UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

COMMISSIONERS:

Kristine L. Svinicki, Chairman
Jeff Baran
Annie Caputo
David A. Wright

In the Matter of TENNESSEE VALLEY AUTHORITY (Clinch River Nuclear Site Early Site Permit Application)	Docket No. 52-047-ESP

CLI-19-10

MEMORANDUM AND ORDER

On August 14, 2019, we held a hearing on the application of the Tennessee Valley Authority (TVA) for an early site permit (ESP) for the Clinch River Nuclear site. In this uncontested proceeding, we consider whether the NRC Staff's review of the application has been adequate to support the findings set forth in 10 C.F.R. §§ 52.24(a) and 51.105(a). As discussed below, we find that the Staff's review was sufficient to support the regulatory findings. We authorize issuance of the ESP.

I. BACKGROUND

TVA filed its application for an ESP for the Clinch River site in 2016.[1] Although three organizations sought to intervene and request a hearing, ultimately, none of the intervenors'

[1] *See* Letter from J.W. Shea, TVA, to NRC Document Control Desk (May 12, 2016) (ADAMS accession no. ML16139A752) (Application Transmittal Letter). TVA revised portions of the application in December 2017 and January 2019. *See generally* Exs. NRC-006 to NRC-011, NRC-013A to NRC-013D, Tennessee Valley Authority, Early Site Permit Application. Staff

contentions proceeded to consideration on the merits in a contested hearing.[2] In July 2018, the Atomic Safety and Licensing Board terminated the contested portion of the proceeding.[3]

A. Proposed Action

TVA seeks an ESP for the Clinch River Nuclear site in Oak Ridge, Roane County, Tennessee, on which it proposes to construct two or more light-water small modular reactors (SMRs).[4] The purpose of an ESP is to provide for the early resolution of certain safety and environmental issues relating to the suitability of a proposed site; an ESP does not authorize the construction or operation of a reactor at the site, for which a separate construction permit and operating license or combined license (COL) must be obtained.[5] The ESP for the Clinch River site would, for a duration of twenty years, approve the site as suitable for the construction and

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exhibit NRC-012 contains the non-public portion of the ESP application, and as such, it was filed on the non-public docket for this proceeding.

[2] *See* LBP-17-8, 86 NRC 138 (2017), *rev'd in part*, CLI-18-5, 87 NRC 119 (2018); LBP-18-4, 88 NRC 55 (2018). In LBP-17-8, the Atomic Safety and Licensing Board admitted a contention of omission concerning the environmental impacts of spent fuel pool accidents and a contention alleging that TVA's environmental report contained an impermissible discussion of energy alternatives and need for power. *See* LBP-17-8, 86 NRC at 160-61, 165. On appeal, we reversed the Board's admission of the contention regarding energy alternatives and need for power. *See* CLI-18-05, 87 NRC at 127-29. Upon the Staff's issuance of its Draft Environmental Impact Statement (EIS), which contained an analysis of spent fuel pool accidents, the Board dismissed the remaining admitted contention as moot. *See* LBP-18-4, 88 NRC at 59-60, 68; "Environmental Impact Statement for an Early Site Permit (ESP) at the Clinch River Nuclear Site" (Draft Report for Comment), NUREG-2226, vols. 1-2 (Apr. 2018), at 5-85 to 5-89 (ML18100A220, ML18100A223) (Draft EIS).

[3] LBP-18-4, 88 NRC at 68.

[4] *See* Application Transmittal Letter at 1 (unnumbered).

[5] An ESP allows a future applicant for a construction permit and operating license or COL to seek early NRC review and approval of certain siting and environmental issues and to "bank" a site for up to 20 years in anticipation of its future reference in an application for a construction permit or COL. *See* 10 C.F.R. § 52.26. ESP applicants may request a limited work authorization in conjunction with an ESP. *See* 10 C.F.R. § 52.17(c). TVA did not seek a limited work authorization in this case and has not set a date for any pre-construction activities. Ex. NRC-009A, Tennessee Valley Authority, "Clinch River Nuclear Site Early Site Permit Application, Part 3, Environmental Report," rev. 2 (Jan. 2019), at 1-5 (ML19030A478 (package)) (Environmental Report); Tr. at 48 (Ms. Bradford).

operation of two or more SMRs with a maximum combined electrical output of 800 megawatts electric (MW(e)) and could be referenced as part of a future construction permit or COL application.[6]

As permitted by our regulations, TVA did not reference a specific reactor design in its application.[7] Instead, TVA employed a plant parameter envelope (PPE) approach, in which technical information from various designs is used to develop a set of postulated design parameters that bound the characteristics of any reactor that may be constructed at the site.[8] In developing its PPE, TVA considered four light-water SMR designs under development in the United States at the time of the submission of the application.[9] The Staff relied on the PPE as a surrogate for the future selected reactor design when conducting its safety and environmental reviews.[10]

The Staff spent approximately 40,000 hours, with an additional 6,000 hours from outside technical experts, reviewing TVA's application to determine whether it complies with the Atomic Energy Act of 1954, as amended (AEA), the National Environmental Policy Act of 1969 (NEPA),

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[6] *See* Exs. NRC-015A & NRC-015B, "Environmental Impact Statement for an Early Site Permit (ESP) at the Clinch River Nuclear Site" (Final Report), NUREG-2226, vols. 1-2 (Apr. 2019), at 1-1 to 1-2 (ML19227A213, ML19227A215) (Final EIS); Tr. at 43-44 (Mr. Brown).

[7] *See* 10 C.F.R. § 52.17; *see also* Ex. NRC-014A, "Final Safety Evaluation Report for the Early Site Permit Application for the Clinch River Nuclear Site" (June 2019), at 1-3 to 1-4 (ML19227A216) (Final SER); Ex. NRC-015A, Final EIS, at 1-2 to 1-3.

[8] *See* Ex. NRC-014A, Final SER, at 1-3 to 1-4; Ex. NRC-015A, Final EIS, at 1-2 to 1-3. An applicant for a construction permit or COL referencing the ESP would be required to identify a specific reactor technology. The Staff's environmental and safety reviews of the application would compare "the PPE values and the ESP . . . to those of the selected technology. If the design characteristics of the selected technology exceed the bounding ESP PPE values, additional reviews would be conducted to ensure that the site remains suitable from a safety and environmental standpoint . . . ." Tr. at 45-46 (Ms. Bradford).

[9] *See* Application Transmittal Letter at 1 (unnumbered); Ex. NRC-014A, Final SER, at 1-3; Ex. NRC-015A, Final EIS, at 1-3.

[10] *See* Ex. NRC-014A, Final SER, at 1-3 to 1-4; Ex. NRC-015A, Final EIS, at 3-1.

and the NRC's regulations.[11] The Staff's review included an analysis of the environmental impacts of granting the ESP, including impacts from the construction and operation of two or more SMRs at the Clinch River site and alternate sites, in accordance with NEPA.[12] The Advisory Committee on Reactor Safeguards (ACRS), a committee of technical experts advising the Commission, provided an independent assessment of the safety aspects of the application.[13] The ACRS recommended that the ESP be issued.[14]

B. Review Standards

Section 189a. of the AEA requires that we hold a hearing on each application to construct a nuclear power plant.[15] Additionally, an ESP application is subject "to all procedural requirements in 10 C.F.R. part 2."[16] We issued a notice in the *Federal Register* that set the time and place for the mandatory hearing and outlined the standards for our review of the application.[17] These standards track the two major areas of focus for the review of a license application: the Staff's safety and environmental reviews. With respect to safety matters, we must determine whether:

(1) the applicable standards and requirements of the AEA and the Commission's regulations have been met;

(2) any required notifications to other agencies or bodies have been duly made;

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[11] Tr. at 42 (Mr. Brown).

[12] *See* Ex. NRC-015A, Final EIS, at 4-1, 5-1, 9-2 to 9-3; Tr. at 157 (Ms. Dozier).

[13] *See* Letter from Michael L. Corradini, Chairman, ACRS, to Kristine L. Svinicki, Chairman, NRC (Jan. 9, 2019) (ML19009A286) (ACRS Letter); Tr. at 46 (Ms. Bradford).

[14] ACRS Letter at 1; Tr. at 46 (Ms. Bradford).

[15] *See* AEA § 189a., 42 U.S.C. § 2239(a).

[16] 10 C.F.R. § 52.21; *see id.* § 52.1(a); *see also Exelon Generation Co.* (Early Site Permit for Clinton ESP Site), CLI-05-17, 62 NRC 5, 27-29 (2005).

[17] *See* Tennessee Valley Authority; Clinch River Nuclear Site; Early Site Permit Application; Notice of Hearing, 84 Fed. Reg. 31,358 (July 1, 2019) (Hearing Notice).

(3) there is reasonable assurance that the site is in conformity with the provisions of the AEA and the Commission's regulations;

(4) the applicant is technically qualified to engage in the activities authorized by the early site permit;

(5) issuance of the permit will not be inimical to the common defense and security or to the health and safety of the public; and

(6) the findings required by subpart A of 10 C.F.R. part 51 have been made.[18]

The findings required by subpart A of 10 C.F.R. part 51 reflect our agency's obligations under NEPA, a statute that requires us to consider the impacts of NRC actions on environmental values.[19] To ensure that these obligations are fulfilled for this ESP proceeding, we must

(1) determine whether the requirements of Sections 102(2)(A), (C), and (E) of NEPA and the applicable regulations in 10 C.F.R. part 51 have been met;

(2) independently consider the final balance among conflicting factors contained in the record of the proceeding with a view to determining the appropriate action to be taken;

(3) determine, after weighing the environmental, economic, technical, and other benefits against environmental and other costs, and considering reasonable alternatives, whether the early site permit should be issued, denied, or appropriately conditioned to protect environmental values; and

(4) determine whether the NEPA review conducted by the NRC staff has been adequate.[20]

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[18] Hearing Notice, 84 Fed. Reg. at 31,358 (citing 10 C.F.R. § 52.24). The findings described in 10 C.F.R. § 52.24(a)(5) and (a)(7) are not applicable to the Clinch River site because TVA did not propose inspections, tests, analyses and acceptance criteria under 10 C.F.R. § 52.17(b)(3), nor did it request a limited work authorization under 10 C.F.R. § 52.17(c). *See* Tr. at 48 (Ms. Bradford).

[19] NEPA § 102(2), 42 U.S.C. § 4332(2); 10 C.F.R. § 51.10.

[20] Hearing Notice, 84 Fed. Reg. at 31,358 (citing 10 C.F.R. § 51.105). Because this is an uncontested proceeding, 10 C.F.R. § 51.105(a)(5), which concerns only contested cases, does not apply.

We do not review TVA's application *de novo*; rather, we consider the sufficiency of the Staff's review of the application on both safety and environmental matters.[21] In other words, we consider whether the safety and environmental record is adequate to support issuance of the ESP and whether the Staff's findings are reasonably supported in logic and fact.[22] Under our regulations, we must reach our own independent determination on certain environmental findings—i.e., whether the cited NEPA requirements have been met, what is the appropriate "final balance among conflicting factors," and whether the early site permit "should be issued, denied[,] or appropriately conditioned."[23] But we will not "second guess [the Staff's] underlying technical or factual findings" unless we find the Staff's review incomplete or inadequate or its findings insufficiently explained in the record.[24]

C. The Hearing Process

The Staff completed its Final EIS in April 2019 and its Final SER on June 14, 2019. On June 21, 2019, we received the Staff's information paper regarding its work, which serves as the Staff's pre-filed testimony for the uncontested hearing.[25]

1. Pre-hearing Activities

We issued a Notice of Hearing on July 1, 2019, which set a schedule for pre-hearing filings.[26] We issued fifty-eight questions on environmental and safety-related topics for the Staff

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[21] *See Clinton ESP Site*, CLI-05-17, 62 NRC at 38-39.

[22] *See id*. at 39.

[23] *See id*. at 45 (citing 10 C.F.R. § 51.105(a)(1)-(3)).

[24] *Id.* at 45.

[25] *See* Ex. NRC-001, "Staff's Statement in Support of the Uncontested Hearing for Issuance of an Early Site Permit for Clinch River Nuclear Site," Commission Paper SECY-19-0064 (June 21, 2019) (ML19107A241) (Staff Information Paper).

[26] *See* Hearing Notice, 84 Fed. Reg. at 31,358.

and TVA to answer in writing in advance of the hearing.[27] The questions covered safety-related issues regarding emergency preparedness, seismic hazards, and geologic characteristics of the Clinch River site and environmental issues including the identification of alternative sites, the Staff's interaction with other federal agencies, the consideration of impacts to various resource areas, and the deferred issues related to the construction permit or COL stage.[28]

We also invited interested states, local government bodies, and federally-recognized Indian tribes to provide statements for us to consider as part of the uncontested proceeding.[29] In response, we received comments from the Federal Emergency Management Agency (FEMA) and the Tennessee Emergency Management Agency (TEMA).[30] The letter from FEMA provided comments on TVA's proposal to use a two-mile or site boundary plume exposure pathway (PEP) emergency planning zone (EPZ), which we discuss below.[31] The letter from TEMA expressed support for the ESP and TEMA's commitment "to be an active participant in all emergency planning and Radiological Emergency Preparedness exercises and evaluations to assure that this project meets or exceeds all standards as they are refined or developed."[32]

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[27] *See* Order of the Secretary (Transmitting Pre-Hearing Questions) (July 12, 2019) (unpublished) (Pre-Hearing Questions Order).

[28] *See generally id*.

[29] *See* Hearing Notice, 84 Fed. Reg. at 31,358-59.

[30] *See* Letter from Michael S. Casey, FEMA, to the Secretary of the Commission (July 8, 2019) (ML19189A318) (FEMA Letter); Letter from Patrick C. Sheehan, TEMA, to the Secretary of the Commission (July 9, 2019) (ML19191A060) (TEMA Letter).

[31] FEMA Letter at 1-2 (unnumbered). Our regulations describe two separate EPZs: a "plume exposure pathway" EPZ of about ten miles from a power reactor site and an "ingestion pathway" EPZ of about fifty miles from a power reactor site. *See* 10 C.F.R. § 50.33(g). This case involves consideration of exemptions to our requirements for the PEP EPZ but not the ingestion pathway EPZ. *See* Ex. NRC-014A, Final SER, at 13-60. Hereinafter, when we refer to the "EPZ" or TVA's "EPZ-sizing methodology," we refer only to the PEP EPZ.

[32] TEMA Letter at 1 (unnumbered).

2. The Hearing

The scheduling note, issued to the parties before the hearing, set the topics for and the order of presentations at the hearing.[33] In the first panel, witnesses for TVA provided an overview of TVA's SMR project and the Clinch River ESP application. In the second panel, witnesses for the Staff provided an overview of the ESP review process and a summary of the Staff's review and regulatory findings. The third panel focused on safety-related issues, and the fourth panel focused on environmental issues. The Staff made available twenty-two witnesses at the hearing.[34] Nine of these witnesses were scheduled panelists; the remainder stood by to answer questions on topics related to their areas of expertise.[35] A total of nine TVA witnesses attended the hearing, six of whom offered testimony on behalf of TVA on panels at the hearing and in pre-filed written testimony.[36]

a. Summary of the Overview Panels

Joe Shea, TVA Vice President of Regulatory Affairs and Support Services, and Dan Stout, TVA Director of Nuclear Technology Innovation, provided testimony for the TVA overview

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[33] Memorandum from Annette L. Vietti-Cook, Secretary of the Commission, to Counsel for the Applicant and Staff (Aug. 9, 2019) (ML19221B631) (Scheduling Note).

[34] *See NRC Staff Revised Witness List* (Aug. 12, 2019), Attach. (ML19224C641); Tr. at 13.

[35] *See* Ex. NRC-016-R, Staff Presentation Slides—Overview (Aug. 12, 2019), at 1-2 (ML19227A247); Ex. NRC-017, Staff Presentation Slides—Safety Panel (Aug. 7, 2019) (ML19227A244), at 2 (Staff Safety Panel Presentation); Ex. NRC-018, Staff Presentation Slides—Environmental Panel (Aug. 7, 2019) (ML19227A246), at 2 (Staff Environmental Panel Presentation).

[36] *See Tennessee Valley Authority's Amended Witness List* (Aug. 2, 2019), at 1-3 (ML19214A247); Tr. at 11; Ex. TVA-001, *Applicant's Pre-filed Testimony in Support of the Mandatory Hearing for the Clinch River Nuclear Site Early Site Permit* (July 26, 2019) (ML19227A223); Ex. TVA-004, Tennessee Valley Authority's Presentation Slides—Overview (Aug. 7, 2019) (ML19227A237); Ex. TVA-005, Tennessee Valley Authority's Presentation Slides—Safety Panel (Aug. 7, 2019), at 1 (ML19227A238) (TVA Safety Panel Presentation); Ex. TVA-006, Tennessee Valley Authority's Presentation Slides—Environmental Panel (Aug. 7, 2019), at 1 (ML19227A239); Ex. TVA-007, Tennessee Valley Authority's Presentation Slides—Conclusion (Aug. 7, 2019) (ML19227A240).

panel.[37] Mr. Shea provided background on TVA and its mission.[38] Mr. Stout described TVA's technical qualifications and objectives for the Clinch River SMR project.[39] Mr. Stout also answered questions regarding the effectiveness of TVA's interaction with the Staff during its review and the design-driven safety enhancements expected of SMR technology.[40]

Frederick Brown, Director of the Office of New Reactors (NRO), and Anna Bradford, Deputy Director of the Division of Licensing, Siting and Environmental Analyses, NRO, provided background on the Staff's review of the Clinch River ESP.[41] Mr. Brown provided an overview of the Clinch River ESP application.[42] Ms. Bradford described the Staff's safety and environmental reviews and the regulatory standards governing those reviews.[43] Ms. Bradford also provided the Staff's findings in support of issuance of the ESP.[44] Ms. Bradford answered questions relating to the applicant's decision to defer its analysis of the need for power; Mr. Brown and Ms. Bradford each addressed questions regarding lessons learned from the Staff's review of the ESP application.[45]

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[37] Tr. at 16-39; Scheduling Note, Encl. at 1.

[38] Tr. at 16-21.

[39] Tr. at 21-29.

[40] Tr. at 31-36.

[41] Tr. at 39-56; Scheduling Note, Encl. at 2.

[42] Tr. at 41-44.

[43] Tr. at 44-56.

[44] Tr. at 47-48, 53-56.

[45] Tr. at 57, 58-62.

b. Summary of the Safety Panel

The safety panel focused on Parts 2, 5, and 6 of the ESP application and corresponding chapters of the Final SER.[46] Mr. Stout; Archie Manoharan, TVA Senior Program Manager of Site Nuclear Licensing; Alex Young, TVA Mechanical Engineer for Design; and Wally Justice, President, NAVCON Consulting Services, LLC, served as witnesses for TVA.[47] Allen Fetter, NRO Senior Project Manager; Mallecia Sutton, NRO Senior Project Manager; Bruce Musico, Senior Emergency Preparedness Specialist, Office of Nuclear Security and Incident Response (NSIR); Michelle Hart, NRO Senior Reactor Engineer; and Michael Scott, Director of the Division of Preparedness and Response, NSIR, testified for the Staff.[48]

TVA presented testimony on the ESP application's emergency preparedness approach.[49] Ms. Manoharan described the two alternative "major features" emergency plans submitted as part of the ESP application and the exemptions TVA sought from the EPZ requirements in 10 C.F.R. part 50.[50] Mr. Young discussed the EPZ-sizing methodology that TVA used in its application.[51] The Staff focused its presentation on novel issues relating to emergency preparedness that the Staff identified in its review of the application, including the Staff's evaluation of and conclusions on TVA's proposed exemptions from certain emergency planning requirements and the risk-informed, dose-based, and consequence-oriented

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[46] Tr. at 64-74, 80-82; Ex. TVA-005, TVA Safety Panel Presentation, at 2-11; Ex. NRC-017, Staff Safety Panel Presentation, at 11-29, 39-42.

[47] Tr. at 64-74; Scheduling Note, Encl. at 2.

[48] Tr. at 74-100; Scheduling Note, Encl. at 2.

[49] Tr. at 64-74.

[50] Tr. at 64-70.

[51] Tr. at 70-73.

methodology for determining the appropriate EPZ for SMRs at the Clinch River site.[52] The Staff also summarized its proposed permit conditions.[53] Mr. Scott answered questions relating to TVA's EPZ-sizing methodology, the basis for the Staff's approval of that methodology, and questions regarding the Staff's consultation with FEMA.[54]

c. Summary of the Environmental Panel

The environmental panel focused on relevant sections of TVA's environmental report and the Staff's Final EIS. Mr. Stout; Mr. Holcomb; Jeff Perry, TVA Senior Project Manager; and Ruth Horton, TVA Program Manager for Environmental Support represented TVA.[55] Tamsen Dozier, NRO Project Manager, and Kenneth Erwin, Chief of the NRO Environmental Technical Review Branch, testified on behalf of the Staff.[56] The TVA witnesses discussed the regulatory bases for the environmental report, the site selection process, characteristics of the Clinch River site, their environmental impact conclusions, and their interactions with state and federal agencies.[57] The Staff described the proposed federal action, the Clinch River project objectives, as well as the Staff's environmental review process, evaluation of alternatives to the proposed action, consultation with other agencies and Indian tribes, and consideration of and conclusions on environmental impacts.[58] Ms. Dozier answered questions relating to the Staff's consideration

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[52] Tr. at 79-92; Scheduling Note, Encl. at 2-3.

[53] Tr. at 77 (Ms. Sutton).

[54] Tr. at 101-06, 120-32, 134-38.

[55] Tr. at 146; Scheduling Note, Encl. at 3.

[56] Tr. at 153; Scheduling Note, Encl. at 3.

[57] Tr. at 146-52.

[58] Tr. at 163-69.

of the benefits of the proposed action, and Mr. Erwin addressed questions regarding the Staff's consideration of alternatives.[59]

Following the environmental panel, witnesses for TVA and the Staff each provided a short closing statement, and the Staff addressed additional questions from the Commission.[60]

3. Post-Hearing Activities

After the hearing, we issued additional questions for written answers from the Staff.[61] We also received a supplemental letter from FEMA regarding information presented by the Staff at the hearing.[62] We admitted the Staff's response to our post-hearing questions as an exhibit, and we adopted corrections to the hearing transcript.[63] The Staff responded to FEMA's supplemental letter, we admitted that response as an exhibit, and closed the evidentiary record for the uncontested proceeding.[64]

II. DISCUSSION

The discussion that follows provides a survey of the key facts that support our findings and certain site-specific and novel issues in the Staff's safety and environmental reviews. Our review and our decision to authorize issuance of the Clinch River ESP, however, is based on

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[59] Tr. at 172-74.

[60] Tr. at 178-84, 185-87.

[61] *See* Order of the Secretary (Transmitting Post-Hearing Questions) (Aug. 21, 2019) (unpublished) (Post-Hearing Questions Order).

[62] *See* Letter from Michael S. Casey, FEMA, to the Secretary of the Commission (Aug. 24, 2019) (ML19240A938) (Supplemental FEMA Letter).

[63] *See* Ex. NRC-019, NRC Staff Responses to Commission Post-Hearing Questions and Request for Additional Record Corrections (Aug. 28, 2019) (ML19259A099) (Staff Post-Hearing Responses); *see also* Order of the Secretary (Adopting Proposed Transcript Corrections, Granting Motions Requesting Additional Record Corrections and Leave to Submit a Response to FEMA's Post-Hearing Letter, Admitting Post-Hearing Exhibits, and Closing the Record of the Proceeding) (Sep. 13, 2019) (unpublished) (Transcript Correction Order).

[64] Ex. NRC-020, NRC Staff Response to FEMA Post-Hearing Letter (Sept. 5, 2019) (ML19259A100) (Staff Response to Post-Hearing Letter); Transcript Correction Order.

the record in its entirety.[65] Further, we emphasize that our authorization of the ESP for the Clinch River site does not constitute authorization to construct or operate a reactor at the site. The construction and operation of one or more reactors at the Clinch River site would require further authorization from the NRC and the attendant consideration of any safety and environmental issues that are not resolved in this ESP proceeding.[66]

A. The Clinch River Site

The Clinch River site is located within the city limits of the City of Oak Ridge, in Roane County, Tennessee.[67] The site encompasses approximately 935 acres of land on a peninsula within a 1,200 acre parcel of land owned by the United States and administered by TVA.[68] The U.S. Department of Energy's Oak Ridge Reservation and Wildlife Management Area borders the site to the north, and the Clinch River arm of the Watts Bar Reservoir bounds the site to the east, south, and west.[69] Some basic infrastructure features, including service roads and storm water retention structures, are present on the site.[70] Two transmission lines intersect the

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[65] *See Exelon Generation Co., LLC* (Early Site Permit for Clinton ESP Site), CLI-06-20, 64 NRC 15, 21-22 (2006) (in a mandatory hearing, a presiding officer "must narrow its inquiry to those topics or sections in Staff documents that it deems most important and should concentrate on portions of the documents that do not on their face adequately explain the logic, underlying facts, and applicable regulations and guidance.").

[66] *See System Energy Resources, Inc.* (Early Site Permit for Grand Gulf ESP Site), CLI-07-14, 65 NRC 216, 218-19 (2007); *see also Dominion Nuclear North Anna, LLC* (Early Site Permit for North Anna ESP Site), 66 NRC 215, 235 (2007) ("[c]ourts have permitted agencies to defer certain issues in an EIS for a multistage project when detailed useful information on a given topic is not 'meaningfully possible' to obtain, and the unavailable information is not essential to determination at the earlier stage." (quoting *Environmental Law & Policy Center v. U.S. NRC*, 470 F.3d 676, 684 (7th Cir. 2006))).

[67] Ex. NRC-014A, Final SER, at 2-2.

[68] *Id*.; Ex. NRC-002, Draft Early Site Permit, at 1; Tr. at 24 (Mr. Stout).

[69] Ex. NRC-014A, Final SER, at 2-2; Tr. at 24 (Mr. Stout).

[70] Tr. at 25, 30-31 (Mr. Stout).

property, and this feature would "mak[e] transmission connection relatively easy."[71] There are no residences or businesses within the Clinch River site boundary. TVA controls all activities within, and access to, the site and prohibits recreational activities and hunting on the property.[72] TVA also controls access to a small family cemetery and a single Native American burial mound on the property.[73] Although no public transportation routes cross the property, U.S. Interstate 40 (I-40) passes the site approximately 0.6 miles to the southeast, and Tennessee state Routes 58 and 95 pass within approximately 0.9 and 2.6 miles of the site, respectively.[74]

The City of Oak Ridge is the largest community within ten miles of the Clinch River site and had, as of the time of the 2010 census, a population of 29,330.[75] Other communities located near the site, all in Tennessee, include Kingston, approximately seven miles to the west; Harriman, approximately nine miles to the west-northwest; Lenoir City, approximately nine miles to the southeast; and Knoxville, approximately twenty-six miles to the east-northeast.[76]

The Clinch River site has undergone prior site characterization studies performed when it was proposed as the location for the subsequently cancelled Clinch River Breeder Reactor Project.[77] Prior studies were used (along with field studies and other current information) to characterize geotechnical and hydrogeological conditions at the site.[78] Previous site

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[71] Ex. NRC-014A, Final SER, at 1-3; Tr. at 24-25 (Mr. Stout).

[72] Ex. NRC-014A, Final SER, at 2-5.

[73] *Id*.

[74] *Id*. at 2-2, 2-5.

[75] *Id*. at 1-2.

[76] Ex. NRC-002, Draft Early Site Permit, at 1.

[77] Ex. NRC-014A, Final SER, at 2-135 to 2-137.

[78] *Id.* at 2-140; Tr. at 115-16 (Mr. Stout). Prior site characterization studies resulted in an unknown number of abandoned wells. The Staff found, however, that potential groundwater movement through undiscovered wells poses no safety exposure risks based on the Staff's evaluation of groundwater flow and discharge at the site. *See* Ex. NRC-014A, Final SER, at

characterization also significantly aided in the understanding of karst formations in the area, which include caves, cavities, and sinkholes. Karst formations are caused by dissolution of carbonate bedrock and constitute the primary geologic hazard at the Clinch River site.[79] TVA conducted detailed mapping of the Clinch River site to develop an inventory of those formations.[80] The Staff proposed permit conditions to minimize the adverse effects of karst features on the stability of subsurface materials and foundations.[81] The permit conditions would require excavations and detailed geologic mapping of excavations for safety-related structures at the Clinch River site to provide additional information before construction is authorized.[82]

The Clinch River site features non-horizontal layers of geologic strata, which the Staff found were appropriately investigated through geophysical testing and properly considered in TVA's evaluation of seismic hazards.[83] The Clinch River site is considered a dry site because it sits at an elevation higher than maximum flood levels, such that flooding would have no safety-related impact.[84]

B. Plant Parameter Envelope

In lieu of selecting a specific reactor technology for deployment at the Clinch River site, TVA used a PPE approach in its ESP application.[85] To serve as an effective surrogate for a

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2-140 to 2-143; Ex. NRC-005, *NRC Staff Responses to Pre-Hearing Questions* (July 26, 2019), Attach. at 3 (Staff Pre-Hearing Responses).

[79] Ex. NRC-014A, Final SER, at 2-200.

[80] Ex. NRC-014A, Final SER, at 2-185.

[81] Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 6-7.

[82] *Id*.; Ex. NRC-014A, Final SER, at 2-304, 2-249 to 2-250.

[83] Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 8-12.

[84] Ex. NRC-014A, Final SER, at 2-82, 2-84; Tr. at 108 (Mr. Giacinto).

[85] Ex. NRC-014A, Final SER, at 1-3.

specific reactor design, a PPE "should provide sufficient bounding parameters and characteristics of the reactor or reactors and the associated facilities so that an assessment of site suitability can be made."[86] TVA's PPE for this ESP application was informed by the designs of four light water SMRs under development in the United States—BWXT mPowerTM SMR (Generation mPower LLC), Holtec SMR-160 (Holtec SMR, LLC), NuScale SMR (NuScale Power, LLC), and Westinghouse SMR (Westinghouse Electric Company, LLC).[87] TVA's ESP application assumes the deployment and operation of two or more SMRs with "a maximum of 800 megawatts thermal for each individual reactor unit and a maximum of 2,420 megawatts thermal," with combined maximum generating capacity of 800 MW(e) for the site.[88]

C. Emergency Planning Zones

This case presents us with our first opportunity to consider how current emergency planning zone requirements, originally developed for large, light-water reactors (~1200 MW(e)) (LLWRs), should be applied to SMRs. We recently indicated our willingness to revisit the current framework in this context, and in 2015 we directed the Staff to initiate rulemaking to revise emergency planning regulations and guidance for SMRs and other new technologies.[89] We further directed that "[f]or any small modular reactor reviews conducted prior to the establishment of a rule, the staff should be prepared to adapt an approach to emergency planning zones for SMRs under existing exemption processes, in parallel with its rulemaking efforts."[90]

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[86] Ex. NRC-015A, Final EIS, at 1-2 to 1-3.

[87] *Id*. at 1-3; Tr. at 23 (Mr. Stout).

[88] Tr. at 25 (Mr. Stout); *see* Ex. NRC-014A, Final SER, at 1-2; Tr. at 45 (Ms. Bradford).

[89] *See* Staff Requirements—SECY-15-0077—Options for Emergency Preparedness for Small Modular Reactors and Other New Technologies (Aug. 4, 2015) (ML15216A492).

[90] *Id*.

The Staff followed that direction in its review of TVA's requested exemptions in this case.[91] TVA requested exemptions from our regulations governing power reactor EPZ size, which generally establish a nominal ten-mile radius around a power reactor for the EPZ. TVA proposed either a two-mile or site boundary EPZ using a dose-based, consequence-oriented EPZ-sizing methodology based in part on the Environmental Protection Agency's (EPA) protective action guides (PAGs).[92] As a result, TVA submitted two distinct "major features" emergency plans as part of its application, one that assumes a 2-mile EPZ and another that assumes a site boundary EPZ.[93] The Staff concluded that TVA's methodology for establishing a two-mile and site boundary EPZ is consistent with the methodology used to establish the ten-mile EPZs reflected in our current regulations, and recommended that the exemptions be granted.[94]

The ACRS also evaluated and examined TVA's EPZ-sizing methodology through a series of briefings held between May and December 2018.[95] Those briefings provided the ACRS with the opportunity to question both TVA and Staff representatives on the principles underlying TVA's proposed risk-informed, dose-based, consequence-oriented approach to determine the plume exposure pathway EPZ sizing methodology.[96] The ACRS concluded that the Staff was correct in determining that TVA's EPZ-sizing methodology is "consistent with analyses that form the technical basis of the current [ten-mile] PEP EPZ and maintains the

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[91] *See* Ex. NRC-014A, Final SER, at 13-31 to 13-61.

[92] *See* Ex. NRC-010, "Clinch River Nuclear Site; Early Site Permit Application; Parts 5A and 5B, Emergency Plan," rev. 1 (Dec. 2017) (ML19227A202) (Emergency Plan Application).

[93] *See id.* The Staff found each plan acceptable, subject to certain conditions set forth in the ESP. *See* Ex. NRC-014A, Final SER, at 13-126 to 13-130.

[94] Tr. at 87-88 (Ms. Hart).

[95] ACRS Letter at 1.

[96] *Id.* at 1, 4-5.

same level of protection"[97] and that "the design characteristics within the plant parameter envelope used by TVA in developing its Clinch River Nuclear Site early site permit application can be constructed and operated without undue risk to the health and safety of the public."[98] Consequently, the ACRS recommended that TVA's exemption requests should be granted.[99]

Neither TVA nor the Staff proposes to definitively establish the EPZ for the Clinch River site now because TVA's EPZ-sizing methodology would require evaluation of design-specific accident scenarios against dose criteria. At this point, no specific reactor design has been chosen for this detailed analysis. Rather, the Staff evaluated "the reasonableness of the applicant's proposed method for determining the" EPZ, which would be used by a future COL or construction permit applicant as justification for using a two-mile or site boundary EPZ in a future application.[100] According to the Staff, a future applicant would need to "confirm that the criteria are met for the selected . . . EPZ, using the specific information related to potential accidents that result in airborne radiological releases for the plant design chosen to be constructed and operated at the [Clinch River] Site."[101] If a future applicant shows that its selected SMR design could meet the dose criteria established in TVA's EPZ-sizing methodology at either a two-mile radius or the site boundary, then one of the two "major features" emergency

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[97] *Id.* at 5.

[98] *Id.* at 1.

[99] *Id.* at 1, 5.

[100] Ex. NRC-014A, Final SER, at 13-16.

[101] *Id*. at 13-15.

plans submitted by TVA in this case could be used.[102] Otherwise, a new emergency plan would need to be developed.[103]

FEMA largely disagreed with TVA's proposed EPZ-sizing methodology and the potential future approval of a two-mile or site boundary EPZ. Prior to the hearing, FEMA communicated several concerns with the smaller EPZs being proposed in this case, including assertions that TVA's EPZ-sizing methodology misapplies EPA's PAGs for radiological accidents.[104] FEMA also noted that "State, Local, Tribal and Territorial . . . stakeholders must play a central role in managing and mitigating the risk by determining the appropriate offsite radiological [emergency planning] requirements" because radiological emergency preparedness is "unique" and "not sufficiently addressed" in an all-hazards emergency planning framework.[105] Finally, FEMA questioned whether the emergency preparedness framework applied by the Staff included the full spectrum of threats that can give rise to a reactor accident.[106]

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[102] Although TVA has not chosen a specific SMR design to construct and operate, it used design values from the PPE to demonstrate its methodology. TVA found that a two-mile EPZ "provides reasonable assurance of public health and safety from any of the four SMR designs within the PPE," and it is possible that at least one of the SMR designs will demonstrate that the 1 rem total effective dose equivalent threshold established in the EPA PAG Manual will not be exceeded at the site boundary. *Id*. at 13-27.

[103] As TVA has acknowledged, "[i]f the dose consequences of the selected technology exceed the EPA PAG or present a substantial risk that doses at which significant early health effects may occur for the PEP EPZ boundary at a two-mile radius, then neither Emergency Plan included [in the ESP application] will be incorporated by reference in the [COL application] and a new Emergency Plan will be included in the [COL application] for NRC review." Ex. NRC-008, "Clinch River Nuclear Site; Early Site Permit Application; Part 2, Site Safety Analysis Report," rev. 2 (Jan. 2019) (ML19227A256) at 13.3-13 (SSAR).

[104] *See* FEMA Letter at 1-2; *see* U.S. Environmental Protection Agency, Office of Radiation and Indoor Air, "PAG Manual: Protective Action Guides and Planning Guidance for Radiological Incidents" (Jan. 2017) (2017 PAG Manual).

[105] FEMA Letter at 2.

[106] *See id*. at 1-2.

To evaluate FEMA's concerns and determine for ourselves the sufficiency of the Staff's review, we posed several questions to the Staff before, during, and after our hearing regarding the EPZ-sizing methodology and related exemptions proposed in this case.[107] Representatives from FEMA attended the hearing, and, as noted above, FEMA provided a supplemental letter following the hearing.[108] We considered both the FEMA supplemental letter and the Staff's response to FEMA's supplemental letter.[109]

After considering the entire record, and as explained in greater detail below, we agree with the Staff that TVA's EPZ-sizing methodology is "reasonable and consistent with the analyses that form the technical basis for the current regulatory requirement of a plume exposure pathway EPZ with about a ten-mile radius for large LWRs."[110] We also agree that the proposed methodology would result in an EPZ that "maintains the same level of protection in the environs of the [Clinch River site] as that which exists at the [ten-mile] plume exposure pathway EPZ for large LWRs."[111] Therefore, we approve the Staff's proposal to grant TVA's requested exemptions to our ten-mile EPZ requirements and associated emergency plan regulations.

1. Methodology Used to Establish Ten-Mile EPZs

Our existing EPZs are based upon work done by a joint NRC-EPA task force, which first introduced the concept of EPZs to our regulatory framework in the late 1970s.[112] The task

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[107] *See* Pre-Hearing Questions Order at 2, 8-15; Tr. at 101-06, 111-14, 117-44; Post-Hearing Questions Order at 2-4.

[108] *See* Tr. at 7 (Chairman Svinicki); Supplemental FEMA Letter; Ex. NRC-020, Staff Response to Post-Hearing Letter.

[109] *See* Supplemental FEMA Letter; Ex. NRC-020, Staff Response to Post-Hearing Letter.

[110] Ex. NRC-001, Staff Information Paper, at 14.

[111] *Id*.

[112] *See* "Planning Basis for the Development of State and Local Government Radiological Emergency Response Plans in Support of Light Water Nuclear Power Plants," NUREG-0396/EPA-520 (Dec. 1978) (ML051390356) (NUREG-0396/EPA-520).

force's report, NUREG-0396/EPA-520, considered a number of different potential bases for LLWR emergency planning and developed a methodology for defining EPZs. The Commission endorsed the task force's report and methodology shortly after publication in 1978. The report continues to form the basis for our current ten-mile EPZ requirements.[113]

The task force was convened shortly after the Conference of Radiation Control Program Directors passed a resolution in 1976 that requested that the NRC "make a determination of the most severe accident basis for which radiological emergency response plans should be developed by offsite agencies."[114] The task force "interpreted the request as a charge to provide a clearer definition of the types of radiological accidents for which States and local governments should plan and develop preparedness programs." [115]

The task force identified three key factors to effective radiological emergency planning: 1) "[t]he distance to which planning for the initiation of predetermined protective actions is warranted"; 2) "[t]he [time-dependent] characteristics of potential releases and exposures"; and 3) "[t]he kinds of radioactive materials that can potentially be released to the environment."[116] Of these factors, "the most important guidance for planning officials is the distance from the nuclear facility which defines the area over which planning for predetermined actions should be carried out."[117]

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[113] *See* Policy Statement, Planning Basis for Emergency Responses to Nuclear Power Reactor Accidents, 44 Fed. Reg. 61,123 (Oct. 23, 1979); Emergency Planning; Final Rule, 45 Fed. Reg. 55,402 (Aug. 19, 1980).

[114] NUREG-0396/EPA-520, app. II at II-14.

[115] *Id*.

[116] NUREG-0396/EPA-520 at 8.

[117] *Id*. As NUREG-0396/EPA-520 makes clear, emergency planning for reactor accidents took place well before the establishment of EPZs. *See id*., app. II at II-1 to II-8. Establishment of EPZs was an attempt to improve consistency regarding reactor emergency planning by

The task force concluded that the appropriate planning distance should be determined by consideration of a spectrum of accident consequences tempered by probability considerations and that no single reactor accident scenario should drive determination of EPZ size.[118] Rather, "the objective of emergency response plans should be to provide dose savings for a spectrum of accidents that could produce offsite doses in excess of the PAGs" published by EPA.[119] More specifically, the EPZ should be the area beyond which the projected dose from design basis accidents (DBAs) and less severe core damage accidents (i.e., accidents not involving large releases of radioactive material to the environment) would not likely exceed the EPA early-phase PAGs. Additionally, the EPZ should be of sufficient size to provide for substantial reduction in early severe health effects in the event of more severe core-melt sequence accidents (i.e., beyond-design basis accidents with release of substantial quantities of radioactive materials to the environment).[120]

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generically defining the areas within which predetermined, as opposed to *ad hoc*, emergency planning should take place.

[118] NUREG-0396/EPA-520 at 4-6, 15-17.

[119] *Id*. at 5. FEMA has commented in this case that the use of PAGs to assist in the determination of an EPZ boundary is "an incorrect application of the EPA PAG" because they "are not guides to define the need for offsite preparedness." Supplemental FEMA Letter at 1. Although we agree that the PAGs do not "define the need for offsite preparedness," we disagree that using them in combination with accident-consequence analysis to determine EPZ size is "an incorrect application." As the Staff noted in its testimony and in its response to FEMA's post-hearing letter, the 2017 revision to the EPA PAG manual explicitly states that "the size of the EPZ is based on the maximum distance at which a PAG might be exceeded." Tr. at 97 (Mr. Scott); *see also* Ex. NRC-020, Staff Response to Post-Hearing Letter, at 2 (citing 2017 PAG Manual, at 23). And as NUREG-0396/EPA-520 makes clear, our development of the ten-mile EPZ currently contained in 10 C.F.R. § 50.33(g) explicitly relied on the EPA PAGs to determine where to draw that boundary. NUREG-0396/EPA-520 at 15-17. We therefore see no basis to revisit or revise the well-established use of PAGs to guide EPZ sizing.

[120] TVA has used a methodical procedure for selecting accident scenarios from the plant-specific probabilistic risk assessment and categorizing them as "less severe" or "more severe," based on core damage frequency (CDF). Ex. NRC-014A, Final SER, at 13-7. The less severe accident category includes core-melt accidents with intact containment, beyond-design basis scenarios, and accident scenarios with mean CDFs greater than 1×10^{-6}/reactor-yr. *Id.* The more severe accident category includes core-melt accidents with postulated containment

The task force considered but rejected rationales other than a dose-based, consequence-oriented accident analysis for radiological emergency planning, and also considered public perception of radiation hazards.[121] The task force suggested that if one were to compare the probability of reactor accidents to other public hazards, radiological emergency planning might arguably be "a matter of prudence rather than necessity" because "society tolerates much more probable non-nuclear events with similar consequence spectrums without any specific planning."[122] The task force further observed that nuclear "reactors are unique in this regard [because] radiation tends to be perceived as more dangerous than other hazards because the nature of radiation effects are less commonly understood and the public generally associates radiation effects with the fear of nuclear weapons effects," and that "[r]adiological emergency planning is not based upon probabilities, but on public perceptions of the problem and what could be done to protect health and safety. In essence, it is a matter of prudence rather than necessity."[123] Therefore, the task force rejected the idea that a comparison of the risks or probabilities of reactor accidents against the risks or probabilities of other public hazards should drive radiological emergency planning.[124] Instead, the task force conservatively

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bypass or failure with potential for higher consequences with mean CDFs greater than 1×10^{-7}/reactor-yr. *Id.*

[121] *See* NUREG-0396/EPA-520, app. I at I-1 to I-4.

[122] *Id.* at I-2.

[123] *Id*. at I-1 to I-2. FEMA cites this language from NUREG-0396/EPA-520 in its August 24, 2019, letter, stating that FEMA "supports a methodology for EPZ sizing that takes into account such 'non-technical' criteria." Supplemental FEMA Letter at 2. To the extent FEMA suggests that the task force based its determination of an appropriate EPZ size on public perception or other "non-technical" criteria, we disagree. The technical criteria and quantitative methodology applied to determine EPZ size in NUREG-0396/EPA-520 are fully described beginning on page 4 of Appendix I of that report. The criteria and methodology do not include public perception of an appropriate EPZ.

[124] NUREG-0396, app. I at I-2 to I-4.

determined that “the calculated consequences from a spectrum of postulated accidents,” including accidents that may be less likely than other public hazards, should be used to determine the appropriate radiological emergency planning basis.[125]

The task force’s accident-analysis methodology modeled the dose consequences of a range of accidents at LLWRs, compared the resulting doses to various dose thresholds—including the EPA PAGs and the dose at which significant early injuries start to occur, and defined a planning zone according to the distance at which various dose thresholds could be exceeded, tempered by probability considerations.[126] The task force determined the size of the EPZ by evaluating DBA data from licensees’ Final Safety Analysis Reports (FSARs) and accident sequences, risk, and source term data from NUREG-75/014 (WASH-1400), “Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants,” October 1975. The task force’s analysis showed a ten-mile EPZ would be “of sufficient size to provide dose savings to the population in areas where the projected dose from design basis accidents could be expected to exceed the applicable PAGs under unfavorable atmospheric conditions.”[127] A ten-mile EPZ would also provide for substantial reduction in early severe health effects in the event of the more severe accidents.[128]

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[125] *Id*. at I-3 to I-4.

[126] *Id*. at I-4 to I-7.

[127] *Id.* at 16. The phrase “same level of protection” as used by the NRC staff refers to “dose savings” and not to overall established emergency response capabilities. As with all events, the response capabilities should be proportional to the hazard. The EPA PAGs are used for EPZ sizing to avoid the negative impacts of evacuations when they are not exceeded by the positive result of the evacuation (i.e., reduced radiation exposure and thus reduced stochastic risk). EPA’s PAG Manual states that, “[w]hen dose projections are at levels less than 1 rem (10 mSv) over the first four days, evacuation is not recommended due to the associated risks of moving large numbers of people.” 2017 PAG Manual at 16.

[128] NUREG-0396/EPA-520 at 17.

FEMA criticized TVA's EPZ-sizing methodology, claiming that it misapplied the PAGs for radiological accidents.[129] But the Staff found TVA's proposed methodology for calculating the EPZ is consistent with the methodology used in NUREG-0396/EPA-520, which, as discussed above, explicitly uses PAGs in determining the appropriate EPZ size for LLWRs.[130] We therefore agree with the Staff that TVA's EPZ-sizing methodology appropriately applied the PAGs as a threshold for EPZ sizing.

2. TVA's Proposed EPZ-Sizing Methodology

The Staff found that TVA's proposed methodology for calculating the EPZ is consistent with the methodology used in NUREG-0396/EPA-520. The methodology includes four steps: 1) select and categorize accident scenarios; 2) develop the fission product release to the environment as a function of time (radiological release source term); 3) calculate the projected dose consequences at a distance, and compare them to dose criteria for DBAs and less severe accidents; and 4) calculate the probability of dose exceedance at a distance, and evaluate the substantial reduction in early health effects criterion for more severe accidents.[131]

Before reviewing the four-step methodology, the Staff first reviewed TVA's dose criteria. TVA's dose criteria are 1) that the EPZ should encompass the areas in which projected dose from DBAs and less severe core-melt accidents could exceed the EPA early phase PAGs, and 2) the EPZ should be of sufficient size to provide for substantial reduction in early severe health

[129] *See* FEMA Letter at 2.

[130] *See* Ex. NRC-014A, Final SER, at 13-126.

[131] *Id.*

effects in the event of more severe core-melt accidents.[132] These dose criteria are consistent with those in NUREG-0396/EPA-520.[133]

The Staff proceeded to evaluate TVA's methodology for calculating the EPZ and first found TVA's approach to accident selection and categorization consistent with the methodology used in NUREG-0396/EPA-520.[134] Specifically, TVA proposed to evaluate design basis, less-severe, and more-severe accidents to determine the EPZ size.[135] This approach contemplates description of design basis accidents in the FSAR developed for the selected SMR design, which the Staff would review in accordance with its standard review plan.[136] TVA would develop a range of severe accident scenarios for evaluation based on design-specific probabilistic risk analysis and core damage frequencies, and the Staff would also review and verify.[137]

Second, the Staff reviewed TVA's planned approach for developing design-specific radiological source terms, to be used in accident analyses once a specific SMR design is proposed. The Staff found TVA would develop the source terms in accordance with NRC-accepted methodologies, and the Staff would review the source terms in detail once

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[132] *See id.* at 13-16. TVA's criterion for "substantial reduction in early severe health effects" is that "the conditional probability of acute dose exceeding a 200 rem whole body dose from more severe accident scenarios is less than 1×10^{-3} per reactor-year (rx-yr)." *Id*. at 13-17. The Staff found this criterion acceptable because it is "similar to the criterion used to evaluate consequences of very severe accidents (e.g., less probable core damage accidents that release very large quantities of radioactive material to the atmosphere) in NUREG–0396," and "based upon the same reasoning that was used as the technical basis for the PEP EPZ distance, as codified in NRC regulations." *Id*.

[133] *See id*. at 13-16 to 13-17.

[134] *See id*. at 13-17 to 13-18.

[135] *Id*.; Ex. NRC-008, SSAR, at 13.3-8.

[136] Ex. NRC-014A, Final SER, at 13-17 to 13-18.

[137] *Id*.

submitted.[138] With regard to the third and fourth considerations, the Staff also reviewed in detail TVA's "method for performing the consequence analyses to support the determination . . . of the PEP EPZ size" and found it "reasonable and consistent with the analyses that were described in NUREG-0396/EPA-520."[139]

In addition to reviewing each step of TVA's EPZ-sizing methodology against the methodology employed in NUREG-0396/EPA-520, the Staff reviewed two example evaluations using that methodology to determine the likelihood that it could in fact be relied upon to support TVA's exemption requests.[140] TVA performed the first example evaluation "using information about potential design basis and severe accidents for one of the SMR designs used to develop the [ESP application] PPE."[141] That evaluation showed that doses from design basis and severe accidents would be "much less" than the pertinent EPA PAGs at the site boundary.[142] The Staff's audit of TVA's calculations "determined that the DBA and severe accident scenarios, as well as isotopic release values in the example calculation, are consistent with the information that the SMR vendor supplied in its design certification application FSAR," and that "the SMR vendor used reasonable assumptions and acceptable computer codes to develop the accident source terms."[143] Therefore, the Staff found the "example calculation accident source terms to be not unreasonable for use in evaluation of the likelihood that a [future applicant] would be able

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[138] *Id*. at 13-18.

[139] *Id*. at 13-18 to 13-19.

[140] *Id*. at 13-19 to 13-24.

[141] *Id.* at 13-19.

[142] *Id*. at 13-19 to 13-20.

[143] *Id*. at 13-20.

to justify an EPZ size of less than a [ten-mile] radius, with an analysis using SMR design-specific information."[144]

The Staff also requested that TVA develop "non-design-specific plant parameters (i.e., accident atmospheric release source term) for the EPZ exemption requests," because TVA stated that it "does not intend the exemption requests to be applicable only to a specific design as in the example calculation" initially evaluated.[145] In response, TVA developed a "non-design-specific 4-day total atmospheric release source term . . . based on vendor information about accident source terms from a spectrum of accidents and SMR vendors."[146] To account for design uncertainty given that no SMR designs have currently been certified, "TVA increased the isotopic releases by a discretionary margin of 25 percent" and then used the non-design-specific source term as an input to its EPZ-sizing methodology.[147] The resulting analysis, which the Staff independently audited, "confirmed that the radiological consequences of accidents would not exceed the methodology dose criteria."[148] The analysis provided assurance that, "if the releases from the specific plant chosen for a [COL application] are bounded by those in the non-design-specific plant parameter accident atmospheric release source term, it is likely that the [COL application] evaluation of EPZ size would support the use of [the requested] EP exemptions."[149]

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[144] *Id*.

[145] *Id*.

[146] *Id*. at 13-21.

[147] *Id*.

[148] *Id.*

[149] *Id*. To ensure that the proposed exemptions in this case are limited to a future application that accords with the Staff's detailed safety evaluation of TVA's proposed EPZ-sizing methodology, the Staff proposed Permit Condition 5. *See id*. at 13-23. Permit Condition 5 would require a future applicant to demonstrate that the accident release source term

In summary, the Staff found that "the basis for the establishment of a site boundary and [two-mile] PEP EPZ in the [ESP application] maintains the same level of protection (i.e., dose savings) in the environs of the [Clinch River site], as that which exists at the [ten-mile] PEP EPZ for LLWRs" because "the methodology that is, or would be, used to determine the acceptability of all three distances (i.e., site boundary, [two-mile], and [ten-mile] PEP EPZs) uses the same radiation exposure bounding criteria/limits, which ensure that any radiation exposures beyond the PEP EPZ would be highly unlikely to exceed the EPA early phase PAGs."[150] Therefore, "the basis for the site boundary and [two-mile] PEP EPZs for the [Clinch River site] is acceptable because it meets the same radiation protection criteria . . . that are required for LLWRs."[151]

3. Exemption Requests

We may grant exemptions to our rules in 10 C.F.R. part 50 when 1) the exemptions are authorized by law, will not present an undue risk to the public health and safety, and are consistent with the common defense and security and 2) special circumstances are present.[152] Special circumstances are present when application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule.[153]

The Staff found that granting exemptions to our requirements for a nominal ten-mile EPZ is authorized by law because the standards of 10 C.F.R. § 50.12 are met and the exemptions

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information used to determine the EPZ size is bounded by the non-design-specific plant parameter source term evaluated in the Final SER. *See* Tr. at 89-90 (Ms. Hart).

[150] Ex. NRC-014A, Final SER, at 13-40.

[151] *Id*.

[152] 10 C.F.R. § 50.12.

[153] 10 C.F.R. § 50.12(a)(2)(ii).

would not result in a violation of any of our regulations or the AEA.[154] The Staff found that granting the exemptions would not affect the common defense and security because the change would be unrelated to security issues.[155] The Staff also found that a smaller EPZ would present no undue risk to the public health or safety because, as discussed at length above, application of the EPZ-sizing methodology and dose criteria approved in this case would result in a EPZ for the Clinch River site that would still be "required to meet the same EPA early phase PAGs as the [ten-mile] EPZs for LLWRs," such that there is "no change in risk to public health and safety."[156]

The Staff found special circumstances were present per 10 C.F.R. § 50.12(a)(2)(ii) because the underlying purpose of the regulations would be met under the terms of the proposed exemption. The Staff stated that the underlying purpose of the ten-mile EPZ in 10 C.F.R. § 50.33(g), 10 C.F.R. § 50.47(b) and (c)(2), and Appendix E to 10 C.F.R. Part 50 "is to ensure that the . . . EPZ size is sufficient to provide dose savings to the population in areas where the projected dose from DBAs could be expected to exceed the applicable EPA early phase PAGs . . . under unfavorable atmospheric conditions."[157] The Staff concluded that, because the site boundary EPZ would be subject to the same EPA early phase PAGs, the underlying purpose of the above regulations would be met under the terms of the proposed

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[154] Ex. NRC-014A, Final SER, at 13-31, 13-35.

[155] *Id*. at 13-32, 13-35.

[156] *Id*. at 13-31 to 13-32, 13-35. The Staff also found that granting an exemption to our ten-mile EPZ requirements would not increase the probability of postulated accidents or result in any new accident precursors and summarized the characteristics of SMR designs that offer increased safety, including a reduced likelihood of accidents, slower accident progression, and reduced accident consequences. *Id*. at 13-31 to 13-32, 13-35, 13-36 to 13-38.

[157] *Id.* at 13-32.

exemptions, pursuant to meeting Permit Condition 5.[158] Accordingly, the Staff found special circumstances were present, which justified granting the exemption.

The Staff also proposed to grant additional exemptions from several requirements for formal offsite emergency planning, notifications, and exercises. These proposed exemptions would apply only in the event a site boundary EPZ is later approved.[159] As the Staff explained during the hearing, "[a] site boundary EPZ, in such circumstances, is analogous to the approach to emergency planning for other facilities posing very small offsite risk, including non-power reactors," for which formal offsite emergency plans are not required.[160]

One of FEMA's concerns with exemptions from offsite planning requirements is that offsite planning for radiological emergencies "is not sufficiently addressed within the [All Hazards] framework."[161] FEMA also expressed concern that the Staff "may be assuming a massive, immediate coordinated federal response should the need arise for offsite response."[162] On the contrary, the Staff did not make any assumptions about the adequacy of "all hazards" planning to support its evaluation, nor does it assume a massive, immediate response would be needed.[163] The Staff determined that "it would be highly unlikely that such a response would be

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[158] *Id.*

[159] The additional exemptions associated with an emergency plan based on a site boundary EPZ were not requested for the emergency plan based on a two-mile EPZ because "[t]he major features emergency plan associated with the [two-mile] PEP EPZ contains the same features as a traditional [ten-mile] EPZ Emergency Plan." *See id*. at 13-27; *see also* Tr. at 81 (Mr. Musico) (noting that for an emergency plan based on a two-mile EPZ, "TVA requested only two exemptions from the requirements in 10 CFR [§] 50.33(g) and 10 CFR [§] 50.47(c)(2), that the plume exposure pathway EPZ, for nuclear power plants, consist of an area about ten-miles in radius" because "the remaining EP requirements for a nuclear reactor site would still apply to it."); Transcript Correction Order, app. A at 2.

[160] Tr. at 97 (Mr. Scott).

[161] FEMA Letter at 2.

[162] *Id*.

[163] Tr. at 97, 104 (Mr. Scott).

needed for the slowly developing and relatively low-level hazard posed by the type of facility that could demonstrate the PAGs would not be exceeded offsite."[164]

FEMA stated in its July 8, 2019, letter that it does not support a two-mile or site boundary EPZ "absent the integration of the full spectrum of threats" into the Staff's evaluation, including insider, cyber, and nation-state and other threats as potential accident-initiators.[165] The Staff responded to this concern in response to prehearing questions 15 and 21. As the Staff explained, "[a]fter September 11, 2001, the NRC conducted vulnerability studies that revealed that the timing and magnitude of releases related to hostile action would be no more severe than in the other accident sequences considered in the EP basis."[166] The Staff determined that "[f]or credible accident sequences, the initiating event may change how an accident starts (e.g., terrorist attack, insider threat, cyber, etc.), but it does not change the source term, how fast fuel melts, or potential offsite consequences."[167] Thus, "the timing and magnitude of releases related to hostile action events are no more severe than the shortest timing or largest magnitude sequences considered in the EP basis," which "accounts for the shortest timing and largest magnitude from a spectrum of accidents."[168]

The Staff testified that its approach is based on a "wide spectrum of initiating scenarios" that "suits the protection to the risk," and, as discussed above, "is consistent with the approach taken when the [current] EPZ regulations were developed."[169] The Staff also testified that if the exemptions are granted, it would "not object to licensees working with state and local authorities

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[164] Tr. at 97 (Mr. Scott).

[165] FEMA Letter at 1.

[166] Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 14.

[167] *Id*.

[168] *Id*., Attach. at 21.

[169] Tr. at 95-96 (Mr. Scott).

to develop capabilities beyond those that we require."[170] Thus, the Staff found that each exemption is authorized by law, presents no undue risk to the public health and safety, consistent with the common defense and security, and justified by special circumstances.[171]

The Dissent suggests that our approval of a site boundary EPZ is unprecedented because "the size of an EPZ has never been exclusively based on the likelihood of an accident occurring."[172] But TVA's approach is not "exclusively based" on accident likelihood, rather, as described above, TVA's methodology is consistent with the approach for determining EPZ size in NUREG-0396/EPA-520.[173] That approach, which considers both likelihood and consequences, forms the basis for our current requirement that operating LLWRs maintain a ten-mile EPZ.[174] We view TVA's application of a consistent EPZ-sizing methodology to a different technology as a logical extension of existing agency practice.

TVA's approach may result in a site boundary EPZ depending on the characteristics of the design TVA ultimately selects. In light of this potential, the Dissent notes that in that case, "there would be no dedicated offsite radiological emergency planning. That element of defense-in-depth would be dropped completely."[175] However, the Staff explained at the hearing that even if there is no NRC requirement for predetermined offsite radiological emergency plans,

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[170] Tr. at 96 (Mr. Scott). TVA's Director of Nuclear Technology Innovation also testified that regardless of whether the EPZ for the Clinch River site could qualify for a site boundary or two-mile EPZ, "there would be offsite coordination on the appropriate emergency plant preparedness response for any type of application going forward." Tr. at 113 (Mr. Stout).

[171] Ex. NRC-014A, Final SER, at 13-41 to 13-61; Tr. at 90-92 (Mr. Musico).

[172] Partial Dissent of Commissioner Baran at 1 (Partial Dissent).

[173] *See supra* at 25-29.

[174] *See supra* at 25. Of particular note, our current requirements also allow for a determination of EPZ size on a case-by-case basis for gas-cooled reactors and reactors with an authorized power level less than 250 MW thermal. 10 C.F.R. § 50.47(c)(2).

[175] Partial Dissent at 2.

offsite emergency planning would still exist within the All Hazards emergency response framework.[176] Consequently, we do not view TVA's proposal as eliminating an element of defense in depth; rather, emergency planning activities would be appropriately scaled to reflect the potential hazards posed by the facility.[177]

Finally, the Dissent states, "We should place great weight on FEMA's views."[178] FEMA opposed the potential establishment of either a two-mile or site boundary EPZ. The Staff addressed FEMA's opposition by explaining in detail, both in the FSAR and at the hearing, the single EPZ-sizing methodology that would be used to reach either result.[179] The Staff convincingly showed that methodology to be consistent with the one used to establish our current EPZ requirements. Nevertheless, the Dissent would reject a site boundary EPZ established by the methodology yet accept a two-mile EPZ over FEMA's objections.[180] We see no basis for such a result.

Nevertheless, we observe that as a generic matter, establishing the EPZ size for an SMR raises important policy considerations. Thus, concurrent with our order today, we have also approved a proposed rule on this topic, which the Staff will soon publish in the *Federal Register*. We look forward to receiving and considering public comments as we continue to evaluate this issue generically.

Based on our independent review of the entire record, we find the Staff has carefully considered the perspectives of FEMA, the technical and regulatory bases for current EPZ and

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[176] *See supra* at 31-32; Tr. at 97 (Mr. Scott).

[177] As noted above, other NRC facilities, such as research and test reactors, also have smaller sized or no EPZs. 10 C.F.R. § 50.47(c)(2).

[178] Partial Dissent at 4.

[179] *See supra* at 25.

[180] *See* Partial Dissent at 1; *supra* at 19.

associated emergency-plan requirements, and our prior direction to consider exemptions to those requirements in licensing proceedings for SMRs, if appropriate. We determine that the Staff's findings regarding the requested exemptions are adequately supported by the record. We encourage the Staff to continue working with FEMA and other counterparts as it considers how best to update existing emergency planning regulations to reflect the safety improvements expected from SMRs and other new technologies.

D. The Staff's Environmental Review

1. Review Process

As required by our regulations, the Staff prepared an EIS for the Clinch River ESP application.[181] The Staff based its environmental review on construction and operation of two or more SMRs with design characteristics bounded by the PPE.[182] The purpose and need for the proposed federal action—the issuance of an ESP for the Clinch River site approving the site as suitable for these purposes—is "to provide for early resolution of site safety and environmental issues, which provides stability in the licensing process."[183]

After publishing a notice of its intent to prepare an EIS, the Staff held a scoping meeting in Oak Ridge, Tennessee, to gather input on issues to consider in its environmental review.[184]

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[181] 10 C.F.R. §§ 51.20(b)(1), 52.18.

[182] Ex. NRC-015A, Final EIS, at 1-9; Ex. NRC-002, Draft Early Site Permit, app. D.

[183] Ex. NRC-015A, Final EIS, at 1-9; *see* Tr. at 49 (Ms. Bradford). The purpose and need for the proposed action was informed by TVA's "objective to use the power generated by SMRs to address critical energy security issues for TVA Federal direct-served customers (which included only DoD or DOE facilities)." Ex. NRC-015A, Final EIS, at 1-9; *see* Tr. at 160 (Mr. Erwin) (NRC's purpose and need is informed by TVA's purpose and need, "specifically TVA's objective to demonstrate the capability of SMR technology to provide reliable power on or near a mission critical facility").

[184] Tennessee Valley Authority; Clinch River Nuclear Site; Early Site Permit Application, 82 Fed. Reg. 17,885 (Apr. 13, 2017); Ex. NRC-001, Staff Information Paper, at 5; Tr. at 50 (Ms. Bradford).

The Staff responded to scoping comments from the public in the Draft EIS, issued for public comment in April 2018.[185] In addition, the Staff held two public meetings in Roane County, Tennessee following the release of the Draft EIS.[186] The Staff received comments on a variety of topics, including the need for the proposed project and its cost; the NRC's regulatory process allowing deferral of cost-benefit and energy alternatives analyses; TVA's requested exemptions from certain emergency planning requirements; and the Draft EIS's evaluation of alternative sites, legacy contaminants, and impacts to cultural resources, water, and wetlands.[187] The Staff responded to these comments in the Final EIS, published in April 2019.[188] As part of its environmental review of TVA's application, the Staff performed a full scope environmental audit, which included a review of the data and information underlying TVA's environmental report, tours of the Clinch River site and two nearby alternative sites, and meetings with TVA and federal, state, and local officials.[189]

The Staff worked with the U.S. Army Corps of Engineers (USACE) as a cooperating agency under an existing Memorandum of Understanding with the agency.[190] Together, the

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[185] Ex. NRC-015A, Final EIS, at 1-6; Ex. NRC-018, Staff Environmental Panel Presentation, at 7.

[186] Ex. NRC-015A, Final EIS, at 1-6; Ex. NRC-001, Staff Information Paper, at 5.

[187] *See* Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 30-31.

[188] Tr. at 40 (Mr. Brown); *see* Ex. NRC-015B, Final EIS, app. E.

[189] Ex. NRC-015A, Final EIS, at xxix, 1-6; "Clinch River Nuclear Site Early Site Permit Application Environmental Audit Summary Report" (Jan. 11, 2018), Encl. at 2-16 (ML17226A020 (package)) (Environmental Audit Summary Report). Members of the environmental review team responsible for the socioeconomics and environmental justice resource evaluations in the EIS also toured an alternative site at the Redstone Arsenal in Alabama. Environmental Audit Summary Report at 3-4, 8-9.

[190] Tr. at 49-50 (Ms. Bradford). Pursuant to its agreement with the USACE, the NRC was designated as the lead agency with the primary role of preparing the EIS, and the USACE provided assistance as the cooperating agency.

Staff and the USACE formed the environmental review team for the EIS.[191] The Staff also consulted with federal, state, tribal, and local authorities, including but not limited to the U.S. Fish and Wildlife Service (FWS), the Tennessee Department of Environment and Conservation, the Tennessee Wildlife Resource Agency, the Alabama Department of Conservation and Natural Resources, the Tennessee Historical Commission (THC), and the Advisory Council on Historic Preservation (ACHP).[192]

The Staff fulfilled its responsibilities under section 106 of the National Historic Preservation Act of 1966 (NHPA) using the NEPA process.[193] The NRC's NHPA section 106 undertaking is the issuance of an ESP resolving the suitability of the Clinch River site for the future construction and operation of two or more SMRs.[194] As a federal land management agency, TVA also has an independent obligation to comply with the NHPA. TVA defined its NHPA undertaking as building and operating two or more SMRs at the Clinch River site, including upgrades to offsite areas.[195]

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[191] Ex. NRC-015A, Final EIS, at 1-7 to 1-8.

[192] *See, e.g.*, Ex. NRC-001, Staff Information Paper, at 6; Ex. NRC-015A, Final EIS, at xxix; Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 32; Tr. at 50 (Ms. Bradford).

[193] Ex. NRC-015A, Final EIS, at 2-139; Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 39; *see* 36 C.F.R. § 800.8(a)(1) ("Federal agencies are encouraged to coordinate compliance with section 106 and the procedures in this part with any steps taken to meet the requirements of the National Environmental Policy Act.").

[194] Ex. NRC-015A, Final EIS, at 2-139. The construction and operation of SMRs on the Clinch River site would not be authorized by the ESP; the NRC's separate action on a future construction permit or COL application referencing the Clinch River ESP would constitute a new undertaking under NHPA section 106. *See* 36 C.F.R. § 800.16(y) (stating that an undertaking includes a project, activity, or program requiring a federal license, permit, or approval).

[195] Ex. NRC-015A, Final EIS, at 2-139; *see* Tennessee Valley Authority and Tennessee State Historic Preservation Office, "Programmatic Agreement Between the Tennessee Valley Authority and the Tennessee State Historic Preservation Office Regarding the Management of Historic Properties Affected by the Clinch River SMR Project" (May 12, 2016), at 1 (ML17296A399) ("TVA considers . . . the Early Site Permit Application . . . , the Combined

The Staff contacted twenty federally recognized tribes, the THC, and the ACHP to initiate consultation under the NHPA.[196] In the Final EIS, the Staff stated that it received comments from the tribes generally related to TVA's undertaking of building and operating SMRs on the Clinch River site rather than to the Staff's undertaking, issuance of an ESP for the site.[197] Three tribes and the THC provided specific comments on the Draft EIS. The Staff held teleconferences and engaged in further correspondence with each tribe regarding the undertaking.[198] One tribe, the Thlopthlocco Tribal Town, disagreed with the Staff's assessment of impacts to historic and cultural resources and evaluation of alternative sites and expressed concerns about the number of historic properties and cultural resources that may be adversely affected at the Clinch River site as compared to the alternative candidate sites.[199] The Staff revised the Final EIS in response to the Thlopthlocco Tribal Town's comments and conveyed the Tribe's concerns about the alternative sites analysis to TVA.[200] To satisfy its own NHPA section 106 obligations, TVA executed a programmatic agreement with the THC that prescribes the process that TVA will follow to ensure compliance with the NHPA for its undertaking "as plans are finalized and specific onsite and offsite project areas associated with these plans are

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License Application . . . , and construction of two or more SMRs . . . as sequential parts of a single, complex undertaking . . . as 'undertaking' is defined at 36 [C.F.R.] § 800.16(y).").

[196] Ex. NRC-015A, Final EIS, at 2-156 to 2-157; Tr. at 170-71 (Mr. Erwin).

[197] Ex. NRC-015A, Final EIS, at 2-158, 2-161. The Staff conveyed the tribes' concerns relevant to TVA's undertaking to TVA for consideration in its independent NHPA section 106 review. *Id*. at 2-158.

[198] *Id*. at 2-159 to 2-161.

[199] *Id*. at 2-161; *see* Letter from Jennivine Rankin, NRC, to Terry Clouthier, Tribal Historic Preservation Office, Thlopthlocco Tribal Town (Nov. 13, 2018) (ML18267A316) (summarizing an October 10, 2018, teleconference between the Staff and Mr. Clouthier and providing the Staff's response to the Thlopthlocco Tribal Town's concerns).

[200] Ex. NRC-015A, Final EIS, at 2-161.

identified."[201]

In light of a letter from the THC stating that issuance of the ESP may adversely affect historic properties at the Clinch River site, as well as statements in the Final EIS that tribal consultation remained "ongoing," we asked the Staff whether it had satisfied the requirements of NHPA section 106.[202] The Staff explained that the general concern regarding impacts expressed in the THC's letter was consistent with the Staff's finding in the Final EIS that pre-construction and construction activities at the Clinch River site could impact historic and cultural resources.[203] The Staff confirmed that it had completed consultation with the tribes and satisfied its obligations under the NHPA by submitting the Final EIS to the tribes, the THC, and the ACHP.[204] In response to a pre-hearing question, TVA also provided additional information on the status of its ongoing efforts to develop an integrated cultural resources database and a comprehensive agreement with the tribes for managing the inadvertent discovery of cultural items under the Native American Graves Protection and Repatriation Act of 1990.[205]

Pursuant to the Endangered Species Act of 1973 (ESA), the Staff prepared a biological

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[201] *Id*. at 2-139; *see also id*. at 2-154.

[202] Pre-Hearing Questions Order at 20.

[203] Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 38-39; *see* Ex. NRC-015A, Final EIS, at 4-69 (concluding that the combined impacts from pre-construction and construction on historic and cultural resources would be moderate to large). The Staff stated that the THC did not raise any other specific concerns about possible effects to historic properties at the Clinch River site. Ex. NRC-005, Staff Pre-Hearing Responses, at 38-39.

[204] Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 32, 39. The Staff stated that the characterization of tribal consultation as "ongoing" in sections 4.6.3 and 5.6.3 of the Final EIS was in error, and that the completion of consultation was documented in a November 2018 letter to the THC. *Id*. at 32 (citing Letter from Jennivine Rankin, NRC, to E. Patrick McIntyre, Jr., THC (Nov. 13, 2018) (ML18267A315)).

[205] *See* Pre-Hearing Questions Order at 19-20; Ex. TVA-003, *Tennessee Valley Authority's Responses to Pre-Hearing* Questions (July 26, 2019), at 29-30 (ML19227A235) (TVA Pre-Hearing Responses).

assessment and initiated informal consultation with the FWS.[206] The FWS informed the Staff that formal consultation under section 7 of the ESA was not required for this federal action because the Clinch River ESP would not authorize activities that may affect listed species.[207] The Final EIS documents the Staff's commitment to consult with the FWS under section 7 of the ESA should the NRC receive a construction permit or COL application referencing the Clinch River ESP.[208] In the Final EIS, the Staff considered the federally listed, proposed, and candidate species identified during informal consultation with the FWS, as well as the important state-listed species identified through the Staff's consultation with the Tennessee Natural Heritage Program.[209]

2. Evaluation of Impacts

In its environmental review, the Staff evaluated "the direct, indirect, and cumulative impacts of the construction activities that would be authorized if the holder of an ESP applied for and was issued a [construction permit] or a [COL] for the site."[210] These impacts are evaluated for the following resource areas: land use, water use and quality, terrestrial and wetland

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[206] Ex. NRC-015A, Final EIS, at 4-30; *see* Ex. NRC-015B, Final EIS, app. M. Section 7 of the ESA requires an "agency, in consultation with and with the assistance of the Secretary [of the Interior or the Secretary of Commerce (as appropriate)], insure that any action authorized, funded, or carried out by such agency . . . is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of [critical] habitat of such species." ESA § 7(a)(2), 16 U.S.C. § 1536(a)(2). The Fish and Wildlife Service (under the Department of the Interior) and the National Marine Fisheries Service (under the Department of Commerce) jointly administer the ESA.

[207] Ex. NRC-015A, Final EIS, at 4-30. The FWS recommended that the Staff re-engage the agency once the NRC receives an application for a construction permit or COL referencing the Clinch River ESP. *Id*.

[208] *Id*. at 4-30, 5-18; Ex. NRC-015B, Final EIS, at M-14.

[209] Ex. NRC-015A, Final EIS, at 2-64.

[210] *Id*. at 4-1. The Staff evaluates the "environmental effects of preconstruction activities (e.g., clearing and grading, excavation, and erection of support buildings)," which are outside the NRC's jurisdictional authority, in its evaluation of cumulative impacts. *Id*.

resources, aquatic resources, socioeconomics, environmental justice, historic and cultural resources, air quality, non-radiological health impacts, radiological health impacts from normal operations, non-radioactive waste impacts, and postulated accidents.[211] For each of the resource areas analyzed, the Staff determined whether the potential impacts of the proposed action would be expected to be small, moderate, or large.[212] The Staff found that impacts would be small, moderate, or range from small to moderate, for all resource areas except traffic and historic and cultural resources, where the combined impacts from pre-construction and construction activities would range from moderate to large.[213]

Before the hearing, we asked TVA and the Staff to address several questions related to the potential impacts of the project on various resource areas. We obtained clarification from the Staff regarding the scope of its evaluation of impacts to air quality from traffic exhaust emissions and the basis for its determination that traffic impacts would be moderate to large.[214] At our request, the Staff also expanded on information underlying its conclusions in several

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[211] *See generally* Ex. NRC-015A, Final EIS, chs. 4, 5 & 7. Additionally, the Staff considered potential impacts of the uranium fuel cycle, radioactive waste transportation, and decommissioning of SMRs at the Clinch River site. *Id*. ch. 6. The Final EIS incorporates by reference the impacts of continued storage of spent nuclear fuel assessed in the "Generic Environmental Impact Statement for Continued Storage of Spent Nuclear Fuel," NUREG-2157, vols. 1-2 (Sept. 2014) (ML14196A105, ML14196A107). Ex. NRC-015A, Final EIS, at 6-15 to 6-16.

[212] Ex. NRC-015A, Final EIS, at 1-5, 4-3, 5-1. In making its findings on pre-construction and construction impacts, the Staff delineated between the impacts attributable to all pre-construction and construction activities combined, and the more limited category of construction activities requiring NRC authorization under a construction permit or COL. *See id*. at 3-12 to 3-13, 4-86 to 4-90.

[213] Ex. NRC-015A, Final EIS, tbls.4-14 & 5-20; Ex. NRC-018, Staff Environmental Panel Presentation, at 15-18. With regard to historic and cultural resources, the Staff found that the impacts attributable only to NRC-authorized activities would be small. Ex. NRC-015A, Final EIS, tbl.4-14.

[214] Pre-Hearing Questions Order at 20; Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 32-33.

areas. The Staff described the measures it considered to limit public risk from a hypothetical release of radioactive material to an aquatic food pathway in a severe accident scenario. The Staff also explained the reasons for its conclusion that decommissioning impacts would be bounded by the generic determinations in the Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities.[215]

Because TVA intends to draw most of its intake water for the project from the Clinch River arm of the Watts Bar Reservoir, we asked the parties to explain the process for acquiring any necessary water rights and authorizations.[216] We also asked the parties to discuss the impact on construction and operation of low water flow velocity from the Melton Hill Dam located up-river of the site.[217] TVA explained that it expected to draw water for its operations consistent with state law and that TVA would further provide voluntary registration reports to the state to assist its tracking of water use for withdrawals associated with the operation of SMRs at the Clinch River site.[218] Prior to construction, TVA would also obtain any necessary permits and certifications from the state and USACE under the Tennessee Water Quality Control Act and sections 401 and 404 of the Clean Water Act for the construction and use of its water intake

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[215] Pre-Hearing Questions Order at 21 (citing "Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors" (Final Report), NUREG-0586, Supplement 1, vols. 1-2 (Nov. 2002) (ML023470327, ML023500228)); Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 34. The Staff also clarified that the list of mitigation measures outlined in Table 4-13 of the Final EIS are not enforceable by the NRC because they are not under NRC jurisdiction, but that "many of these measures are expected to be required by other Federal, state or local permits or authorizations that would be required in order for TVA to perform those building activities that are outlined in the [environmental report]." Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 33; *accord* Ex. TVA-003, TVA Pre-Hearing Responses, at 31.

[216] Pre-Hearing Questions Order at 20.

[217] *Id*. at 19.

[218] Ex. TVA-003, TVA Pre-Hearing Responses, at 30.

structure.[219] TVA stated that the future design of the water intake structure would account for low water levels in the Reservoir and that no adverse impacts to water intake were expected due to low water flow velocities through the Melton Hill Dam.[220] In its response, the Staff noted that the water surface elevations at the intake location are primarily controlled by releases from the Watts Bar Dam and would not be significantly affected by reductions in flow velocity downstream of the Melton Hill Dam.[221]

3. Alternative Sites and System Designs

The Staff's review of alternatives to the proposed action included consideration of the no-action alternative, alternative sites, and system design alternatives.[222] For the no-action alternative—denial of the ESP for the Clinch River site—the Staff found that no environmental impacts would occur, but this alternative would not accomplish the benefits intended by the ESP process, such as early resolution of siting and environmental issues prior to the outlay of large investments in new plant design and construction, the ability to bank sites on which nuclear plants might be located, and the facilitation of future decisions regarding the construction of new nuclear power-generating facilities.[223]

The Staff independently reviewed and verified TVA's process for identifying the proposed Clinch River site and alternative candidate sites.[224] The region of interest considered for the identification of alternative sites was TVA's power service area, which "includes most of Tennessee and portions of six adjacent states (Alabama, Kentucky, Georgia, Mississippi, North

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[219] *Id.* at 30-31; *see* Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 32.

[220] Ex. TVA-003, TVA Pre-Hearing Responses, at 29-31.

[221] Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 31.

[222] Ex. NRC-015A, Final EIS, ch. 9.

[223] *Id*. at 9-1.

[224] *Id*. at 9-6 to 9-12; Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 35-36.

Carolina, and Virginia) . . . [and] the Tennessee River watershed, the Cumberland River watershed, and areas surrounding these watersheds."[225] The site selection process was informed by (a) seismology considerations, (b) population density, (c) cooling-water availability, (d) proximity to targeted customers, (e) the requirement for a contiguous 120-ac[re] site, (f) the percent of the forest cover, and (g) the amount of undeveloped versus previously disturbed land.[226] In its ranking of candidate sites, TVA also considered sensitive land features such as important plant and wildlife habitats, wetlands, land use and land rights, flooding, and topography.[227] In its independent review, the Staff found that TVA's site selection process was reasonable and provided an adequate basis for comparing the proposed and alternative sites.[228]

In the Final EIS, the Staff conducted a detailed qualitative evaluation of three alternative sites: two sites on the Oak Ridge Reservation in Roane County, Tennessee, and one site on the Redstone Arsenal in Madison County, Alabama.[229] All three alternative sites, like the Clinch River site, are undeveloped and federally managed.[230] The Staff compared the environmental

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[225] Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 36.

[226] *Id*.; *see also* Tr. at 173-74 (Mr. Erwin). In the Final EIS, the Staff stated that it expected the actual footprint of disturbance for any site that TVA may select to be "substantially greater than the 120 ac[res] that TVA used for identifying potential sites." Ex. NRC-015A, Final EIS, at 9-20. In response to a pre-hearing question concerning TVA's choice of footprint in the site selection process, TVA stated that the decision to use 120 acres for the site selection process was "the minimum reasonable area needed to site an SMR . . . based on information from potential SMR vendor designs" and that it "did not want to rule out any obviously superior sites by using a larger acre requirement as screening criteria." Ex. TVA-003, TVA Pre-Hearing Responses, at 33.

[227] Ex. TVA-003, TVA Pre-Hearing Responses, at 32.

[228] Ex. NRC-015A, Final EIS, at 9-10.

[229] *Id*. at 9-10 to 9-12. Although the Redstone Arsenal site had lower overall environmental scores than any of the Oak Ridge Reservation sites considered in the site selection process, the Staff included this site in its detailed evaluation as a geographically diverse alternative, consistent with guidance in its Environmental Standard Review Plan. Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 36.

[230] Ex. NRC-015A, Final EIS, at 9-20.

impacts of pre-construction, construction, and operation of SMRs at the Clinch River site and at the alternative sites. For each of these sites, the Staff evaluated impacts associated with land use, water use and quality, terrestrial and wetland resources, aquatic resources, socioeconomics, environmental justice, historic and cultural resources, air quality, non-radiological health impacts, radiological health impacts from normal operations, and postulated accidents.[231]

For the two alternative sites located on the Oak Ridge Reservation, the Staff found that environmental impacts would be comparable to those at the proposed site for all resource areas except for terrestrial resources, which would be moderate at the Clinch River site but large at the Oak Ridge Reservation alternative sites.[232] The Staff found that the environmental impacts at the Redstone Arsenal site would also be comparable to those at the proposed site for most resource areas, but that impacts to groundwater at the Redstone Arsenal site would be greater than those at the Clinch River site due to consumptive use from dewatering during plant construction.[233] Because the impacts would be comparable and in some resource areas

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[231] *Id*. at 9-19 to 9-70. With regard to the evaluation of ecological resources, we asked the Staff to explain whether the absence of field survey data impacted its ability to analyze the alternative sites. Pre-Hearing Questions Order at 23. The Staff explained that the absence of these data "did not compromise [its] ability to evaluate and compare ecological impacts and reach impact level conclusions for the alternative sites" because its analysis relied on state databases of published information on important species at each site, which provided a more consistent and meaningful basis for its comparative analysis of the alternative sites. Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 37.

[232] Ex. NRC-015A, Final EIS, at 9-74. The Staff's conclusion on impacts to terrestrial resources at these sites "accounted for possible loss and fragmentation of additional forest cover" from the clearing of offsite corridors for intake and discharge pipelines, transmission lines, and roads. Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 37. For its analysis of these areas, the Staff used sketches provided with the application to estimate the acreage affected; the Staff was able to conclude that the impacts would be large without a more precise quantification of the total acreage affected. *Id*.

[233] Ex. NRC-015A, Final EIS, at 9-74.

potentially would be greater at the alternative sites, the Staff concluded that none of the alternative sites was environmentally preferable or obviously superior to the Clinch River site.[234]

The Staff also considered system design alternatives.[235] As alternatives to the mechanical draft cooling towers evaluated as part of the proposed action, the Staff considered a once-through cooling system and closed-cycle cooling systems such as spray ponds and natural draft, dry, and wet/dry cooling towers.[236] The Staff also evaluated alternatives to the proposed action's circulating water system, including alternative intake designs, discharge systems, and water supply sources.[237] The Staff concluded that each of these alternative system designs was either obviously unsuitable or not environmentally preferable to the proposed plant system designs.[238] Because the environmental report did not include a water treatment plan as part of the proposed cooling water system, the Staff did not consider water treatment alternatives in its analysis of alternative design systems.[239]

We asked the Staff whether alternative transmission line corridors were considered as a potential system design alternative.[240] The Staff explained that although it had not specifically evaluated alternative transmission line corridors as a system design alternative, the Staff considered the impacts related to transmission lines as a cumulative impact related to each

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[234] *Id*. at 9-73 to 9-74.

[235] *Id*. at 9-74.

[236] *Id*. at 9-74 to 9-79.

[237] *Id*. at 9-79 to 9-83.

[238] *Id*. at 9-83.

[239] *Id*. As the Staff notes in the Final EIS, because the water treatment needs for the proposed cooling water system were not described in TVA's ESP application or evaluated in the Staff's environmental review, any application for a combined license or construction permit referencing the ESP must address this aspect of the proposed system design. *See id*.

[240] Pre-Hearing Questions Order at 24.

alternative site. The Staff stated that it considered TVA's proposed transmission line routes "reasonable, appearing to minimize length and impacts to sensitive geographic features while taking advantage of existing transmission line corridors," and it therefore "[did] not see a potential for reasonable routing alternatives that might substantially reduce adverse environmental impacts."[241]

4. Deferred Issues

The Staff's Final EIS addressed most of the environmental issues related to the Clinch River site, but TVA and the Staff deferred some issues for consideration as part of a future construction permit or COL application. As permitted by our regulations, TVA chose not to include in its application an assessment of the costs and benefits of the proposed action, including need for power, or an evaluation of alternative energy sources.[242] Because these analyses were not provided in the application, the Staff did not address them in the EIS.[243] Any construction permit or COL application referencing the Clinch River ESP will be required to perform these analyses, and the Staff's environmental review for such an application will likewise consider these issues.

Additionally, the staff deferred consideration of two issues given insufficient information regarding a reactor design: severe accident mitigation alternatives and water treatment alternatives.[244] With respect to the severe accident mitigation alternatives analysis, the Staff explained that the inputs required for this evaluation must be based on a selected reactor

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[241] Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 38.

[242] Ex. NRC-009B, Environmental Report, at 8-1, 10-11; Ex. NRC-015A, Final EIS, at xxxiii.

[243] Tr. at 52, 55 (Ms. Bradford); Ex. NRC-015A, Final EIS, at 1-4, 8-1, 9-2, 10-22. *See* 10 C.F.R. § 51.75(b) (precluding assessment in an EIS "of the economic, technical, or other benefits (for example, need for power) and costs of the proposed action or an evaluation of alternative energy sources" if such issues are not addressed in the ESP environmental report).

[244] Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 38.

design.[245] Because TVA's application uses a PPE approach, a reactor design will not be selected until the construction permit or COL stage of the project.[246] Likewise, neither the environmental report nor the Final EIS evaluated water treatment alternatives because such an evaluation requires design information that will not be defined until a final reactor design is selected at a future stage of the project.[247] Because these issues were not resolved in this ESP proceeding, they must be addressed at the construction permit or COL stage of the project.

For the remaining issues resolved in the environmental review for the ESP, we asked TVA and the Staff to describe the process they intend to use to account for new and significant information that may arise between issuance of the ESP and the future submission of a construction permit or COL application.[248] TVA stated that it intends to "use a methodical, comprehensive review process to catalog any new and significant information that it would include" in any supplemental environmental report associated with a construction permit or COL application. In support of that process, TVA "is developing project procedures and a database to identify and document any such new and significant information," and plans to update such information with every revision of its construction permit or COL application.[249] For its part, the Staff will verify the effectiveness of TVA's procedures for identifying new and significant information, and it will use the public scoping process to assist it in its independent obligation to ensure that the EIS for a construction permit or COL application referencing the Clinch River ESP appropriately identifies and evaluates any new and significant information.[250]

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[245] *Id.*; *see* Ex. NRC-015A, Final EIS, at 5-85, 5-89.

[246] Ex. NRC-015A, Final EIS, at 1-2 to 1-3.

[247] Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 38; *see* Ex. NRC-015A, Final EIS, at 9-83.

[248] Pre-Hearing Questions Order at 19.

[249] Ex. TVA-003, TVA Pre-Hearing Responses, at 28.

[250] Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 29-30.

E. Findings

We now turn to the findings necessary for issuance of the ESP. We have conducted an independent review of the sufficiency of the Staff's safety and environmental findings. Although our decision today highlights the topics discussed above, our findings are based on the entire record.

1. Safety Findings

Based on our independent review, we find that the requirements of the AEA and NRC regulations have been met. The required notifications to other agencies or bodies have been duly made.[251] There is reasonable assurance that the site is in conformity with the provisions of the AEA and issuance of the permit will not be inimical to the common defense and security or to the health and safety of the public. We find TVA is technically qualified to engage in the activities authorized. In addition, we find that the proposed regulatory exemptions meet the standards in 10 C.F.R. § 50.12. And finally, we find that the proposed permit conditions are appropriately drawn and sufficient to provide reasonable assurance of adequate protection of public health and safety.

2. Environmental Findings

We have also conducted an independent review of the Staff's environmental analysis in the Final EIS and took into account NEPA's requirements. NEPA section 102(2)(A) requires agencies to use "a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts" in decision-making that may

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[251] The Staff notes that "TVA is the regulatory agency that has jurisdiction over the rates and service incident to the proposed activities as noted in 10 [C.F.R §] 50.43(a)(1)." Ex. NRC-001, Staff Information Paper, at 15. In addition, the Staff published notices of the application in the *Oak Ridger*, *Roane County News*, and *Knoxville Sentinel*. *Id.* The Staff also published notices of the application in the *Federal Register* on May 17, 2019, May 24, 2019, May 31, 2019, and June 7, 2019 (at 84 Fed. Reg. 22,523; 84 Fed. Reg. 24,185; 84 Fed. Reg. 25,310; 84 Fed. Reg. 26,707, respectively). *See* 10 C.F.R. 50.43(a).

impact the environment.[252] We find that the Staff's environmental review employed the systematic, interdisciplinary approach that NEPA requires.[253]

NEPA section 102(2)(E) calls for agencies to study, develop, and describe appropriate alternatives.[254] The alternatives analysis is the "heart of the environmental impact statement."[255] The Staff's discussion of alternatives is in Chapter 9 of the Final EIS. Based on the discussion in the Final EIS, the Staff's testimony at the hearing, and its responses to our pre-hearing questions, we find that the Staff identified an appropriate range of alternatives, including the no-action alternative, alternative sites, and alternative system designs, and adequately described the environmental impacts of each alternative.[256] Since no alternative site was environmentally preferable to the Clinch River site, the Staff concluded that none of the alternative sites would be "obviously superior" to the Clinch River site.[257] We find reasonable the Staff's conclusion that none of the alternatives considered is environmentally preferable or obviously superior to the proposed action.

Distinct from the deferred assessment of costs and benefits of the proposed action, NEPA section 102(2)(C) requires us to assess the relationship between short-term uses and long-term productivity of the environment, to consider alternatives, and to describe the

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[252] NEPA § 102(2)(A), 42 U.S.C. § 4332(2)(A).

[253] *See, e.g.,* Tr. at 48-56 (Ms. Bradford) (providing an overview of the Staff's environmental review methodology and findings). The environmental review team consisted of individuals with expertise in disciplines including ecology, hydrology, meteorology, radiological health, socioeconomics, and cultural resources. Ex. NRC-015B, Final EIS, app. A. The team consisted of individuals from the NRC, the USACE, and the Pacific Northwest National Laboratory, the NRC's contractor. *Id*.

[254] NEPA § 102(2)(E), 42 U.S.C. § 4332(2)(E).

[255] 10 C.F.R. pt. 51, app. A, § 5.

[256] *See, e.g.*, Tr. at 159-62 (Mr. Erwin); Ex. NRC-015A, Final EIS, ch. 9.

[257] *See* Tr. at 51-52, 54-55 (Ms. Bradford).

unavoidable adverse environmental impacts and the irreversible and irretrievable commitments of resources associated with the proposed action.[258] As noted above, the Staff's discussion of alternatives is in Chapter 9 of the Final EIS. The Staff discussed the remaining items throughout the Final EIS and summarized its findings in Chapter 10 of the Final EIS.

The Staff described the project's principal short-term benefit as the production of electricity, and its long-term benefit as a corresponding increase in regional productivity.[259] The Staff determined that the economic productivity of the Clinch River site resulting from its use for the production of electricity would be substantially greater than the productivity of the site from other probable uses, such as agriculture.[260] With regard to long-term impacts on productivity at the Clinch River site, the Staff noted that the maximum impact would occur if two or more SMRs were not immediately dismantled at the end of their period of operation, but the Staff found that "the enhancement of regional productivity resulting from the electrical energy produced by two or more SMRs would lead to a correspondingly large increase in regional long-term productivity that would not be equaled by any other long-term use of the site."[261] The Staff concluded that "the negative impacts of plant construction and operation as they affect the human environment would be outweighed by the positive long-term enhancement of regional productivity through the generation of electrical energy."[262]

In our questions for the Staff during and after the hearing, we probed the Staff on the

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[258] NEPA § 102(2)(C)(ii)-(v), 42 U.S.C. § 4332(2)(C)(ii)-(v).

[259] Ex. NRC-015A, Final EIS, at 10-19.

[260] *Id*.

[261] *Id*. The Staff also noted that "most long-term impacts resulting from land-use preemption by plant structures could be eliminated by removing these structures or by converting them to other productive uses at the end of operations." *Id*.

[262] *Id*.

basis for its conclusion given TVA's decision to defer its analysis of the costs and benefits of the project, including need for power, to the construction permit or COL stage.[263] Further, we found aspects of the Staff's discussion unclear with regard to the assumptions underpinning the "positive long-term enhancement of regional productivity" expected from "the generation of electrical energy" at the site.[264] In our post-hearing questions, we asked the Staff to address the amount of electrical output and the regional area assumed for the projected increase in "regional productivity."[265] We also sought to better understand the relationship, if any, between the projected long-term benefit of increased regional productivity and the sole project objective considered in the Staff's review—TVA's "objective to use the power generated by SMRs to address critical energy security issues" for two direct-served federal customers, the U.S. Department of Defense and the U.S. Department of Energy.[266]

In response, the Staff clarified that the "projected increase in productivity described in Section 10.2 of the Final EIS is based on the maximum electrical output stated in the PPE of 800 MW(e)."[267] This total electrical output includes, but is not limited by, "the portion . . . that could be used to address critical energy security issues for TVA['s] [f]ederal direct-served customers."[268] The Staff anticipated that TVA "could include additional customers and a broader service area in a need for power analysis" in a future construction permit or COL

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[263] *See* Tr. at 172-73 (Chairman Svinicki); Post-Hearing Questions Order at 4-5.

[264] *See* Ex. NRC-019, Staff Post-Hearing Responses, Attach. at 7-8; Ex. NRC-015A, Final EIS, at 10-19.

[265] Post-Hearing Questions Order at 5.

[266] *Id*.; *see* Ex. NRC-015A, Final EIS, at 1-10; Tr. at 160 (Mr. Erwin).

[267] Ex. NRC-019, Staff Post-Hearing Responses, Attach. at 8.

[268] *Id*.

application.[269] The Staff also clarified that the "region" considered in this analysis is the region defined in section 2.2.3 of the Final EIS—the area within a fifty-mile radius of the site.[270]

In addition, the Staff clarified that its analysis assumed that SMRs would be constructed and operated at the site, but it "did not assume that there was a need for power."[271] The need for power analysis and cost-benefit discussion provided at the construction permit or COL stage "would define the region where the benefits would be expected to be provided and this would be included in the updated Section 10.2 for the supplemental EIS and the new NEPA findings for [the construction permit or COL] agency action."[272] For the purpose of the current analysis, the Staff relied on TVA's statement in its environmental report that "[t]he production of power throughout the operational life of the SMRs would enhance regional development and economic activity," which the Staff found reasonable as supported by "TVA's objective to demonstrate that SMR technology allows reactors to be brought into operation incrementally to achieve a capacity of up to 800 MW(e), along with other discussions in the application."[273]

On balance, we find that the Staff's conclusion is adequately supported by the information in the Final EIS and in the Staff's testimony in this proceeding.[274] We agree with the Staff that its analysis and conclusion on this NEPA requirement may be updated in a supplement to the Final EIS if and when it receives an application for a construction permit or

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[269] *Id*.

[270] *Id*.

[271] *Id*. at 2. The Staff requested that we admit this statement into the record of this proceeding to correct its testimony on this matter in the uncontested hearing; we granted this request. *See* Transcript Corrections Order at 1.

[272] Ex. NRC-019, Staff Post-Hearing Responses, Attach. at 8.

[273] *Id*. at 8 (quoting Ex. NRC-009B, Environmental Report, at 10-11).

[274] *See, e.g.*, Ex. NRC-015A, Final EIS, at 10-19; Tr. at 172-73 (Ms. Dozier); Staff Post-Hearing Responses, at 1-2 & Attach. at 8.

COL referencing the ESP that contains cost benefit and need for power information.[275]

With regard to unavoidable adverse environmental impacts, the Staff found that the unavoidable impacts during pre-construction and construction would be small for the following resource areas: water use, water quality, aquatic resources, demography, tax and economic impacts on the region (a small beneficial impact), air quality, radiological health, and non-radiological wastes.[276] The pre-construction and construction impacts for socioeconomic impacts associated with increased physical impacts and non-radiological health impacts related to noise would be small to moderate, and the impacts for land use and terrestrial and wetland resources would be moderate.[277] The pre-construction and construction impacts to infrastructure and community services would be moderate to large for traffic impacts; all other infrastructure and community services impacts would be small.[278] The pre-construction and construction impacts to historic and cultural resources would also be moderate to large.[279] For operation, the Staff found that the unavoidable adverse impacts would be small for all resource areas except for non-radiological health and socioeconomic impacts to aesthetics and recreation; impacts to those resource areas would be small to moderate.[280] For each resource area considered in the Final EIS, the Staff described the specific unavoidable adverse impacts, if any, anticipated from pre-construction, construction, and operation, along with actions to

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[275] *See* Ex. NRC-019, Staff Post-Hearing Responses, Attach. at 8; *System Energy Resources, Inc.,* CLI-07-14, 65 NRC at 218-19.

[276] Ex. NRC-015A, Final EIS, tbl.10-1. In its environmental justice analysis, the Staff found that the project would not have unavoidable adverse impacts on any minority or low-income populations in any disproportionate manner, relative to the general population. *Id*.

[277] *Id*.

[278] *Id*.

[279] *Id*.

[280] *Id*. tbl.10-2.

mitigate those impacts.[281] We find that the Staff adequately considered the range of unavoidable adverse environmental impacts from the pre-construction, construction, and operation of the project.

Finally, with regard to irreversible and irretrievable commitments of resources, the Staff concluded that disposal of radioactive and nonradioactive wastes would require an irreversible commitment of land but that the land used for the constructed SMRs, with the exception of any permanently filled wetlands, can be returned to other uses in the future after the units cease operation and are decommissioned.[282] De-watering for construction of the power block would commit a small amount of groundwater, but these impacts would be localized and limited in duration. Operation of the SMRs would consume 12,808 gallons of water per minute from the Clinch River that would not be available to downstream users.[283] Construction and pre-construction of the SMRs would permanently commit some portions of terrestrial, wetland, and aquatic habitats and would "permanently damage an unknown number of historic and cultural resources," including the possible permanent loss of deeply buried archaeological deposits and an unknown number of the seventeen identified historic properties on the Clinch River site.[284] The Staff found that construction of the project would irretrievably consume construction materials (for example, concrete, steel, and other building materials) but the quantity consumed would be of small consequence compared to the availability of such

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[281] Ex. NRC-015A, Final EIS, tbls.10-1 & 10-2.

[282] *Id*. at 10-20.

[283] *Id*.

[284] *Id*. at 10-20 to 10-21. Should an applicant choose to proceed with the project, it would need to apply for, and receive, a separate authorization (such as a COL) from the NRC in order to construct and operate a nuclear power plant at the Clinch River site. This authorization would require the NRC to prepare a supplemental EIS and complete a separate NHPA Section 106 review and consultation.

resources.[285] The Staff also determined that operation would irretrievably commit uranium but the amount consumed would be negligible compared to the availability of uranium ore and existing stockpiles of highly enriched uranium.[286] We find reasonable the Staff's assessment of the irreversible and irretrievable commitments of resources associated with the construction and operation of the project.

In sum, within the limitations imposed by TVA's decision to defer its assessment of certain issues, most notably its analysis of the benefits of the project, including need for power, we find that the Staff's review was reasonably supported in logic and fact and sufficient to support the Staff's conclusions in the Final EIS. In accordance with the Notice of Hearing for this uncontested proceeding, we have independently considered the relevant requirements of NEPA sections 102(2)(A), (C), and (E), and the applicable regulations in 10 C.F.R. part 51, and we find that these requirements have been satisfied with respect to the ESP application. In this regard, we consider the Staff's analysis of the "relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity" in the Final EIS sufficient, but we agree that this determination may be updated at the construction permit or COL stage.[287]

In our review of the Final EIS and hearing record, and our questioning of the parties in this uncontested proceeding, we have independently considered, probed and weighed these factors within the ambit of this ESP proceeding. In doing so, we have considered the benefits of

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[285] *Id*. at 10-21. The Staff based its estimate on a study by the U.S. Department of Energy on new reactor construction but noted that the estimate could be significantly lower given the comparatively small generating capacity (800 MW(e)) of the project; further, the actual amount of construction resources consumed will depend on the final reactor design selected by TVA at the construction permit or COL stage. *Id*.

[286] Ex. NRC-015A, Final EIS, at 10-21.

[287] *Cf.* NEPA § 102(2)(C)(iv), 42 U.S.C. § 4332(2)(C)(iv).

issuing an ESP for the Clinch River site, such as providing stability in the licensing process through early resolution of siting and environmental issues, as well as the costs described in the Staff's environmental review.[288] We have considered the reasonable alternatives, and we find that the deferred and unresolved environmental issues in this proceeding have not affected the Staff's determination that there is no obviously superior alternative to the Clinch River site.[289] Therefore, based on our review of the Final EIS and the record in this proceeding, we find that the ESP should be issued.

[288] *See, e.g.*, Ex. NRC-015A, Final EIS, at 1-9, 9-1; Ex. NRC-004, Draft Summary Record of Decision, at 4-5; *see also* Licenses, Certifications, and Approvals for Nuclear Power Plants; Final Rule, 72 Fed. Reg. 49,352, 49,434 (Aug. 28, 2007) (when applicant has not addressed all the costs and benefits of construction and operation in the ESP application, benefits of issuing an ESP include "early resolution of siting issues, early resolution of issues on the environmental impacts of construction and operation of a reactor(s) that fall within the site characteristics, and ability of potential nuclear power plant licensees to 'bank' sites on which nuclear power plants could be located without obtaining a full construction permit or combined license"); *see* 10 C.F.R. § 51.75(b).

[289] *Cf.* 10 C.F.R. § 51.75(b) (EIS must evaluate environmental effects of construction and operation of reactors "only to the extent addressed in the [ESP environmental report] or otherwise necessary to determine whether there is any obviously superior alternative to the site proposed"); *North Anna ESP*, CLI-07-27, 66 NRC at 237 (lack of resolution on such issues as need for power, alternative energy sources, and severe accident mitigation alternatives, did not prevent issuance of ESP).

III. CONCLUSION

We find that, with respect to the safety and environmental issues before us, the Staff's review of the Clinch River ESP application was sufficient to support issuance of the ESP. We *authorize* the Director of the Office of Nuclear Reactor Regulation to issue the ESP for the Clinch River site.[290] Additionally, we *authorize* the Staff to issue the record of decision, subject to its revision as necessary to reflect the findings in this decision.

IT IS SO ORDERED.

For the Commission

NRC SEAL

/RA/

Annette L. Vietti-Cook
Secretary of the Commission

Dated at Rockville, Maryland,
this 17th day of December 2019.

[290] On October 15, 2019, the Office of New Reactors merged into the Office of Nuclear Reactor Regulation.

Commissioner Baran, Dissenting in Part

I agree with most of the Commission's decision, including the overall conclusion that the NRC Staff's review of the Clinch River early site permit (ESP) application was sufficient to support issuance of the ESP. However, I dissent in part on the issuance of exemptions from NRC's regulatory requirement that nuclear power plants have an emergency planning zone (EPZ) that extends about 10 miles out from the site.[1] Although I agree that the standards of 10 C.F.R. § 50.12 are met for the requested exemptions for a potential 2-mile EPZ, I find that those standards are not met for exemptions for a potential site boundary EPZ.

Since 1978, when the concept of an EPZ was first developed, the size of an EPZ has never been exclusively based on the likelihood of an accident occurring. The joint NRC-EPA task force that introduced the EPZ concept specifically stated: "Emergency planning is not based upon quantified probabilities of incidents or accidents."[2] NRC and EPA understood that beyond-design-basis accidents were unlikely, but they also knew that EPZs should be in place to provide defense-in-depth because "the probability of an accident involving a significant release of radioactive material, although small, is not zero."[3]

NRC's recognition of the important role emergency planning plays in providing defense-in-depth has endured over the years. In the 1986 Safety Goals Policy Statement, even as the Commission focused on the quantitative risk of nuclear reactor accidents, the Commission recognized "emergency planning as [an] integral part[] of the defense-in-depth concept associated with its accident prevention and mitigation philosophy."[4] The Commission stated

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[1] *See* 10 C.F.R. § 50.33(g).

[2] NUREG-0396/EPA-520, app. I at I-2.

[3] *Id.*, app. II at II-1.

[4] Safety Goals for the Operations of Nuclear Power Plants; Policy Statement, 51 Fed. Reg. 28,044, 28,045 (Aug. 4, 1986).

that “emergency response capabilities are mandated to provide additional defense-in-depth protection to the surrounding populations.”[5] And again in 1993, when the agency was working through non-light-water reactor issues, the NRC Staff proposed “no changes to the existing regulations governing EP for non-light-water reactor licensees,” explaining that it “views the inclusion of emergency preparedness by advanced reactor licensees as an essential element in NRC’s ‘defense-in-depth’ philosophy.”[6] Four years later, the Staff emphasized the importance of getting the buy-in of federal, state, and local emergency response agencies for any emergency response changes relating to new, potentially safer reactor designs.[7]

But under the proposed application of the EPZ-sizing methodology, the quantitative dose formula exclusively determines the size of the EPZ. It is a purely quantitative, risk-based determination rather than a risk-informed decision that accounts for expert judgment, defense-in-depth, and public confidence. Instead of risk being one important factor considered in setting emergency planning requirements, it is the only factor that matters. For one or more small modular reactors (SMRs) that met the dose criteria for a site boundary EPZ, there would be no dedicated offsite radiological emergency planning. That element of defense-in-depth would be dropped completely.

The Federal Emergency Management Agency (FEMA) has expressed major concerns about this approach. It disagrees that quantitative dose criteria should completely determine the size of an EPZ. Consistent with the 1978 joint task force report, FEMA has expressed its

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[5] *Id.* at 28,047.

[6] “Issues Pertaining to the Advanced Reactor (PRISM, MHTGR, and PIUS) and CANDU 3 Designs and their Relationship to Current Regulatory Requirements,” Commission Paper SECY-93-092 (April 8, 1993), at 13 (ML040210725).

[7] *See* “Results of Evaluation of Emergency Planning for Evolutionary and Advanced Reactors,” Commission Paper SECY-97-020 (Jan. 27, 1997) (ML051640616).

support for "a methodology for EPZ sizing that takes into account such 'non-technical' criteria" as public confidence.[8]

Moreover, "FEMA has consistently raised concerns about a methodology that allows for a site boundary EPZ for a commercial nuclear power plant."[9] In the absence of an EPZ and dedicated offsite radiological emergency planning, emergency responders would be left with all-hazards planning. FEMA does not believe that all-hazards planning would be adequate in the event of an actual nuclear power plant accident. According to FEMA, "Radiological [emergency planning] is not sufficiently addressed within the All Hazards framework – radiological [emergency planning] is unique. In a Worst-Case Scenario, our [offsite response organizations] could be challenged to effectively protect the health and safety of the public using an ad hoc [emergency planning] construct."[10] FEMA explains that "[a]dvanced planning – such as provided by an EPZ – reduces the complexity of the decision-making process during an incident."[11] And FEMA "stress[es] that the proven best way to ensure offsite readiness is to develop, exercise, and assess [offsite response organization] radiological capabilities, as is now done throughout the offsite EPZ."[12] While a radiological emergency plan could be "scaled up" to address a more severe accident than what was planned for, FEMA notes that it is "unrealistic" to scale up "non-existent plans" and that the resulting "lack of necessary equipment, and shortage of trained emergency personnel could have unfortunate consequences."[13]

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[8] Supplemental FEMA Letter at 2.

[9] *Id.*

[10] FEMA Letter at 2.

[11] *Id*.

[12] *Id*.

[13] Supplemental FEMA Letter at 4.

In short, all-hazards planning would not be as effective as dedicated radiological emergency planning in an actual radiological emergency. As a result, a site boundary EPZ with all-hazards planning would not provide the same level of protection for a community located near a reactor site as an offsite EPZ with dedicated radiological emergency planning. FEMA, therefore, "believes that the NRC staff conclusion that the proposed methodology of offsite emergency preparedness maintains the same level of protection as a ten-mile EPZ is unsupported."[14]

We should place great weight on FEMA's views. FEMA has a key role in determining whether the emergency planning for a nuclear power plant site is adequate. Under our regulations, an early site permit cannot be issued unless NRC makes a finding that the major features of the emergency plan meet the regulatory requirements.[15] And NRC is supposed to base its finding on FEMA's determinations as to whether the offsite emergency plans are adequate and whether there is reasonable assurance that they can be implemented. In fact, under our regulations, "in any NRC licensing proceeding, a FEMA finding will constitute a rebuttable presumption on questions of adequacy and implementation capability."[16] FEMA has this prominent role in our licensing process because of its well-known expertise in this area. Yet, FEMA would have no role in assessing the adequacy of offsite emergency plans and capabilities for any reactor with a site boundary EPZ.

A potential 2-mile EPZ recognizes that SMRs could be safer than large-light-water reactors while still ensuring that there will be dedicated offsite radiological emergency planning to provide defense-in-depth in the unlikely event of a severe accident. A site boundary EPZ, on

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[14] *Id.* at 2.

[15] 10 C.F.R. § 50.47(a)(1)(iv).

[16] 10 C.F.R. § 50.47(a)(2).

the other hand, would not provide the same level of protection afforded by dedicated offsite radiological emergency planning.

For these reasons, I disagree with the Staff that the exemptions related to a potential site boundary EPZ meet the requirements of 10 C.F.R. § 50.12. Specifically, I cannot conclude that these exemptions "will not present an undue risk to the public health and safety." Therefore, I would deny the request for these exemptions.

With respect to the exemptions for a potential 2-mile EPZ, the Staff stated that "depending on the plant design, multiple reactor accidents for multi-module designs may or may not be included in the spectrum of accidents used for the plume exposure pathway EPZ size determination."[17] A key lesson of the Fukushima accident is that severe natural disasters can simultaneously threaten multiple reactors at a site. It is important that the EPZ sizing methodology account for the possibility of accidents affecting more than one SMR module when several modules are on site, rather than evaluate only one module in isolation. Two or more SMRs with a maximum combined electrical output of 800 MW(e) could create a larger source term than some operating LLWRs. In granting the exemptions for a potential 2-mile EPZ, the Commission should require the Staff to ensure that possible accidents affecting more than one SMR module are included in the spectrum of accidents used for the EPZ size determination in any future request for a 2-mile EPZ at the Clinch River site.

[17] Ex. NRC-005, Staff Pre-Hearing Responses, Attach. at 18.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
TENNESSEE VALLEY AUTHORITY	)	
	)	Docket No. 52-047-ESP
(Early Site Permit Application	)	
for Clinch River Nuclear Site)	)	
	)	
(Mandatory Hearing)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing **COMMISSION MEMORANDUM AND ORDER (CLI-19-10)** have been served upon the following persons by Electronic Information Exchange.

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[Original signed by Herald M. Speiser]
Office of the Secretary of the Commission

Dated at Rockville, Maryland,
this 17th day of December 2019