA does handle the Nantahala.

MEMBER CORRADINI: So, it's on the upper right where these are not controlled by you all?

MR. HENRY: Correct.

MEMBER CORRADINI: And due to flood control, there are procedures that are normally instituted in terms of what to handle, based on season and location?

MR. HOLCOMB: That is correct.

MEMBER CORRADINI: Okay. Lot of dams.

MR. HOLCOMB: The TVA River Forecasting Center regulates the Tennessee River and major tributary flow to maximize flood management, power generation, and recreation.

The main reservoirs are lower in the late fall, winter, and early spring, to maximize flood storage. The main reservoirs are raised in late spring, summer, and early fall, to increase electric generation and provide for general recreation.

The staff toured the River Forecasting Center as part of the April 2017 audit. The River Forecasting Center is staffed 24/7 to monitor and control the TVA River System.

These operation characteristics, known as operating rules, as well as established flood guides, are integrated into the hydrologic analysis for the Clinch River Site.

The TVA dams within the water control system are under the TVA Dam Safety Program. Changes in the TVA water control system that potentially impact the flooding analysis at the TVA Nuclear Sites are evaluated by the TVA Nuclear Power Group.

MEMBER CORRADINI: So, I'm sorry to get

particular, I'm just trying to understand. So, the red dot is actually where it is or is the red dot really a little bit higher, where the river kind of winds around the site? I'm trying to get geographically oriented.

MR. HOLCOMB: So, if this was actually --

MEMBER CORRADINI: Clinch River is to the left, right? Upper left?

MR. HOLCOMB: Yes. So, the Clinch River is here. You got Melton Hill Dam, the Clinch River Site is just south on the river of the dam. And then, you have the Watts Bar Backwater Reservoir, which we've been discussing.

MEMBER CORRADINI: Okay. Well, the reason I'm asking the question --

MR. HOLCOMB: Yes, go ahead.

MEMBER CORRADINI: -- is that on the actual map, which is back on some slide that you don't have to go back to, shows that the river winds around the site.

And yet, the way you have it described here, it's off to the side of the winding around. So, I assume that's wrong and the actual map is right.

MR. HOLCOMB: Ray, can you go to the next slide, please?

MEMBER BROWN: The red dot's in the wrong place?

MR. HOLCOMB: Yes.

MEMBER BROWN: Because that's what he's trying to say.

MR. HOLCOMB: Yes, so --

MEMBER BROWN: I had the same question --

MR. HOLCOMB: -- right here --

MEMBER BROWN: -- but he got ahead of me.

MR. HOLCOMB: Yes. So, the red dot is, that is basically a cartoon drawing depicting --

MEMBER CORRADINI: Yes, it's fine, it's fine, it's fine.

MR. HOLCOMB: Yes. So, if you look here, you'll see the site is --

MEMBER CORRADINI: That's fine.

MR. HOLCOMB: -- north of the river.

MEMBER CORRADINI: I like the cartoon drawing, because I can understand the geography of all the various dams and what feeds what. But that's one thing that confused me. All right, thank you.

MR. HOLCOMB: Yes, you are correct. As shown in this picture, the Clinch River Site is on the north bank of the Clinch River, about five miles downstream of the Melton Hill Dam.

The planned finished grade at the site is

821 feet, approximately 80 feet above the normal river water elevation. The Watts Bar Dam Backwater Reservoir level is typically the main factor in the actual water level at the Clinch River Site.

MEMBER CORRADINI: Can you repeat that last statement, please?

MR. HOLCOMB: Yes. The Watts Bar Dam Backwater Reservoir level is typically the main factor in the actual water level at the Clinch River Site.

MEMBER CORRADINI: So, the downstream dam and what it holds up determines the base level, due to any sort of event?

MR. HOLCOMB: That is correct.

MEMBER CORRADINI: Okay. Okay, thank you.

MR. HOLCOMB: All right. The Watts Bar Operating Guide is set at 735 feet in the winter and 740 feet in the summer.

Since the building of the dams on the Clinch River and Tennessee Rivers, the maximum floods occurred in 1973 and 2003, and were estimated to have reached elevations of 749 at the Clinch River Site.

The site has a significant margin of over 70 feet between historical flooding levels and the planned plant grade. Next slide. Go ahead.

MEMBER CORRADINI: I am sure there's a

Regulatory Guide that tells you what to worry about, so those aside. If you go back historically, you said it was 1970 and something and 2003. If you go back even further, there's nothing that was higher than those in recorded --

MR. HOLCOMB: So, when they installed the dams, it drastically changed the river systems. So, that's why --

MEMBER CORRADINI: Oh, and so, the Watts Bar Dam is of what vintage?

MR. HOLCOMB: Stu, can you --

MEMBER CORRADINI: So, what you're saying is, prior to that, it was lower?

MR. HENRY: Watts Bar is later than that. We can get that information for you.

MEMBER CORRADINI: Well, I'm just trying to understand historically. But your point, I just want to make sure I don't confuse the issue, your point is, when the dam comes up, what it holds back determines the base from which you have to worry about the flood level? And that is back decades ago, in terms of the Watts Bar Dam?

MR. HOLCOMB: Yes. So, what this slide is saying is that, since the dams have been installed, this is the highest flood level. Now, there may be different flooding levels historically, but that was before the dams were installed.

MEMBER CORRADINI: Okay.

CHAIRMAN KIRCHNER: The system was begun in the mid-1930s.

MEMBER CORRADINI: That's what I remembered, yes.

MR. HOLCOMB: Okay.

CHAIRMAN KIRCHNER: Now, when you give these nominal elevation numbers, you are considering, what?, an A and B site on the actual map?

MR. HOLCOMB: That is correct.

CHAIRMAN KIRCHNER: And that hasn't been resolved yet. Is there any significant differential elevation between A and B?

MR. HOLCOMB: No, the planned site elevation is 821 for either site. Next slide.

Section 2.4, Hydrologic Engineering, describes hydrological characteristics of the Clinch River Site. This section addresses hydrologic characteristics and natural phenomena that have the potential to affect the design-basis for the surrogate plant.

This section is divided into 14 subsections, for each hydrological characteristic, as shown here. We will briefly describe how TVA addressed the majority of these and give more detail to describe the 2.4.3.4 and 2.4.3.12 characteristics. Next slide.

CHAIRMAN KIRCHNER: Before you go into great detail here, could you just refresh for the record and for the members, just refresh at least my memory on, with your Plant Parameter Envelope, what your heat sink is and what your requirements are, if any, from the river system that you're on?

MR. HOLCOMB: For the PPE, we looked at all four of the reactor vendor technologies and none of them utilized the river system as the ultimate heat sink. So, it is all passive technologies, so they're not dependent on the river system for a heat sink.

CHAIRMAN KIRCHNER: And for heat rejection, it's cooling towers?

MR. HOLCOMB: For the PPE, that's what was assumed for the analysis --

CHAIRMAN KIRCHNER: Right.

MR. HOLCOMB: -- for the ESP, it was cooling towers.

CHAIRMAN KIRCHNER: Thank you.

MR. HOLCOMB: Next slide, Ray. With the exception of three characteristics that we'll discuss in more detail, we'll present the remainder of the characteristics in three groups.

The first group is hydrologic characteristics demonstrated to have no safety-related impacts. These include Subsection 2.4.2, Floods. For this characteristic, the preliminary plant grade of 821 feet is well above the maximum flood level.

For Subsection 2.4.7, Ice Effects. Due to climate conditions and the elevated design, the plant grade in combination with the SMR plant design, it is concluded that the ice effects will not cause flooding or water availability concerns.

MEMBER CORRADINI: So, the rive has had ice on it in the past, it's just, again, the elevation precludes concern? That's what I wanted to understand.

MR. HOLCOMB: That and also, the design of the SMRs in consideration.

MEMBER CORRADINI: What does the ice do? Since we have a minute or two. Does it back the water up or does it cause it to divert into tributaries? I'm kind of --

MR. HOLCOMB: So, the ice could have varying effects, depending on what you're analyzing. It could be blocking of the cooling water source, if you were depending on it for a heat sink, or it could be changing in the flood level due to blockage of the river system.

MEMBER CORRADINI: Have you had that combination of ice effects and a flood event historically there?

MR. HOLCOMB: Stu, can you speak to that?

MR. HENRY: Not that I'm aware of. There's very little icing on the river. We just, we don't get enough cold weather in that area of the country, in order for the ice to form and build up sufficiently.

MEMBER CORRADINI: I see, okay. I'm from a different climate. Thank you.

MR. HOLCOMB: Next slide. The third characteristic in this category is Subsection 2.4.9, Channel Diversions.

A review of the hydrologic, hydraulic, climatic, topographic, and geologic evidence and anthropogenic impacts on the Clinch River arm of the Watts Bar Reservoir indicates that the channel diversions are not expected in the Clinch River during the operating life of the plant. Next slide.

The fourth characteristic in this grouping is Subsection 2.4.10, Flooding Protection Requirements.

The design-basis flood level is well below the grade elevation of the site and minimal backwater effects are anticipated due to the local intense precipitation event.

The local intense precipitation event would be evaluated further at COLA. There are no expected flood protection requirements. Next slide.

The last characteristic in this group is Subsection 2.4.13, Accidental Releases of Radionuclides in Ground and Surface Waters. Subsection 2.4.13 describes the evaluation of an accidental release of the liquid radio effluents into the ground and surface waters.

This evaluation assumes the contents of a radwaste tank stored onsite are released into the groundwater. The contents of the tank were determined utilizing a PPE approach.

The source term is conservatively based on unfiltered RCS fluid, with a failed fuel fraction of one percent. To assess the source term for reasonableness, the values were compared to those that were previously approved by the NRC.

This assessment concluded that the PPE values were reasonable and once released into the groundwater, it is transported to the Clinch River, that is 1,400 feet away.

That is based on the shortest travel distance from any assumed release point on the Clinch

River Site to the Clinch River. The resulting total dose from all exposure pathways to the river receiving the maximum dose meets the 10 CFR 20.1301 limit. Next slide.

MEMBER CORRADINI: It doesn't meet it, what was the estimate in comparison to the limit? I guess I --

MR. HOLCOMB: Alex, do you have a number you can provide?

MR. YOUNG: Alex Young, Design Engineer for the SMR Project. Before I attempt to read the number off the top of my head, let me just confirm with our calculations.

MEMBER CORRADINI: We're not in a rush, take your time.

(Laughter.

MR. YOUNG: Yes, 93 rem TEDE, compared to the --

MEMBER CORRADINI: Okay.

MR. YOUNG: -- 100 --

CHAIRMAN KIRCHNER: Millirem?

MR. YOUNG: Millirem, yes --

MEMBER CORRADINI: I figured --

MR. YOUNG: -- 93 millirem TEDE, excuse me.

MEMBER CORRADINI: I figured you meant that, thank you.

(Laughter.)

MEMBER CORRADINI: All right, thank you.

CHAIRMAN KIRCHNER: Just to put that in perspective, you assumed one percent failed fuel. The branch technical position suggests a lower number than that?

MR. HOLCOMB: That is correct.

CHAIRMAN KIRCHNER: That's a big difference, that's --

MR. HOLCOMB: But that adds --

CHAIRMAN KIRCHNER: -- an order of magnitude difference.

MR. HOLCOMB: Yes. That adds some conservatism.

CHAIRMAN KIRCHNER: All right, thank you.

MR. HOLCOMB: The next group of hydrologic characteristics are those considered to be unlikely hazards at the site. This group includes Subsections 2.4.5 and 2.4.6.

Subsection 2.4.5, Probable Maximum Surge and Seiche Flooding. Because the site is not located on an open or large body of water, surge or seiche flooding will not produce the maximum water levels at the site.

For Subsection 2.4.6, Probable Maximum Tsunami Hazards. The site is not subject to any tsunami events originating from the ocean, due to the distance from the nearest seacoast. Next slide.

The third and last group of hydrologic characteristics are those demonstrated not to apply due to the design of the SMR reactors under consideration.

Because the Clinch River is not used as a safety-related water supply for the small modular reactor designs being considered, Subsection 2.4.8, Cooling Water Canals or Reservoirs, and Subsection 2.4.11, Low Water Considerations, do not apply.

And as shown on the next slide, Subsection 2.4.14, Technical Specifications and Emergency Operation Requirements, also does not apply.

As we begin the remainder of the 2.4 presentations, I would like to introduce the Subject Matter Experts TVA employed to assist us in preparing these subsections.

We have Stu Henry of Barge Design Solutions. He'll present Subsections 2.4.3 and 2.4.4. And he'll be followed by Dr. Hillol Guha, who will be joining us shortly, of Bechtel Engineering.

MR. HENRY: Thank you, John. My name is

Stu Henry. I'm a civil engineer and Vice President at Barge Design Solutions, for over 20 years. I've assisted TVA with nuclear site flooding potential calculations for the last ten years. Next slide.

The flooding guidance that was used in the calculations followed the Regulatory Guide 1.59, supplemented by the best current practice.

We used the Weather Service Hydrometeorological Reports 41, 51, 52, and 56, as well as previous watershed-specific guidance from the National Weather Service to TVA. We reviewed ANS 2.8 and used the current practice in NUREG/CR-7046 as well. Next slide.

For dam failure guidance, again, we used the Reg Guide 1.59 and reviewed ANS 2.8. The current practice was from the Japanese Lessons Learned Directorate, Interim Staff Guidance 2013, as well as that in the CR-7046. Next slide.

The CRN simulations were run looking at the probable maximum precipitation based the HMRs applicable to the basin's size and location.

Inflows were calculated based on 100 percent runoff, there were no losses applied there, and the unit hydrographs were adjusted for a nonlinear basin response, as recommended by the CR-7046. The routing software was the Corps of Engineers HEC-RAS software.

And the downstream project, the Watts Bar Dam, as we discussed, has an impact on the site due to backwater. And it was assumed stable under all conditions to maximize the impact at the site.

The dam stability was determined by the TVA Dam Safety Organization and that was used and assumed in the calculations. Next slide.

The controlling flood simulations were found to be the probable maximum flood, produced the highest calculated water surface at the site. Seismically-induced and sunny day dam failure simulations were performed, but were found not to be controlling.

The PMF and seismic simulation results show the site to be dry, with significant margin. And, again, the local intense precipitation will be evaluated at COLA, since there are no specific site plans at this time.

And we'll -- as soon as he gets up here, that concludes my part of the presentation and I will hand off to Hillol Guha for the groundwater.

MEMBER CORRADINI: Perfect timing.

DR. GUHA: Perfect timing, exactly. I've

been running. Okay.

CHAIRMAN KIRCHNER: Feel free to take your time setting up.

DR. GUHA: Okay, thank you. Good morning, actually, it should be good afternoon, I thought. Good morning to all of you.

My name is Hillol Guha and I'm a hydrogeologist with 20 years of experience and I work for Bechtel, supporting TVA on the Clinch River ESP project.

I have been associated with this project since early 2013 and undertook a few subsurface investigations and originated groundwater flow and transport modeling calculations. Next slide, please.

So, this slide provides the outline of the groundwater investigation. As stated in Section 2.4.12, and which includes regional to local hydrogeology, specific data collected from the Clinch River Breeder Reactor Project and the CRN Site.

Also, we'll discuss maximum groundwater levels from groundwater modeling, any groundwater used, and construction de-watering. The figure to the lower right shows Oak Ridge Reservation area, to the east of the Clinch River Nuclear Site. Next slide, please.

So, this figure depicts a cross-section

for the east Tennessee aquifer system of the Valley and Ridge province. The principal aquifer is composed of carbonate rocks of the Knox group.

Groundwater movement is localized by the repeating lithology created by thrust faulting. Older rocks sits on top of younger rocks and dips towards the southeast.

The Chickamauga and the Knox group are the principal lithologic formations in the Clinch River Nuclear area. The Chickamauga group is composed of limestone, siltstone, shale, while the Knox group is made up of dolomite.

Groundwater primarily flows along the strike of the bedding plane, that is along the weathered rocks and fractures. Groundwater flow significantly diminishes with depth due to less fractures and more competent bedrock.

Within a 1.5 mile radius of the CRN Site, there are 32 residential wells, three commercial wells, and one farm well, for a total of 36 individual wells.

The estimated yields range from 0.5 to 75 gallons per minute. None of these wells occur in the CRN Site. Thus, there is no groundwater withdrawal at the CRN Site. Next slide, please.

So, this slide shows the conceptual

hydrogeologic model of the CRN Site. The conceptual hydrogeologic model is similar to the adjacent Oak Ridge Reservation area to the east.

From top to bottom, the conceptual model is divided into a stormflow zone, that is a thin region at the surface where 90 percent or more water from precipitation move at this zone.

This zone is absent at the CRN Site, due to the Clinch River Breeder Reactor Project rework. Below the stormflow zone is the unsaturated zone or the Vadose zone. The thickness varies. It is thicker in the ridges and reach up to 100 feet. And nearly absent near stream channels.

Groundwater zone is the next zone. Also, the water table zone. And is encountered at the top of the bedrock. This zone could be few feet to more than 100 feet and conveys ten percent of the subsurface flow. Below the groundwater zone is the aquiclude, where flow is nonexistent. Next slide, please.

So, the figure on the right of this slide shows some of the boring locations from the Clinch River Breeder Reactor Project, which was undertaken between 1972 to 1980.

Total of 129 borings, 37 observation wells, 11 piezometers, and 117 bedrock packer permeability tests were undertaken. Groundwater levels fluctuated by as much as 20 feet, due to response to precipitation events.

Groundwater flows from topographically high areas in the center of the peninsula to the low relief areas that is towards the Clinch River arm of the Watts Bar Reservoir. Chestnut Ridge, located north of the site, acts as a groundwater divide. Next slide, please.

So, CRN Site subsurface investigations were undertaken between 2013 to 2015, which included 82 borings, three test pits, 44 observation wells, 41 packer tests in 30 wells, one pumping test, and two chemical sampling in 34 observation wells. Also included geophysical investigations.

Nested observation wells were installed in two-well cluster and three-well cluster. The adjacent figure to the right depicts the location of the observation wells. The wells were screened at different depths.

Groundwater flow was predominantly along fractures and joints, with active flow at shallow depths at the interface of the soil and weathered rocks.

Flow was predominantly along the strike that is trending north, 52 degrees east. And the frequency of fractures and joints decrease with depth. Dominant groundwater flow was between 812 to 712 feet elevation. The Clinch River acts as a sink for the shallow groundwater flow zone.

Pumping test was conducted within the square box, as shown in the figure on the adjacent slide. The horizontal radius of pumping test influence was limited to approximately 150 feet.

MEMBER RICCARDELLA: Excuse me, what exactly is a pumping test?

DR. GUHA: So, the pumping test also known as aquifer performance test. It is the test where, what you do is, basically, you stress the aquifer and once you stress the aquifer through pumping and you have observation wells, and the signals, you observe the signals through the drawdown in those wells. And then, you analyze that data to come up with the hydrogeologic parameters of the subsurface.

MEMBER CORRADINI: So, do you put water in or take water out?

DR. GUHA: You basically, in this case, we took out the water.

MEMBER CORRADINI: Okay. And then, you watched the behavior on surrounding --

DR. GUHA: Surrounding observation wells.

CHAIRMAN KIRCHNER: Just to calibrate us a bit, where is the basemat elevation expected to be, approximately? How many feet?

DR. GUHA: So, you mean to say the basemat here is the --

CHAIRMAN KIRCHNER: Of the -- you mentioned power block, I'm thinking of the reactor building and its foundation.

DR. GUHA: So, the --

CHAIRMAN KIRCHNER: What do you expect it to be, approximately, in terms of elevation?

DR. GUHA: Yes, so, we did a PPE, which is Plant Parameter Envelope --

CHAIRMAN KIRCHNER: Yes.

DR. GUHA: -- so, because this is a ESPA. So, we did two analysis, which I will show in the later slides.

CHAIRMAN KIRCHNER: Okay.

DR. GUHA: And we had, one was the shallow foundation depth of the reactor building, which is 50 feet below the grade elevation of 821.

CHAIRMAN KIRCHNER: Okay.

DR. GUHA: I think it was approximately 770 feet elevation. And the deep was 140 below, below the grade, which came close to, I think, 658, something like that, shallow than that. I will come back to those slides later.

CHAIRMAN KIRCHNER: Please.

DR. GUHA: After a few more slides.

CHAIRMAN KIRCHNER: Thank you.

DR. GUHA: Yes, sure. Next slide, please. So, this figure to the right shows horizontal groundwater flow directions of potentiometric surface. Groundwater flows towards the southeast or southwest, from the proposed nuclear island towards the Clinch River arm of the Watts Bar Reservoir.

The figure to the left shows vertical groundwater flows on equipotential lines, which dominant downward vertical gradient at the center of the peninsula and flows upwards to the Clinch River. Next slide, please.

So, this slide shows a geological cross-section along northwest and southeast. That is, along the dipping direction of the rocks. The Chestnut Ridge Fault is shown on the left of the figure and occurs further north of the proposed -- this one right here, excellent.

So, this is the Chestnut Ridge Fault, which occurs further north of the proposed nuclear site. The Knox dolomite of the Newala formation outcrops just north of the proposed nuclear site. This is the Knox dolomite.

The Chickamauga group lies on top of the Knox group. And the Chickamauga group of rocks dips southeasterly at an average dip of 33 degrees. This is an average dip angle of 33 degrees.

The Chickamauga group consists mainly of limestone and the Chickamauga group is divided into the Blackfoot formations, the Eidson formation, and the Fleanor member of the Lincolnshire formations. But they are all part of the Chickamauga group.

The Rockdell, Benbolt, Bowen, Witten, and Moccasin formations, they are also part of the Chickamauga group.

The Fleanor member is comprised of approximately 75 to 80 meter of maroon calcareous shale, siltstone, with numerous light gray limestone bed. So, this is the Fleanor member. So, all average dipping at 33 degrees towards southeasterly dipping. Next slide, please.

So, this is the slide where you have the foundation depths that are discussed. So, this slide shows a post-construction groundwater model for five section along the strike of the bedding plane.

So, this is the strike of the rock, this is the direction of the rock. And so, along this profile is what you see the model section or the profile section that has been implemented here.

MEMBER CORRADINI: So, just so I've got it. So, you cut this so that you can see the rock angular deviation, and the colored pictures on the left are river-to-river.

DR. GUHA: That's correct, yes. This is the -- the river bends from this side --

MEMBER CORRADINI: Yes.

DR. GUHA: -- like that, yes.

MEMBER RICCARDELLA: And those are sections through the planned view in the middle?

DR. GUHA: This is the section planned through this sections, yes. And so, you have one -- so, we did a PPE, Plant Parameter Envelope. So, one is the deep foundation of that reactor. And this is the shallow foundation of the reactor. So, but along, this is particularly showing around this profile section.

So, the slide shows the post-construction groundwater model profile sections along the strike of the bedding plane, that is trending north, 52 degrees east, along which the predominant groundwater flows. The center figure shows the location of two profile section.

So, this is one profile section that has been shown for the deep foundation and the shallow foundation. And there is another one profile section that we have done similar, but is not shown in the slide.

The second figure shows the location of the two profile sections. So, one profile section is shown on the left. The colors within the figure depicts various layers within the groundwater model that are different hydrogeologic properties.

The dark area depicts the foundation embedment of the reactor. So, this is the reactor, the rad waste, the auxiliary building, and the turbine building, right here. This is the rad waste. So, this is the deep foundation depth for the reactor building.

The dark area depicts the foundation embedment of the reactor building, rad waste, the turbine, and the auxiliary buildings. The deep embedment depth of the reactor building is set at an elevation of 681 feet, which is 140 feet below the site grade.

The figure below shows the foundation embedment depth of the shallow reactor. This is the shallow reactor, with the auxiliary building, and you have the rad waste building here, as well as the turbine building there.

At an elevation of 770 feet, which is approximately 50 feet below the site grade elevation. The deep and shallow reactor foundation depths serve as bounding limits as part of the Plant Parameter Envelope.

The figure to the right depicts groundwater contours in color blue, for both the figures with deep and shallow foundation depths.

The maximum groundwater elevations under and around the structure varies between 802.3 to 816.1 feet elevations. So, this value is less than the site grade elevation of 821 feet.

So, the red arrow, the red arrows here, depicts downward flows from the center of the nuclear island. And the blue arrow depicts upward flow to the Clinch River, which acts as a sink. Next slide, please.

CHAIRMAN KIRCHNER: So, before you go on, in the case of Profile A, where you have a very deep foundation, that's below, the bottom of that foundation is below the river level, if I'm interpreting this correctly.

And yet, you still show gradients flowing out to the river. So, just explain, in physical terms, why that is so.

DR. GUHA: So, the natural groundwater gradient is basically -- so, you have -- this is the center of the peninsula --

CHAIRMAN KIRCHNER: Right.

DR. GUHA: -- so, that's where the buildings are. And the natural, just pre-construction --

CHAIRMAN KIRCHNER: Right.

DR. GUHA: -- is basically you have the flows going towards the Clinch River, off the Breeder Reactor.

CHAIRMAN KIRCHNER: Okay.

DR. GUHA: One went this side, one went towards your southeasterly and other going toward southwesterly.

So, this -- only difference from the pre-construction, now this is the post-construction, only difference what you have is basically incorporation of this foundation depths, the structure depths.

So, you have the reactor building, the turbine, all the structures up there. So, and then, surrounding the structures are your -- the structural backfill material.

But your -- it still remains, even within that area, only in the limited area just around the structures, the gradients a little bit could be altered a little bit. But overall, you still have -- it still remains the natural flow gradient direction.

CHAIRMAN KIRCHNER: Okay.

DR. GUHA: So, it's still flowing towards the river.

CHAIRMAN KIRCHNER: Okay, thank you.

MEMBER CORRADINI: So, this is not to scale. So, whether it's Site A or B, what is the width of the hole versus, you said the depth was 150 and 50?

DR. GUHA: So, this is --

MEMBER CORRADINI: It's not to scale, that's what I'm trying to get at.

DR. GUHA: Yes. This is --

MEMBER CORRADINI: So, what's the width of the black thing versus the depth? The depth is 150 and 50 in Profile A and Profile B.

DR. GUHA: Right.

MEMBER CORRADINI: What is the width?

DR. GUHA: So, the width, you mean to say the width from here to here?

MEMBER CORRADINI: The width of the black stuff.

DR. GUHA: Oh, the width of the black stuff, this would be approximately -- I got to look at it, I got to look at the thing.

MEMBER CORRADINI: Approximately.

DR. GUHA: Yes. Approximately, I think it will be close to about, about minimum will be maybe 200 feet.

MEMBER CORRADINI: So, the L/D is still it's wider than it is deep?

DR. GUHA: The --

MEMBER CORRADINI: Right? What you just said was, since this is not to scale, the black cylinder is more like a couple of hundred feet wide and 150 deep versus 50, have I approximately got it right?

DR. GUHA: Yes.

MR. HOLCOMB: It is wider than it is deep.

DR. GUHA: Yes.

MEMBER CORRADINI: Okay, fine. Because this --

DR. GUHA: This is, yes, exaggerated.

MEMBER CORRADINI: Okay.

MEMBER RICCARDELLA: Excuse me, what are the contour lines on the box on the right? The contours of what?

DR. GUHA: So, this is the contour of the groundwater levels.

MEMBER RICCARDELLA: Okay.

DR. GUHA: So, potentiometric surfaces.

So, you're seeing, on the one, the arrows, depicts the direction of the groundwater flow. The red's showing, you have a downward groundwater flow direction.

And the ones which is in your blue shows, depicts flow towards the river, which is an upward gradient. But the water is basically discharging to the river. Okay. So, next slide.

So, there is no groundwater usage at the CRN Site SMR designs. Potable and other water for site usage will come from Oak Ridge Department of Public Works. The makeup water for the closed cycle cooling system will be sourced from the Clinch River arm of the Watts Bar Reservoir. Next slide, please.

So, there will not be any permanent de-watering system during operation of the plant. Temporary de-watering will be required during excavation, which will be based on similar techniques was was done during the CRBRP excavation, such as installation of horizontal gravity drains in the excavation rock faces, pumping from sumps located in the perimeter of the excavation and the base of the excavation. And the flow rate is expected to be minimal, as was observed in the CRBRP excavation.

MEMBER CORRADINI: So, can you back to the black cylinder?

DR. GUHA: Sure.

MEMBER CORRADINI: So, let me ask it differently. So, if I had a deep embedment, will that create a sink and I'll have water accumulation there? In the soil?

Or is the calculation or the estimate is that essentially it is unperturbing the flow past the cylinder and you're still feeding the river? That's what I'm trying to understand with the different embedments.

DR. GUHA: So, what we are seeing here is -- so, this is the -- so, basically, only change from the pre-construction, the existing condition, is basically, you're incorporating this black, the reactor, all these buildings, and you have this backfill that's been included.

MEMBER CORRADINI: Well, what I guess -- okay. So, you've actually gotten to what I was going to ask. Is the way the backfill is designed such that you won't have essentially an accumulation of water around the cylinder, it essentially will flow past?

DR. GUHA: Yes.

MEMBER CORRADINI: Okay. And that's a typical construction approach? Since I'm not familiar, but that's what is normally done?

DR. GUHA: Yes.

MEMBER CORRADINI: Okay. So, one last question, at least for the moment, are these -- 50 feet embedment seems typical, 150 feet seems atypical. Are those typical embedments in certain civil structures?

DR. GUHA: You're talking relative to the nuclear reactors or --

MEMBER CORRADINI: Well, let's start generally and then --

DR. GUHA: Okay.

MEMBER CORRADINI: -- we can get specific. So, generally, I would think, yes. But specifically to nuclear structures, I'm not familiar with 150-foot embedments.

DR. GUHA: Nor do I actually. So, this is SMR, I guess that's --

MEMBER CORRADINI: I'm just looking for experiential deviations that cause me concern.

CHAIRMAN KIRCHNER: But again, the gray matter in the -- you're illustrating -- unfortunately, we can't read this very well. The gray contour there is like bedrock, essentially. Is that what I'm to infer from the left-hand --

DR. GUHA: You --

CHAIRMAN KIRCHNER: -- with the shallower foundation, you're probably going to go in and backfill and then, put the mat down, so to speak, the bottom of the foundation. It looks like the upper one would reach into a bedrock-like structure, in terms of the foundation conditions.

MEMBER CORRADINI: But they still would have to put something -- they would still have to put back -- they'd have to make a bigger hole and put backfill.

DR. GUHA: Yes. So, basically, anywhere where you have -- so, the way -- so, I should have said before, the way the geology goes here -- so you have this construction backfill, so this is something coming in during the construction.

Then, you have this -- your -- below that, you have the fill, the soil materials. And below that, you have this -- your weathered zone, weathered rock, which is an interface of the bedrock, as well as in the soil. And below that, you have this competent bedrock.

CHAIRMAN KIRCHNER: Yes.

DR. GUHA: So, where the fractures are very less.

CHAIRMAN KIRCHNER: Yes.

DR. GUHA: So, most of this, the foundation, the depth that you're seeing, the deep foundation basically rests within that competent bedrock, as you pointed out.

And on the shallow foundation, basically, is still in the part of the competent, still it is competent, but not as competent as that --

CHAIRMAN KIRCHNER: Okay.

DR. GUHA: -- because it's shallower. The fracture frequency basically increases as you go up.

CHAIRMAN KIRCHNER: Basically, you're going to be in dolomite or limestone with that foundation on the top?

DR. GUHA: So, you'll be basically --

CHAIRMAN KIRCHNER: I'm trying to marry several different elevation views of the geology to convince myself where your foundation is sitting in each of these pictures on the left. It looks like you'll be in either -- let me get the correct group. You'll be in the Knox group or the --

DR. GUHA: The Chickamauga group.

CHAIRMAN KIRCHNER: -- Chickamauga group.

DR. GUHA: So, the Knox group actually outcrops further north of the site.

CHAIRMAN KIRCHNER: And that means you'll be sitting in limestone, a well-anchored foundation on the top left picture. The bottom left, you would probably then put some kind of material in and then, float the foundation, the concrete.

DR. GUHA: So, the Chickamauga group, yes, is mostly composed of limestone.

CHAIRMAN KIRCHNER: Okay.

DR. GUHA: But it's basically -- it's composed of also siltstone. Siltstone, shale materials. So, yes, exactly. And so, it's very likely it'll be anchored within that siltstone --

CHAIRMAN KIRCHNER: Right.

DR. GUHA: -- group.

CHAIRMAN KIRCHNER: So, you're not going to be in sandstone?

DR. GUHA: It's not going to be in the sandstone.

CHAIRMAN KIRCHNER: Okay, good --

DR. GUHA: The sandstone is --

CHAIRMAN KIRCHNER: -- for seismic reason.

DR. GUHA: Yes.

CHAIRMAN KIRCHNER: Good. All right. I'm just -- and once again, the river level is --

DR. GUHA: At 740 feet elevation.

CHAIRMAN KIRCHNER: And that upper left one is like 680 feet elevation at the bottom?

DR. GUHA: Yes, 680 approximately, yes.

CHAIRMAN KIRCHNER: Okay. Thank you.

DR. GUHA: I think we are in the last slide, I guess. Yes, so basically, this is the second to the last slide, yes.

CHAIRMAN KIRCHNER: Yes. We were trying to ask questions until you got here.

(Laughter.)

CHAIRMAN KIRCHNER: Okay. Keep going.

DR. GUHA: Okay. So, this is the concluding slide. It says, is the groundwater conclusion. The following can be concluded from the CRN Site hydrogeology investigation.

The proposed CRN Site SMR designs do not rely on groundwater during the operations. Permanent de-watering is not required. The maximum water levels are below the site grade of 821 feet. That is range between 802.3 to 816.1 feet elevation.

CHAIRMAN KIRCHNER: Okay. Members, any questions?

MEMBER CORRADINI: Yes, I'm still trying to understand qualitatively what's going on. So, you're trying to bound the proposition.

But what I'm trying to get at is, your conclusion is, regardless of the embedment depth, and the combination of essentially the backfill and the rock structure, is there is not going to be a preferential sink for water to accumulate at the bottom of the black cylinder? That's what I'm worried about.

DR. GUHA: So, groundwater is moving through, so it's like conductivity, just similarly --

MEMBER CORRADINI: Sure.

DR. GUHA: -- so, it's the same concept as in electricity. So, you have various conductive materials. So, the backfill is the conductive material, the backfill material is higher than the native hydrogeology property material. So --

MEMBER CORRADINI: So, it allows for -- it prevents accumulation?

DR. GUHA: That's correct.

MEMBER CORRADINI: Okay. Remind me what the backfill is planned to be? I'm sorry, the -- I remember this, because another one of the Subcommittee meetings, we had a discussion about voids and finding voids and voids bigger than 15 feet, et cetera, et cetera. Remind me what the backfill material is?

DR. GUHA: So, the backfill material is going to be, it's a structured material. So, it's going to be a material from the site itself. So, it will be composed of, if I understood, it's composed of material which is of -- could be a limestone --

MEMBER CORRADINI: Okay. So, it's the base rock crushed up --

DR. GUHA: Yes.

MEMBER CORRADINI: -- and reinstituted?

DR. GUHA: Yes, certain size and certain grade level.

MEMBER CORRADINI: Okay. Thank you.

CHAIRMAN KIRCHNER: Okay. Thank you. We'll turn to the staff, please.

DR. GUHA: Thank you to everyone.

MR. CAMPBELL: So, this is Andy Campbell, Deputy in DLSE. Presenting for the staff will be Yuan Cheng and Joe Giacinto and Mallecia Sutton.

MS. SUTTON: Thank you, Andy. So, this presentation you have Yuan, Joe, and Rich Clement. Dr. Yuan Cheng will be presenting on the surface water.

Dr. Cheng holds a professional engineering license in several states, including Maryland, Pennsylvania, and Ohio. He has worked for NRC approximately five years as a hydrologist.

Prior to joining NRC, he worked in the private sector for approximately 35 years. From 2013 to 2014 at NRC, he performed the technical review for probable maximum flood for the license amendment request for TVA Watts Bar Nuclear Power Plant Unit 1.

From 2015 to 2016, he performed another technical review for Fukushima Near Term Task Force Recommendation 2.1, Flood Hazard, reevaluations for TVA's Watts Bar, Sequoyah, and Browns Ferry Nuclear Plants.

Recently, he completed a technical review for hydrologic engineering for the Clinch River early site permit.

Mr. Joseph Giacinto will also present on the review related to groundwater. Joe is a certified professional geologist and has been with the NRC for ten years, serving as a hydrologist and a geologist.

He served as staff hydrologic technical lead for Lee, North Anna, PSEG, and Turkey Point applications, and has participated in technical review for all new reactor early site permit applications submitted within the last ten years, to include Watts Bar 2.

He has approximately 30 years of combined public and private industry experience in the hydrologic science.

Also, I discussed Dr. Clement this morning, so I'm going to turn the presentation over to Dr. Cheng.

DR. CHENG: Good morning, hello, everyone. And I would like to introduce my working team. Joe

Giacinto is a hydrogeologist and Richard Clements is the health physicist.

Together with myself, Yuan Cheng, I'm a hydrologist, we are NRC's Technical Reviewers for the Site Safety Analysis Report Section 2.4, Hydrologic Engineering, for the Clinch River Nuclear early site permit application.

I will start with a brief background summary and then, we will work our way towards the staff's key areas of review for surface water, groundwater, and radionuclide transport resulting from a liquid effluent source release to groundwater and the resulting dose estimates.

As shown, the Clinch River -- next slide, please. As shown, the Clinch River Nuclear Site is located adjacent to the Clinch River, a tributary of the Watts Bar Reservoir, along the southwestern border of the Oak Ridge Reservation, with the City of Oak Ridge, Tennessee. Next slide, please.

Within the Valley and the Ridge geographic province, the Clinch River Nuclear Site occupies approximately 935 acres owned by the United States and operate by the Tennessee Valley Authority, or TVA.

Site investigations and work associated with the Clinch River Breeder Reactor Project was conducted in the mid-1970s through the early 1980s on what is now the Clinch River Nuclear Site.

After termination of the Breeder Reactor Project, the Department of Energy, the project's management corporation, and the Tennessee Valley Authority, in coordination with the Nuclear Regulatory Commission, conducted site redress activity to prepare the site for future industrial use.

The proposed Clinch River Nuclear Site grade is 821 feet. Next slide, please.

The staff reviewed the applicant's Plant Parameter Envelope, which was based on four small reactor technologies: BWXT mPower, NuScale, Small Modular Reactor 160, and the Westinghouse Small Modular Reactor. Next slide, please.

The staff review included a pre-application review, site visit, and the audit, with the audit taking place in 2017.

During the early site permit application review, the staff consulted with the Department of Energy, the Tennessee Department of Environment and Conservation, and the US Geological Survey.

The Staff's Safety Evaluation Report, or SER, has been completed with no open items. I will now present the staff's findings for surface water.

Next slide, please.

The staff's review of the computations for applicant's riverine flood elevation and the applicant's considerations of the probable maximum precipitation, surface runoff, and the dam failures included in the flooding model scenarios.

In addition, the staff reviewed the applicant's sensitivity study and confirmed that only small change in the computed flood elevation occurred when the modeling parameters were varied.

The staff reviewed the applicant's riverine hydrologic model, which utilized the US Army Corps of Engineers Hydrologic Engineering Center River Analysis System, or HEC RAS, model for the modeling.

The staff confirmed that the applicant used the historical flood events to calibrate the model, using reasonable parameters. The staff confirmed the applicant's hydrologic models could be used to reasonably estimate the probable maximum flood elevation at the Clinch River Nuclear Site.

The staff then reviewed each of the applicant's considerations in developing the flood scenario as follows.

For the probable maximum precipitation estimates, the staff confirmed that the applicant followed the methodologies as described in the National Oceanic and Atmospheric Administration's Hydrometeorological Reports, or HMRs, to probably compute the various storm size and they reasonably select the probable maximum precipitation, or PMP.

Regarding surface runoff, the staff confirmed that the applicant's methods for converting the probable maximum precipitation to surface runoff were reasonable.

For the dam failure scenario, the staff confirmed that the applicant set applicable dams for instantaneous failures. And so, the staff reviewed the applicant's simulations of the resultant flood wave due to the dam failures.

The staff found that the applicant reasonably determined a probably maximum flood elevation from riverine flooding utilizing conservative assumptions, which includes 100 percent of river dams converted into surface runoff, instantaneous dam failure, and intentionally maximize backwater effect on the Clinch River Nuclear Site.

The staff reviewed the applicant's modeling results and found that the applicant's probable maximum flood elevation is significantly below the site grade elevation. Next slide, please.

Local intense precipitation, or LIP, effects are a flood-causing mechanism associated with the site drainage design and the site grading plan. Because no reactor technology has been selected for the early site permit applications, neither a drainage system design, nor a site grading plan was included.

The staff deferred the evaluation of the localized flooding due to local intense precipitation and has posted COL action item 2.4-1 for a later evaluation of local flooding, which could be included in the applicant's combined license or construction permits. Next slide, please.

The needs for a flood protection plan is dependent on the evaluation of the site grading plan and the site drainage designs associated with a local intense precipitation event.

In the early site permit applications, neither a reactor technology and associated site drainage design, nor a grading plan has been selected. Therefore, the staff deferred the evaluation of the flood protection plan and has included in the COL action item 2.4-2, which should be included in the applicant's combined license or construction permit.

Now, I will hand off the presentation to Joe Giacinto for a discussion of the staff's groundwater finding. Joe, next slide, please.

MR. GIACINTO: Thank you, Yuan. And good morning to all. Based on the Plant Parameter Envelope, the staff reviewed groundwater model simulations developed by the applicant for a deep and a shallow excavation geometry.

The maximum water level for these two geometries was approximately 816 feet, based on the groundwater modeling results, utilizing characteristic aquifer parameters.

Staff determined that the maximum level is conservative and well above maximum levels of approximately 810 feet that have been observed during the period of monitoring.

Staff notes that the backfill hydraulic properties may affect water levels and, therefore, included information in COL action item 2.5-8 in the staff's Safety Evaluation Report Subsection 2.5.4.4.5, Excavation and Backfill, where backfill characteristics are evaluated in detail.

COL action item 2.5-8 was included in the staff's October 17, 2018 ACRS presentation discussion for Site Safety Analysis Report Section 2.5.4, Stability of Subsurface Materials and Foundations. Next slide, please.

In reviewing the literature for the site and surrounding areas, staff found that low levels of radionuclides have been documented for the Clinch River Nuclear Site's groundwater samples, based on 2014 and 2015 reports associated with the Tennessee Department of Environment and Conservation and the Department of Energy's ongoing environmental monitoring studies for the Oak Ridge Reservation.

After staff discussions with the Tennessee Department of Environment and Conservation and the DOE concerning the sampling results, staff determined that COL action item 2.4-3 was necessary to differential accident releases from existing background concentrations, consistent with minimizing contamination in accordance with 10 CFR 20.1406, Minimization of Contamination.

MEMBER RICCARDELLA: And what is the source of these current levels of radionuclides?

MR. GIACINTO: It's not been conclusively been determined, but they are consistent with the radionuclides that are coming off the Oak Ridge Site, as a result of the weapons production from the 1940s on.

MEMBER RICCARDELLA: Okay.

MR. GIACINTO: Yes.

MEMBER RICCARDELLA: Thank you.

MEMBER CORRADINI: Remind me how far away the Oak Ridge Site is?

MR. GIACINTO: This site is adjacent to the Oak Ridge Site, so it's --

MEMBER CORRADINI: So, we're talking ten miles?

MR. GIACINTO: No --

MEMBER CORRADINI: Not even?

MR. GIACINTO: -- a matter of feet.

MEMBER CORRADINI: Oh, it's that close?

MR. GIACINTO: Now, the release areas from the Oak Ridge Reservation are on the order of a mile away.

MEMBER CORRADINI: Okay. But the signature of what is being detected is judged to be from that site?

MR. GIACINTO: Yes, fission products and transuranics.

MEMBER CORRADINI: Okay. Thank you.

MR. GIACINTO: Next slide, please.

CHAIRMAN KIRCHNER: Before you go on, I'm looking at the wording of this, is there any basis for a contention later on, in terms of level of contamination that's coming offsite onto this planned site? In other words, from the Oak Ridge Reservation to the planned site, what if that were to increase?

MR. GIACINTO: Well, it's been -- like I say, from the 1940s on, this was released and the levels on the Cinch River Nuclear Site are very similar to those in the Hood Ridge area, just to the east across the river.

And they're all basically right about or just below detection limits in drinking water standards.

CHAIRMAN KIRCHNER: Okay. So, they're well down?

MR. GIACINTO: Yes. And in fact, there's been some actions on that by the DOE in the Hood Ridge area for the residences there.

CHAIRMAN KIRCHNER: Thank you.

MR. GIACINTO: Okay. So, reviewing the literature for the site -- oops, sorry about that. Slide 11.

Consistent with Appendix A to Part 50, General Design Criteria for Nuclear Power Plants, General Design Criterion II, Design-Basis for Protection Against Natural Phenomena, the application considered the most severe natural phenomena that have been historically reported for the site and surrounding area and appropriately evaluated the design-basis flood elevation, including consideration of hypothetical dam failure and wind-induced wave height resulting in a design-basis flood level significantly below the site grade of 821 feet.

Additionally, the maximum estimated groundwater level is approximately five feet below site grade. Staff determined that site characteristics are bounded by the Plant Parameter Envelope.

Now, Richard Clement will summarize the staff's findings for the determination of the source term radionuclide transport and the resulting dose evaluation. Rich? Next slide, please.

MR. CLEMENT: Thank you, Joe, and good morning. The staff reviewed TVA's basis and assumptions for developing the Plant Parameter Envelope, or PPE, accident liquid source term in a postulated accidental release to the groundwater at the Clinch River Nuclear Site.

The accidental liquid source term is used in the radionuclide transport analysis for estimating the dose to a member of the public.

Although the PPE is based on four small modular reactor designs, the application described that design information from two vendors included features to possibly mitigate a postulated accidental release and, therefore, they were excluded from further evaluation.

For the remaining two vendors, a site-specific analysis would be expected in a combined license application, using source term information in those designs.

The staff determined that the accident liquid source term developed from those two designs considered conservative assumptions that included a higher failed fuel fraction and an entire release of radioactivity in the primary coolant.

In addition, the staff verified TVA's comparison of its accident liquid source term to that approved by the NRC in the Public Service Enterprise Group early site permit.

The staff determined from its review and confirmatory analysis that TVA's methodology for developing the PPE source term to bound the dose to members of the public from a postulated accidental liquid release to the groundwater at the Clinch River Nuclear Site was reasonable. Next slide, please.

The staff reviewed TVA's transport values and assumptions and performed confirmatory calculations for a select number of radionuclides, using the guidance in NUREG/CR-3332 and Branch Technical Position 11-6.

Conservative assumptions in TVA's radionuclide transport analysis, in addition to those used in developing that accident liquid source term included selection of transport parameters and values to minimize travel time and maximize radionuclide concentrations, a catastrophic tank release scenario assuming no credit for mitigating design features, and instantaneous and direct release of the failed tank contents into groundwater, peak radionuclide concentrations, including daughter products, and assumed minimal Clinch River flow rate of 400 cubic feet per second, and minimal radionuclide travel distance and decay from the release point to the Clinch River.

Based on the review, the staff found TVA's methodology for estimating initial radionuclide concentrations at the site boundary from a postulated accidental liquid release to the groundwater reasonable.

The staff confirmed that the unity rule applied in 10 CFR 20, Appendix B, Table 2, Column 2 for the mixture of radionuclide concentrations at the site boundary was met. Next slide, please.

The staff verified TVA's input parameters and assumptions in the exposure pathway dose analysis associated with the accidental liquid release to the groundwater using the guidance in Regulatory Guide 1.109.

The staff reviewed TVA's modifications within the LADTAP II computer code, using the dose conversion factors published in the Environmental Protection Agency's Federal Guidance Reports 11 and 12, and found them reasonable and acceptable for calculating the total effective dose equivalent, or TEDE.

The staff confirmed that the public dose limit of 100 millirem TEDE specified in 10 CFR 20.1301 was met.

Because the reactor design that may be constructed at the Clinch River Nuclear Site is not known at the early site permit stage, the staff identified combined license, or COL, action item 2.4-4 for the COL or a construction permit applicant to evaluate and justify any changes in the PPE source term used in a postulated accidental release to the groundwater and verify that the calculated dose evaluated in the early site permit is bounded. Next slide, please.

Based on the staff's review of TVA's early site permit application, subject to the staff-identified COL action items, the staff concludes that the site characteristics and bounding site parameters meet the applicable regulatory requirements and that there is no undue risk to the public health and safety.

Thank you. At this point, we will take any questions or comments you may have.

CHAIRMAN KIRCHNER: Thank you. Members? I should turn to Dennis, if he's still on the line. Dennis, are you there? Theron's going to open up the --

MEMBER BLEY: I am here, thank you, Walt.

CHAIRMAN KIRCHNER: Yes, Dennis, have you any questions of the applicant or the staff?

MEMBER BLEY: I do not. I appreciated today's presentations and I think they addressed the issues pretty well. Thank you.

CHAIRMAN KIRCHNER: Thank you. Let me then, we'll turn to the public in a moment. Let me thank the applicant and the staff for your presentations.

We've become well versed in the site's geology and hydrology and maybe need a little work on the meteorology, but thank you for your thoroughness in all the presentations.

Now, if there's any member of the public here in the audience who wishes to make a comment, please come forward to the microphone, state your name, and make your comment.

Seeing no one here, is there anyone on our bridge line from the public who wishes to make a comment? Please state your name and make your comment. Hearing no one, I think we can close the bridge line, Theron. Thank you.

So, at this point, Andy, I would like to turn in your direction, in preparation for our full Committee meeting in December, I think with the time allotted, I would like to ask both you and the applicant to focus on the emergency planning exemptions and the analyses that back that up.

And that, I think, would be, with an appropriate amount of introductory material, would be the best use of our time during the meeting coming up in December.

MR. CAMPBELL: So, let me make sure Mallecia and I understand correctly, so we can be prepared.

What you would like the full Committee meeting staff presentation to focus on is the EPZ and the basis for our analysis that, I think the Subcommittee received a briefing in August, 13.3, right, Mallecia?

CHAIRMAN KIRCHNER: Yes, that's correct.

MS. SUTTON: That's correct.

CHAIRMAN KIRCHNER: It was August 22.

MS. SUTTON: Yes.

CHAIRMAN KIRCHNER: And we would ask that you would, both the applicant and you, focus on that, given the important precedent that will be set here in going to more of a performance-based approach to that topic.

MR. CAMPBELL: So, we'll come prepared to make presentations and leave it up to the applicant for developing their presentation. And then, we'll focus on that area.

MEMBER CORRADINI: We have, just so you remember, we have 90 minutes set aside for the full Committee presentation.

MR. CAMPBELL: Ninety minutes, so that's usually half for presentations --

MEMBER CORRADINI: Half a morning.

MR. CAMPBELL: Okay. We can do that. I'm looking for Ray, there he -- Ray's thumbs up, okay.

CHAIRMAN KIRCHNER: Ray, are you good for that?

MR. SCHIELE: Yes.

CHAIRMAN KIRCHNER: Okay. And keep in mind that we've asked a number of questions, at least I think I have, that are in the area of uncertainty.

When I look at the regulations, and forgive me if I don't get the number right, I'm thinking 10 CFR 5034, there's an admonition in a footnote that these values, in the case I'm thinking of, 25 rem, are not viewed as limits, but not something to really be approached.

So, I want to explore and make sure that there is sufficient margin in what is presented. So, if you can address the question of uncertainty and cover that as part of your presentation, so we have confidence that, in your independent review or confirmatory analysis, that we do indeed have margin below the requisite limits.

MR. CAMPBELL: And we'll do that.

CHAIRMAN KIRCHNER: Thank you. And if there are any other comments by the members? No. With that, then --

MEMBER BROWN: I have one other --

CHAIRMAN KIRCHNER: Oh, yes, Charlie.

MEMBER BROWN: -- thing for the meeting.

They went through a number of COL items --

MS. SUTTON: The green light and --

MEMBER BROWN: Sorry, I thought I had the mic that was on, I just didn't bother to talk into it. They went through a number of COL items to cover a couple of the critical points, in terms of the -- I would think they ought to just address those, as part of the evaluation, to make sure those are clear as to what needs to be done, since we don't really know what the reactor is going to look like.

That's my only suggestion, as part of a full Committee presentation. There weren't a lot, there were half a dozen or a dozen, whatever they were, that they went through.

CHAIRMAN KIRCHNER: Yes. These, like, confirmatory items for the --

MEMBER BROWN: You have to come back --

CHAIRMAN KIRCHNER: -- COL applicant, right.

MEMBER BROWN: -- with whatever --

CHAIRMAN KIRCHNER: Can you highlight those, Andy, in a table that summarizes or addresses at least the key, and all of them are important of course, but those that you see as key requirements --

MR. CAMPBELL: So, let me --

CHAIRMAN KIRCHNER: -- for the COL applicant?

MR. CAMPBELL: Let me parrot back to you what I think I'm hearing. We -- you would like us to focus on the EPZ --

CHAIRMAN KIRCHNER: Right.

MR. CAMPBELL: -- and the basis for our analysis and the margin and the uncertainty. And then, any COL action items that are related to that?

CHAIRMAN KIRCHNER: Primarily, and if there are any other that are worth highlighting for the entire Committee. Perhaps just a -- is the tabulation of them very long? I'm -- we've seen them mainly by section or chapter --

MR. CAMPBELL: Yes, in each SER section --

CHAIRMAN KIRCHNER: -- so, in my own mind, I don't remember how many there are, overall, confirmatory items.

MR. CAMPBELL: Mallecia probably knows that answer, but not right off the top of her head.

MS. SUTTON: There's approximately 18 COL action items for 13.3. So, if you want me to highlight all of them and explain the substance of each?

MR. NGUYEN: Chairman?

CHAIRMAN KIRCHNER: How much -- yes?

MR. NGUYEN: I understand what your comment is, I'll work with the staff and --

CHAIRMAN KIRCHNER: Okay.

MR. NGUYEN: -- to make an effective presentation.

CHAIRMAN KIRCHNER: All right, thank you, Quynh.

MS. SUTTON: And one other question. Just 18 for the EPZ or you want me to highlight the other COL action items that we think are important to the project?

MEMBER BROWN: I would suggest a few of them that were related to dose or something like that --

MS. SUTTON: Okay.

MEMBER BROWN: -- to make sure --

CHAIRMAN KIRCHNER: Yes.

MEMBER BROWN: -- groundwater transportation, dispersion, a few --

CHAIRMAN KIRCHNER: Right.

MEMBER BROWN: -- those relevant to the EPZ as well. So, I didn't mean all, if there's 1,500 of them, I didn't mean --

CHAIRMAN KIRCHNER: Right.

MEMBER BROWN: -- I'm exaggerating slightly, but those that were really critical to the

--

CHAIRMAN KIRCHNER: To this issue, yes.

MEMBER BROWN: -- main decision, yes.

CHAIRMAN KIRCHNER: Yes.

MR. FETTER: Can I ask a clarifying question, because we have COL action items on the order of 15 or 16 for the geosciences area. Were you interested in any of those?

MEMBER CORRADINI: So, let me help the Chairman. So, not the whole Committee has heard all the Subcommittee meetings. So, there's a chance that a member is going to ask you something out of the blue, so to speak. So, I think you have to be prepared for that.

But I think what Walt's really saying is, because of the exemption relative to the EPZ, you need to focus on that, because that really is something that's different, right?

But I think the other things, you've got to be ready for. I'm sorry, but you've got to be ready for them. But I wouldn't necessarily take a good deal of time doing that.

MS. SUTTON: Okay.

MEMBER CORRADINI: Does that give you a little more guidance?

MS. SUTTON: Yes, that's great.

MR. FETTER: Yes, that's very helpful.

MS. SUTTON: Thank you.

MR. CAMPBELL: We'll work with Quynh to make sure we're clearly addressing your needs for the full Committee presentation and make sure that we have sufficient backup information in case we get the out of the blue question.

MEMBER CORRADINI: And the members will be highly disciplined.

(Laughter.)

MR. CAMPBELL: We appreciate that.

CHAIRMAN KIRCHNER: Okay. With that, then, we are adjourned.

(Whereupon, the above-entitled matter went off the record at 11:40 a.m.)

Clinch River
Early Site Permit
Part 2, SSAR Sections 2.3, 2.4, 11.2, 11.3 and 17.0

Advisory Committee on Reactor Safeguards

November 14, 2018

Introduction

Ray Schiele, SMR Licensing

Acknowledgement and Disclaimer

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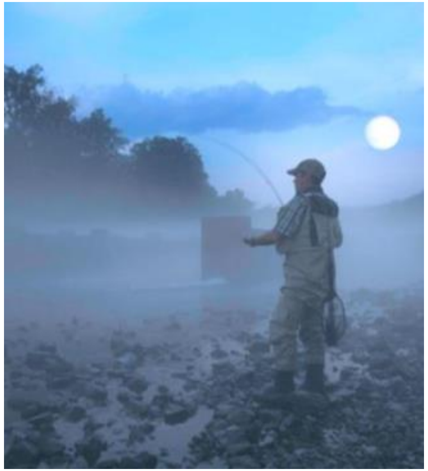
TVA's Mission

Serving the people of the Tennessee Valley to make life better.

Energy

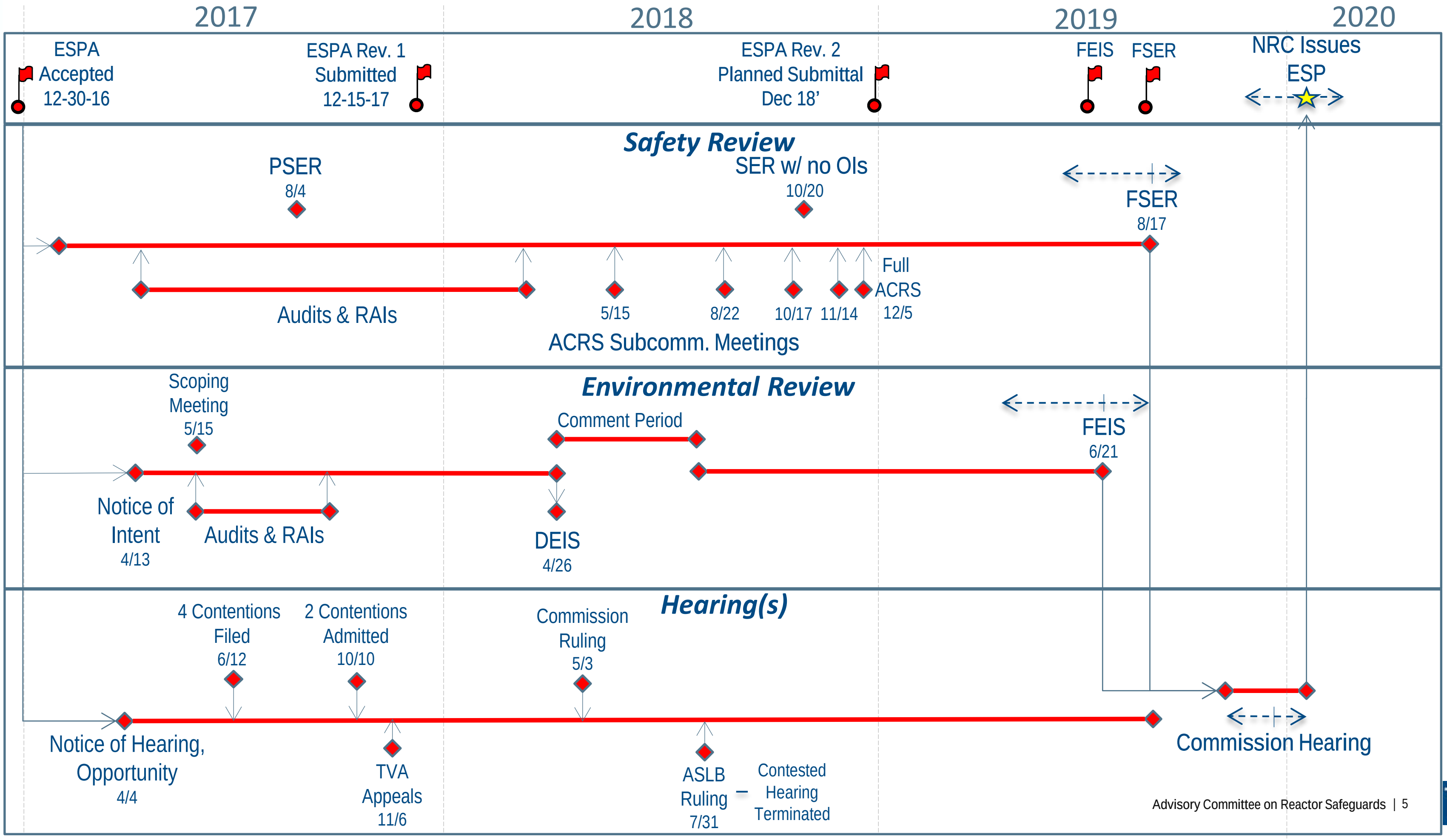


Environment

Economic Development

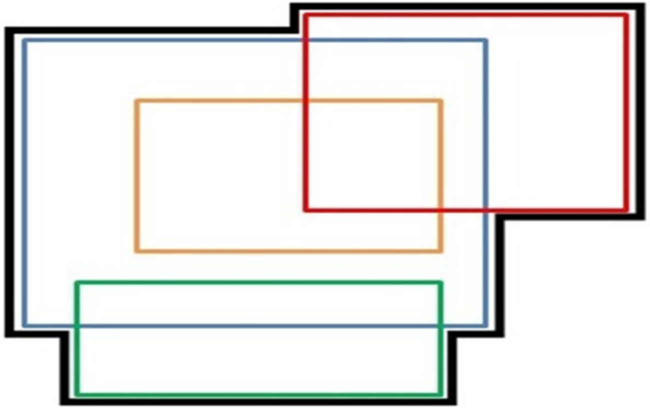
Partner with 154 local power companies, to serve more than 9 million customers in parts of seven states. Directly serve 56 large industries and federal installations.

NRC Review of ESPA



What is a Plant Parameter Envelope (PPE)?

Composite of reactor and engineered parameters that bound the safety and environmental impact of plant construction and operation



Considers 4 SMR Vendors

- BWXT mPower
- NuScale
- Holtec SMR-160
- Westinghouse

Developed based on NEI 10-01 Guidance

- Margin added to specific parameters as appropriate
- Creates “Franken-plant” or a “Black Box Plant”

PPE Use Considerations

Includes Appropriate Conservatism

- Prevents rework when vendor analysis is updated
- Safety conclusion becomes more apparent
- Document and, when possible, quantify conservatisms

Allows use of multiple reactor designs, providing flexibility for future business decisions.

An integral element of 10 CFR Part 52

- Works well with a future COLA

Presentation Outline

Part 2, Site Safety Analysis Report (SSAR) Sections:

- Section 11 – Radioactive Waste Management
  - Alex Young
- Section 2.3 – Meteorology
  - Alex Young
- Section 17 – Quality Assurance
  - Michelle Conner
- Section 2.4 – Hydrology
  - John Holcomb, Stu Henry, Hillol Guha

ESPA Part 2, SSAR Section 11.2 and 11.3 Radioactive Waste Management

Alex Young, SMR Engineering

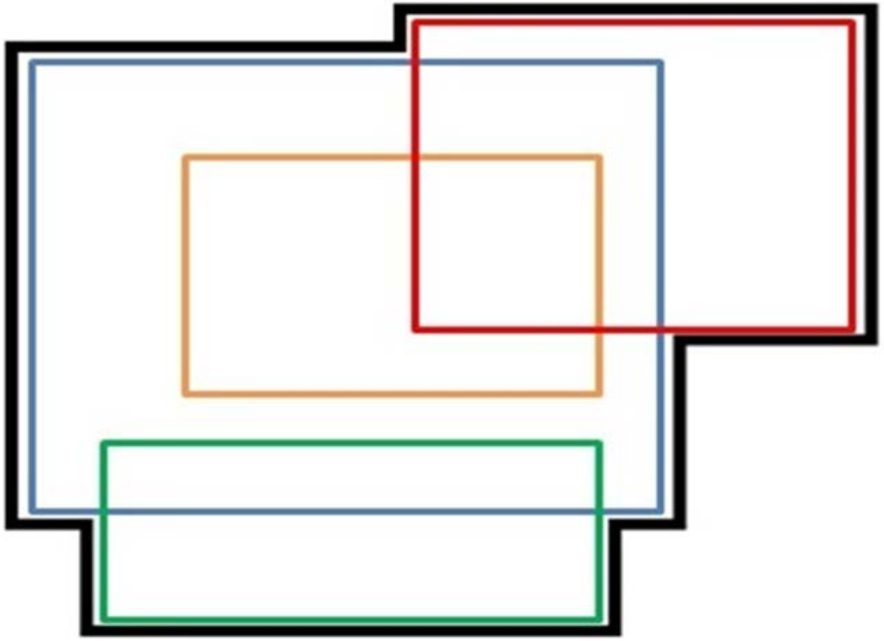
Key NRC Interactions Related to ESPA SSAR Chapter 11

One two-part audit was conducted to review the radioactive waste management information in the ESPA

- Audit Part 1 – April 14-17, 2017
  - Bechtel Power Corporation office in Reston, VA
- Audit Part 2 – April 24-27, 2017
  - TVA Knoxville Office Complex, Knoxville, TN
  - Tour of CRN Site and Surrounding Area
- Supplemental Letter – June 16, 2017
  - CNL-17-075 “Resubmittal of Supplemental Information Regarding Radiation Protection Accident Consequences in Support of Early Site Permit Application for Clinch River Nuclear Site”

Normal Radioactive Release Source Terms

- Plant Parameter Envelope (PPE) Source Terms
- Annual activities released for each vendor were reviewed
- Composite source term developed on individual unit and site basis
- Generally assumes the maximum activity by individual radionuclides
- Assessed for being “not unreasonable” by comparing to previously approved source term



TVA

SSAR Section 11.2 – Liquid Radioactive Releases

- LADTAP II used to calculate doses
- Exposure pathways assumed (RG 1.109)
- Within the effluent concentration limits (ECLs) of 10 CFR 20, Appendix B, Table 2, Column 2
- Doses are within design objectives of 10 CFR 50, Appendix I
- Doses are within the environmental standards of 40 CFR 190
- Doses are within the limits of 10 CFR 20.1301

SSAR Section 11.3 – Gaseous Radioactive Releases

- GASPAR II used to calculate doses
- Exposure pathways and analytical methods consistent with RG 1.109 and RG 1.111
- Within the effluent concentration limits (ECLs) of 10 CFR 20, Appendix B, Table 2, Column 1
- Doses are within design objectives of 10 CFR 50, Appendix I
- Doses are within the environmental standards of 40 CFR 190
- Doses are within the limits of 10 CFR 20.1301

ESPA Part 2, SSAR Section 2.3 Meteorology

Alex Young, SMR Engineering

Key NRC Interactions Related to ESPA SSAR Section 2.3

Two audits were conducted to review the meteorology information in the ESPA

- Audit – May 15-19, 2017
  - TVA Knoxville Office Complex, Knoxville, TN
  - Tour of CRN Site Including Meteorological Tower Location

- Audit – May 7-11, 2018
  - Conducted via TVA Electronic Reading Room
  - Supporting April 9, 2018 Supplemental Letter

- Supplemental Letter – April 9, 2018
  - Comparing results utilizing vector- versus scalar-averaged wind directions

Subsection 2.3.1 Regional Climatology

CRN Site Characteristics (SSAR Table 2.0-1)

- Winter Precipitation
  - Normal Winter Precipitation Event – 21.9 psf
  - Extreme Frozen Winter Precipitation Event – 21.9 psf
  - Extreme Liquid Winter Precipitation Event (48-hour Probable Maximum Winter Precipitation (PMWP)) – 23.5 in
- Maximum Rainfall Rate – 18.8 in/hr, 6in/5-minutes
- Basic Wind Speed – 96.3 mph for 3-second gust
- Historical Maximum Wind Speed – 87 mph for 3-second gust, 73 mph fastest mile
- Design-Basis Hurricane Windspeed – 130 mph for 3-second gust

Subsection 2.3.1 Regional Climatology

CRN Site Characteristics (SSAR Table 2.0-1)

- Tornado
  - Maximum Pressure Drop – 1.2 psi
  - Maximum Rotational Speed – 184 mph
  - Maximum Translational Speed – 46 mph
  - Maximum Wind Speed – 230 mph
  - Radius of Maximum Rotational Speed – 150 ft
  - Rate of Pressure Drop – 0.5 psi/s

Subsection 2.3.1 Regional Climatology

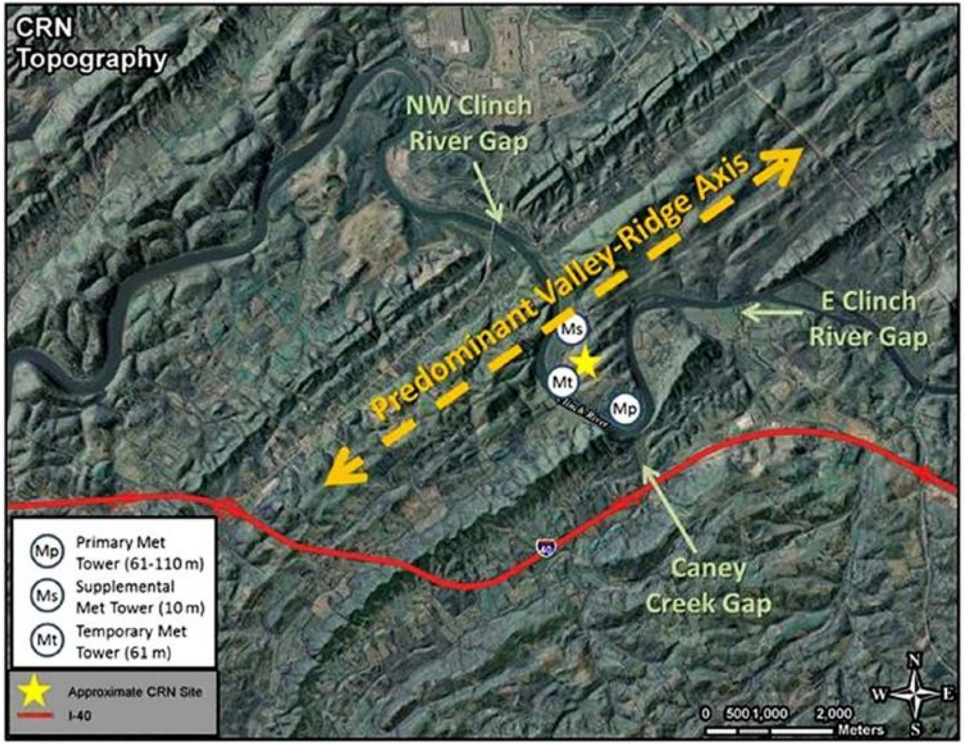
CRN Site Characteristics (SSAR Table 2.0-1)

- Ambient Air Temperatures

Exceedance Criteria	Max. Dry-Bulb Temp. (°F)	Max. Coincident Wet-Bulb Temp. (°F)	Max. Non-coincident Wet-Bulb Temp. (°F)	Min. Dry-Bulb Temp. (°F)
2% Annual Exceedance	90	73.7	75.7	25
1% Annual Exceedance	92	74.2	76.7	21
0.4% Annual Exceedance	95	74.9	77.6	16
0% Annual Exceedance	105	74.6	81.7	-9
100-Year Return Period	107	73.1	83.6	-9.9

SSAR Section 2.3.2 – Local Meteorology

- Topography around the site strongly influences the local climate
- Predominant up-valley/down-valley flow is readily apparent at all three meteorological towers
- CRN Site conditions are consistent with regional conditions



SSAR Section 2.3.3 – Onsite Meteorological Measurements Program

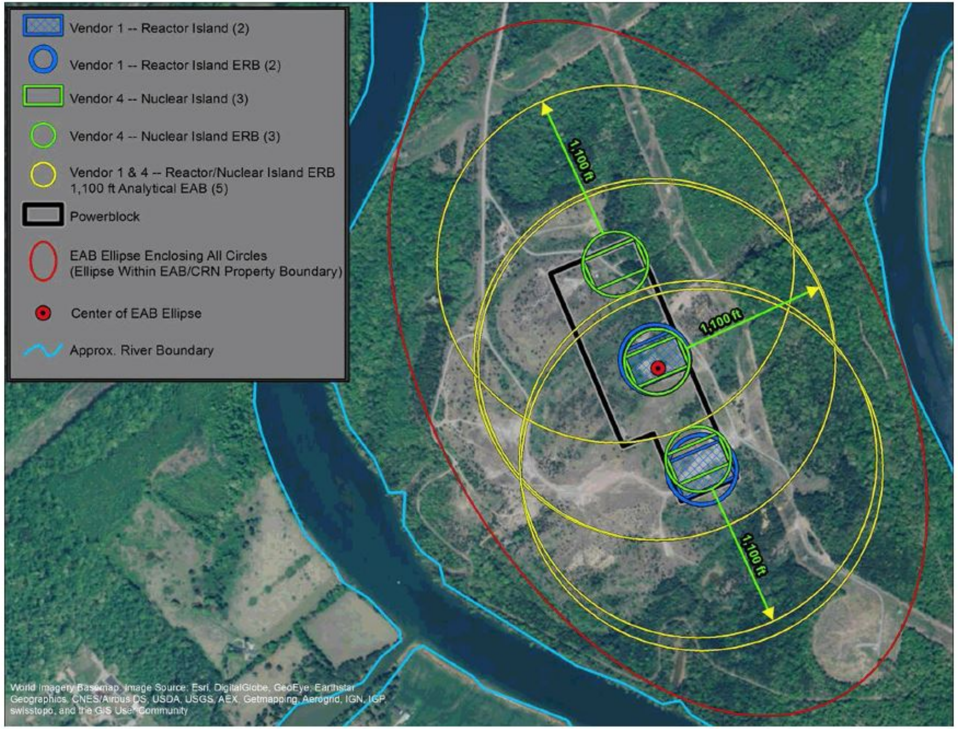
- Primary Meteorological Tower [1977-1978 and 1982-1983]
  - 110-meter
  - CRBRP Construction
  - Reactivated for CRN ESPA Pre-Application Data [2011-2013]
- Supplemental Meteorological Tower [1977-1978 and 1982-1983]
  - 10-meter
  - CRBRP Construction
- Temporary Meteorological Tower [1973-1978]
  - 61-meter
  - Pre-application Data for CRBRP

SSAR Section 2.3.3 – Onsite Meteorological Measurements Program

- RG 1.23 references ANSI/ANS-3.11-2005
- ANSI/ANS-3.11-2005 states that the transport wind direct for straight-line Gaussian models **should** be based on the scalar mean (or unit vector) wind direction
- TVA has evaluated the use of vector and scalar wind direction for the CRN Site
- Various differences in results between the two approaches
- Vector was bounding for SSAR Chapter 15
- Vector was bounding for SSAR Chapter 11

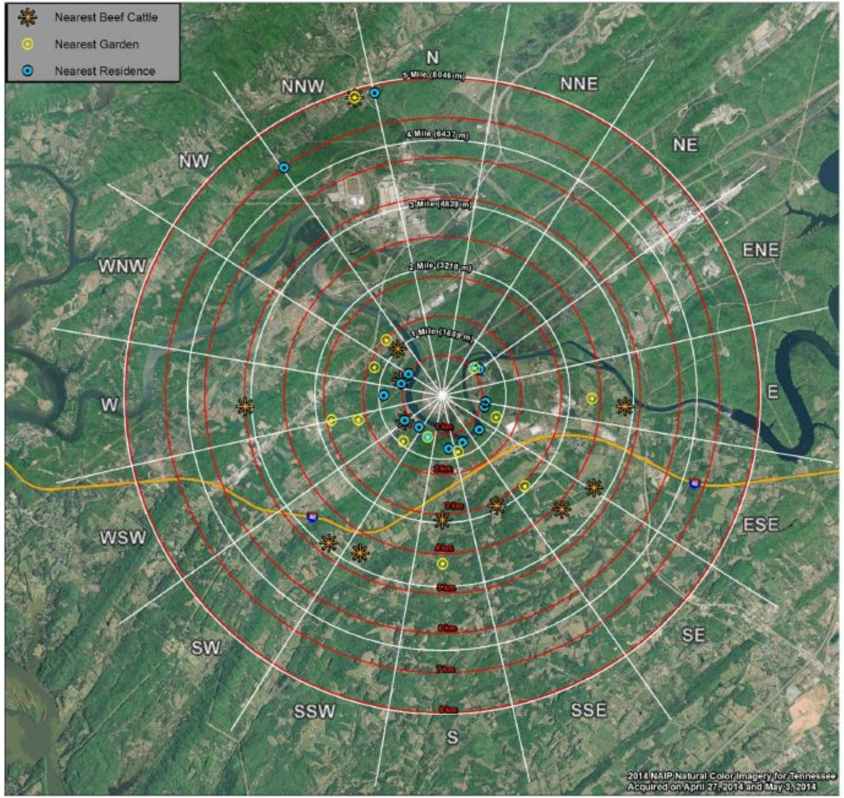
SSAR Section 2.3.4 – Short-Term (Accident) Diffusion Estimates

- Atmospheric dispersion calculations performed using PAVAN
- Met the requirements of RG 1.145 and 1.23
- Meteorological data from June 1, 2011 through May 31, 2013
- No credit for building wake effects
- Assumed ground level release



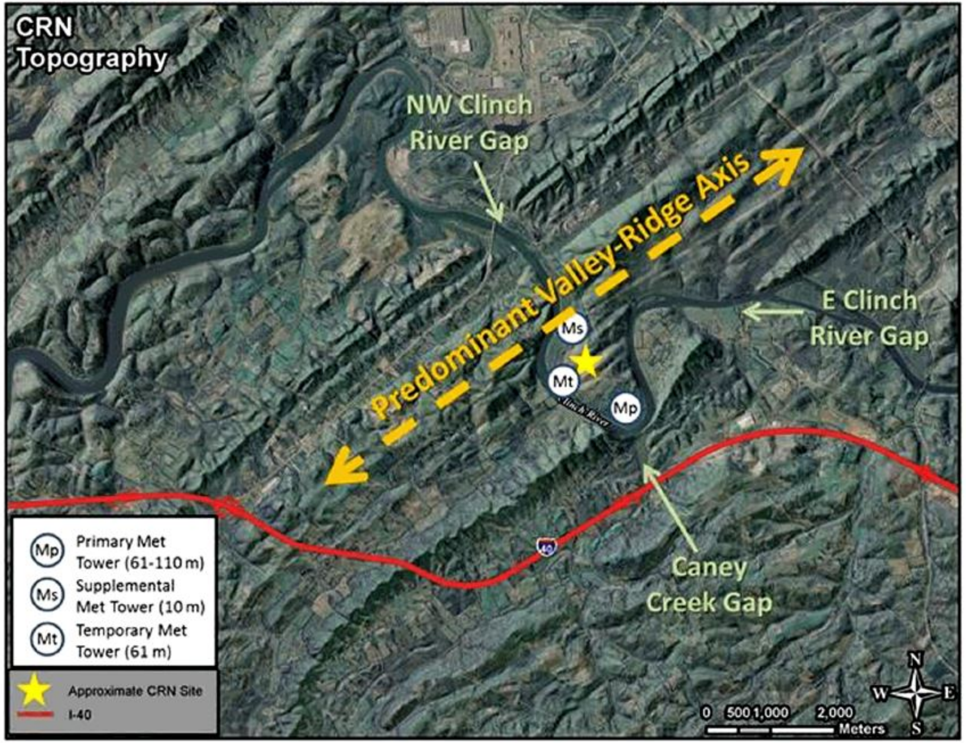
SSAR Section 2.3.5 – Long-Term (Routine) Diffusion Estimates

- XOQDOQ-82 utilized for calculating X/Q and D/Q
- Meteorological data from June 1, 2011 through May 31, 2013
- 16 wind direction sectors out to 50 miles
- Nearest residence, vegetable garden, and beef animal at each wind direction sector
- No credit given for building wake effects
- Assumes a ground-level release scenario
- Radioactive decay and deposition were considered



SSAR Section 2.3.5 – Complex Terrain

- Made comparison of results with a variable trajectory model
- CALPUFF utilized for variable trajectory model
- Meteorological data from June 1, 2011 through May 31, 2013
- Rainfall data was taken from Oak Ridge Automated Surface Observing System (ASOS)
- No credit given for building wake effects
- Assumes a ground-level release scenario
- Concluded that the XOQDOQ model was bounding



TVA

ESPA Part 2, SSAR Section 17
Quality Assurance

Michelle Conner,
SMR Operations, Training, and Programs

Agenda for Quality Assurance- Section 17.5

- Chronology
- CRN ESPA activities
- Program Description
- Quality Assurance Implementation
- Inspection Conclusion

CRN ESPA Quality Assurance Chronology

- ESPA Rev. 1 Submitted to NRC – December 2017
- NRC issued RAI on QA – March 9, 2018
- TVA provided RAI response – April 9, 2018
- NRC Quality Assurance Inspection – April 16-20, 2018
- TVA issued the NQAP Rev 36 – May 8, 2018
- NRC issued the QA Inspection Report – June 1, 2018

TVA Nuclear Quality Assurance Plan Description

- TVA NQAP is the top-level document that defines the quality assurance policy and assigns major functional responsibilities.

- ESPA Part 2, provides a summary of the TVA CRN QA Plan attributes. The TVA CRN QAPD is a separately controlled document and is included in Part 8 of the ESPA.

- The TVA NQAP was revised to meet SRP 17.5 that was in effect six months prior to the ESPA submittal.

- For ESPA, the TVA NQAP applies to site suitability activities.

NRC QA Inspection

- NRC staff QA implementation inspection of TVA's ESPA activities for the proposed SMR at the CRN Site, from April 16 through April 20, 2018.

- Areas inspected included 10 CFR Part 21, corrective actions, QA records, QAP, internal audits, QA organization, design control, procurement document control, control of purchased material, equipment, and services, and external audits.

- No violations or non-conformances were identified.

Conclusion

- TVA NQAP provides adequate guidance for establishing controls to comply with the applicable requirements of 10 CFR Part 52.17(a)(xi) and (xii); and 10 CFR Part 50, Appendix B.

ESPA Part 2, SSAR Section 2.4 Hydrology

John Holcomb, SMR Engineering
Stu Henry, Barge Design Solutions
Hillol Guha, Bechtel

Presentation Agenda

- NRC Interactions Related to ESPA SSAR Section 2.4
  - Overview of Tennessee River System and Clinch River Watershed
- ESPA Development and Subsection Presentations
  - General Hydrologic Characteristics of the Site
  - Specific Hydrologic Characteristics of the Site
    - 2.4.3 – Probable Maximum Flood on Streams and Rivers (Stu Henry)
    - 2.4.4 – Potential Dam Failures (Stu Henry)
    - 2.4.12 – Groundwater (Hillol Guha)

TVA

Key NRC Interactions Related to ESPA SSAR Section 2.4

One audit was conducted to review the site hydrologic engineering information in the ESPA

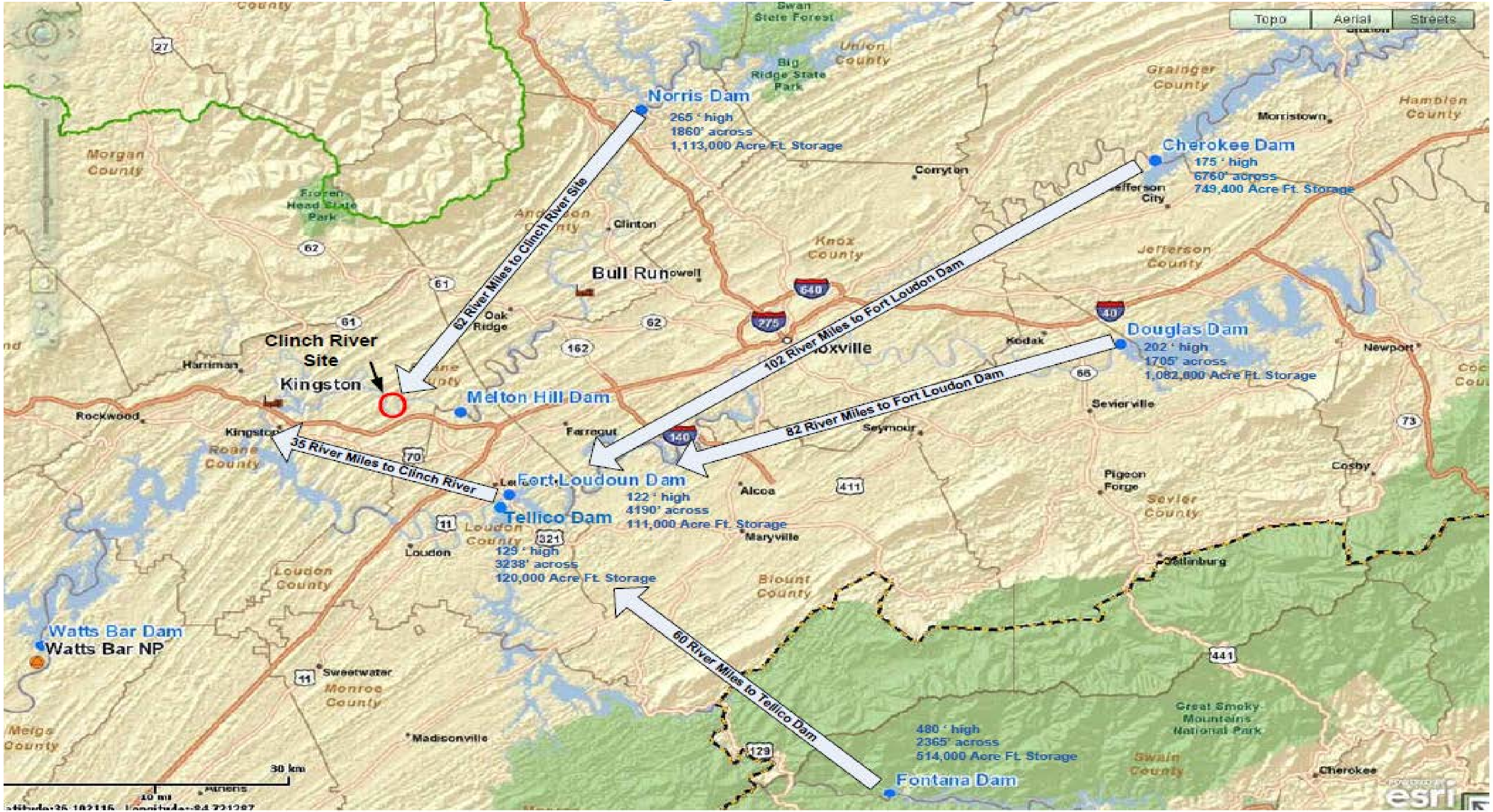
- Audit – April 24 - 27, 2017
  - Office discussion
    - General presentation of the Clinch River site
    - Presentation and discussion of responses to 40 Audit Information Needs
  - Site and Dam Tour
    - Tour site and site hydrologic engineering features including:
      - The bend in the Clinch River and surrounding topography that controls routing of flood flows;
      - Bridges bounding the CRN Site;
      - Proposed cut/fill areas for the CRN Project and existing backfill and backfilled areas of the former Clinch River Breeder Reactor Project
      - Areas of planned cooling water intake and discharge structures
    - Tour the TVA Norris, Melton Hill, Douglas (and its saddle dams) and Cherokee Dams

Site Overview

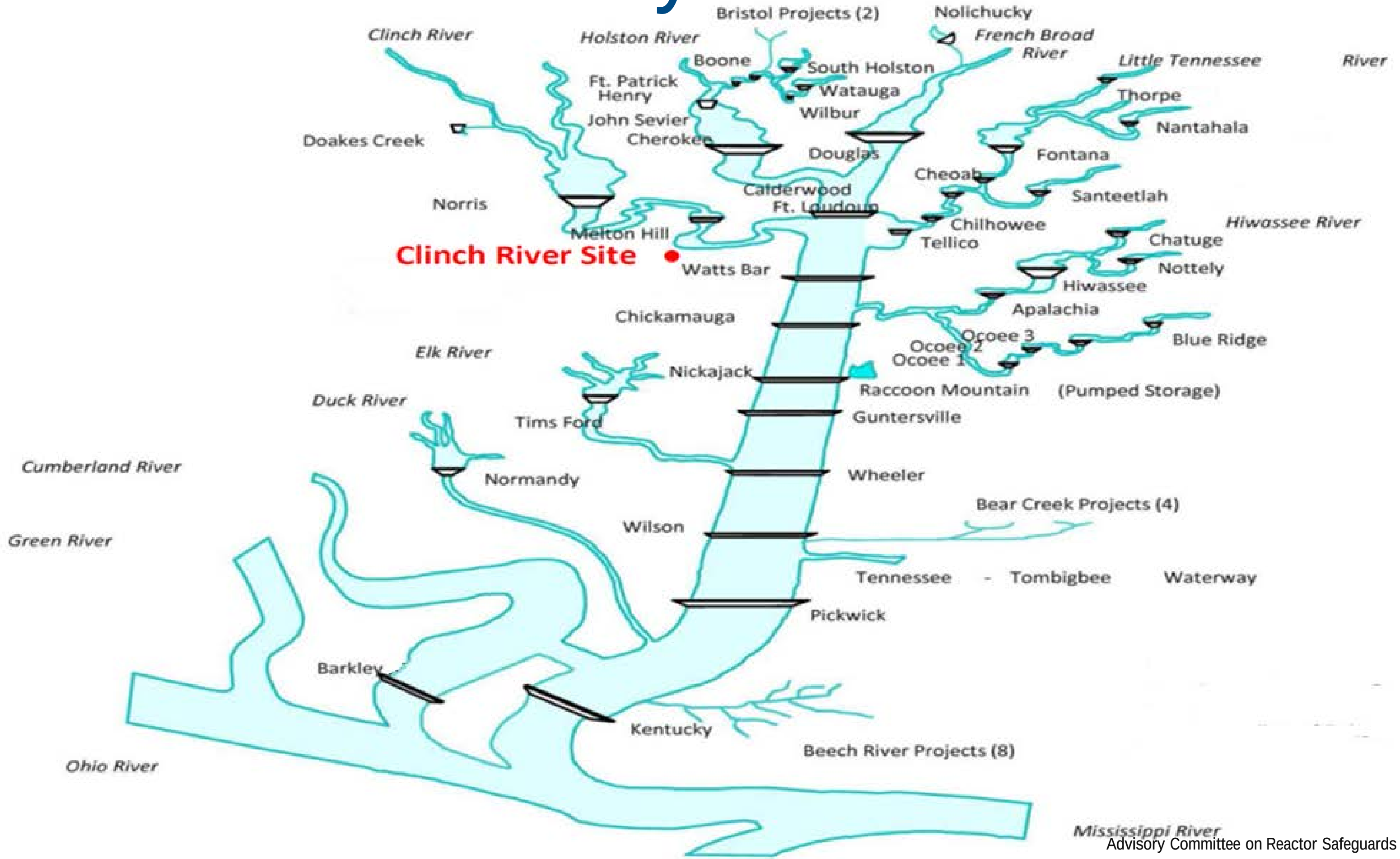
- Overview of Tennessee River System
- Clinch River Watershed
- Site Details

Orients Clinch River Site Relative to Tennessee River and Other TVA Nuclear Plants

Tennessee River System



TVA Water Control System



Clinch River Site

- Planned finish grade elevation is 821 ft
- Nominal Clinch River elevation at site varies between 735 and 740 ft (seasonally)

ESPA – SSAR Section 2.4 Development

Section 2.4 – Hydrologic Engineering

- ESPA SSAR Section 2.4 describes the hydrological characteristics of the Clinch River Nuclear Site. This section addresses hydrologic characteristics and natural phenomena that have the potential to affect the design basis for the surrogate plant.
- The section is divided into fourteen subsections describing the following hydrological characteristics:

2.4.1 – Hydrologic Description	2.4.8 – Cooling Water Canals and Reservoirs
2.4.2 – Floods	2.4.9 – Channel Diversions
2.4.3 – Probable Maximum Flood on Streams and Rivers	2.4.10 – Flooding Protection Requirements
2.4.4 – Potential Dam Failures	2.4.11 – Low Water Considerations
2.4.5 – Probable Maximum Surge and Seiche Flooding	2.4.12 – Groundwater
2.4.6 – Probable Maximum Tsunami Hazards	2.4.13 – Accidental Release of Radioactive Liquid Effluent in Groundwater and Surface Waters
2.4.7 – Ice Effects	2.4.14 – Technical Specification and Emergency Operation Requirements

Hydrologic Characteristics Demonstrated to have no Safety-Related Impact

- Subsection 2.4.2 – Floods
  - Preliminary plant grade is well above the calculated maximum flood level.
- Subsection 2.4.7 – Ice Effects
  - Due to the relatively mild climatic condition at the Clinch River Nuclear Site, and the elevated design plant grade above natural drainages, in combination with the SMR plant design that does not rely on external water sources for safety-related water use, it is concluded that ice effects will not cause flooding or water availability concerns.

Hydrologic Characteristics Demonstrated to have no Safety-Related Impact

- Subsection 2.4.9 – Channel Diversions
  - A review of hydrologic, hydraulic, climatic, topographic and geologic evidence and anthropogenic impacts on the Clinch River arm of the Watts Bar Reservoir near the Clinch River Nuclear Site indicates that channel diversions are not expected in the Clinch River during the operating life of the plant.

Hydrologic Characteristics Demonstrated to have no Safety-Related Impact

- Subsection 2.4.10 – Flooding Protection Requirements
  - No adverse impacts to the function of safety-related and risk-significant SSCs at the CRN Site are expected during the design basis extreme flooding event and the local intense precipitation event.

2.4 Subsections Demonstrated to have no Safety-Related Impact

- Subsection 2.4.13 - Accidental Releases of Radionuclides in Ground and Surface Waters
  - Radwaste tank rupture releases 80% (per BTP 11-6) of contents instantaneously into groundwater outside containment.
  - Source is based on 1% failed fuel (BTP 11-6 suggests 0.12%).
  - Groundwater transport is based on shortest travel distance from release point to Clinch River (1400 ft).
  - The resulting total dose from all exposure pathways meets 10 CFR 20.1301 limit of 100 mrem TEDE.

Hydrologic Characteristics Demonstrated to be an Unlikely Hazard at Site

- Subsection 2.4.5 - Probable Maximum Surge and Seiche Flooding
  - Because the site is not located on an open or large body of water, surge or seiche flooding will not produce the maximum water levels at the site.
- Subsection 2.4.6 - Probable Maximum Tsunami Hazards
  - The Clinch River Nuclear Site is located more than 300 miles from the nearest seacoast. In addition, the site finish grade elevation is at 821 feet above sea level. Thus, the site is not subject to any tsunami events originated from the ocean.

Hydrologic Characteristics Demonstrated to not be Applicable due to Design

- Subsection 2.4.8 – Cooling Water Canals and Reservoirs
  - The small modular reactors under consideration at the Clinch River Nuclear Site do not rely on the Clinch River arm of the Watts Bar Reservoir for a safety-related water supply, and the site does not include cooling water canals or reservoirs.
- Subsection 2.4.11 – Low Water Considerations
  - The Ultimate Heat Sink for the Clinch River Nuclear Site does not rely on the Clinch River arm of the Watts Bar Reservoir to perform its function.

Hydrologic Characteristics Demonstrated to not be Applicable due to Design

- Subsection 2.4.14 – Technical Specifications and Emergency Operation Requirements
  - The current designs of the small modular reactors being evaluated for deployment at the Clinch River Nuclear Site do not require use of a safety-related source of cooling water from the Clinch River arm of the Watts Bar Reservoir, and thus related technical specifications or emergency operation requirements are not necessary.

Subsection 2.4.3 –

Probable Maximum Flood on Stream and Rivers

Subsection 2.4.4 –

Potential Dam Failures

Flooding Guidance

- NRC Regulatory Guide 1.59, “Design Basis Floods for Nuclear Power Plants,” supplemented by best current practice
- Hydrometeorological Reports (HMRs) 41, 51, 52 and 56
- Previous watershed specific guidance from National Weather Service (NWS)
- ANSI/ANS 2.8-1992 (W2002), “Determining Design Basis Flooding at Power Reactor Sites”
- NUREG/CR-7046, “Design-Basis Flood Estimation for Site Characterization at Nuclear Power Plants in the United States of America”

Dam Failure Guidance

- NRC Regulatory Guide 1.59
- JLD-ISG-2013-01, “Guidance for Assessment of Flooding Hazards Due to Dam Failure”
- NUREG/CR-7046
- ANSI/ANS 2.8-1992 (W2002)

CRN Simulations

- Probable Maximum Precipitation (PMP) based on HMRs applicable to basin size and location
- Inflows – 100% runoff and unit hydrographs adjusted for non-linear basin response
- USACE HEC-RAS software utilized
- Downstream project (Watts Bar Dam) was assumed stable to maximize CRN impacts
- Dam stability determined by TVA Dam Safety Organization

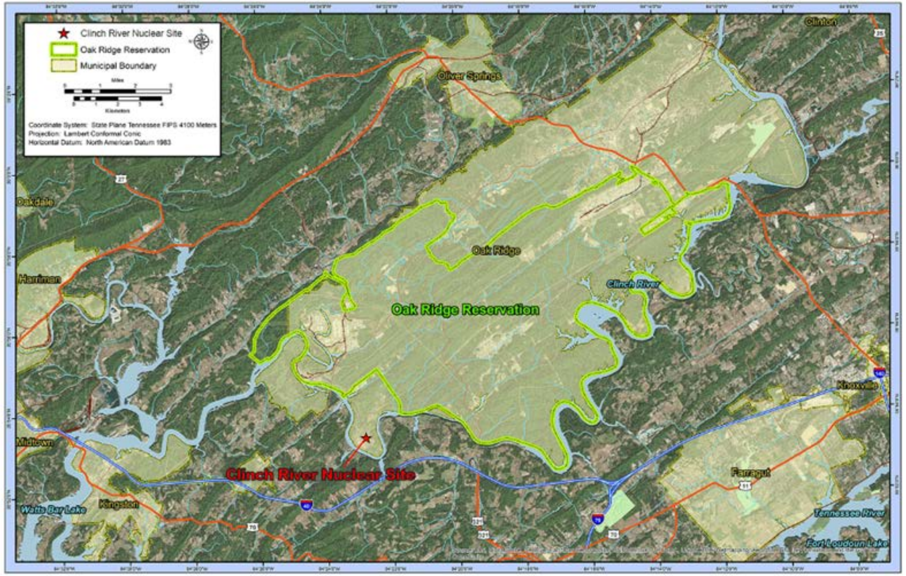
Controlling Flood Simulation

- Probable Maximum Flood (PMF) was found to produce the highest calculated water surface elevation at the CRN site
- Seismically induced and sunny day dam failure simulations were performed but were not controlling
- PMF and seismic simulation results show CRN is a dry site with significant margin
- Local Intense Precipitation (LIP) will be evaluated at COLA

Subsection 2.4.12 – Groundwater

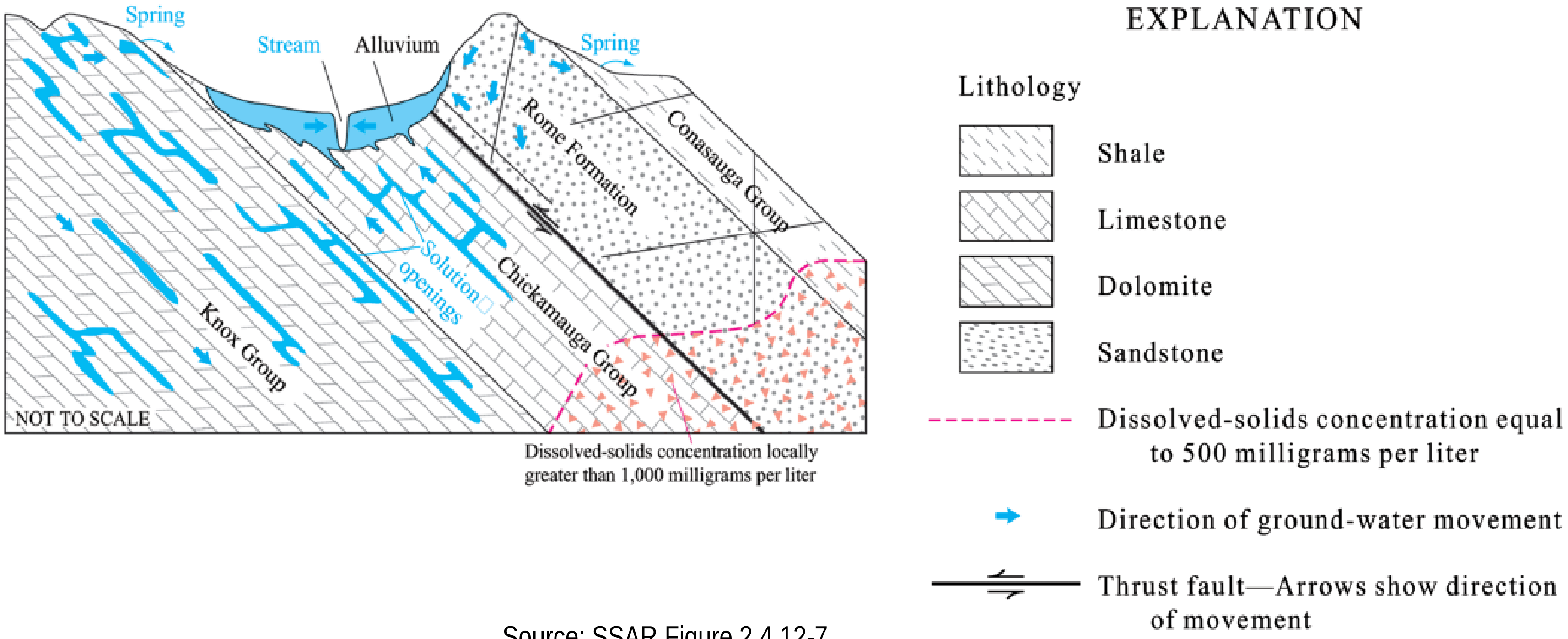
Groundwater Investigation Outline

- Regional Hydrogeology
- Local Hydrogeology: Conceptual Model
- Site-Specific Data From the Clinch River Breeder Reactor Project (CRBRP)
- Site-Specific Data From the Clinch River Nuclear (CRN) Site
- Groundwater Flow Directions
- Geological Cross Section
- Post-Construction Groundwater Model
- CRN Site: Groundwater Use
- Construction Dewatering



Source: SSAR Figure 2.4.12-1

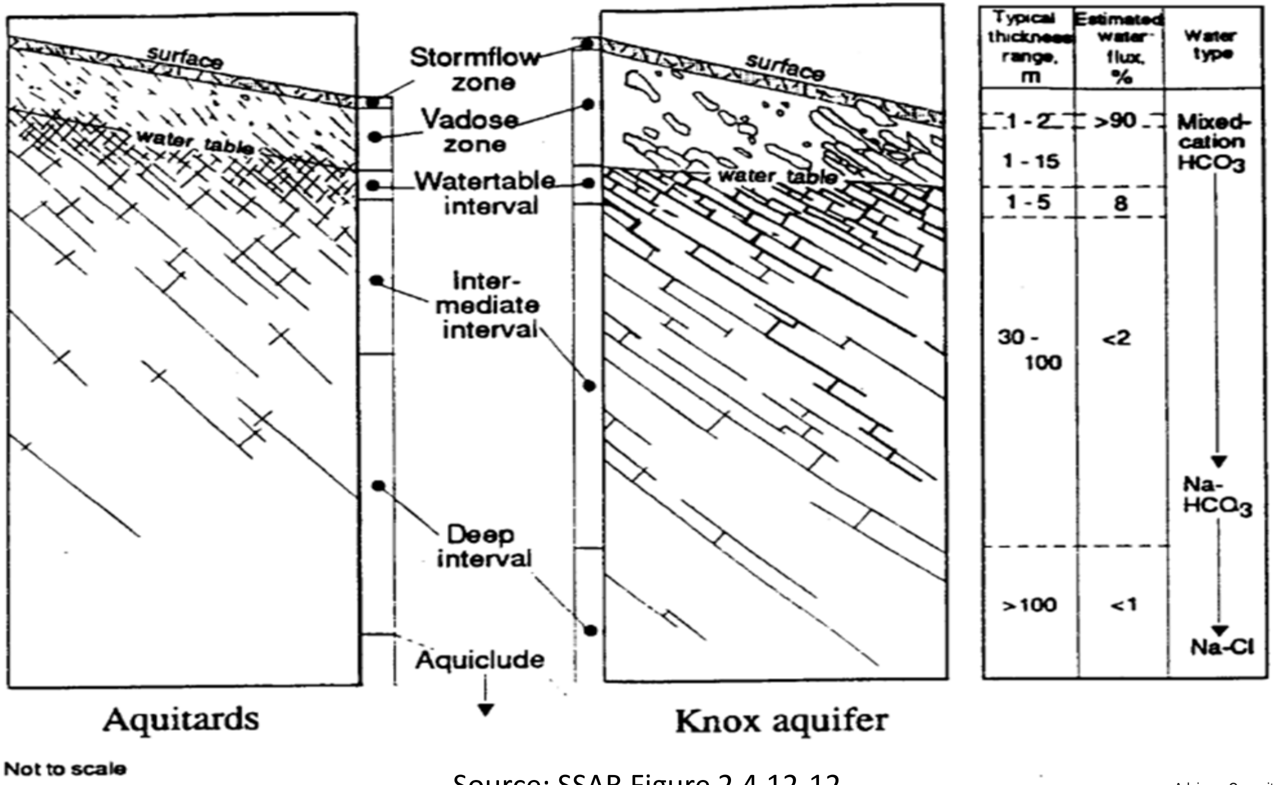
Regional Hydrogeology



Source: SSAR Figure 2.4.12-7

Local Hydrogeology: Conceptual Model

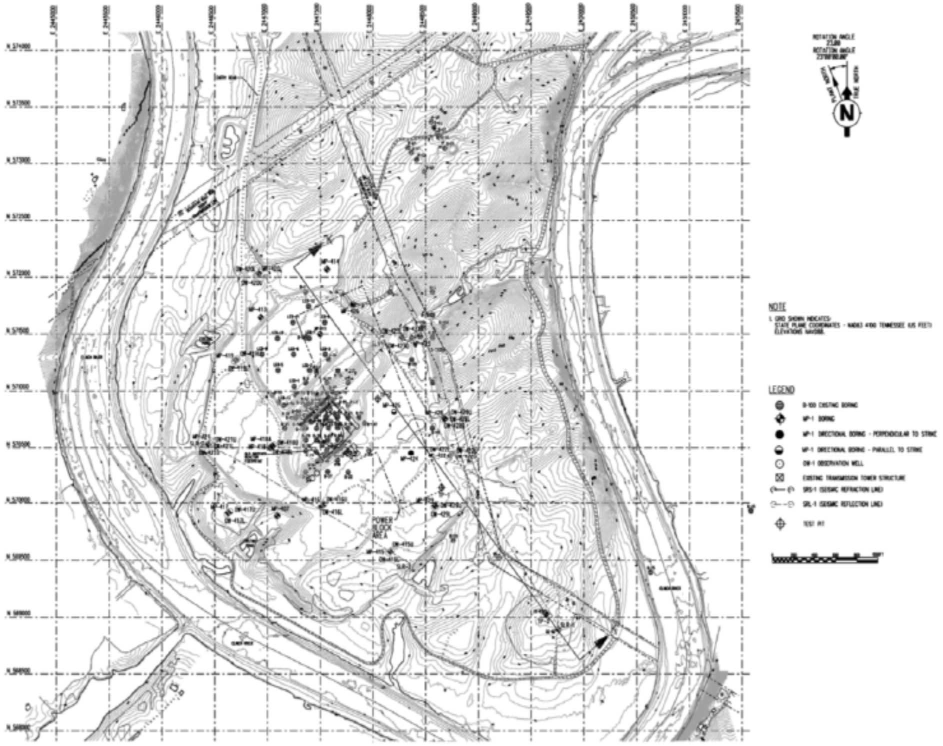
- Local hydrogeology is based on information from the adjacent ORR and the CRN Site:



Source: SSAR Figure 2.4.12-12

Site-Specific Hydrogeology: CRBRP Site Interpretations

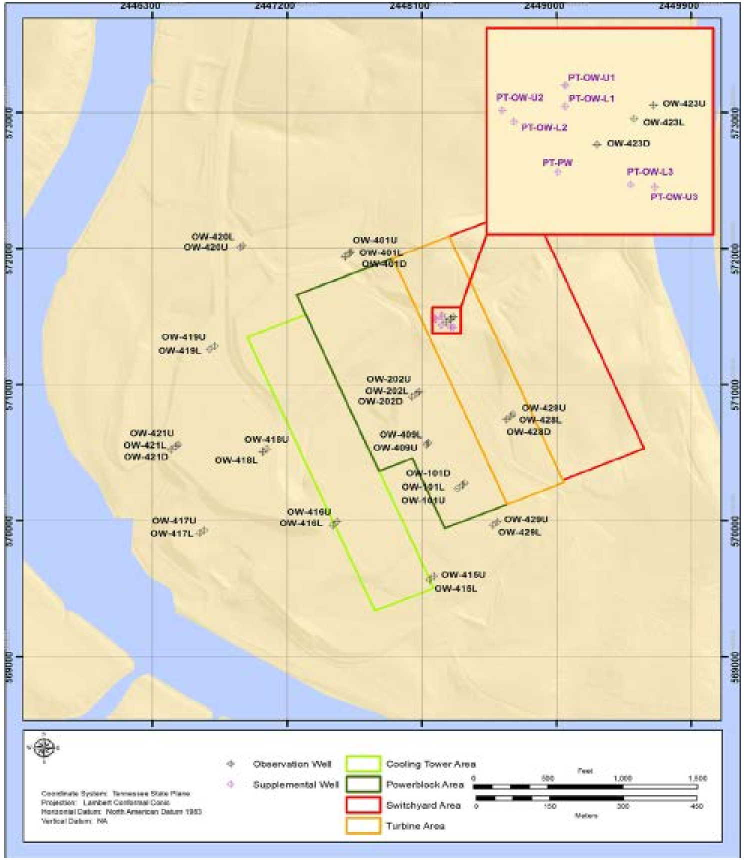
- Groundwater levels fluctuate as much as 20 ft – response to precipitation events
- Groundwater flows from topographically high areas (center of the peninsula) to topographically low areas (Clinch River arm of the Watts Bar Reservoir)
- Chestnut Ridge to the north acts as a groundwater divide



Source: SSAR Figure 2.5.4-1

Site-Specific Hydrogeology: Clinch River Site Interpretations

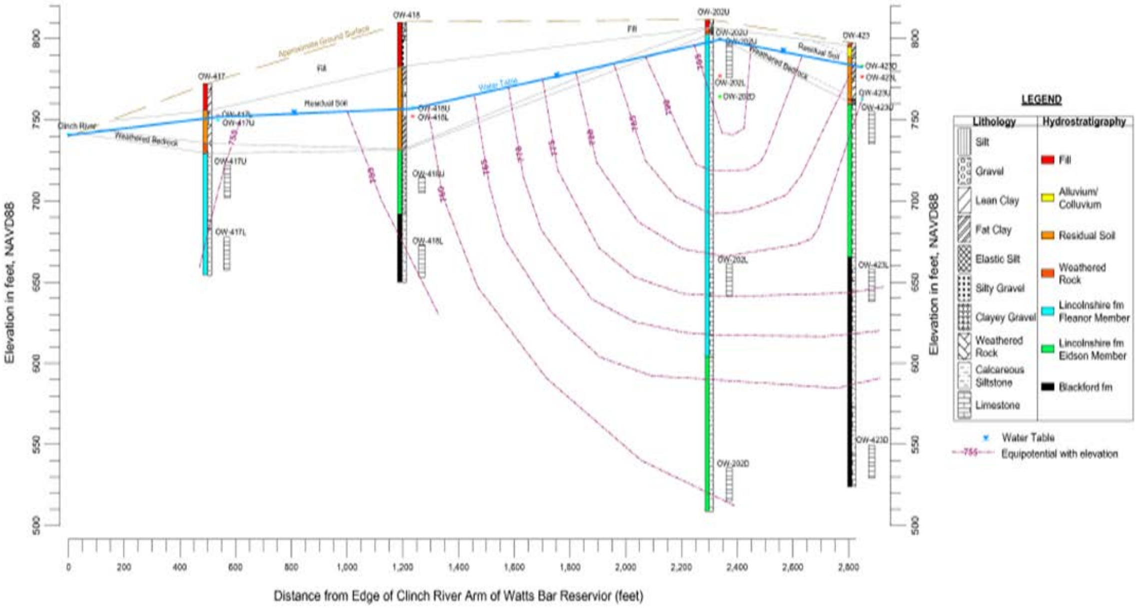
- Groundwater flow is predominantly along the fractures and joints – with active flow primarily at shallow depths (interface of soil and weathered bedrock)
- Predominant groundwater flow occurs along the strike of the bedding plane at N520E
- Frequency of fractures/joints decreases significantly with depth – predominant flow is at shallow depth, i.e., elevation 812 to 712 ft
- Clinch River acts as a sink for the shallow flow zone
- Pumping test radius of influence limited to approximately 150 ft from the pumping well



Source: SSAR Figure 2.4.12C-4

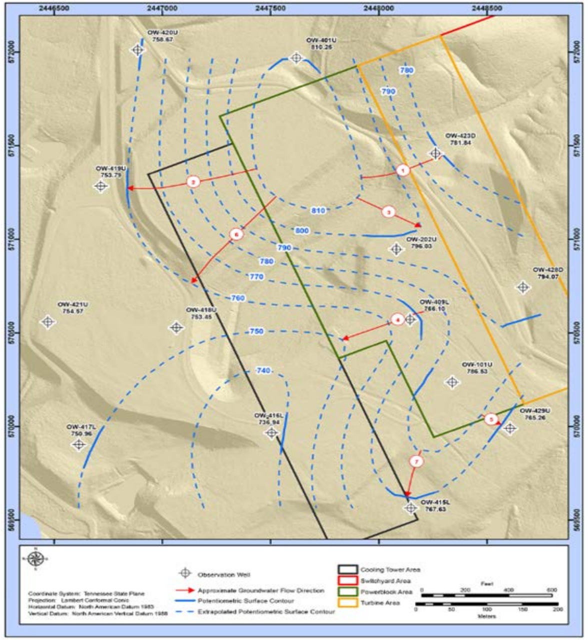
Groundwater Flow Directions

- General groundwater flow direction toward the southeast or southwest in the area of the proposed nuclear island
- Dominant downward flow at the center of the peninsula and upward at the Clinch River



Equipotential Lines in the Vertical Plane (Along Strike): June 13th, 2014

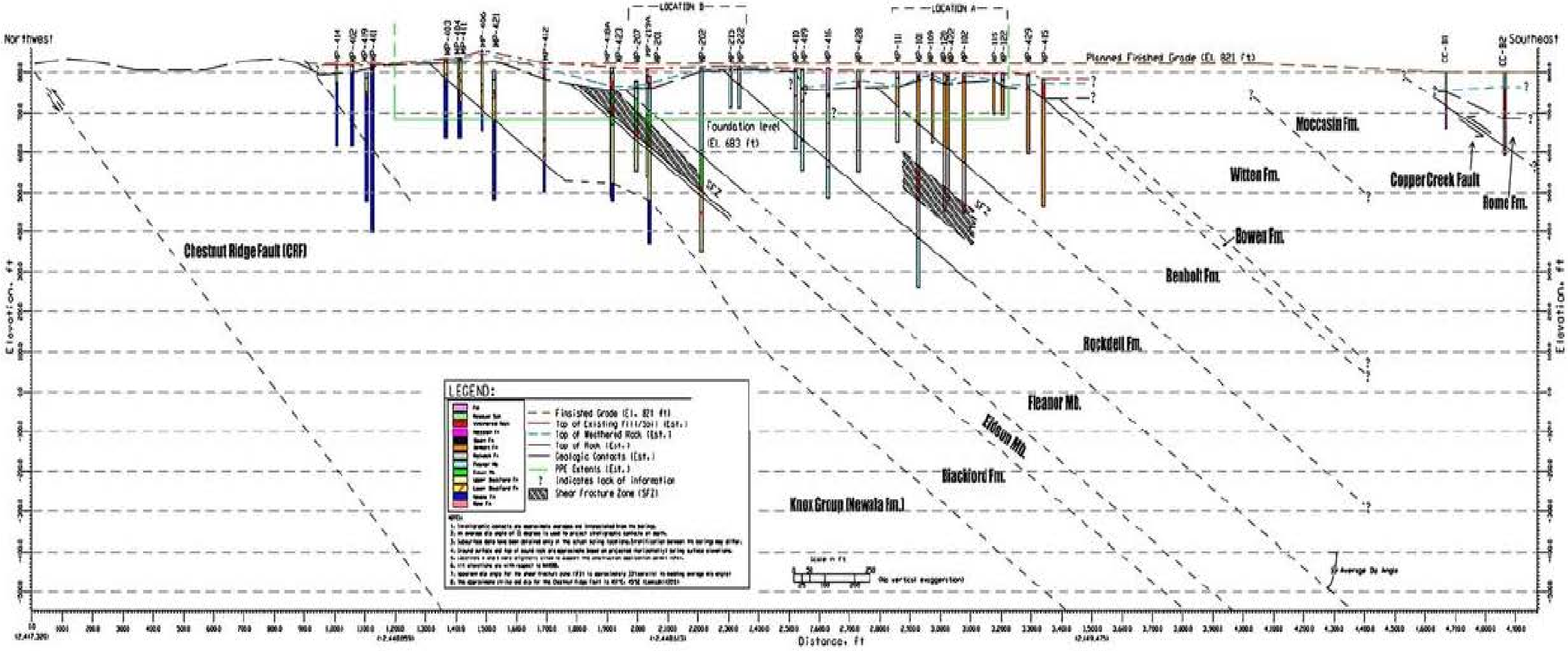
Source: SSAR Figure 2.4.12-29



Potentiometric Surface: February 12th, 2015

Source: SSAR Figure 2.4.12-26

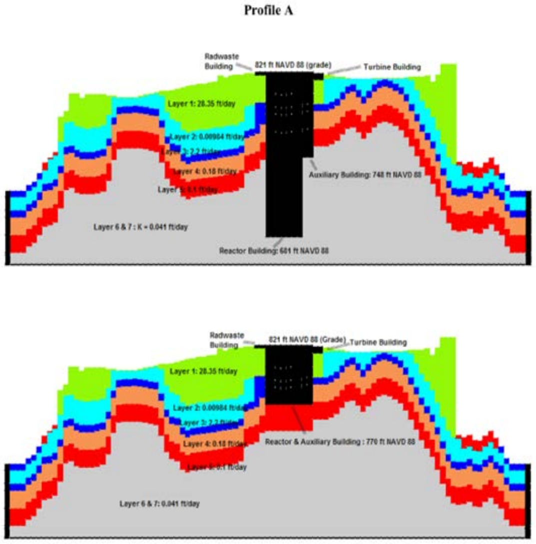
Geological Cross Section of Clinch River Site



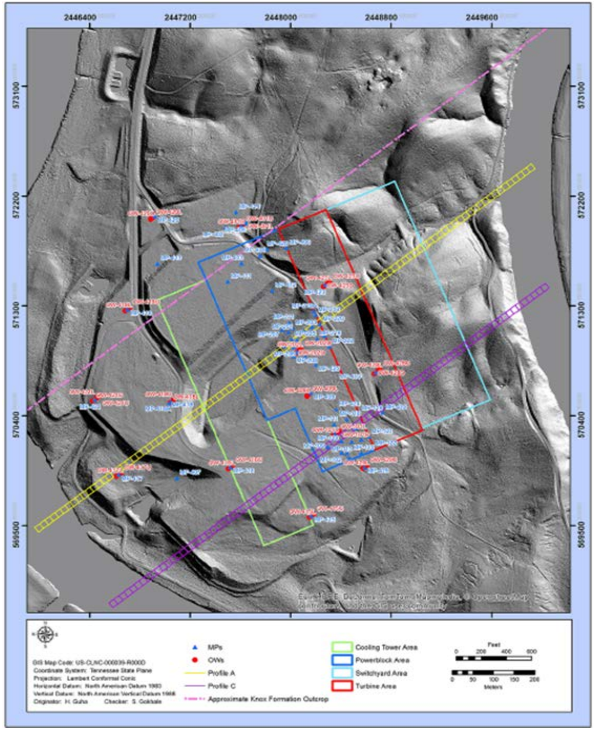
Source: SSAR Figure 2.5.1-30

Post-Construction Groundwater Model: Maximum Groundwater Levels

Site Grade of 821 ft NAVD88

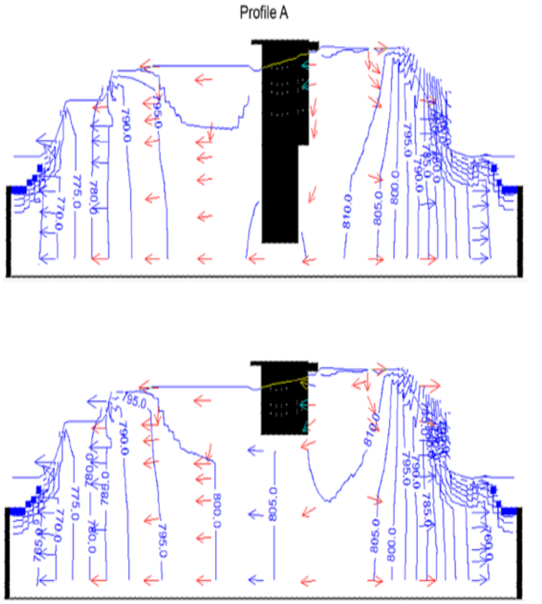


Source: SSAR Figure 2.4.12C-23



Source: SSAR Figure 2.4.12C-13

802.3 to 816.1 ft NAVD88



Note: Red arrow indicates downward flow and blue arrow indicates upward flow; blue lines with numbers indicates groundwater contours; deep blue blocks represent constant head of Clinch River; and black blocks represents no flow cells.

Source: SSAR Figure 2.4.12C-27

CRN Site: Groundwater Use

- Proposed CRN Site SMR designs do not rely on groundwater for plant operations
- Potable and other water will come from the Oak Ridge Department of Public Works
- Makeup water for the closed-cycle cooling system will be sourced from the Clinch River arm of Watts Bar Reservoir

Construction Dewatering

- No permanent dewatering system will be employed
- Temporary dewatering will be required during excavation
- Temporary dewatering based on similar techniques as in CRBRP excavation
- Flow rate will be minimal – as observed in CRBRP excavation

Groundwater Investigation Conclusion

- The proposed CRN Site SMR designs do not rely on groundwater for operations.

- Permanent dewatering is not required.

- Maximum groundwater levels range between 802.3 to 816.1 ft NAVD88, below CRN Site grade of 821 ft NAVD88.

Advisory Committee on Reactor Safeguards

Presentation to the ACRS
Clinch River Nuclear (CRN) Site Early Site Permit (ESP) Application

Chapter 11 Radioactive Waste Management
Sections 11.2.3 & 11.3.3
Safety Evaluation Review

Presented by
Richard Clement
November 14, 2018

Sections 11.2.3 & 11.3.3

- Involves source term information and offsite doses that include:
  - Liquid effluent releases (Section 11.2.3)
  - Liquid exposure pathways (Section 11.2.3.1)
  - Liquid effluent doses (Section 11.2.3.2)
  - Gaseous effluent releases (Section 11.3.3)
  - Gaseous exposure pathways (Section 11.3.3.1)
  - Gaseous effluent doses (Section 11.3.3.2)
  - Review interface with hydrology (Section 2.4.13) and meteorology (Section 2.3.5)

Key Review Areas

- Staff participated in the Pre-application Readiness Assessment and Acceptance Review.
- Staff conducted an audit at Bechtel Power Corporation, Tennessee Valley Authority (TVA) Knoxville Complex, Clinch River Nuclear (CRN) Site and surrounding areas (ML17341A276):
  - Normal plant parameter envelope (PPE) liquid and gaseous effluent release source terms and offsite doses
  - Accident PPE liquid effluent release source term and dose
  - CRN site tour and current receptor locations
- Staff conducted an audit of TVA's voluntary submittal on vector- and scalar-averaged wind direction and scalar-averaged wind speed data (ML18248A113):
  - Offsite gaseous effluent dose and receptor information

PPE Source Terms

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- TVA identified four small modular reactor (SMR) designs to develop the PPE source terms:
  - BWXT mPower (Generation mPower)
  - NuScale (NuScale Power)
  - SMR-160 (Holtec SMR)
  - Westinghouse SMR (Westinghouse Electric Co.)
- TVA used Nuclear Energy Institute 10-01 to evaluate composite source terms in the surrogate plant and develop the normal PPE liquid and gaseous effluent release source terms.
- Staff performed confirmatory calculations of normal PPE liquid and gaseous effluent release source terms.
- Staff confirmed that the unity rule in 10 CFR Part 20, Appendix B, Table 2, Columns 1 and 2 was met.
- Staff found TVA’s methodology to develop the normal PPE liquid and gaseous effluent release source terms for use in calculating offsite doses was reasonable.

Dose Evaluation

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- Staff verified the input parameters and assumptions for exposure pathway dose analyses.
- Staff performed confirmatory calculations of offsite doses using Regulatory Guide 1.109 and NRCDose 2.3.20 computer code.
- Staff identified COL Action Item:

  COL Action Item 11-1

  An applicant for a combined license (COL) or a construction permit (CP) referencing this early site permit (ESP) should verify that the calculated doses to members of the public from normal gaseous and liquid effluent releases for a chosen reactor design at the CRN Site are bounded by the doses evaluated in this ESP application as reviewed by the NRC staff. The applicant should evaluate discrepancies and justify any changes made to address differences in the source term for the reactor design used to calculate the doses for a COL or CP application.

Conclusions

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- Staff completed its Safety Evaluation with no Open Items.
- Normal PPE liquid and gaseous effluent release concentrations meet the unity rule in 10 Code of Federal Regulations (CFR) Part 20, Appendix B, Table 2, Columns 1 and 2.
- Offsite doses from normal PPE liquid and gaseous effluent release source terms meet the design objectives in 10 CFR Part 50, Appendix I, Sections II.A, II.B, and II.C; Environmental Protection Agency's radiation standards in 40 CFR Part 190, as implemented under 10 CFR 20.1301(e); and public dose limit in 10 CFR 20.1301.
- Subject to the staff's proposed condition (COL Action Item 11-1), reactor designs falling within the normal PPE effluent release source terms and offsite doses for the CRN site are without undue risk to public health and safety.

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Questions?

Acronyms

U.S.NRC
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CFR – Code of Federal Regulations

COL – Combined License

CP – Construction Permit

CRN – Clinch River Nuclear

ESP – Early Site Permit

NRC – Nuclear Regulatory Commission

NRCDose – Code system which contains three NRC endorsed computer codes used for exposure pathway dose analysis

PPE – Plant Parameter Envelope

SMR – Small Modular Reactor

TVA – Tennessee Valley Authority

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Staff Presentation to ACRS Subcommittee

Clinch River Early Site Permit Application

SER Chapter 2, Site Characteristics
Section 2.3 – Meteorology

Kevin Quinlan

Chapter 2, Section 2.3 – Meteorology

Involves site specific information such as:

- regional climatology (2.3.1)
- local meteorology (2.3.2)
- onsite meteorological measurements program (2.3.3)
- short-term atmospheric dispersion estimates for accidental releases (2.3.4)
- long-term atmospheric dispersion estimates for routine releases (2.3.5)

2.3.1 Regional Climatology

Staff performed review and analysis for the following –

- Tornado/Hurricane Wind Speeds and Associated Missiles
  - Staff confirmed the applicant's site characteristic values were appropriately derived from RG 1.76 and RG 1.221
- 100-year return Wind Speed (3-second gust)
  - Staff confirmed the applicant's site characteristic values were appropriately derived using ASCE/SEI 7-05
- Maximum Winter Precipitation
  - Staff confirmed the applicant's site characteristic values were appropriately derived using DC/COL-ISG-007 methodology
- Ambient Air Temperature and Humidity
  - Staff independently confirmed the applicant's site characteristic values using NWS data from Chattanooga, TN
- Staff concludes that the identification and consideration of the climatic site characteristics are acceptable and meet the requirements of 10 CFR 52.17(a)(1)(vi), 10 CFR 100.20(c), and 10 CFR 100.21(d)

2.3.2 Local Meteorology

- Staff reviewed and verified that the local meteorological data provided by Clinch River are representative of the site area as impacted by local topography.

- NRC Staff reviewed the Clinch River analysis of the following atmospheric phenomena recorded at the CRN site:
  - Onsite wind speed and direction
  - Atmospheric stability
  - Ambient temperature and humidity

- NRC Staff also confirmed information recorded at offsite locations (such as National Weather Service reporting stations)
  - Precipitation
  - Fog
  - Air quality and potential influence of the plant and related facilities on local meteorology

2.3.2 Local Meteorology (cont'd)

- Staff concludes that the applicant's identification and consideration of the meteorological, air quality, and topographical characteristics of the site and the surrounding area meet the requirements of 10 CFR 100.20(c), and 10 CFR 100.21(d), and are sufficient to determine the acceptability of the site.

2.3.3 On-site Meteorological Measurements Program

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- Staff held an audit at the Clinch River site and surrounding area on May 15-17, 2017

- Audit topics related to meteorological monitoring included:
  - Location and exposure of previously sited meteorological instrumentation and tower
  - Instrument maintenance
  - Data quality assurance program

- NRC staff completed a quality assurance review of the onsite meteorological database submitted by TVA as part of the ESP application.

- Staff confirmed that the TVA meteorological tower conformed to RG 1.23 criteria for siting of the tower in relation to the proposed Clinch River site

2.3.3 On-site Meteorological Measurements Program

- The SSAR used vector-averaged wind direction data as input to the straight-line Gaussian dispersion models (such as PAVAN and XOQDOQ). The applicant chose an alternative method to the best practice guidance cited in RG 1.23 and ANSI Standard 3.11-2005 which states that “the transport wind direction for straight-line Gaussian models should be based on the scalar mean (or unit vector) wind direction.”

- TVA voluntarily provided a submittal on April 9, 2018 (ML18100A950), which evaluated the effects of having used vector-averaged wind directions in lieu of using scalar-averaged wind directions for the accident and routine release atmospheric dispersion estimates and the resulting doses presented in SSAR Chapters 15 and 11.

- TVA’s analysis showed that the dose modeling results were bounding based on the use of vector-averaged wind directions. However, the applicant acknowledged that atmospheric dispersion and deposition factors for routine radiological releases were greater in some directions and lower in others when compared to using scalar-averaged wind directions.

2.3.3 On-site Meteorological Measurements Program

- TVA concluded that for normal and accident gaseous release dose assessments, the existing dose analyses included in the ESP application, which are based on vector-averaged wind directions and scalar-averaged wind speeds, is conservative and remains the basis of the CRN Site ESP application.

- NRC staff conducted an audit of this voluntary submittal (ML18248A113) to evaluate the potential implications of the applicant's use of vector-averaged wind directions as input to the dispersion modeling analyses and wind-related data summaries.

- Staff audited CRNS' atmospheric dispersion and dose analyses and agrees with the applicant's conclusion.

- The staff concluded that the onsite meteorological monitoring system provides adequate data to represent onsite meteorological conditions as required by 10 CFR 100.20 and 10 CFR 100.21

2.3.3 On-site Meteorological Measurements Program

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The staff proposed COL Action Items as stated below:

COL Action Item 2.3-2: An applicant for a COL or a CP referencing this ESP should verify that the onsite meteorological measurement system, including the instrument tower, expected at the site prior to operation, is as described in SSAR Section 2.3.3. Any differences in instrumentation, exposure, or siting should be identified and discussed in order to demonstrate that the meteorological measurements program continues to meet the guidance provided in RG 1.23.

COL Action Item 2.3-3: An applicant for a COL or a CP referencing this ESP should verify whether the operational phase of the onsite meteorological measurements program will include wind data averaging on the basis of scalar or vector averages.

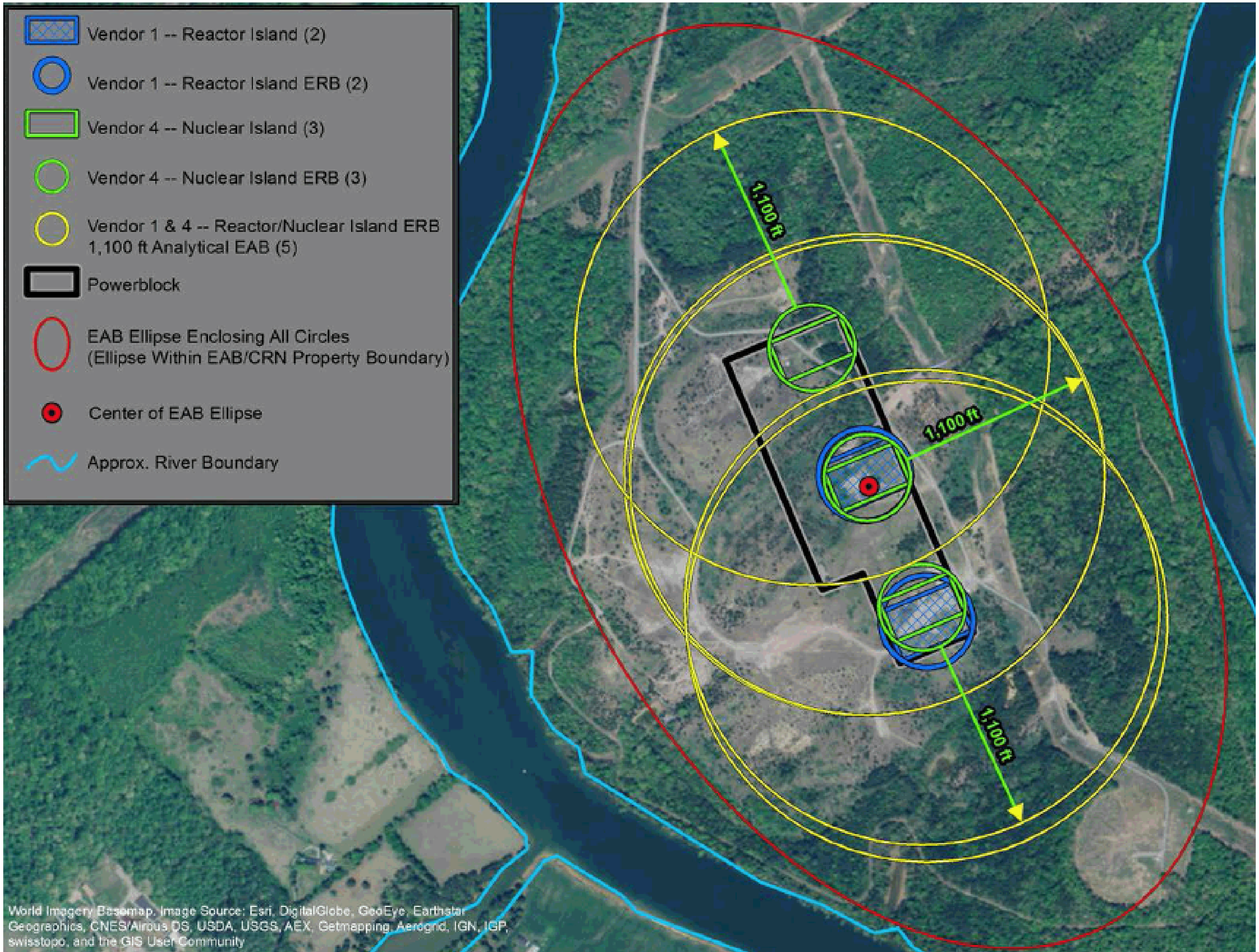
COL Action Item 2.3-4: An applicant for a COL or a CP referencing this ESP should identify and justify the wind speed and direction averaging approach(es) (either vector or scalar) to be used in the COL or CP:

- for modeling accident-related Control Room and Technical Support Center (TSC) atmospheric dispersion; and
- to be used during the operational phase to support emergency planning.

2.3.4 Short-Term (Accident) Diffusion Estimates

- Staff performed an independent verification of the applicant's accident diffusion estimates
    - Staff created a Joint Frequency Distribution (JFD) from the onsite meteorological data for input to the PAVAN atmospheric dispersion computer model
    - Staff executed its PAVAN computer model and generated offsite dispersion estimates (X/Q) values for all sectors along the uniform analytical Exclusion Area Boundary (EAB) (1100 feet) and the Low Population Zone (LPZ) (5279 feet) boundary
    - The staff found the applicant's EAB & LPZ site characteristic X/Q values acceptable
- The staff concludes that the applicant has established site characteristics and design parameters acceptable to meet the requirements of 10 CFR 52.17(a)(1)(ix), 10 CFR 100.21(c)(2), and 10 CFR 100.20(c)

SSAR Figure 2.3.4-1. Effluent Release Boundary with Analytical EABs



2.3.5 Long-Term (Routine) Diffusion Estimates

- Staff performed an independent verification of the applicant's routine release diffusion estimates

  - Staff created a JFD from the onsite meteorological data for use as part of the input into the XOQDOQ atmospheric dispersion computer model

  - Staff executed the XOQDOQ computer model and generated atmospheric dispersion and deposition estimates (X/Q and D/Q) for receptors of interest

- Staff concludes that representative atmospheric dispersion and deposition conditions have been calculated for receptors of interest. The characterization of atmospheric dispersion and deposition conditions meet the requirements of 10 CFR 100.21(c)(1) and are appropriate for the evaluation to demonstrate compliance with 10 CFR Part 50, Appendix I.

Conclusion

- All regulatory requirements for Section 2.3 have been satisfied
- No open items
- Three confirmatory items

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Questions?

Acronyms

- ASCE – American Society of Civil Engineers
- CFR – Code of Federal Regulations
- COL – combined license
- CP – construction permit
- DC/COL-ISG – Interim Staff Guidance for design certifications and combined licenses
- D/Q – atmospheric deposition factor
- EAB – exclusion area boundary
- ESP – early site permit
- JFD – joint frequency distribution
- LPZ – low population zone
- RG – Regulatory Guide
- SSAR – Site Safety Analysis Report
- TVA – Tennessee Valley Authority
- X/Q – atmospheric dispersion factor

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Presentation to the ACRS Subcommittee

Safety Review of the Clinch River Nuclear Site, Early Site Permit Application

Quality Assurance Program Description: (SSAR Section 17.5)

Presented by
Nicholas Savwoir, Reactor Operations Engineer
NRO/DCIP/QVIB-1
November 14, 2018

Early Site Permit (ESP) Regulations

- Appendix B to Part 50, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants"
- 10 CFR Part 52.17, "Contents of applications; technical information" Subsections (a)(1)(xi) and (xii)

Background

- TVA (Tennessee Valley Authority) submitted Operating Nuclear Quality Assurance Plan (NQAP), Revision 32, with their ESP application
- TVA NQAP, Revision 32, commits to ANSI N45.2-1971 as endorsed by RG 1.28, Revision 3
- Review involved multiple public meetings and clarification calls
- One request for additional information (RAI) with 8 questions; TVA responded by submitting NQAP, Revision 36

Key Review Areas

[1] Quality Assurance Program Description (QAPD)

- Criterion I – Organization
- Criterion II- Quality Assurance (QA) Program

[2] Quality Assurance (QA)

- Gap analysis evaluation
- Criterion XVII- QA Records
- Criterion VII- Control of Purchased Material, Equipment and Services
- Criterion XV-Nonconforming Material Parts of Components

[3] QA Implementation Inspection

- April 16-20th 2018 at TVA (Chattanooga, TN)

Key Review Area [1]

[1] QAPD Clinch River Nuclear Site, Criterion I and Criterion II

- NRC Staff RAI:
  - Small Modular Reactor (SMR) Organization for the Clinch River Nuclear (CRN) Site
  - Independent Assessments at the CRN site
  - Reference or commitment to 10 CFR Part 52

- As a result of the staff's review; TVA revised the NQAP to Revision 36:
  - Added Appendix K (roles and responsibilities) and Appendix L (organization chart) in support of the SMR organization.
  - Added Independent Assessments at the CRN site.
  - Added 10 CFR Part 52 to NQAP.

Key Review Area [2]

[2] QA Gap Analysis and Criterion XVII

- NRC Staff RAI:
  - Gap Analysis evaluation between RG 1.28 Rev 3 & 4 (10 CFR 52.17(a)(1)(xii))
  - CRN QA record documents
  - CRN electronic records controls
- As a result of the staff's review; TVA revised the NQAP to Revision 36:
  - TVA provided a gap analysis evaluation during inspection (ML18143B478)
  - Added Appendix M (Clinch River Commitments and Clarifications for the ESP QA Program) and committed to RG 1.28 Rev 4.
  - Identified the documents that are considered QA records per Criterion XVII
  - Added electronic records controls per RIS 2000-18 and NIRMA (Nuclear Information & Records Management Association), TG-11,15,16, and 21

Key Review Area [2]

[2] QA Gap Analysis, Criterion VII and Criterion XV

- NRC Staff RAI:
  - An incorrect exemption for the use of Accreditation in lieu of Commercial Grade Surveys for Procurement of Laboratory Calibration and Test Services
  - Did not address the notification of affected organizations for nonconforming materials, parts or components

- As a result of the staff's review; TVA revised the NQAP to Revision 36:
  - Revised ILAC (International Laboratory Accreditation) conditions per NEI 14-05A "Guidelines for the use of Accreditation in lieu of Commercial Grade Surveys for Procurement of Laboratory Calibration and Test Services." Revision, 0.
  - Added Appendix M and the commitments to address the notification of affected organizations.

Key Review Area [3]

[3] QA Implementation Inspection

- April 16-20th, 2018
- Tennessee Valley Authority (TVA) office in Chattanooga, TN
- Inspection Procedure (IP) 35017, “Quality Assurance Implementation Inspection”
- Initial review of TVA revised NQAP, Revision 36
- No findings of significance were identified
- QA Inspection Report publicly-available (ML18143B478)

Conclusion

- QAPD for the CRN Site ESP application meets the requirements of 10 CFR Part 50, Appendix B and 10 CFR Part 52.17(a)(1)(xi) and (xii) .

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Presentation to the ACRS
Clinch River Nuclear (CRN) Site Early Site Permit (ESP) Application

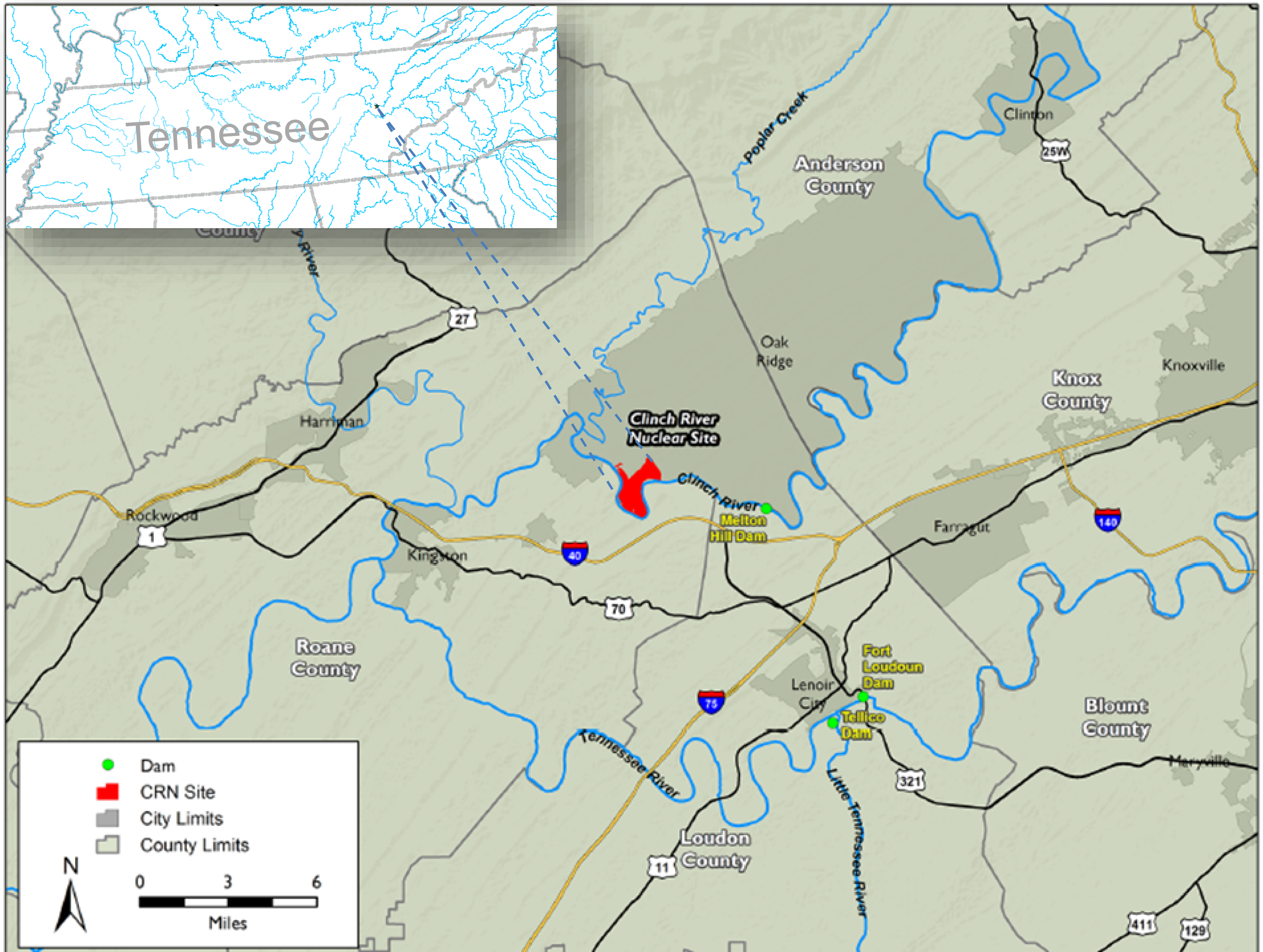
Section 2.4 Hydrologic Engineering Safety Evaluation Review

Presented by

Yuan Cheng, Joseph Giacinto, Richard Clement

November 14, 2018

CRN Site Location



CRN Site Overview

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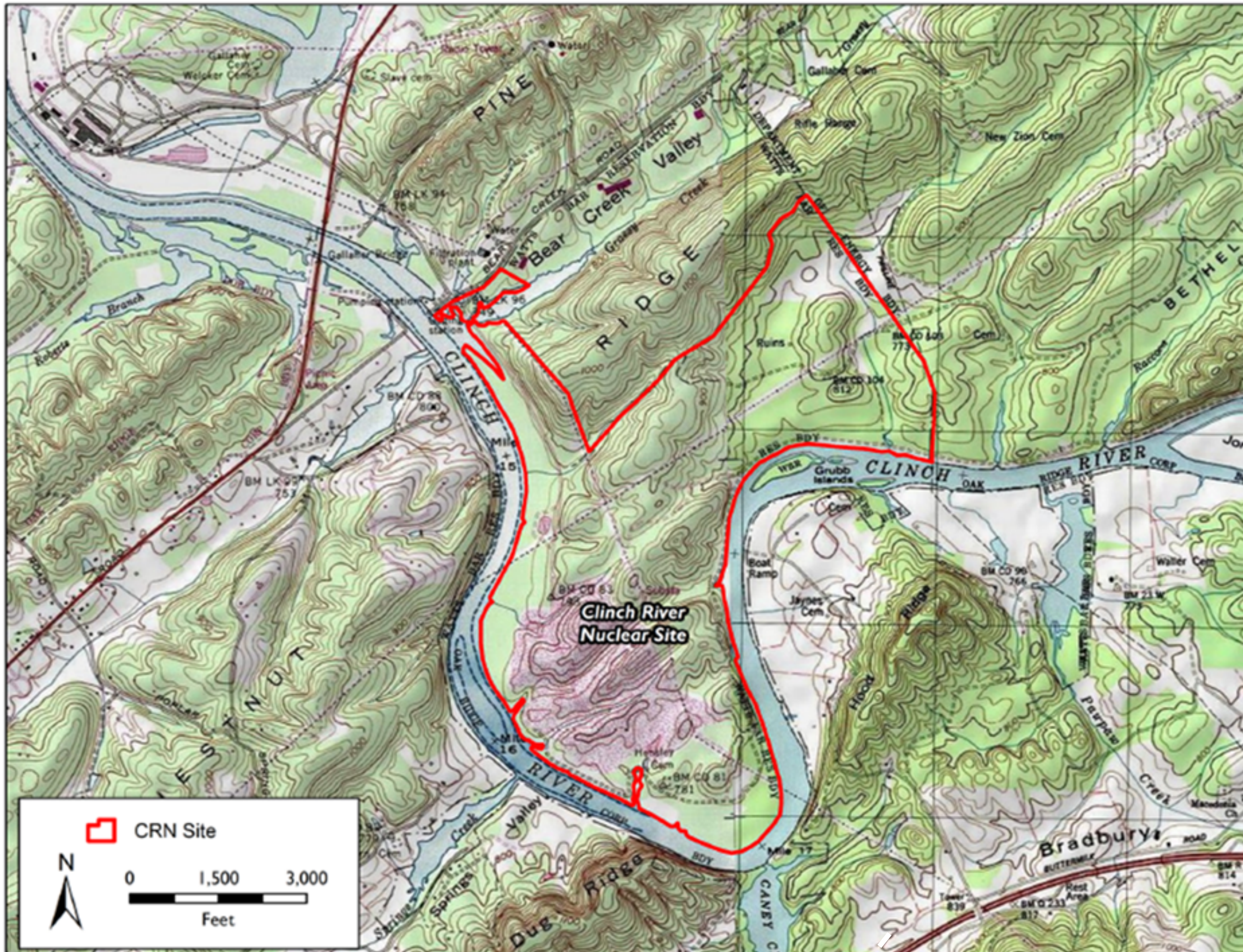
- Approximately 935 acres of land owned by the United States and operated by TVA
- Within Valley and Ridge Province
- Former Clinch River Breeder Reactor Project Site
- Proposed site grade of 821.0 ft



CRN Site PPE

- The applicant identified four small modular reactor (SMR) technologies for development of a plant parameter envelope (PPE):
  - BWXT mPower (Generation mPower)
  - NuScale (NuScale Power)
  - SMR-160 (Holtec SMR)
  - Westinghouse SMR (Westinghouse Electric Co.)

Staff Review

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- Staff’s review included a pre-application readiness assessment, acceptance review and, site visit and audit
- Staff worked in cooperation with U.S. Department of Energy (DOE), Tennessee Department of Environment and Conservation (TDEC) and the U.S. Geological Survey (USGS)
- Staff completed the safety evaluation report with no open Items

Probable Maximum Flood

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- Staff reviewed the riverine flooding considering:
  - Probable maximum precipitation
  - Surface runoff hydrology
  - Upstream dam failures with flood waves
  - Sensitivity study related to modeling flood elevations
- Staff confirmed the maximum flood level computed by riverine hydraulic modeling with conservatisms including:
  - 100 percent rainfall depth converted into surface runoff
  - Instantaneous dam failure without breach formation time
  - Maximizing backwater effect at the CRN site
- Resulting maximum flood level is significantly below site grade

Local Intense Precipitation

- Site drainage design:
  - A site drainage design and site grading plan in combined license application is required to evaluate local intense precipitation (LIP) effects. Therefore, staff proposed COL Action Item 2.4-1.

- COL Action Item 2.4-1:

  An applicant for a combined license (COL) or construction permit (CP) that references this early site permit should design the site grading to provide flooding protection to safety-related structures at the ESP site based on a comprehensive flood water routing analysis for a local intense precipitation (LIP) event.

Flood Protection

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- Flood protection evaluations:
  - The flood protection should be evaluated in the COLA after a reactor technology and associated site grading plan are determined by the applicant. Therefore, staff proposed COL Action Item 2.4-2.
- COL Action Item 2.4-2:

  An applicant for a Combined Operating License (COL) or Construction Permit (CP) referencing this Early Site Permit (ESP) should address whether the local flood elevation exceeds the site grade elevation and whether the local flood elevation needs to be incorporated with flood protection measures to prevent flooding of any safety-related Structures, Systems and Components (SSCs). If so, the applicant should address necessary flooding protection for safety-related SSCs based on the flooding event and associated effects.

Groundwater

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- Staff reviewed two excavation geometries: a deep (681 ft. maximum) and a shallow (770 ft. maximum) elevation
- Staff confirmed maximum groundwater level of 816.1 ft. is reasonable
  - Backfill properties determined for the COL, therefore staff proposed a directive for COL Action Item 2.5-8.
- COL Action Item 2.5-8:

  An applicant for a COL or CP application referencing this early site permit should provide detailed design of backfill materials including identification of sources and quantity requirements, backfill material property and placement specifications, applicable industry standards, as well as related ITAAC. The in-place backfill hydraulic characteristics such as permeability and porosity should be consistent with those specified in the SSAR. If differences exists, the effect on the site conceptual model and site characterization as described in the SSAR should be evaluated. Geologic mapping of the final exposed surface after excavation is required before placement of backfill, and should be conducted under the guidelines of NRC requirements.

Groundwater

- Staff noted that TDEC analyses of CRN Site groundwater samples indicate low levels of radionuclides
  - Therefore, staff proposed COL Action Item 2.4-3.

- COL Action Item 2.4-3:

  An applicant for a combined license (COL) or construction permit (CP) that references this early site permit will establish, as part of its plan to minimize contamination in accordance with 10 CFR 20.1406, a baseline for background radionuclide concentrations.

Surface and Ground Water Findings

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- Staff confirmed that the applicant considered most severe natural phenomena that have been historically reported for the site and surrounding area
  - Staff confirmed that the design-basis flood elevation estimate, including the considerations of hypothetical dam failure and wind induced wave height, is sufficiently below site grade (821.0 ft).
  - Staff confirmed that maximum groundwater level (816.1 ft) is approximately 5 ft below site grade
- Staff determined that site characteristics are bounded by plant parameter envelope design parameters

PPE Source Term

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- Staff reviewed the basis and assumptions for developing the accident PPE liquid effluent release source term:
  - Source term information for surrogate plant evaluated from two vendors with preliminary designs
  - One percent failed fuel fraction (verses 0.12 percent in Branch Technical Position [BTP] 11-6) applied in one vendor's source term
  - CRN Site ESP application and Public Service Enterprise Group ESP PPE source terms compared
- Staff performed confirmatory calculations to verify the accident PPE liquid effluent release source term.
- Staff found TVA's methodology for developing the PPE source term to bound the dose to members of the public from a postulated accidental liquid effluent release to the groundwater reasonable.

Radionuclide Transport

- Staff reviewed transport values and assumptions, and performed confirmatory calculations using NUREG/CR-3332 and BTP 11-6:
  - Site-specific radionuclide transport values
  - No credit for mitigating design features
  - 80 percent of tank volume released
  - Instantaneous release into groundwater
  - Peak radionuclides and daughter product concentrations
  - Minimum dilution flow of 400 cubic feet per second to Clinch River
  - Minimal travel distance and decay
- Staff found TVA's methodology for estimating initial radionuclide concentrations from a postulated accidental liquid effluent release to the groundwater reasonable.
- Staff confirmed that the unity rule in 10 CFR Part 20, Appendix B, Table 2, Column 2 was met (considering sorption and retardation).

Dose Evaluation

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- Staff found TVA's methodology for estimating dose from a postulated accidental liquid effluent release to the groundwater using Regulatory Guide 1.109, Environmental Protection Agency's Federal Guidance Reports 11 and 12, and LADTAP II computer code reasonable.
- Staff confirmed that the public dose limit of 100 millirem total effective dose equivalent in 10 CFR 20.1301 was met.
- Staff identified COL Action Item:

COL Action Item 2.4-4

An applicant for a combined license (COL) or a construction permit (CP) referencing this early site permit (ESP) should verify that the calculated dose to members of the public from a postulated accidental liquid radionuclide effluent release to the groundwater from a chosen reactor design at the CRN Site is bounded by the dose evaluated in this ESP application as reviewed by the NRC staff. The applicant should evaluate discrepancies and justify any changes made to address differences in the source term for the reactor design used to calculate the dose for a COL or CP application.

Staff Conclusions

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- Staff proposed site characteristics and bounding design parameters for inclusion in the ESP.
- CRN ESP site characteristics meet requirements of 10 CFR Part 100, “Reactor Site Criteria” and 10 CFR Part 20, “Standards for Protection Against Radiation.”
- Subject to the staff’s proposed conditions (COL Action Items 2.4-1, 2.4-2, 2.4-3, 2.4-4, and 2.5-8), technologies falling within the PPE design parameters for the CRN site characteristics are without undue risk to public health and safety.

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Questions?

Acronyms

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CFR – Code of Federal Regulations

COL – Combined License

CP – Construction Permit

CRN – Clinch River Nuclear

DBF – Design Basis Flood

DOE - Department of Energy

ESP – Early Site Permit

LADTAP – Liquid Annual Doses To All Persons

NRC – Nuclear Regulatory Commission

PPE – Plant Parameter Envelope

SMR – Small Modular Reactor

SSCs – Structures, Systems and Components

TDEC - Tennessee Department of Environment and Conservation

TVA – Tennessee Valley Authority

USGS - U.S. Geological Survey