

**Safety Evaluation of Early Site Permit Application in the
Matter of Dominion Nuclear North Anna, LLC, for the
North Anna Early Site Permit Site**

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U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
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ABSTRACT

This draft safety evaluation report (DSER) documents the U.S. Nuclear Regulatory Commission (NRC) staff's technical review of the site safety analysis report and emergency planning information included in the early site permit (ESP) application submitted by Dominion Nuclear North Anna, LLC (Dominion or the applicant) for the North Anna ESP site. By letter dated September 25, 2003, Dominion submitted the ESP application for the North Anna ESP site in accordance with Title 10, Part 52, Subpart A, "Early Site Permits," of the *Code of Federal Regulations*. The North Anna ESP site is located approximately 40 miles north-northwest of Richmond, Virginia, and is adjacent to two existing nuclear power reactors operated by Virginia Electric and Power Company, which, like Dominion Nuclear North Anna, LLC, is a subsidiary of Dominion Resources, Inc. In its application, Dominion seeks an ESP that could support a future application to construct and operate additional nuclear power reactors at the ESP site, with a total nuclear generating capacity of up to 8600 megawatts (thermal).

This DSER presents the results of the staff's review of information submitted in conjunction with the ESP application. In addition, this report discusses the status of the staff's review of information submitted to the NRC through September 30, 2004. The staff has identified open and confirmatory items that the applicant needs to resolve before the staff can complete its review of the ESP application. Section 1.6 of this report summarizes these items. To resolve these items, the staff requests the additional information identified in this report. The staff will provide its conclusions on the review of the North Anna ESP application in a final safety evaluation report.

The staff has also identified certain site-related items that will need to be addressed at the combined license or construction permit stage, should an applicant desire to construct one or more new nuclear reactors on the North Anna ESP site. The staff determined that these items do not affect the staff's regulatory findings at the ESP stage and are, for reasons specified in Section 1.7, more appropriately addressed at later stages in the licensing process.

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In accordance with U.S. Nuclear Regulatory Commission Review Standard (RS)-002, "Processing Applications for Early Site Permits," the chapter and section layout of this safety evaluation report is essentially consistent with the format of (1) NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," (2) Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," and (3) the applicant's site safety analysis report. Numerous sections and chapters in NUREG-0800 are not within the scope of or addressed in an early site permit (ESP) proceeding. The reader will therefore note "missing" chapter and section numbers in this document. The subjects of chapters and sections in NUREG-0800 not addressed herein will be addressed, as appropriate and applicable, in other regulatory actions (design certification, construction permit, and/or combined license) for a reactor or reactors that might be constructed on the North Anna ESP site.

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EXECUTIVE SUMMARY

Title 10, Part 52, “Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants” of the *Code of Federal Regulations* (10 CFR Part 52) contains requirements for licensing, construction, and operation of new nuclear power plants.¹ These regulations address early site permits (ESPs), design certifications, and combined licenses (COLs). The ESP process (10 CFR Part 52, Subpart A, “Early Site Permits”) is intended to address and resolve site-related issues. The design certification process (10 CFR Part 52, Subpart B, “Standard Design Certifications”) provides a means for a vendor to obtain U.S. Nuclear Regulatory Commission (NRC) certification of a particular reactor design. Finally, the COL process (10 CFR Part 52, Subpart C, “Combined Licenses”) allows an applicant to seek authorization to construct and operate a new nuclear power plant. A COL may reference an ESP, a certified design, both, or neither. It is incumbent on a COL applicant to resolve issues related to licensing that were not resolved as part of an ESP or design certification proceeding before the NRC can issue a COL.

This draft safety evaluation report (DSER) describes the results of a review by NRC staff of an ESP application submitted by Dominion Nuclear North Anna, LLC (Dominion or the applicant) for the North Anna ESP site. The staff’s review verified, with noted exceptions, the applicant’s compliance with the requirements of Subpart A of 10 CFR Part 52. The DSER serves to identify the status of completion of the safety review and to identify remaining items to be addressed before the staff issues its final safety evaluation report (FSER).

The NRC regulations also contain requirements for an applicant to submit an environmental report pursuant to 10 CFR Part 51, “Environmental Protection Regulations for Domestic Licensing and Related Regulatory Activities.” The NRC reviews the environmental report as part of the Agency’s responsibilities under the National Environmental Policy Act of 1969, as amended. The NRC presents the results of that review in a draft environmental impact statement, which is a report separate from this DSER.

By letter dated September 25, 2003, Dominion submitted an ESP application (ADAMS Accession No. ML032731517)² for the North Anna ESP site. The North Anna ESP site is

¹Applicants may also choose to seek a construction permit and operating license in accordance with 10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities,” instead of using the 10 CFR Part 52 process.

²ADAMS (Agencywide Documents Access and Management System) is the NRC’s information system that provides access to all image and text documents that the NRC has made public since November 1, 1999, as well as bibliographic records (some with abstracts and full text) that the NRC made public before November 1999. Documents available to the public may be accessed via the Internet at <http://www.nrc.gov/reading-rm/adams/web-based.html>. Documents may also be viewed by visiting the NRC’s Public Document Room (PDR) at One White Flint North, 11555 Rockville Pike, Rockville, Maryland. Telephone assistance for using web-based ADAMS is available at (800) 397-4209 between 8:30 a.m. and 4:15 p.m., eastern standard time, Monday through Friday, except Federal holidays. The staff is also making this DSER available on the NRC’s new reactor licensing public web site at <http://www.nrc.gov/reactors/new-licensing/esp/north-anna.html>.

located approximately 40 miles north-northwest of Richmond, Virginia, and is adjacent to two existing nuclear power reactors operated by Virginia Electric and Power Company.

In accordance with 10 CFR Part 52, Dominion submitted information in its ESP application that includes (1) a description of the site and nearby areas that could affect or be affected by a nuclear power plant(s) located at the site; (2) a safety assessment of the site on which the facility would be located, including an analysis and evaluation of the major structures, systems, and components of the facility that bear significantly on the acceptability of the site; and (3) proposed major features of emergency plans. The application describes how the site complies with the requirements of 10 CFR Part 52 and the siting criteria of 10 CFR Part 100, "Reactor Site Criteria."³

This DSER presents the status of the staff's review of information the applicant submitted to the NRC through September 30, 2004. The staff has identified open and confirmatory items that the applicant needs to resolve before the staff can complete its review of the ESP application. Section 1.6 of this DSER summarizes these items. To close these items, the staff requests the additional information identified in this DSER. The staff will provide its conclusions on its review of the North Anna ESP application in its FSER.

The staff has identified, in Section 1.7, proposed permit conditions that it will recommend the Commission impose, should an ESP be issued to the applicant. Also, it has identified certain site-related items that will need to be addressed at the COL or construction permit stage, should an applicant desire to construct one or more new nuclear reactors on the North Anna ESP site. The staff determined that these items do not affect the staff's regulatory findings at the ESP stage and are, for reasons specified in Section 1.7, more appropriately addressed at these later stages in the licensing process.

Inspections conducted by the NRC have verified, where appropriate, the conclusions in this DSER. The scope of the inspections consisted of selected information in the ESP application and its references. This DSER identifies applicable inspection reports as reference documents.

The NRC's Advisory Committee on Reactor Safeguards (ACRS) will also review the bases for the conclusions in this report. The ACRS will independently review those aspects of the application that concern safety, as well as the DSER, and will report the results of its review to

³ The applicant has also submitted information intended to partially address some of the general design criteria (GDCs) in Appendix A to 10 CFR Part 50. Only GDC 2 applies to an ESP application, and it does so only to the extent necessary to determine the safe shutdown earthquake (SSE) and the seismically induced flood. The staff has explicitly addressed partial compliance with GDC 2, in accordance with 10 CFR 52.17(a)(1) and 10 CFR 50.34(a)(12), only in connection with the applicant's analysis of the SSE and the seismically induced flood. Otherwise, an ESP applicant need not demonstrate compliance with the GDCs. The staff has included a statement to this effect in various sections of this SER that are not connected to the SSE or the seismically induced flood. Nonetheless, this SER describes the staff's evaluation of information submitted by the applicant to address GDC 2.

the Commission. The NRC will include the ACRS comments and recommendations, and the staff's responses to them, in the FSER.

As required by 10 CFR 52.21, "Hearing," the review process for the ESP will include a hearing. The NRC published a notice of hearing in the *Federal Register* on December 2, 2003. The Blue Ridge Environmental Defense League, Public Citizen, and the Nuclear Information and Resource Service collectively filed a petition for leave to intervene on January 2, 2004 (ADAMS Accession No. ML040510285), and subsequently filed several contentions (ADAMS Accession No. ML041320393) alleging deficiencies in Dominion's application on May 3, 2004. The Atomic Safety and Licensing Board ruled on August 6, 2004 that two contentions would be admitted (ADAMS Accession No. ML041320393). Neither admitted contention relates to the safety review that is the subject of this DSER; both relate to the accompanying environmental review that is the subject of the NRC's draft environmental impact statement.

ABBREVIATIONS

ABWR	advanced boiling water reactor
ADAMS	Agencywide Documents Access and Management System
ALWR	advanced light-water reactor
ANS	alert and notification system
ANSI	American National Standards Institute
ANSS	Advanced National Seismic System
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASTM	American Society for Testing and Materials
BRH	Bureau of Radiological Health
BWR	boiling water reactor
CDE	committed dose equivalent
CEUS	central and eastern United States
CVSZ	Central Virginia Seismic Zone
CFR	<i>Code of Federal Regulations</i>
COL	combined license
COVREMP	Commonwealth of Virginia Radiological Emergency Response Plan
CP	construction permit
CPT	cone penetrometer test
DBA	design-basis accident
DCD	design control document
DEIS	draft environmental impact statement
DOE	Department of Energy
DSER	draft safety evaluation report
EAB	exclusion area boundary
EAL	emergency action level
EAS	emergency alert system
ECFS	East Coast fault system
EDS	engineering design spectrum
EIS	environmental impact statement
EMI	Emergency Management Institute
EOC	emergency operations center
EOF	emergency operations facility
EPA	Environmental Protection Agency
EPIP	emergency plan implementing procedure
EPZ	emergency planning zone
EPRI	Electric Power Research Institute
ER	Environmental Report
ERO	emergency response organization
ERDS	Emergency Response Data System
ESE	east-southeast
ESP	early site permit
EST	earth science team
ETE	evacuation time estimate
ETSZ	Eastern Tennessee Seismic Zone
FAA	Federal Aviation Administration
FEMA	Federal Emergency Management Agency

FRMAC	Federal Radiological Monitoring and Assessment Center
FRP	Federal Response Plan
FRERP	Federal Radiological Emergency Response Plan
FS	factor of safety
FSER	final safety evaluation report
GDC	general design criterion
GIS	Geographical Information System
GSA	Geological Society of America
HEAR	hospital emergency and administrative radio
HEC	Hydrologic Engineering Center
HMR	hydrometeorological report
INPO	Institute of Nuclear Power Operations
ISFSI	independent spent fuel storage installation
KI	potassium iodide
kPa	kiloPascals
LLNL	Lawrence Livermore National Laboratory
LOCA	loss-of-coolant accident
LPZ	low-population zone
LWR	light water reactor
M&TE	measuring and test equipment
MCVH	Medical College of Virginia Hospitals
MIDAS	meteorological information and dose assessment system
MSL	mean sea level
NAEP	North Anna Emergency Plan
NAPS	North Anna Power Station
NBU	Nuclear Business Unit
NCDC	National Climatic Data Center
NDCP	Nuclear Design Control Program
NE	northeast
NEI	Nuclear Energy Institute
NEP	nuclear emergency preparedness
NMSZ	New Madrid Seismic Zone
NNE	north-northeast
NOAA	National Oceanic and Atmospheric Administration
NPSEPT	Nuclear Power Station Emergency Preparedness Training
NRC	U.S. Nuclear Regulatory Commission
NSSL	National Severe Storms Laboratory
NWS	National Weather Service
OBE	operating-basis earthquake
ODEC	Old Dominion Electric Cooperative
OSC	operational support center
OW	observation well
PAR	protective action recommendation
PAZ	protective action zone
PGA	peak ground acceleration
PMF	probable maximum flood
PMH	probable maximum hurricane
PMP	probable maximum precipitation
PNNL	Pacific Northwest National Laboratories

PPE	plant parameter envelope
PSHA	probabilistic seismic hazard analysis
PWR	pressurized-water reactor
QA	quality assurance
RAA	remote assembly area
RAI	request for additional information
RAP	radiological assistance program
RERP	radiological emergency response plan
RERT	Radiological Emergency Response Team
RG	regulatory guide
RQD	rock quality designation
RS	review standard
S	south
SCS	Soil Conservation Service
SE	southeast
SEI	Structural Engineering Institute
SER	safety evaluation report
SF	scale factor
SPT	standard penetration test
SSAR	site safety analysis report
SSE	safe-shutdown earthquake
SRCC	Southern Regional Climate Center
SSC	system, structure, and component
SWR	service water reservoir
TEDE	total effective dose equivalent
TLD	thermoluminescent dosimeter
TSC	technical support center
USACE	U.S. Army Corps of Engineers
UFSAR	updated final safety analysis report
UHF	ultra-high frequency
UHS	ultimate heat sink
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
VCU	Virginia Commonwealth University
VDEM	Virginia Department of Emergency Management
VDGIF	Virginia Department of Game and Inland Fisheries
VDH	Virginia Department of Health
VT	Virginia Polytechnic Institute and State University
WHTF	Waste Heat Treatment Facility
ZPA	zero period acceleration

1. INTRODUCTION AND GENERAL DESCRIPTION

1.1 Introduction

Dominion Nuclear North Anna, LLC (Dominion or the applicant) filed an application with the U.S. Nuclear Regulatory Commission (NRC), docketed on October 23, 2003, for an early site permit (ESP) for a site the applicant designated as the North Anna ESP site. The proposed site is located near Lake Anna in Louisa County, Virginia, approximately 40 miles north-northwest of Richmond, Virginia.

The staff has completed its review, to the extent possible at this time, in the areas of seismology, geology, meteorology, and hydrology, as well as in the area of hazards to a nuclear power plant that could result from manmade facilities and activities on or in the vicinity of the site. The staff also assessed the risks of potential accidents that could occur as a result of the operation of a nuclear plant(s) at the site, and evaluated whether the site would support adequate physical security measures for a nuclear power plant(s). The staff evaluated whether the applicant's quality assurance measures were equivalent in substance to the measures discussed in Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants" to Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," of the *Code of Federal Regulations*. The NRC has found that such measures provide reasonable assurance that information derived from ESP activities that would be used in design and/or construction of structures, systems, and components (SSCs) important to safety would support satisfactory performance of such SSCs in service. The staff also evaluated the adequacy of the applicant's program for compliance with 10 CFR Part 21, "Reporting of Defects and Noncompliance." Finally, the staff has reviewed the proposed major features of the emergency plan that Dominion would implement if a new reactor(s) is eventually constructed at the ESP site. The complete and integrated emergency plan would need to be reviewed by the NRC in a separate licensing proceeding.

The Dominion ESP application included a description and a safety assessment of the site, as required by 10 CFR 52.17, "Contents of Applications." The public may inspect copies of this document via the Agencywide Documents Access and Management System (ADAMS) using ADAMS Accession No. ML032731517. The application was subsequently revised to address requests from the NRC staff for additional information. The applicant submitted the latest revision (Revision 3) on September 7, 2004 (ADAMS Accession No. ML042590081). The documents are also available for public inspection at the NRC's Public Document Room at One White Flint North, 11555 Rockville Pike, Rockville, Maryland, and at the Louisa County Public Library, 881 Davis Highway, Mineral, Virginia. The staff is also making the revised application and this DSER available on the NRC's new reactor licensing public web site at <http://www.nrc.gov/reactors/new-licensing/esp/north-anna.html>.

This DSER summarizes the results of the NRC staff's technical evaluation of the suitability of the proposed North Anna ESP site for a nuclear power plant(s) falling within the plant parameter envelope (PPE) that Dominion specified in its application. The DSER delineates the scope of technical matters the staff considered in evaluating the suitability of the site. The NRC Review Standard (RS)-002, "Processing Applications for Early Site Permits," provides additional details on the scope and bases of the NRC staff's review of the radiological safety and emergency planning aspects of review of a proposed nuclear power plant site. This review

standard contains regulatory guidance based on NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants" (hereinafter referred to as the Standard Review Plan). The Standard Review Plan reflects many years of experience the NRC staff has had in establishing and promulgating guidance to enhance the safety of nuclear facilities, as well as in evaluating safety assessments.

The applicant also filed an environmental report for the North Anna ESP site in which it evaluated those matters relating to the environmental impact assessment that can be reasonably reviewed at this time. The staff discussed the results of its evaluation of the environmental report for the North Anna ESP site in a draft environmental impact statement (DEIS) issued on December 7, 2004 (ADAMS Accession No. ML043380308; also available on the NRC's new reactor licensing public web site). The applicant has also provided a site redress plan, in accordance with 10 CFR 52.17(c), in order to perform the limited site activities allowed by 10 CFR 52.25(a), "Extent of Activities Permitted" [i.e., the activities listed in 10 CFR 50.10(e)(1), "License Required"]. The results of the staff's evaluation of that plan are also contained in the DEIS.

Appendix A to this DSER details a chronology of the principal actions and correspondence related to the staff's review of the ESP application for the North Anna ESP site. Appendix B is the bibliography for this DSER.

1.2 General Site Description

The ESP site is a parcel of land on the North Anna Power Station (NAPS) site in Louisa County, Virginia, approximately 40 miles north-northwest of Richmond, Virginia. The NAPS site includes other, existing nuclear facilities licensed by the NRC, specifically NAPS Units 1 and 2 (Docket Nos. 50-338/339; NRC Facility Operating License Nos. NPF-4/7) and the North Anna Independent Spent Fuel Storage Installation (NRC Docket No. 72-16; Materials License No. SNM-2507). As shown in SSAR Figure 1.2-4, the ESP site is adjacent to and generally west of the existing nuclear reactor units. The Virginia Electric and Power Company (Virginia Power) and the Old Dominion Electric Cooperative (ODEC) own the NAPS site as tenants in common. Virginia Power is the licensed operator of the existing nuclear units, with control of these facilities and the authority to act as ODEC's agent. Virginia Power and the ESP applicant, Dominion Nuclear North Anna, LLC, are direct and indirect wholly owned subsidiaries, respectively, of Dominion Resources, Inc.

The application stated that the NAPS site comprises 1803 acres, of which about 760 acres are covered by water. Virginia Power and ODEC own, and Virginia Power controls, all of the land within the NAPS site boundary, including those portions of the North Anna Reservoir and Waste Heat Treatment Facility (WHTF) that lie within the site boundary. These companies also own all land outside the NAPS site boundary that forms Lake Anna, up to the expected high-water marks. The NAPS site and all supporting facilities, including the North Anna Reservoir, the WHTF, the earth dam, dikes, railroad spur, and roads, constitute approximately 18,643 acres. Lake Anna, which includes the North Anna Reservoir and the WHTF, was created to serve the needs of the power station.

The application indicates that if the ESP is granted and Dominion decides to proceed with the development of new nuclear units on the ESP site, it would enter into and obtain, to the extent necessary, appropriate State public utility commission approval(s) of an agreement to purchase

or lease the ESP site. The staff has determined that the applicant needs to demonstrate that it has the legal right to control the exclusion area, or has the irrevocable right to obtain such control. The staff identified this issue as an open item, as discussed in Sections 1.6 and 2.1.2 of this report.

The application also indicates that if the ESP is granted and Dominion decides to undertake any preconstruction activities described in the ESP pursuant to 10 CFR 52.25, Dominion would enter into and obtain, to the extent necessary, appropriate State public utility commission approval(s) of site redress or related agreement(s) with Virginia Power before conducting the activities. The application states that the approvals and agreement(s) would authorize the applicant to conduct the preconstruction activities and that they would confirm Dominion's obligation to perform any site redress that might be needed, pursuant to the NRC-approved site redress plan. The application states that Dominion's site redress obligation would be supported by a guaranty provided by its ultimate parent company, Dominion Resources, Inc.

Should the ESP holder decide to perform the activities authorized by 10 CFR 52.25, the ESP holder will need to obtain the authority to undertake those activities on the ESP site. In obtaining such right, the ESP holder will also need to obtain the corresponding right to implement the site redress plan described in the staff's final environmental impact statement in the event no plant is built on the ESP site. The applicant may resolve this issue in resolving the open item identified above on exclusion area control. If, however, it does not do so, the staff intends to include, in any ESP that might be issued for this application, a permit condition to address the matter, as discussed in Section 2.1.2 of this DSER.

The largest community within 10 miles of the site is the town of Mineral, Virginia. According to the 2000 census, Mineral has a population of 424 located within about 1 square mile (incorporated). As reported in the NAPS Updated Final Safety Analysis Report, the population in 1990 was 452. Therefore, the population of Mineral has remained essentially constant during the past decade. The 2000 resident population within 6 and 10 miles of the site was 5,890 and 15,511 persons, respectively. The applicant estimated the total peak daily transient population on Lake Anna (including the WHTF and Lake Anna State Park) to be less than 11,270. The nearest population center to the ESP site with more than 25,000 residents is the City of Charlottesville, Virginia, with a population of 45,049. The closest point of Charlottesville to the site is 36 miles to the west.

No military bases, missile sites, manufacturing plants, chemical plants, chemical or other storage facilities, airports, major railroad lines, major water transportation, or hazardous material (e.g., oil or gas) pipelines are located within 5 miles of the ESP site. As previously noted, the only industrial facilities within 5 miles of the ESP site are the existing NAPS units. Major highways, such as Interstates 95 and 64, are located more than 16 miles away from the site. U.S. Route 522 is located about 5 miles west of the site. The closest point of Virginia Route 652 is 1.5 miles to the south of the site. The only road that provides access to the site is State Route 700, coming from the southwest to within about one-half mile of the site. No public or commercial highways, railroads, or waterways traverse the site.

Two airports are located within 15 miles of the ESP site. Operations at the Louisa County Airport (Freeman Field), located 11 miles west-southwest of the site, primarily involve single-engine light aircraft. The Lake Anna Airport, near Bumpass, Virginia, is 7 miles south-southeast of the site. This airport has limited facilities.

1.3 Plant Parameters Envelope

The regulations at 10 CFR Part 52 and 10 CFR Part 100, "Reactor Site Criteria," that apply to an ESP do not require that an ESP applicant provide specific design information. However, some design information may be required to address 10 CFR 52.17(a)(1), which calls for "an analysis and evaluation of the major structures, systems, and components of the facility that bear significantly on the acceptability of the site under the radiological consequence evaluation factors identified in § 50.34(a)(1) of this chapter."

In Section 1.3 of the ESP site safety analysis report (SSAR), Dominion provided a list of postulated design parameters, referred to as the "plant parameter envelope" or PPE. The applicant stated that the PPE approach provides sufficient design details to support the NRC's review of the ESP application, while recognizing that new reactor technologies, not envisioned at the time Dominion submitted its ESP application, may become available in the future. Therefore, the applicant stated that it based the PPE on data from selected reactor designs, and that the PPE is intended to bound multiple reactor designs. The applicant also stated that the actual reactor design selected would be reviewed at the combined license (COL) stage to ensure that the design fits within the PPE.

In request for additional information (RAI) 1.3-1, the staff asked the applicant to explain its use of the plant parameters in SSAR Table 1.3-1 for the cases in which site-specific characteristics are provided. The staff also requested that the applicant clearly identify site characteristics and plant design parameters that it proposed be included as the bases for an ESP, should one be issued. The applicant responded by providing, in Revision 3 of the ESP application, a new section (1.9) of its SSAR. In this section, the applicant provided a summary listing of site characteristics that were established by analyses presented throughout the SSAR. The applicant proposed this section as a listing of important site characteristics necessary to establish the findings required by 10 CFR Parts 52 and 100 on the suitability of the proposed ESP site. The applicant stated that this section also provides a listing of design parameters and assumptions about the design of a future nuclear power plant(s) that might be constructed on the ESP site. According to the applicant, the design parameters described in this section are those that are needed to assess the site characteristics.

In RAI 1.3-2, the staff requested that the applicant (1) clarify its use of "bounding values" in Table 1.3-1, (2) add the dose criteria in 10 CFR 50.34(a)(1) to the table as "bounding value references" or explain why these references are not needed, and (3) clarify the use of "Bound Notes" in the table, including how they were used for the accident analyses. In its response, the applicant provided clarification and corrections to Table 1.3-1.

In RAI 1.3-3, the staff requested that the applicant clarify the relationship between the items in the "bounding values" provided in Table 1.3-1 and the references. The applicant responded that the PPE is a compilation of parameters that generally describe a bounding (or limiting) plant design. According to the applicant, the PPE is not intended to reflect the design of any single reactor type, but to provide assumed parameters for any future reactor(s) that might be built at the ESP site. The applicant stated that it developed assumed parameter values in the PPE from a diverse group of reactor designs, and the "bounding value" is the limiting value from those designs. Finally, the applicant clarified that the "Bound Notes" column in Table 1.3-1 provides information as to the source of the bounding value and other pertinent information for the parameter.

The applicant has provided, through its PPE, sufficient design information to allow it to perform the evaluation required by 10 CFR 52.17(a)(1) to determine the adequacy of the proposed exclusion area and low-population zone (LPZ) for the site. Chapter 15 of the SSAR reports the results of this evaluation. In this evaluation, the applicant used design information limited to the rate of release of radioactivity to the environment as a result of a design-basis accident for hypothetical reactors similar to two representative reactor types that vendors have offered for construction in the United States.

In addition to the information supporting the dose consequence evaluation, the applicant provided other design information in its PPE. Because the applicant is not requesting that an ESP be issued referencing a particular reactor design, the staff's review criterion for the PPE is that the PPE values should not be unreasonable for a reactor that might be constructed on the ESP site. The applicant's PPE is based on various reactor designs that are either certified by the NRC, are in the certification process, or may be submitted for certification in the future. The PPE references the following designs:

- ACR-700 (Atomic Energy of Canada, Ltd.)
- Advanced Boiling-Water Reactor (General Electric)
- AP1000 (Westinghouse Electric Company)
- Economic and Simplified Boiling-Water Reactor (General Electric)
- Gas Turbine Modular Helium Reactor (General Atomics)
- International Reactor Innovative and Secure (IRIS) Project (consortium led by Westinghouse)
- Pebble Bed Modular Reactor (PBMR (Pty) Ltd.)

The staff has reviewed the applicant's PPE values and has found them to be reasonable. As previously noted, the applicant identified certain PPEs as appropriate for inclusion in an ESP, should one be issued. The staff has reviewed the applicant's proposed list of PPE values and finds them to be acceptable for this purpose as discussed in the individual sections of this DSER.

Should an ESP be issued for the North Anna ESP site, an entity might wish to reference that ESP, as well as a certified design, in a COL or construction permit (CP) application. Such a COL or CP applicant would need to demonstrate that the site characteristics established in the ESP bound the postulated site parameters established for the chosen design, and that the design characteristics of the chosen design fall within the PPE values specified in the ESP. Otherwise, the COL or CP applicant would need to demonstrate that the new design, given the site characteristics in the ESP, complies with the Commission's regulations. Should an entity wish to reference the ESP and a design that is not certified, the COL or CP applicant would need to demonstrate that the design characteristics of the chosen design, in conjunction with the site characteristics established for the ESP, comply with the Commission's regulations.

1.4 Identification of Agents and Contractors

Dominion is the applicant for the North Anna ESP application and has been the only participant in the review of the suitability of the North Anna ESP site for a nuclear power plant. Bechtel Power Corporation, under contract with Dominion, served as primary contractor for development of the ESP application, supplying personnel, systems, and project management.

Several subcontractors also assisted in the development of Dominion's ESP application. Tetra Tech NUS, Inc., performed data collection and analysis and prepared several sections of the applicant's environmental report. MACTEC Engineering and Consulting, Inc., performed geotechnical field investigations and laboratory testing. William Lettis & Associates, Inc., performed geologic mapping and characterization of seismic sources. Finally, Risk Engineering, Inc., performed probabilistic seismic hazard assessments and related sensitivity analyses.

1.5 Summary of Principal Review Matters

This DSER summarizes the results of the NRC staff's technical evaluation of the North Anna ESP site. The staff's evaluation included a technical review of the information and data the applicant submitted, with emphasis on the following principal matters:

- population density and land use characteristics of the site environs and the physical characteristics of the site, including seismology, meteorology, geology, and hydrology, to evaluate whether these characteristics have been adequately described and were given appropriate consideration to determine whether the site characteristics are in accordance with the Commission's siting criteria (Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or after January 10, 1997," of 10 CFR Part 100)
- potential hazards to a nuclear power plant(s) that might be constructed on the ESP site posed by manmade facilities and activities (e.g., mishaps involving storage of hazardous materials (toxic chemicals, explosives), transportation accidents (aircraft, marine traffic, railways, pipelines), and the existing nuclear power plants at the nearby NAPS
- potential capability of the site to support the construction and operation of a nuclear power plant(s) with design parameters falling within those specified in the applicant's PPE under the requirements of 10 CFR Parts 52 and 100
- suitability of the site for development of adequate physical security plans and measures for a nuclear power plant(s)
- proposed major features for an emergency plan to be developed should an applicant decide to seek a license to construct and operate a nuclear power plant(s) on the ESP site; any significant impediments to the development of emergency plans for the North Anna ESP site; and a description of contacts and arrangements made with local, State, and Federal government agencies with emergency planning responsibilities
- quality assurance measures applied to the information submitted in support of the applicant's ESP application and safety assessment

- the acceptability of the applicant's proposed exclusion area and LPZ under the dose consequence evaluation factors of 10 CFR 50.34(a)(1)

During its review, the staff held several meetings with representatives of the applicant and the applicant's contractors and consultants to discuss various technical matters related to the staff's review of the North Anna ESP site (see Appendix A to this report). The staff also visited the site to assist in its evaluation of safety matters.

1.6 Summary of Open and Confirmatory Items

As set forth in this DSER, the staff is requesting additional information from the applicant regarding certain matters. The individual sections of this DSER refer to these issues as "open items." The staff assigns each of these issues an identifying number for tracking purposes. Table 1.6-1 lists each open item, the DSER section in which it appears, and the subject matter to which it is related. Completion of the staff's final safety analysis report (FSER) on the current schedule will depend on the applicant's timely submission of information sufficient to resolve each open item.

Table 1.6-1 Open Items

Open Item No.	DSER Section	Subject
2.1-1	2.1.2	Demonstrate that the applicant has the legal right to control the exclusion area, or has an irrevocable right to obtain such control.
2.3-1	2.3.1	Provide acceptable fastest-mile design-basis wind speed. Applicant's chosen 100-year return period fastest-mile design-basis wind speed of 64 mph is nonconservative compared to the minimum 50-year return period fastest-mile basic wind speed of 70 mi/h specified in Section 6.5.2 of ANSI A58.1-1982 and compared to the highest fastest-mile wind speed of 68 mi/h recorded at Richmond during the 32-year period of record, 1958–1989.
2.3-2	2.3.1	Justify exclusive use of snowpack weight for calculating snow load or use alternate method (e.g., combination of the 100-year return snowpack and maximum-recorded monthly snowfall in the North Anna ESP site region).
2.3-3	2.3.1	Identify an additional ultimate heat sink (UHS) design-basis site characteristic for use in evaluating potential for water freezing in the UHS water storage facility.
2.3-4	2.3.2	Describe how potential increases in atmospheric temperature resulting from operation of closed-cycle dry cooling towers associated with proposed Unit 4 would impact plant design and operation.

Open Item No.	DSER Section	Subject
2.4-1	2.4.1	Provide coordinate reference system for identification of plant parameter envelope (site footprint) location.
2.4-2	2.4.1	Specify minimum distance between existing unit SSCs and proposed unit intake and discharge tunnels.
2.4-3	2.4.1	Because expected inflow into Lake Anna can periodically be substantially lower than average inflow, describe potential impacts of low-flow conditions on the operation of all units.
2.4-4	2.4.7	Address the possibility of an ice jam or an ice dam formation upstream of the ESP site, and evaluate the effect of a flood wave generated from the breakup of such an ice formation.
2.4-5	2.4.7	Provide minimum Lake Anna water temperature at the intake for the proposed additional units as a site characteristic.
2.4-6	2.4.8	Provide UHS construction and location details sufficient to assess reliability and stability of the ultimate heat sink under the pressure head of ground water (i.e., determine differential head), since water table is at grade level at certain locations in the ESP site.
2.4-7	2.4.12	Correlate ground water level measurements taken in support of the ESP application with data from long-term piezometers.
2.4-8	2.4-12	Explain why more conservative hydraulic conductivity was not used.
2.4-9	2.4.13	Provide magnitude, frequency, and spatial location of upward hydraulic gradients at the ESP site.
2.4-10	2.4.13	Provide data to support statement that the typical hydraulic gradient of ground water flow across the ESP site to Lake Anna and the Waste Heat Treatment Facility is 0.03 m/m. Define the range of seasonal and long-term variation in the hydraulic gradient.
2.4-11	2.4.13	Provide onsite measured values of adsorption and retention coefficients for radioactive materials in soils.

Open Item No.	DSER Section	Subject
2.5-1	2.5.2	Provide and evaluate criteria or weights used for ranking of model clusters and the judgments involved in balancing data consistency and adherence to seismological principles in the EPRI 2003 ground motion evaluation. Explain how recordings from a single earthquake can provide well-resolved values of both crustal quality factor (Q) and site kappa, why the Q value provided of 317 at 1 Hz is much lower than values found in other studies of eastern North American earthquakes, and why other studies find less frequency dependence of Q in the east than in the west.
2.5-2	2.5.2	Incorporate lower shear wave velocities and other subsurface material properties and their uncertainties into the determination of the ESP site safe-shutdown earthquake, and provide the site amplification or transfer function.
13.3-1*	13.3.3	Provide information on availability and capability of laboratories referred to in State and local emergency plans.
13.3-2*	13.3.3	Describe periodic program in Orange County for informing public on how they will be notified of an emergency.
13.3-3	13.3.3	Address adequacy of technical support center, emergency operations facility, and operational support center and related equipment in support of emergency response, and address with specificity such facility and equipment features as location, size, structure, function, habitability, communications, staffing and training, radiological monitoring, instrumentation, data system equipment, power supplies, technical data and data systems, and record availability and management.
13.3-4*	13.3.3	Provide additional information concerning assumptions regarding reliance on DOE for plume tracking.
13.3-5*	13.3.3	Provide additional information regarding use of Patrick Henry High School, agreements for assistance from offsite agencies, measures for dealing with impediments to use of evacuation routes, and when sheltering would be considered.
13.3-6	13.3.3	Provide additional information on evacuation time estimate as specified in staff's request for additional information 13.3-15.

Open Item No.	DSER Section	Subject
13.3-7*	13.3.3	Provide information on decision-making guidance and authority for exceeding exposure limits.
13.3-8*	13.3.3	Describe capabilities of local and backup hospital and medical services.
13.3-9*	13.3.3	Describe program for qualifying State and local directors of emergency response.
13.3-10*	13.3.3	Provide additional information on cross-references to Supplement 2 to NUREG-0654, as well as description of training programs and review/updates of Orange County emergency response program.

* Information needs for which the applicant provided information, but which the staff received too late for consideration in this DSER.

In addition, the staff has identified one item that it considers resolved based on the applicant's commitment to action, but for which the staff needs confirmation that the applicant has taken the planned actions. Table 1.6-2 lists this confirmatory item, the DSER section in which it appears, and the subject matter to which it is related. Completion of the staff's FSER will depend on the applicant's timely confirmation of completion of planned actions to allow the staff to review and, if appropriate, close the confirmatory item before issuance of the FSER.

Table 1.6-2 Confirmatory Item

Confirmatory Item No.	DSER Section	Subject
17.3-1	17.3	Verification of information obtained from the Internet

1.7 Summary of Permit Conditions and COL Action Items

The staff has identified certain permit conditions that it will recommend the Commission impose should an ESP be issued to the applicant. Table 1.7-1 summarizes these conditions.

Table 1.7-1 Permit Conditions

Permit Condition No.	DSER Section	Description
2.1-1	2.1.2	In obtaining the authority to perform the activities authorized by 10 CFR 52.25, also obtain the corresponding right to implement the site redress plan described in the staff's final environmental impact statement in the event no plant is built on the ESP site.
2.4-1	2.4.1	Maintain minimum distance between existing unit and proposed unit SSCs (see Open Item 2.4-2).
2.4-2	2.4.1	Maximum additional water budget available for use by the new units is 71.9 m ³ /s (2540 cfs).
2.4-3	2.4.2	Design minimum site grade based on intense local precipitation without crediting engineered drainage systems that could become blocked.
2.4-4	2.4.2	Locate safety-related facilities above maximum water surface elevation produced by local intense precipitation.
2.4-5	2.4.4	Free surface elevation of UHS shall not fall below 82.3 m (270 ft) MSL.
2.4-6	2.4.4	Minimum UHS storage capacity shall be 116,453 m ³ (4.1 million ft ³).
2.4-7	2.4.7	Design UHS capacity to accommodate ice formation.
2.4-8	2.4.8	Design facility such that there is no reliance on Lake Anna or the Waste Heat Treatment Facility for safety-related water supply.
2.4-9	2.4-10	Construct safety-related SSCs with ingress and egress openings located above elevation of 83 m (271 ft) MSL.
2.4-10	2.4-10	Provide erosion protection for slope embankment at plant intake for new units.
2.4-11	2.4.10	Ensure no compromise of flood-control measures protecting safety-related facilities of the existing units during construction and operation of new units.

Permit Condition No.	DSER Section	Description
2.4-12	2.4.12	Construct additional units within area where ground water levels do not exceed 82.3 m (270 ft) MSL.
2.5-1	2.5.1	Replace fractured and weathered rock at facility foundation with lean concrete.
2.5-2	2.5.1	Perform additional borings to identify significant weathered or fractured zones at plant foundations.
2.5-3	2.5.1	Design facility such that saprolite is not used as engineered fill.
2.5-4	2.5.4	Perform geologic mapping of future excavations for safety-related structures, evaluate any unforeseen geologic features that are encountered, and notify the NRC when any excavations for safety-related structures are open for NRC's examination and evaluation.
2.5-5	2.5.4	Improve Zone II saprolitic soils to reduce any liquefaction potential if safety-related structures are to be founded on them.

The staff has also identified certain site-related items that will need to be addressed at the COL or CP stage, should a COL or CP applicant desire to construct one or more new nuclear reactors on the North Anna ESP site. The staff determined that these items do not affect the staff's regulatory findings at the ESP stage and are, for reasons specified in Table 1.7-2 for each item, more appropriately addressed at these later stages in the licensing process.

Table 1.7-2 Site-Related COL Action Items

Action Item No.	DSER Section	Subject To Be Addressed	Reason for Deferral
2.1-1	2.1.1	Provide latitude, longitude, and Universal Transverse Mercator coordinates for new units.	Exact unit locations not known at ESP stage
2.1-2	2.1.2	Make arrangements with the appropriate local, State, Federal, or other public agencies to provide for control of the portions of Lake Anna and the WHTF that are within the exclusion area. These public agencies, together with the ESP holder, will need authority over these bodies of water sufficient to allow for the exclusion and ready removal, in an emergency, of any persons present on them.	Such arrangements not required at ESP stage
2.2-1	2.2.2	Evaluate hazards posed by nearby industrial area.	No hazard present, but zoning could allow them during ESP term
2.2-2	2.2.3	Evaluate design-specific interactions between existing and new units.	New unit design and specific location not known at ESP stage
2.3-1	2.3.3	Evaluate dispersion of airborne radioactive materials to the control room.	Control room location and design features not known at ESP stage
2.3-2	2.3.5	Confirm specific release point characteristics and locations of potential receptors for routine release dose computations.	Exact release points and receptor locations not known at ESP stage

Action Item No.	DSER Section	Subject To Be Addressed	Reason for Deferral
2.4-1	2.4.11	Determine restrictions on operation from changes in frequency of low-water conditions in Lake Anna.	Future uses and therefore low-level frequency not known at ESP stage
2.5-1	2.5.4	Perform additional borings to confirm applicant's conclusions regarding engineering properties and stability of soil and rock underlying future plant foundations.	Exact unit locations not known at ESP stage
2.5-2	2.5.4	Compare plot plans and the profiles of all seismic Category I facilities with subsurface profile and material properties.	Exact unit locations and design not known at ESP stage
2.5-3	2.5.4	Submit excavation and backfill plans for NRC review.	Exact unit locations and design not known at ESP stage
2.5-4	2.5.4	Evaluate groundwater conditions as they affect foundation stability or detailed dewatering plans.	Exact unit locations and design not known at ESP stage
2.5-5	2.5.4	Perform soil column amplification/attenuation analyses.	Exact unit locations not known at ESP stage
2.5-6	2.5.4	Analyze stability of all planned safety-related facilities, including bearing capacity, rebound, settlement, and differential settlements under deadloads of fills and plant facilities, and lateral loading conditions.	Exact unit locations and design not known at ESP stage
2.5-7	2.5.4	Provide design-related criteria pertinent to structural design (such as wall rotation, sliding, and overturning).	Exact unit locations and design not known at ESP stage
2.5-8	2.5.4	Provide specific plans for each proposed ground improvement technique to be employed to allow use of Zone IIA saprolitic soils to support safety-related foundations.	Exact unit locations and design not known at ESP stage

Action Item No.	DSER Section	Subject To Be Addressed	Reason for Deferral
2.5-9	2.5-4	Verify average shear-wave velocity of the material underlying the foundation for the reactor containment.	Site average shear-wave velocity of the Zone III-IV bedrock slightly less than design value provided at ESP stage
2.5-10	2.5.5	Provide more detailed dynamic analysis of the stability of the existing slope and any new slopes using the safe-shutdown earthquake (SSE) ground motion.	Locations of safety-related structures relative to the existing or new slopes not known at ESP stage
2.5-11	2.5.5	Provide plot plans, cross sections/profiles of all safety-related slopes, and measures to ensure the safety of slopes and structures located adjacent to them.	Locations of safety-related structures relative to the existing or new slopes not known at ESP stage
13.6-1	13.6	Provide specific designs for protected area barriers.	Exact locations and design of barriers not known at ESP stage

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