NORTH ANNA EARLY SITE PERMIT FINAL SAFETY EVALUATION REPORT CHANGED PAGES

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

~~June~~September 2005

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555-0001

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 (Subpart A, "Early Site Permits," of 10 CFR Part 52) is intended to address and resolve site-related issues. The design certification process (Subpart B, "Standard Design Certifications," of 10 CFR Part 52) provides a means for a vendor to obtain U.S. Nuclear Regulatory Commission (NRC) certification of a particular reactor design. Finally, the COL process (Subpart C, "Combined Licenses," of 10 CFR Part 52) 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 safety evaluation report (SER) 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 the applicant's compliance with the requirements of Subpart A of 10 CFR Part 52. This SER serves to identify the matters resolved in the safety review and to identify remaining items to be addressed by a future COL applicant.

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 final environmental impact statement, which is a report separate from this SER.

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 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

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[1]Applicants 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.

[2]ADAMS (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 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 SER available on the NRC's new reactor licensing public Web site at http://www.nrc.gov/reactors/new-licensing/esp/north-anna.html.

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 SER presents the conclusions of the staff's review of information the applicant submitted to the NRC in support of the ESP application. The staff has reviewed the information provided by the applicant to resolve the open and confirmatory items identified in the draft safety evaluation report for the North Anna ESP, issued on December 20, 2004. In Section 1.6 of this SER, the staff provides a brief summary of the process used to resolve these items; specific details on the resolution for each open item is presented in the corresponding section of this report.

The staff has identified, in Appendix A to this SER, the proposed permit conditions that it will recommend the Commission impose, should an ESP be issued to the applicant. Appendix A also includes a list of COL action items or 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. In addition, Appendix A lists the site characteristics and the bounding parameters identified by the staff for this site.

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

The NRC's Advisory Committee on Reactor Safeguards (ACRS) also reviewed the bases for the conclusions in this report. The ACRS independently reviewed those aspects of the application that concern safety, as well as the ~~draft~~ safety evaluation report, and provided the results of its review to the Commission in the interim report dated March 11, 2005 and in a final report dated July 18, 2005. This SER incorporates the ACRS comments and recommendations, as appropriate. ~~Additional comments from the final ACRS full committee meeting, if any, will be addressed in an addendum to this SER before it is formally issued as a final NRC technical report (i.e., a NUREG). The final ACRS report~~Appendix E includes a copy of the report by the ACRS on the final safety evaluation, as required by 10 CFR 52.53, "Referral to the ACRS~~,~~." ~~will be included in the addendum as an additional appendix to this SER.~~

[3] The applicant has also submitted information intended to partially address some of the general design criteria (GDC) in Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities." Only GDC 2, "Design Bases for Protection Against Natural Phenomena," 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 GDC. The staff has included a statement to this effect in those sections of the SER that do not relate 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.

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 (mi) north-northwest of Richmond, Virginia.

The staff has completed its review 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 or plants at the site and evaluated whether the site could support adequate physical security measures for a nuclear power plant or plants. The staff evaluated whether the applicant's quality assurance measures are 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* (10 CFR Part 50). The NRC has found that such measures provide reasonable assurance that information derived from ESP activities that would be used in the design and/or construction of structures, systems, and components (SSCs) important to safety would support satisfactory performance of such SSCs once 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 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 NRC would need to review the complete and integrated emergency plan in a separate licensing proceeding.

The Dominion ESP application includes the site safety analysis report (SSAR), which describes the 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.[4] Dominion subsequently revised the application to address requests from the NRC staff for additional information. The applicant submitted the most recent version of its application, SSAR ~~Revision 4 (application), to the Commission on May 12, 2005~~Revision 5 (ADAMS Accession No. ~~ML051450310)~~ML052150226), to the Commission by letter dated July 25, 2005. Throughout the course of the review, the staff requested that the applicant submit additional information to

[4]ADAMS (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 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 SER available on the NRC's new reactor licensing public Web site at http://www.nrc.gov/reactors/new-licensing/esp/north-anna.html.

clarify the description of the North Anna site. This report discusses some of the applicant's responses to these requests for additional information (RAIs). Appendix B to this report provides a chronological listing of the licensing correspondence between the applicant and the Commission regarding the review of the North Anna ESP application under Project No. 719 and Docket No. 52-008. The application and other pertinent information and materials are available for public inspection at the NRC's Public Document Room at One White Flint North, 11555 Rockville Pike, Rockville, Maryland. The application and this safety evaluation report (SER) are also available at the Louisa County Public Library, 881 Davis Highway, Mineral, Virginia, as well as on the NRC's new reactor licensing public Web site at http://www.nrc.gov/reactors/new-licensing/esp/north-anna.html. ~~This SER is also available in ADAMS under Accession No. ML051610246.~~

This ~~SER~~report 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 or plants falling within the plant parameter envelope (PPE) that Dominion specified in its application. This SER delineates the scope of technical matters the staff considered in evaluating the suitability of the site. NRR Review Standard (RS)-002, "Processing Applications for Early Site Permits," issued May 2004, provides additional details on the scope and bases of the NRC staff's review of the radiological safety and emergency planning aspects 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," Revision 3, issued July 1981 (hereinafter referred to as the Standard Review Plan). The Standard Review Plan reflects the 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. In addition, this SER documents the resolution of the open and confirmatory items identified in the draft SER (DSER) for the North Anna ESP, issued on December 20, 2004.

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 also provided a site redress plan, in accordance with 10 CFR 52.17(c), in order to perform the site preparation and limited construction activities allowed by 10 CFR 52.25(a) (i.e., the activities listed in 10 CFR 50.10(e)(1)). The DEIS also includes the results of the staff's evaluation of that plan.

As described above, the applicant supplemented the information in the SSAR by providing revisions to the document. The staff reviewed these revisions to determine their impact on the conclusions in this SER. On June 16, 2005, the NRC issued its SER for the North Anna ESP site and made it publically available. In light of the SER, Dominion identified several corrections that needed to be made to Revision 4 of its application. By letter dated July 25, 2005, Dominion provided Revision 5 to the North Anna ESP application. The changes reflected in Revision 5 of the application included corrections to Figure 2.5-55A, depicting the selected horizontal and vertical operating-basis earthquake (OBE) and safe-shutdown earthquake (SSE) spectra for the hypothetical rock outcrop control point at the top of Zone III-IV material. In addition, Dominion provided corrections to the coordinates for the ESP site footprint which was submitted to the NRC in its response to Open Item 2.4-1. The staff completed its review of the most recent version, Revision ~~4~~5 of the SSAR, as documented throughout this report and, for the reasons

set forth herein, finds it to be acceptable. The changes in Revision 5 to the application resulted in minor modifications to the staff's SER issued June 16, 2005 including the following changes: Appendix A to this report was modified to reflect the correct figures submitted with Revision 5 of the application; Section 2.5 of this report was modified to incorporate the correct description of the analysis conducted by Dominion to determine the SSE spectrum and reflect the description in the evaluation; the table of contents was modified to follow the same layout as the standard review plan, and as a result the source term analysis was moved from Chapter 3 and placed in Chapter 11. The scope of all other changes to the SER issued on June 16, 2005 resulting from Revision 5 are limited to corrections of factual inaccuracies. These changes did not impact the staff's conclusions. Independent of Revision 5 to the application, the staff also reformatted and reorganized the SER without changing its substance or conclusions, and revised the definitions of Bounding Parameters for hydrology in Appendix A to better reflect the SER text.

Appendix A to this SER contains the list of site characteristics, permit conditions, combined license (COL) action items, and the bounding parameters that the staff is recommending that the Commission include in any ESP that might be issued for the proposed site. Appendix B to this SER 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 C lists the references for this SER ~~and~~, Appendix D lists the principal contributors to this report, and Appendix E includes a copy of the report by the ACRS.

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 mi 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 the agent of ODEC. 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 (ac), of which about 760 ac 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 ac. 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 Virginia State Corporation Commission (SCC) approval to construct and operate any new unit at the North Anna ESP site. The Virginia Code requires SSC approval of any agreement between the COL applicant and the current owners of the site providing for joint control of the exclusion area. The staff proposes to include a condition to govern exclusion area control on any ESP that might be issued. Section 2.1.2 of this report discusses this issue in detail.

The application also indicates that if the ESP were granted and Dominion were to decide to undertake any preconstruction activities described in the ESP, pursuant to 10 CFR 52.25, "Extent of Activities Permitted," 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 approval(s) 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 must 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. The staff intends to include, in any ESP that might be issued for this application, a permit condition to address this matter, as discussed in Section 2.1.2 of this SER.

The largest community within 10 mi of the site is the town of Mineral, Virginia. According to the 2000 census, Mineral has a population of 424 located within about 1 mi^2 (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 mi 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 mi 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 mi of the ESP site. As previously noted, the only industrial facilities within 5 mi of the ESP site are the existing NAPS units. Major highways, such as Interstates 95 and 64, are located more than 16 mi away from the site. U.S. Route 522 is located about 5 mi west of the site. The closest point of Virginia Route 652 is 1.5 mi 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 0.5 mi of the site. No public or commercial highways, railroads, or waterways traverse the site.

~~Two~~Three airports are located within 15 mi of the ESP site. Operations at the Louisa County Airport (Freeman Field), located 11 mi west-southwest of the site, primarily involve single-

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might be issued to govern exclusion area control as **Permit Condition 1**. This permit condition would require that approvals called for by State law for, among other matters, agreements providing for shared control of the North Anna ESP exclusion area, be obtained and the agreements executed before construction of a nuclear power plant begins under a construction permit or COL referencing the ESP. Such a permit condition provides reasonable assurance that an ESP provides for control of the exclusion area. The condition requires that these arrangements be obtained and executed before the granting of an application referencing the ESP. Therefore, DSER Open Item 2.1-1 is closed.

Should the NRC grant the ESP and the ESP holder decide to perform the activities authorized by 10 CFR 52.25, "Extent of Activities Permitted," the ESP holder must obtain the authority to undertake those activities on the ESP site. In obtaining such a right, the ESP holder must also obtain the corresponding right to implement the site redress plan described in the staff's final environmental impact statement in the event that no plant is built on the ESP site. The staff proposes to include a condition in any ESP that might be issued requiring that the ESP holder obtain the right to implement the site redress plan before initially any activities authorized by 10 CFR 52.25, as **Permit Condition 2**.

The North Anna exclusion area extends into Lake Anna and the waste heat treatment facility (WHTF). Should the NRC grant the ESP and the ESP holder decide to apply for a COL (or for a CP and operating license (OL)), the ESP holder, COL or CP applicant must make arrangements with the appropriate Federal, State, or local agencies to provide for control of the portions of Lake Anna and the WHTF that are within the exclusion area. These agencies, together with COL or CP applicant, must have authority over these bodies of water sufficient to allow for the exclusion and ready removal, in an emergency, of any persons present on them. This is **COL Action Item 2.1-2**. No State or county roads, railways, or waterways traverse the North Anna ESP exclusion area.

2.1.2.4 Conclusions

As set forth above, the applicant has provided and substantiated information concerning its plan to obtain legal authority to determine all activities within the designated exclusion area. The staff has reviewed the applicant's information and concludes that it is sufficient to evaluate compliance with the exclusion area control requirements of 10 CFR 100.21(a) and 10 CFR 100.3.

The applicant has appropriately described the exclusion area and the methods by which access and occupancy of the exclusion area will be controlled during normal operation and in the event of an emergency situation.

Based on the foregoing, the staff concludes that the applicant's exclusion area is acceptable and meets the requirements of 10 CFR Part 100, subject to the limitations and conditions identified in th~~e permit~~is SER. Such permit conditions provide reasonable assurance that an ESP provides for control of the exclusion area. Further, the ESP holder must demonstrate that it will have authority to perform the activities authorized by 10 CFR 52.25, should it choose to do so, and the corresponding right to implement the site redress plan, as described in the discussion of Permit Conditions 1 and 2.

According to NSSL (NCDC, “Severe Thunderstorm Climatology, Total Threat”), the mean number of days per year with the threat of tornados occurring within 25 miles of the North Anna ESP site is approximately 0.4 to 0.6 for any tornado, approximately 0.05 to 0.10 for a significant tornado (F2 or greater; wind speeds in excess of 113 mi/hr), and less than 0.005 for a violent tornado (F4 or greater; wind speeds in excess of 207 mi/hr).

At the NRC’s direction, Pacific Northwest National Laboratories (PNNL) prepared a technical evaluation report evaluating the tornado site characteristics for the North Anna ESP site (Ramsdell, Jr., V.AJ., “Technical Evaluation Report on Design Basis Tornadoes for the North Anna ESP Site”). This report derived a best estimate annual tornado strike probability of 1.6×10^{-4}, based on tornado data from the period January 1950 through August 2003. This probability corresponds to a mean recurrence interval of 6250 years. Using a slightly different methodology and period of record, the applicant calculated a similar but higher tornado return period of 16,835 years. The PNNL report also derived a best estimate 10^{-7} per year occurrence tornado site characteristics wind speed of 245 mi/hr, which is bounded by the applicant’s tornado site characteristics wind speed of 260 mi/hr. The applicant derived the remaining tornado site characteristics (i.e., pressure drop and rate of pressure drop) assuming the radius of the maximum rotational wind speed is 150 ft and the ratio between the rotational wind speed and the translational wind speed is 4. These assumptions are consistent with the staff’s interim position on design-basis tornado characteristics. Therefore, the staff concludes that the applicant’s tornado site characteristics are acceptable.

During the period 1900–2002, a total of 4 hurricanes and 17 tropical storms directly hit Virginia (Landreneau, D., “Atlantic Tropical Storms and Hurricanes Affecting the United States: 1899–2002,” NOAA Technical Memorandum NWS SR-206 (updated through 2002)). These storms typically weaken as they move inland, so wind damage is usually confined to the coastal regions, while damage inland comes primarily from heavy rain and flooding. One of the most significant tropical cyclones to affect portions of east-central Virginia during the last several decades was Hurricane Isabel on September 18–19, 2003. Isabel made landfall near Drum Inlet, North Carolina, as a Category 2 hurricane (maximum sustained winds between 96 and 100 mi/hr), then weakened to a tropical storm over southern Virginia as it tracked northwest into central Virginia, just west of Richmond. The highest sustained wind speed recorded at Richmond was 38 mi/hr; the highest gust recorded at Richmond was 73 mi/hr. The unusually large wind field resulted in the most extensive power outages ever experienced in Virginia. Inland flooding also resulted from rainfall amounts ranging from 4 to 7 in., which occurred over parts of the Piedmont regions of central and south central Virginia (Beven, J., and H. Cobb, “Tropical Cyclone Report, Hurricane Isabel, 6–19 September 2003,” National Hurricane Center and NCDC Storm Event Database, “Storm Events for Virginia, 01/01/1950 through 04/30/2004”). Although Hurricane Isabel had a significant impact on the ESP site region, it did not result in any recordbreaking wind or rainfall statistics and, as such, has no impact on the climatic site characteristics of the North Anna ESP site.

The highest monthly and annual total snowfalls recorded at the Partlow station were 41 in. and 54 in., respectively. One of the highest reported 24-hour snowfall observations in the site region was 21.6 in. in January 1940 at Richmond (NCDC, “Richmond, Virginia, 2002 Local Climatological Data, Annual Summary with Comparative Data”). One of the highest snow depths recorded in the site region was 24 in. on January 26, 1987, and on January 30, 1966, in Louisa (SRCC, “Louisa, Virginia, Period of Record Monthly Climate Summary, Period of

Record: 08/01/1948 to 03/31/2004").

Basic Wind Speed		
3-s Gust	96 mi/hr	The 3-s gust wind speed at 33 ft above the ground that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
Tornado		
Maximum Wind Speed	260 mi/hr	Maximum wind speed resulting from passage of a tornado having a probability of occurrence of 10^{-7} per year
Translational Speed	52 mi/hr	Translation component of the maximum tornado wind speed
Rotational Speed	208 mi/hr	Rotation component of the maximum tornado wind speed
Radius of Maximum Rotational Speed	150 ft	Distance from the center of the tornado at which the maximum rotational wind speed occurs
Maximum Pressure Drop	1.5 lbf/in.^{2}	Decrease in ambient pressure from normal atmospheric pressure resulting from passage of the tornado
Maximum Rate of Pressure Drop	0.76 lbf/in.^{2}/s	Rate of pressure drop resulting from the passage of the tornado
Winter Precipitation		
100-Year Snowpack	30.5 lbf/ft^2	Weight of the 100-year return period snowpack (to be used in determining normal precipitation loads for roofs)
48-Hour Probable Maximum Winter Precipitation	20.75 in. of water	Probable maximum precipitation during the winter months (to be used in conjunction with the 100-year snowpack in determining extreme winter precipitation loads for roofs)
Ultimate Heat Sink		
Meteorological Conditions Resulting in the Minimum Water Cooling During Any 1 Day	78.9 EF wet-bulb temperature with coincident 87.7 EF dry-bulb temperature	Historic worst 1-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures
Meteorological Conditions Resulting in the Minimum Water Cooling During Any Consecutive 5 Days	77.6 EF wet-bulb temperature with coincident 80.9 EF dry-bulb temperature	Historic worst 5-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures resulting in minimum water cooling
Meteorological Conditions Resulting in the Maximum Evaporation and Drift Loss During Any Consecutive 30 Days	76.3 EF wet-bulb temperature with coincident 79.5 EF dry-bulb temperature	Historic worst 30-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures
Meteorological Conditions Resulting in Maximum Water Freezing in the UHS Water Storage Facility	322 EF degree-days below freezing	Historyic maximum cumulative degree-days below freezing

The staff acknowledges that long-term climatic change resulting from human or natural causes may introduce trends into design conditions. However, no conclusive evidence or consensus of

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isosurfaces to independently estimate the stage-storage relationship for Lake Anna. The staff's independent estimates closely match the applicant's stage-storage curve. Therefore, the staff considers the applicant's curve to be satisfactory.

SSAR Section 2.4.1.1 reports an estimated withdrawal of 2540 cfs for Unit 3 and 44 cfs for the proposed Unit 4. A subsequent letter from the applicant to the NRC dated March 31, 2004, stated that the proposed Unit 4 would use a dry cooling tower. In RAI 2.4.1-4, the staff requested the applicant to clarify whether the cooling water flow values are annual averages or maximums. The staff indicated that if they were annual averages, estimates for daily maximums were needed. In its response, the applicant stated that the cooling water flow rate of 2540 cfs for the proposed Unit 3 is a nominal value and that the daily maximum flow rate would be within a few percent of this nominal value. In addition, proposed Unit 4 secondary cooling loop evaporative issues will consume a small amount of water, on the order of 1 gpm.

Based on information provided in the SSAR and the applicant's response to the RAIs discussed in this section of the SER, the staff concludes that the additional water budget available for use by the new units is 2540 cfs. The staff intended to identify this maximum water use as DSER Permit Condition 2.4-2. Since the available water flow is at least equal to the controlling PPE value of 2540 cfs, and Appendix A of this SER identifies the controlling PPE values, it is not necessary to add this permit condition. The future review process will ensure that a new plant's cooling water use is safely limited to the amount of water flow not to exceed 2540 cfs. The PPE Table 3.1-1 of the application states that the bounding Unit 3 discharge water temperature is 113 EF, and the cooling water temperature rise is 18 EF, which results in a maximum inlet temperature limit of 95 EF. Since the available water flow rate depends upon these conditions, the staff proposes to include these controlling PPE values in any ESP that the NRC might issue for the site. Pursuant to 10 CFR 52.24, the staff proposes the cooling water flow rate of 2540 cfs, the cooling water temperature rise of 18 EF, and the maximum inlet temperature of 95 EF as controlling PPE values when the lake level is less than or equal to 244 ft MSL. Appendix A of this SER lists the controlling PPE values. Any COL or CP applicant referencing an ESP issued for the North Anna site should show that the combined cooling water flow rate for the new units does not exceed 2540 cfs. This is **COL Action Item 2.4-3.**

2.4.1.4 Conclusions

As set forth above, the applicant has provided information pertaining to the general hydrologic characteristics of the site, including descriptions of rivers, streams, and lakes; water-control structures; and users of waters. Therefore, the staff concludes that, with the noted conditions, the applicant has met the requirements regarding general hydrologic descriptions with respect to 10 CFR 52.17(a) and 10 CFR 100.20(c).

2.4.2 Floods

2.4.2.1 Technical Information in the Application

Lake Anna was created to provide a reliable supply of cooling water for NAPS. The watershed that drains into Lake Anna is approximately 323 mi^2. The area of Lake Anna, including the WHTF, is approximately 20 mi^2. The North Anna Dam is located about 4 miles north of

The staff estimated inflows from the drainage upstream of the lake using data from an adjacent drainage basin, the Little River drainage basin, adjusted for the difference in drainage areas. The Little River drainage area comprises 107 mi^2 adjacent to the North Anna drainage basin. Based on a review of streamflow records from USGS gauge 01671100 (Little River near Doswell, Virginia), the staff selected the period from October 2001 to September 2002 as the critical water year. The staff used precipitation records from the meteorological station at the Richmond, Virginia, airport to estimate direct precipitation on the lake.

The staff estimated outflows from the lake based on the current operating rules for the Lake Anna Dam. ~~This estimation did not reflect the fact that the current units are not allowed to operate below 244 ft MSL and that the applicant proposes not to operate the additional Unit 3 below 242 ft MSL. Rather, for conservatism, the~~The staff's analysis assumed that ~~all~~the current units and the additional unit~~s~~ 3 continue to operate until the lake water level falls below ~~these thresholds~~242 ft MSL.

The staff estimated the evaporative loss from the ambient compartment of the lake from the Massachusetts Institute of Technology model (Ho, E. and E.E. Adams, "Final Calibration of the Cooling Lake Model for North Anna Power Station," Ralph M. Parsons Laboratory, Aquatic Science and Environmental Engineering, Department of Civil Engineering, Massachusetts Institute of Technology, Report No. 295, August, 1984). This model was empirically validated through onsite observation for the licensing of NAPS Units 1 and 2 and is acceptable. The staff derived the evaporative loss from the fixed temperature compartment using the applicant's PPE values. The staff performed sensitivity analyses to assess the impact of various evaporative loss assumptions.

The staff determined the minimum water surface elevation to be ~~244~~242.6 ft MSL when the existing units and the proposed Unit 3 are operating. The staff estimated that water surface elevation in the lake would fall to this minimum elevation only infrequently during low-water years. The applicant has proposed a minimum water surface elevation of 242 ft MSL in SSAR Section 2.4.11.1.

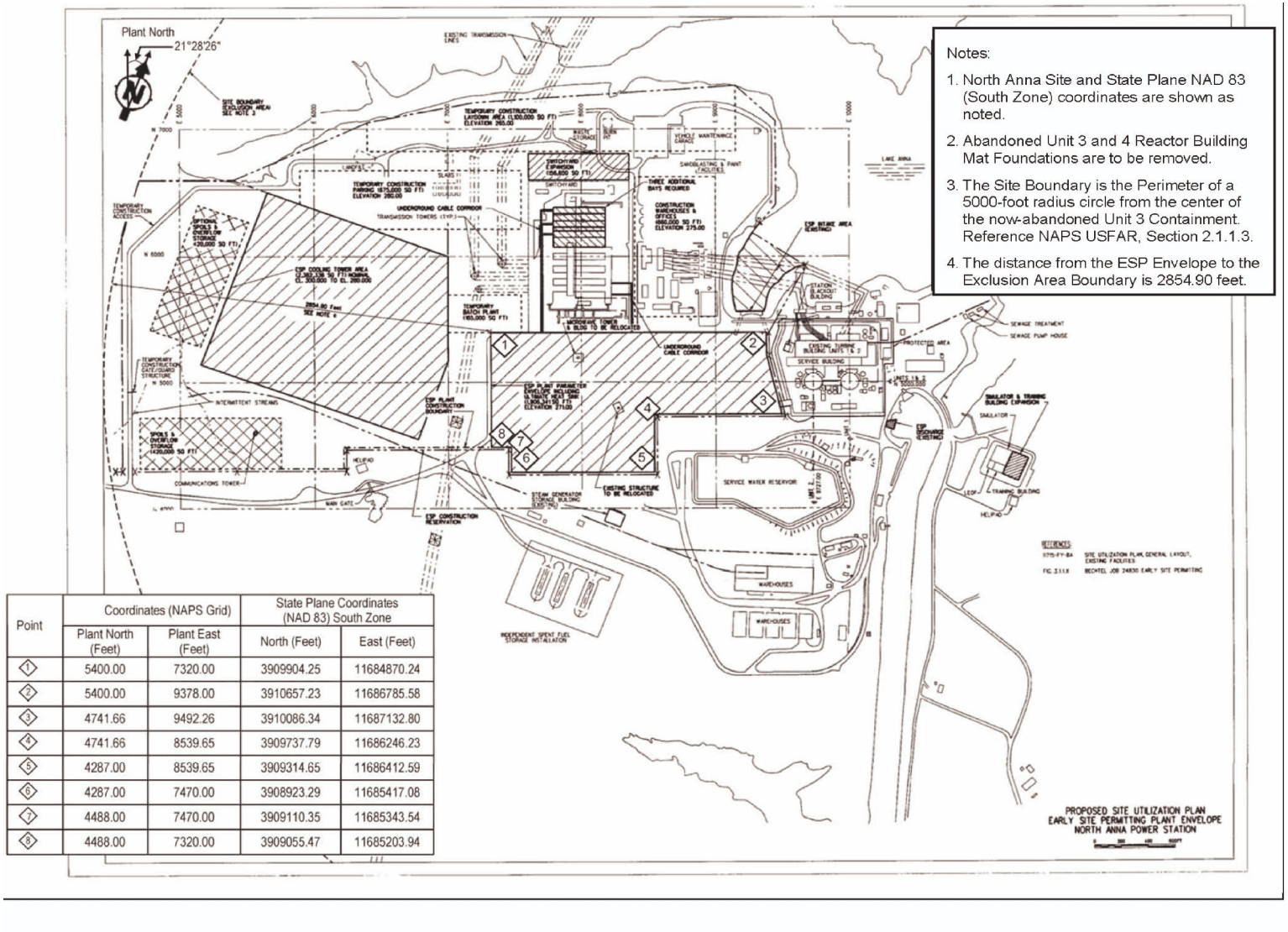
Since the applicant's proposed minimum water surface elevation site characteristic is lower than the staff's estimate, the applicant's value is acceptable.

In RAI 2.4.11-1, the staff requested that the applicant estimate the frequency of low-water conditions that could result in use of the UHS. The staff further asked the applicant to describe in greater detail the critical ambient conditions, such as combinations of temperature and relative humidity, that might limit operations under low-water conditions. In its response, the applicant only discussed the issue related to evaporation loss from the UHS. The applicant identified the meteorological conditions resulting in the maximum evaporation and drift loss of water from the engineered UHS as the worst 30-day average combination of controlling atmospheric parameters. The staff's assessment of meteorological site characteristics is included in Section 2.3 of this SER.

The staff notes that, in addition to evaporation losses, icing in a UHS storage basin, if included in the selected plant design, may also result in limits on UHS operation to ensure the availability of sufficient water during freezing to supply both emergency and service water. The staff determined, in Section 2.3.1.3 of this SER, that the 7-day average of low air temperature is 19.9 EF. In order to obviate the need for limits on the operation of the proposed units, any COL

Table 2.4.14-1 Staff's Proposed Site Characteristics Related to Hydrology

SITE CHARACTERISTIC	VALUE
Proposed Facility Boundaries	Figure 2.4.14-1 shows the proposed facility boundary using its corners numbered 1–8 and also lists the geographical coordinates of these points in Virginia State Plane Coordinate System using NAD 83 Datum. The coordinates are expressed in feet.
Minimum Lake Water Level	242 ft MSL
Maximum Elevation of Ground Water	270 ft MSL or 1 ft below the free surface, whichever is higher
Flood Elevation	270 ft MSL
Local Intense Precipitation	18.3 in./hr and 6.1 in. in 5 minutes
Frazil and Anchor Ice	The ESP site has the potential for the formation of frazil and anchor ice.
Maximum Ice Thickness	17.1 in. thick
Maximum Cumulative Degree-Days Below Freezing	321.8 EF2 EF
Hydraulic Conductivity	3.4 ft/d
Hydraulic Gradient	0.03 ft/ft



Point	Coordinates (NAPS Grid)		State Plane Coordinates (NAD 83) South Zone	
	Plant North (Feet)	Plant East (Feet)	North (Feet)	East (Feet)
1	5400.00	7320.00	3909904.25	11684870.24
2	5400.00	9378.00	3910657.23	11686785.58
3	4741.66	9492.26	3910086.34	11687132.80
4	4741.66	8539.65	3909737.79	11686246.23
5	4287.00	8539.65	3909314.65	11686412.59
6	4287.00	7470.00	3908923.29	11685417.08
7	4488.00	7470.00	3909110.35	11685343.54
8	4488.00	7320.00	3909055.47	11685203.94

~~Figure~~ Figure 2.4.~~14-1~~ 14-1 **The proposed facility boundary for the ESP site**

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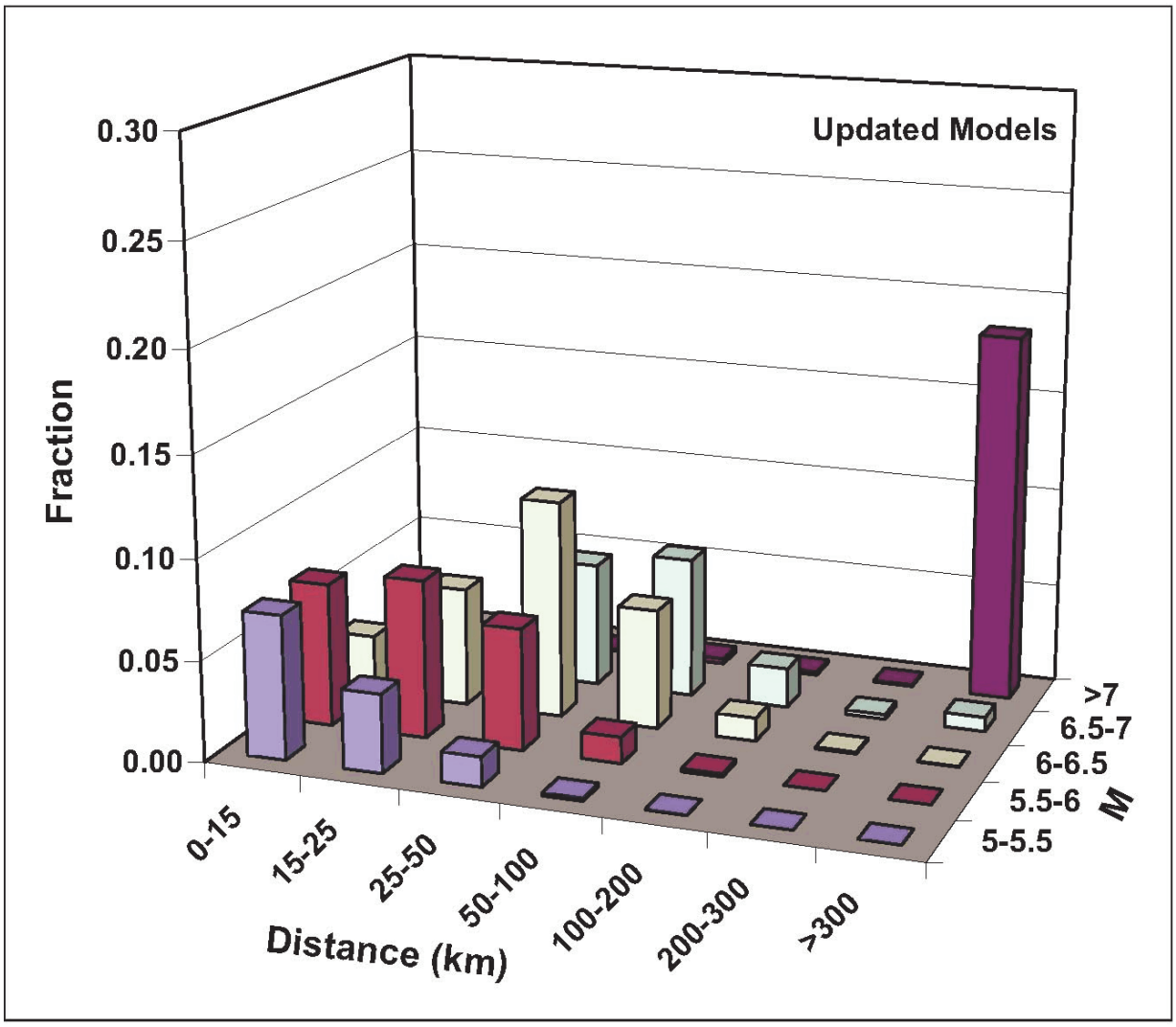

Figure 2.5.2-1 Magnitude-distance deaggregation for low frequencies (1 and 2.5 Hz) at a mean annual frequency of 5x**10^{-5} using updated source and ground motion models**

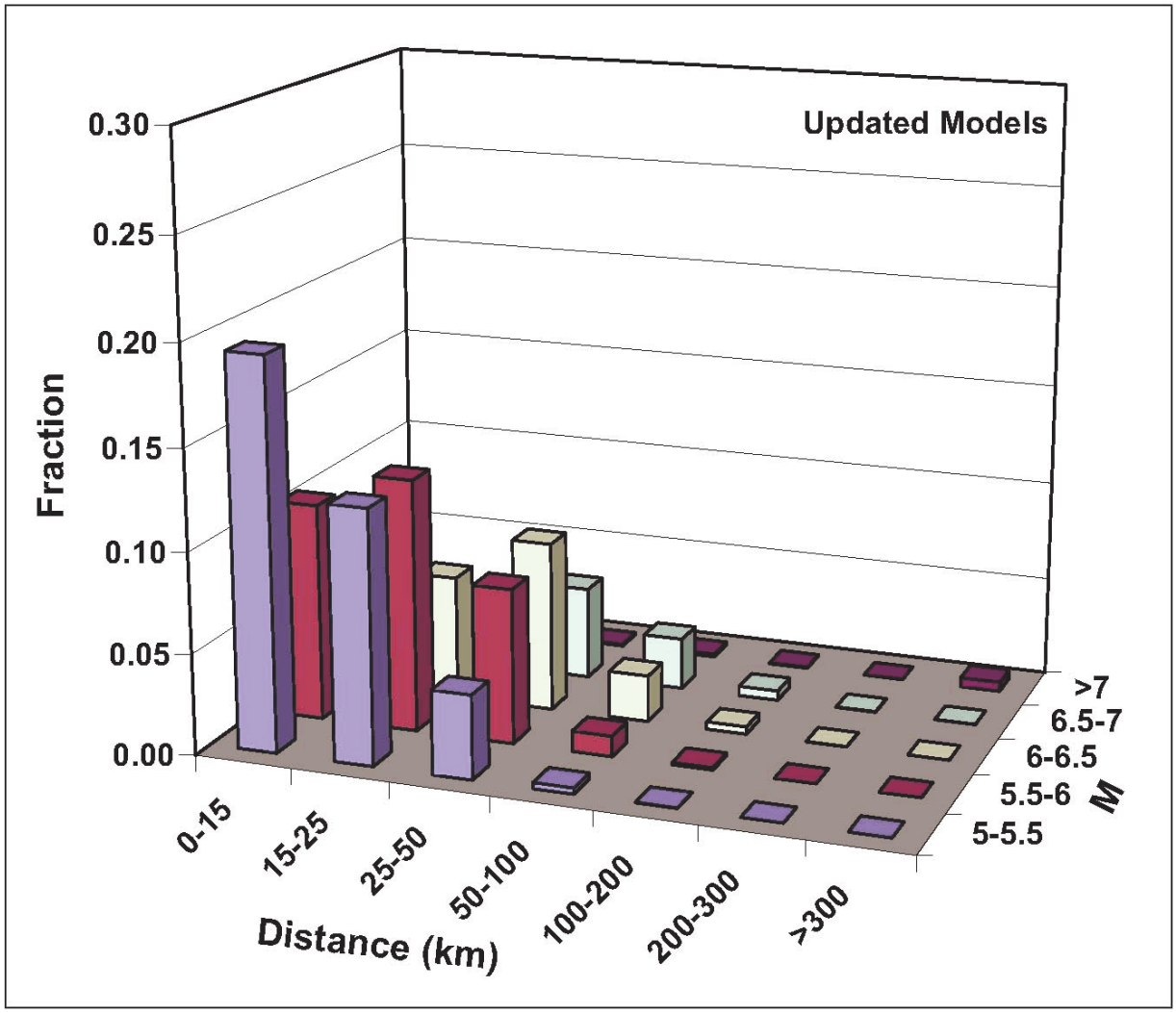

Figure 2.5.2-2 Magnitude-distance deaggregation for high frequencies (5 and 10 Hz) at a mean annual frequency of 5×10^{-5} using updated source and ground motion models

To determine these two controlling earthquakes, the applicant followed the procedure in Appendix C to RG 1.165, using the higher reference probability and the mean PSHA hazard results rather than the median results. Using the two controlling earthquakes, the applicant then determined two ground motion response spectra using the EPRI 2003 ground motion relationships and scaling the two spectra to the appropriate ground motion amplitudes. Figure 2.5.2-3, reproduced from SSAR Figure 2.5-48, shows the hard rock (9200 ft/s) ground motion response spectra for the two controlling earthquakes.

In addition to using the methodology described in RG 1.165 to determine the SSE ground motion, the applicant chose to use an alternative approach, described as a performance-based approach. In RAI 2.5.2-1, the staff asked the applicant to explain how the performance-based approach meets the requirements of 10 CFR 100.23, which provides the geologic and seismic

Development of Vertical SSE Spectrum

To determine the vertical SSE spectrum, the applicant used the vertical-to-horizontal (V/H)
Development of Vertical SSE Spectrum

To determine the vertical SSE spectrum, the applicant used the vertical-to-horizontal (V/H) response spectral ratios provided in NUREG/CR-6728. The ~~V/H response spectral~~vertical SSE spectrum is given by multiplying the horizontal SSE spectrum by the V/H ratios. The V/H ratios given in NUREG/CR~~-~~-6728 are for generic CEUS hard rock~~ site~~ conditions and depend on the PGA value of the horizontal SSE spectrum. For the ESP site, the V/H ratios used by the applicant are based on having a PGA ~~greater than 0.5g. The vertical SSE spectrum is given by multiplying the~~between 0.2g and 0.5g. However, after incorporating the local ESP site properties to determine the final horizontal SSE spectrum ~~by the V/H ratios.~~(see Open Item 2.5-2), the applicant's horizontal SSE PGA value increased from 0.37g to 0.55g. Rather than using the V/H ratios given in NUREG/CR-6728 for a PGA greater than 0.5g, the applicant performed a site-specific analysis to confirm the appropriateness of the V/H ratios for a PGA between 0.2g and 0.5g. Figure 2.5.2-6, reproduced from SSAR Figure 2.5-48A, shows the final horizontal and vertical SSE ground response spectrum at the control point at the top of Zone III-IV rock.

For its analysis to confirm the NUREG/CR-6728 V/H ratios for a PGA between 0.2g and 0.5g, the applicant used site-specific shear and compressional wave profile data together with four different earthquake magnitude-distance pairs from the high-frequency (5 and 10 Hz) deaggregation. The applicant computed horizontal and vertical ground motion spectra for each of the magnitude-distance values. In addition, the applicant used site-specific data from its ESP explorations as well as older data from Dominion's site explorations for Units 1 and 2 to develop two velocity profile models. The applicant assigned weights of 0.75 and 0.25 to these two models, with the higher weight for the more recent ESP site investigation model. The applicant stated that the V/H ratios that it obtained from the site-specific analysis are about 30% lower than the V/H ratios provided in NUREG/CR-6728 for a PGA between 0.2g and 0.5g. As such, the applicant concluded that these V/H ratios (see SSAR Table 2.5-27A) are appropriate for the North Anna ESP site. Higher V/H ratios result in a higher vertical SSE spectrum. The V/H ratios used by the applicant range from 0.75 at low frequencies to 1.12 at 50 Hz.

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PSHAs from the late 1980s, the staff concurs with the applicant's conclusion that this value is likely to be out of date and overly conservative.

To evaluate the applicant's use of a higher reference probability ($5x10^{-5}$) and use of mean rather than median PSHA results, the staff performed an independent analysis to reevaluate the reference probabilities for the 29 nuclear power sites in the CEUS that were used to determine the original reference probability. For its independent analysis, the staff used the most recent 2002 USGS PSHA mean and median hazard curves to determine the probability of exceeding the SSEs for the 29 CEUS sites. The staff also applied the same 5 Hz and 10 Hz site correction factors that were used in the LLNL seismic hazard analysis, published in 1993. Although the staff has not officially endorsed the 2002 USGS PSHA results, the staff was able to verify that the reference probability proposed by the applicant ($5x10^{-5}$) is sufficiently conservative. This larger reference probability value ($5x10^{-5}$) implies a lower return period (20,000 yrs) for the design ground motion; however, the staff was able to verify through its analysis that this revised reference probability results in a final SSE of adequate severity that is representative of the seismic hazard for the ESP site.

Using the RG 1.165 approach, the applicant determined the ground motion response spectra for the ESP site controlling earthquakes (magnitude of 5.4 at 20 km and magnitude of 7.2 at 308 km). The applicant then enveloped these two response spectra with the performance-based spectrum to create the final SSE spectrum. The staff's acceptance of the use of the performance-based spectrum to envelope the two controlling earthquake response spectra does not imply that the staff has endorsed the performance-based approach. As described in Appendix F to RG 1.165, any smooth spectral shape that envelopes the two controlling earthquake response spectra is acceptable as the site SSE. However, as set forth in the DSER, the staff (see Open Item 2.5-2) determined that this final SSE did not meet the requirements specified in 10 CFR 100.23(d)(1), which states that "the Safe Shutdown Earthquake Ground Motion for the site is characterized by both horizontal and vertical free-field ground motion response spectra at the free ground surface." As discussed above, the applicant addressed the staff's concern by performing a detailed site response analysis that incorporates the local site properties as well as the variability in these properties. Therefore, the final ESP site SSE meets the requirements specified in 10 CFR 100.23 in that it incorporates the local site subsurface properties and represents the free-field ground motion.

To determine the vertical SSE spectrum, the applicant used the V/H response spectral ratios provided in NUREG/CR-6728. To confirm the appropriateness of these V/H ratios, the applicant performed a site-specific analysis. For the site-specific analysis, the applicant used the ESP site compressional and shear wave profile data together with four different earthquake magnitude-distance pairs to compute vertical and horizontal ground motion spectra for the Zone III-IV hypothetical rock outcrop control point. The applicant stated that the V/H ratios that it obtained from the site-specific analysis are about 30% lower than the V/H ratios provided in NUREG/CR-6728 for a PGA between 0.2g and 0.5g. As such, the applicant concluded that these V/H ratios are appropriate from the North Anna ESP site.

To verify the adequacy of the V/H SSE ratios used by the applicant, the staff evaluated the applicant's site specific analysis. For its evaluation, the staff considered the adequacy of the four magnitude-distance pairs and the compressional and shear wave velocity profiles. Regarding the magnitude-distance pairs, four earthquake magnitude-distance pairs used by the applicant range from M = 5.1 to 6.1 with accompanying distances from 7.5 km to 75 km. For

that they adequately represent the range of magnitudes and distances from a local earthquake comparison, the high-frequency controlling earthquake from the CVSZ for the ESP site is M = 5.4 at 20 km. Accordingly, the staff finds that they adequately represent the range of magnitudes and distances from a local earthquake in the CVSZ. Regarding the compressional and shear wave velocity profiles, the applicant used data from both its ESP site exploration and older data from the licensee's exploration for Units 1 and 2. The applicant formed two velocity models from these two data sets, giving larger weight (75 percent) to the model based on the more recent ESP velocity data. The staff verified that these two models accurately represent the actual site properties given by the compressional and shear wave velocity profiles. The staff then compared the site-specific V/H ratios with the ratios actually used by the applicant from NUREG/CR-6728. On average, the mean V/H ratios from the site-specific analysis are approximately 30 percent lower, over the complete frequency range considered, than the V/H ratios used by the applicant from NUREG/CR-6728 for a PGA between 0.2g and 0.5g. Since the V/H ratios used by the applicant range from 0.75 to greater than 1.0 and these V/H ratios are 30 percent higher than V/H ratios from the site-specific analysis, the staff finds that they are conservative and adequate for the North Anna ESP site.

In SSAR Sections 2.5.2.6.9 and 2.5.2.6.10, the applicant alluded to future modifications of the site SSE spectrum in order to obtain an engineering design spectrum (EDS) that represents "the proper input into the large nuclear power plant structures." The applicant stated that the ESP site SSE is not suitable for the design of the SSCs of nuclear power plants because of high spectral accelerations in the high-frequency range (about 15 to 30 Hz). According to the applicant, the EDS would take into account plant-specific structural characteristics and local site conditions, as well as the ESP SSE spectrum. However, the ESP application does not include the EDS because the applicant has not selected a specific reactor design. The applicant proposed to include the EDS as part of a COL application. Because the applicant did not provide any specific recommendations or procedures for developing the EDS, the staff cannot evaluate the merits of the proposed approach.

The staff considers the SSE developed for the ESP site to be consistent with Appendix S to 10 CFR Part 50, which defines the SSE as the "vibratory ground motion for which certain structures, systems, and components must be designed to remain functional." Section 2.5.2.3.5 of this SER addresses the applicant's compliance with 10 CFR 100.23(d) with regard to the SSE. Future modifications of the SSE spectrum, if any, in an application for a COL or CP must be compatible with 10 CFR Parts 50 and 100.

2.5.2.4 Conclusions

As set forth above, the staff reviewed the seismological information submitted by the applicant in SSAR Section 2.5.2. On the basis of its review of SSAR Section 2.5.2 and the applicant's responses to the RAIs and open items, as described above, the staff finds that the applicant has provided a thorough characterization of the seismic sources surrounding the site, as required by 10 CFR 100.23. In addition, the staff finds that the applicant has adequately addressed the uncertainties inherent in the characterization of these seismic sources through a PSHA, and that this PSHA follows the guidance provided in RG 1.165. The staff concludes that the controlling earthquakes and associated ground motion derived from the applicant's PSHA are consistent with the seismogenic region surrounding the ESP site. In addition, the staff finds that the applicant's SSE was determined in accordance with RG 1.165 and Section 2.5.2 of NUREG-0800 and accurately includes the effects of the local ESP subsurface properties. The

staff concludes that the proposed ESP site is acceptable from a geologic and seismologic saprolite. The applicant selected a value of 950 ft/s for the Zone IIA saprolite, as shown in SSAR Table 2.5-45. For the Zone IIB saprolite, the shear wave velocity derived from the low strain value of shear modulus agrees well with the results from the CPT seismic tests, at around 1600 ft/s. Section 2.5.4.7 of the SSAR gives the profile of shear wave velocity versus depth for the saprolite.

The applicant derived the high-strain (i.e., in the range of 0.25 to 0.5 percent) elastic modulus values for the coarse-grained Zone IIA saprolite and the Zone IIB saprolite using the relationship with the SPT –value given in the literature (Ref. 151, SSAR Section 2.5). In addition, the applicant derived the high-strain elastic modulus for the fine-grained Zone IIA saprolite using the relationship with undrained shear strength (also given in SSAR Ref. 151). The applicant stated that it slightly adjusted the Zone IIA coarse- and fine-grained values to obtain a common value. The applicant obtained the shear modulus (G) values from the elastic modulus values using the relationship between elastic modulus (~~K~~E), shear modulus, and Poisson's ratio (ν).

$$G = \frac{E}{2(1+\nu)}$$

The applicant derived the low-strain (i.e., 10^{-4} percent) shear modulus for the Zone IIA saprolite from the shear wave velocity of 950 ft/s. Similarly, the applicant derived the low-strain shear modulus (G_{max}) of the Zone IIB saprolite from the shear wave velocity of 1600 ft/s. The applicant obtained the elastic modulus values for the Zone IIB saprolite from the shear modulus values using the relationship between elastic modulus, shear modulus, and Poisson's ratio (Ref. 150, SSAR Section 2.5).

The values derived from the settlement studies performed for the SWR pump house, as detailed in Appendix 3E to the UFSAR, include the recompression ratio (total amount of settlement) and the coefficient of secondary compression (after primary consolidation). The values of unit coefficient of subgrade reaction are based on values for medium-dense sand (Zone IIA saprolite) and very dense sand (Zone IIB saprolite) provided by Terzaghi (Ref. 152, SSAR Section 2.5). The earth pressure coefficients (ratio of lateral load to vertical load) are Rankine values, assuming level backfill and a zero friction angle between the soil and the wall.

In RAI 2.5.4-4, the staff asked the applicant to explain how the total thickness of the soil layers sampled at the ESP site (105 ft) is sufficient to characterize the soil properties underlying the site. The applicant responded that the 138 borings previously performed by Virginia Power for Units 1 and 2 as well as the abandoned Units 3 and 4 characterize the soils at the North Anna site very well. The applicant stated that the soils in all of borings show the same general subsurface profile and that it used the ESP borings to show that the soil (and rock) profiles in each of the borings fit within the general subsurface profile.

The scope of work related to the ESP site investigation consisted of the following:

- seven exploratory borings
- nine observation wells
- eight CPTs
- two downhole seismic cone tests
- two pore pressure dissipation tests
- two sets of crosshole seismic tests
- one downhole seismic test
- a survey of all exploration points
- laboratory testing of borehole samples and cores

Appendix B to SSAR Section 2.5.4 provides details and results of the exploration program. The following summarizes the borings, observation wells (OWs), and CPTs.

Borings and Samples/Cores

According to the applicant, the seven borings drilled range from 50 to 170 ft in depth, averaging 85 ft. The 170-ft deep boring is 30 ft deeper than the deepest reactor design considered for the ESP. The applicant stated that it conducted the SPT in general accordance with American Society for Testing and Materials (ASTM) D1586 and performed rock coring in general accordance with ASTM D2113. The applicant stated that, after removal from the ~~SPT~~ split inner barrel, it carefully placed the recovered rock in wooden core boxes. The onsite geologist visually described the core, noting the presence of joints and fractures and distinguishing natural breaks from mechanical breaks. The geologist also computed the percentage recovery and the RQD. Appendix B to SSAR Section 2.5.4 provides the boring logs and the photographs of the rock cores. These boring logs describe in detail the soil and rock materials encountered at different depths of the borings and also contain a record of the ground water level, the SPT blow counts, and the elevation of the top of the rock surface. The applicant used these data for the liquefaction analyses, bearing capacity calculations, and settlement analyses. The applicant stated that the soil and rock materials encountered in the ESP borings are similar to those found in the previous sets of borings conducted at the NAPS site.

In RAI 2.5.4-1, the staff asked the applicant to provide its basis for concluding that the subsurface conditions in the southeast portion of the ESP footprint (an area of about 500 ft by 1000 ft, in which there are no borings) do not materially differ from conditions in adjacent areas where borings were made. In its response, the applicant stated that the North Anna site is underlain by a consistent geologic profile, which extends to a depth of several thousand feet. The 145 borings performed throughout the North Anna site (including 7 for the ESP) indicate a consistent overall subsurface profile, with expected variations in the thickness of the various strata. As such, the applicant concluded that the southeast portion of the ESP footprint (see SER Figure 2.5.4-3) should be similar to the rest of the site.

In RAI 2.5.4-6, the staff asked the applicant to explain why it did not provide laboratory test results from the borings of subsurface materials over various depth intervals. The applicant responded that the containment (reactor) buildings for the new units would be founded on the Zone III-IV and/or Zone IV metamorphic gneiss bedrock at the North Anna site. Rock coring and testing performed by Virginia Power for Units 1 and 2 gave unconfined compressive strengths for the Zone III-IV and IV rock ranging from 1,000 to 16,300 psi with a median

3.5.1.6 Aircraft Hazards

For an early site permit (ESP) application, the NRC staff reviews the applicant's assessment of aircraft hazards to ensure that the risks associated with aircraft hazards are sufficiently low.

3.5.1.6.1 Technical Information in the Application

In Section 2.2.2.6 of the SSAR, the applicant presented information concerning airports and airways in the site vicinity that could affect a nuclear power plant or plants that might be constructed on the proposed ESP site. The applicant evaluated this information in SSAR Section 2.2.3.2.1.

The applicant stated that three airports exist within 15 miles of the proposed ESP site. Two of the airports are paved civil fields at which one or more aircraft are based, and the other is an unpaved private field at which no aircraft are based. None of the airports has commercial operations.

The closest airport is the Lake Anna Airport, about 7 miles south-southeast of the proposed ESP site. According to the applicant, approximately 3640 operations occurred at the field in 2002. The field is occasionally used for practice takeoffs and landings. The other paved field is the Louisa County Airport, which is about 11 miles west-southwest of the proposed ESP site. Approximately 6240 operations occurred at the field in 2002. The third airport is Cub Field, which is about 10 miles south-southwest of the proposed ESP site, and has a few operations per year.

The applicant stated that none of these airports has a sufficient number of flight operations per year to rise above the threshold set forth in Section 3.5.1.6 of Review Standard (RS)-002, "Processing Applications for Early Site Permits," which would trigger a detailed evaluation of potential hazards associated with airport flight operations. Therefore, the applicant did not include a detailed evaluation of potential hazards associated with airport flight operations.

The applicant stated that one civil airway and three military training routes pass near the proposed ESP site. The centerline of the civil airway (V223) is about 5.5 miles west of the site, and the edge of the airway is about 1.5 miles from the site. No traffic data are kept for this airway. However, the applicant stated that the Federal Aviation Administration (FAA) characterizes the airway as "not heavily used" and estimates the traffic to be less than 200 aircraft per day.

The centerlines of the military training routes, which are 10 miles wide, are less than 1 mile south of the proposed ESP site. The applicant stated that the Oceana Naval Air Station in Virginia Beach controls these routes. The applicant added that, according to a knowledgeable representative of the Navy whom it had contacted, pilots using these routes are instructed to fly near the edge of the route to avoid the North Anna Power Station (NAPS) and to generally remain 3 to 4 miles from NAPS. Flights along the routes typically involve one or two aircraft, and rarely four aircraft. The applicant stated that the number of flights per year on the military routes has remained approximately constant, as evidenced by the documented total traffic for

these three routes over a 3-year period. Specifically, the annual number of flights for these three routes was 2582, 2348, and 2623 for the years 1991, 1992, and 1993, respectively.

The airways are sufficiently close to the proposed site to warrant detailed evaluations of the associated potential hazards. In the SSAR, the applicant included detailed evaluations it performed following the guidance in RS-002, Section 3.5.1.6. The applicant's analysis concluded that the probability of an aircraft crash on the proposed ESP site from flights along the V223 airway is 3.45×10^{-8} per year. Similarly, the applicant's analysis concluded that the probability of an aircraft crash on the proposed ESP site from flights along the military training routes is 1.56×10^{-8} per year.

3.5.1.6.2 Regulatory Evaluation

In SSAR Section 1.8, the applicant identified the applicable NRC regulations and guidance related to the identification and evaluation of hazards associated with aircraft hazards as Title 10, Part 100, "Reactor Site Criteria," of the *Code of Federal Regulations* (10 CFR Part 100), Subpart B; Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants," issued February 1972; and RS-002, Section 3.5.1.6. Section 2.2.3.2 of the SSAR refers to NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants"; however, RS-002 includes the portion of NUREG-0800 that is referenced. The staff agrees that the foregoing regulations and guidance apply to this portion of the review. The staff considered the regulatory requirement in 10 CFR Part 100, Subpart B, in reviewing aircraft hazards.

According to Section 3.5.1.6 of RS-002, the requirement in 10 CFR 100.20, "Factors to be Considered When Evaluating Sites," that individual and societal risks of potential plant accidents be low is met if the probability of aircraft accidents having the potential for radiological consequences greater than the 10 CFR 50.34(a)(1) exposure guidelines is less than about 10^{-7} per year. The probability is considered to be less than about 10^{-7} per year by inspection if the distances from the site meet all of the following criteria:

- The site-to-airport distance, D, is between 5 and 10 statute miles, and the projected annual number of operations is less than 500 D^2; or the site-to-airport distance, D, is greater than 10 statute miles, and the projected annual number of operations is less than 1000 D^2.

- The site is at least 5 statute miles from the edge of military training routes, including low-level training routes, except for those associated with a usage greater than 1000 flights per year, or where activities (such as practice bombing) may create an unusual stress situation.

- The site is at least 2 statute miles beyond the nearest edge of a Federal airway, holding pattern, or approach pattern.

If the above proximity criteria are not met, or if sufficiently hazardous military activities are identified, a detailed review of aircraft hazards should be performed. Section 3.5.1.6 of RS-002 provides guidance on performing such a review.

3.5.1.6.3 Technical Evaluation

The applicant identified three airfields near the proposed ESP site. Two of the three airfields are described as public fields, and the third is identified as a private field. As noted in Section 3.5.1.6.1 of this safety evaluation report (SER), the applicant concluded that none of the fields has a sufficiently large number of flight operations to warrant a detailed analysis of the risk to a plant constructed at the proposed ESP site.

The staff notes, however, that a landing approach holding pattern for the Louisa County Airport is relatively close to the ESP site. Depending on the speed of an aircraft on an approach to the airport, this holding pattern can be less than 2 statute miles from the ESP site. As such, it would not meet the third criterion described in Section 3.5.1.6.2 of this SER. Failure to meet this criterion would, under the guidance in RS-002, necessitate a detailed aircraft hazards review. After consulting with the FAA, the staff has determined that only about 1 percent of all landing approaches to the Louisa County Airport involve the use of this particular holding pattern. Hence, the staff has made an estimate of this hazard by taking into account the above holding pattern usage fraction, the number of annual airport operations (6240 operations per year), the effective target area (0.013 square miles (mi^2)), and the crash frequency for general aviation as given in NUREG-0800, Section 3.5.1.6. On this basis, the estimated crash frequency is about 9.7×10^{-9} crashes per year.

The staff has confirmed that the applicant identified the public airfields closest to the proposed ESP site. The next closest public airfield is in Spotsylvania County, more than 20 miles from the site. The staff did not identify any additional private airfields within 10 miles of the site. Given the typical number of flight operations per year from private airfields and the size and type of aircraft that generally use private fields, the staff concludes that a detailed analysis of risk to a plant at the proposed ESP site from operations at private fields is not necessary.

The applicant identified one airway and three military training routes that pass near or over the proposed ESP and, using procedures described in RS-002, Section 3.5.1.6, separately estimated the probability of an aircraft crashing into a plant constructed at the proposed site from aircraft using the airway or military training routes. The staff has reviewed the applicant's calculations and finds them to be consistent with the procedures detailed in RS-002.

In calculating the crash probabilities, the applicant used an effective area of 0.013 mi^2 for safety-related structures that might be damaged by a crash sufficient to cause the potential for radiological consequences in excess of the 10 CFR 50.34(a)(1) criteria. The applicant used drawings included in the SSAR to estimate this area. The area is somewhat smaller than that listed for the power block (0.018 $mi^{2)}$ in the plant parameter envelope (PPE). The staff considers the area the applicant used in its calculation to be reasonable. Use of either figure for the effective area would result in a crash frequency (for all four routes) of less than 10^{-7} per year.

Appropriately, the applicant used the crash rates per mile of flight included in NUREG-0800 for the calculations. The staff concludes that the probability of an accident having the potential for radiological consequences in excess of the exposure criteria found in 10 CFR 50.34(a)(1) is less than about 10^{-7} per year.

3.5.1.6.4 Conclusions

The staff has reviewed the applicant's aircraft hazard analysis using the procedures set forth in RS-002, Section 3.5.1.6. As set forth above, the staff has independently verified the applicant's assessment of aircraft hazards at the site and concluded that the probability of an accident having the potential for radiological consequences in excess of the exposure criteria found in 10 CFR 50.34(a)(1) is less than about 10^{-7} per year. In addition, equivalent aircraft traffic in equal or closer proximity to plant sites reviewed in past NRC licensing actions was, after careful examination, found to present no undue risk to the safe operation of those plants. Based upon these considerations, the staff concludes that aircraft hazards do not present an undue risk to the health and safety of the public from potential construction and operation of one or more new nuclear plants on the proposed ESP site. Therefore, the staff concludes, with respect to aircraft hazards, that the proposed site is acceptable for constructing a plant falling within the applicant's PPE, and that the site meets the relevant requirements of 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," and 10 CFR Part 100.

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11. RADIOLOGICAL EFFLUENT RELEASE DOSE CONSEQUENCES FROM NORMAL OPERATIONS

11.1 Source Terms

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the information on radiological dose consequences caused by gaseous and liquid effluents that may be released from normal operation of the plant that was provided by reference in Site Safety Analysis Report (SSAR) Section 2.3.5.1 and included in the Environmental Report Section 5.4 and Tables 3.1-9, 5.4-10, and 5.4-11 of the Dominion Nuclear North Anna, LLC (Dominion or the applicant), early site permit (ESP) application to determine whether site characteristics are such that the radiation dose to members of the public would be within regulatory requirements.

11.1.1 Technical Information in the Application

The applicant provided information on the radiological impacts on members of the public from gaseous and liquid effluents that would be generated as a normal byproduct of nuclear power operations. The applicant described the exposure pathways by which radiation and radioactive effluents can be transmitted to members of the public in the vicinity of the site. The estimates on the maximum doses to the public are based on the available data on the reactor designs being considered using the plant parameter envelope (PPE) approach in which the bounding liquid and gaseous radiological effluents were used in the evaluation. The applicant evaluated the impact of these doses by comparing them to regulatory limits.

Using the PPE approach, Dominion provided a list of fission and activation products that may be released as liquid and gaseous effluents from the postulated new units. The applicant evaluated the impacts from releases and direct radiation by considering the probable pathways to individuals, populations, and biota near the proposed new units. The applicant also calculated the highest dose from the major exposure pathways for a given receptor.

If built, the postulated new units at the North Anna ESP site would release liquid effluents into the waste heat treatment facility (WHTF) through the discharge canals used for the operating units. The applicant considered the following liquid pathways–ingestion of aquatic food; ingestion of drinking water; exposure to shoreline sediment; and exposure to water through boating, swimming, and other activities.

Dominion also considered gaseous pathways, including external exposure to the airborne plume, external exposure to contaminated ground, inhalation of airborne activity, and ingestion of contaminated agricultural products, in its application.

The applicant calculated the dose to the maximally exposed individual (MEI) from both the liquid and gaseous effluent release pathways and calculated a collective whole body dose for the population within 50 miles (mi) of the North Anna ESP site.

11.1.2 Regulatory Evaluation

NRC regulations require that applicants for an ESP address the characteristics of the proposed site that could affect the radiation dose to a member of the public from radiological effluents. In SSAR Section 1.8.1, the applicant identified the applicable NRC regulations as Title 10,

Section 52.17(a)(1)(iv), of the *Code of Federal Regulations* (10 CFR 52.17(a)(1)(iv)). Specifically, this regulation states that an ESP application should describe the anticipated maximum levels of radiological effluents that each facility will produce. Furthermore, 10 CFR 100.21(c)(1) requires that radiological effluent release limits associated with normal operation from the type of facility proposed to be located at the site be met for any individual located off site. The staff reviewed this portion of the application for conformance with the applicable regulations.

11.1.3 Technical Evaluation

During normal operation, small quantities of radiological materials are expected to be released to the environment through gaseous and liquid effluents from the plant.

11.1.3.1 Gaseous Effluents

The applicant calculated the estimated dose to a hypothetical maximally exposed member of the public from the gaseous effluents using radiological exposure models based on Regulatory Guide (RG) 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors," issued March 1976; RG 1.109, Revision 1, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," issued October 1977, and the GASPAR II computer program (NUREG/CR-4653, "GASPAR II—Technical Reference and User Guide," March 1987).

Section 2.3.5 of this safety evaluation report discusses the derivation of the atmospheric dispersion parameters used in the applicant's radiological dose assessment.

Dominion calculated the gaseous pathway doses to the MEI using the GASPAR II program at the nearest site boundary, nearest vegetable garden, nearest residence, and nearest meat cow. The applicant did not calculate doses from the milk pathway because no milk cows or goats are located within a 5-mile radius of the ESP site. Table 5.4-7 of the environmental report includes the gaseous effluent releases used to estimate dose to the MEI. These releases, which were estimated for one unit, considered the advanced boiling-water reactor (ABWR) design to have an output level of 4300 megawatt thermal (MWt), rather than the certified level of 3926 MWt. This difference resulted in a slight increase in release rate for those isotopes for which the ABWR design, as certified, was the bounding condition. Tables 5.4-3 through 5.4-5 of the environmental report include other inputs to the GASPAR II program, including meat and vegetable production rates, atmospheric dispersion factors, ground deposition factors, receptor locations, and consumption factors. Table 5.4-9 of the environmental report presents the gaseous pathway doses to the MEI calculated by the applicant. The staff performed an independent evaluation of gaseous pathway doses with similar results.

In Table 1.3-8 of the SSAR, the applicant estimated the radiological dose consequences caused by gaseous effluents that may be released from normal operation of the plant. The applicant determined the gaseous radioactive effluent concentrations based on a composite of the highest activity content of the individual isotopes it anticipated would be released from the alternative reactor designs under consideration.

The applicant also provided a bounding gaseous effluent source term to support its compliance with the gaseous effluent release concentration limits in Table 2 of Appendix B, "Annual Limits on Intakes (ALIs) and Derived Air Concentrations (DACs) of Radionuclides for Occupational Exposure; Effluent Concentrations; Concentrations for Release to Sewerage," to 10 CFR Part 20, "Standards for Protection Against Radiation."

11.1.3.2 Liquid Effluents

The applicant calculated the estimated dose to a hypothetical maximally exposed member of the public from the liquid effluents using radiological exposure models based on RG 1.109 and the LADTAP II computer program (NUREG/CR-4013, "LADTAP II—Technical Reference and User Guide," April 1986).

Dominion calculated liquid pathway doses using the LADTAP II program for various activities, including eating fish and invertebrates caught near the discharge point; drinking water from Lake Anna; and boating, swimming, and using the shoreline for recreational purposes. Table 5.4-6 of the environmental report includes the liquid effluent releases for one new unit used in the estimate of dose to the MEI. These releases considered the ABWR design to have an output level of 4300 MWt, rather than the certified level of 3926 MWt. This difference resulted in a slight increase in release rate for those isotopes for which the ABWR design was the bounding condition. Tables 5.4-1 and 5.4-2 of the environmental report include other parameters used as input to the LADTAP II program, including effluent discharge rate, dilution factor for discharge, transit time to receptor, and impoundment concentration.

The applicant calculated liquid pathway doses to the MEI, including a maximum annual dose to the total body of 0.013 milliSievert (mSv) (1.3 millirem (mrem)) for the adult. Dominion calculated the maximum annual dose to the thyroid as 0.013 mSv (1.3 mrem) for the infant and the maximum annual dose to the liver as 0.017 mSv (1.7 mrem) for the child. The staff performed an independent evaluation of liquid pathway doses with similar results. The staff concludes that the applicant has provided a bounding assessment to demonstrate its capability to comply with the regulatory requirements in 10 CFR Part 20 and Appendix I, "Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as is Reasonably Achievable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents," to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

11.1.4 Conclusions

The applicant provided adequate information to provide reasonable assurance that it will control, monitor, and maintain radioactive gaseous and liquid effluents from the ESP site within the regulatory limits described in 10 CFR Part 20, as well as maintain them at as low as is reasonably achievable (ALARA) levels, in accordance with the effluent design objectives contained in Appendix I to 10 CFR Part 50.

As set forth above, the staff has independently verified the adequacy of the applicant's dose consequence calculations from normal operations. A combined license (COL) or construction permit (CP) applicant that references an ESP for the North Anna site should verify that the calculated radiological doses to members of the public from radioactive gaseous and liquid effluents for any facility to be built on the North Anna site are bounded by the radiological doses

included in the ESP application and reviewed by the NRC staff as described above. This includes any changes made to the input parameters used to calculate the radiological doses (i.e., meteorological data, distance to receptors, and land use data). In addition, detailed information on the solid waste management system used to process the radioactive gaseous and liquid effluents will be required. This is **COL Action Item 11.1-1.**

Based upon these considerations, the staff concludes that radiological doses to members of the public from radioactive gaseous and liquid effluents resulting from the normal operation of one or more new nuclear power plants that might be constructed on the proposed ESP site do not present an undue risk to the health and safety of the public. Therefore, the staff concludes, with respect to radiological effluent release dose consequences from normal operations, that the proposed site is acceptable for constructing a plant falling within the applicant's PPE, and that the site meets the relevant requirements of 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," and 10 CFR Part 100, "Reactor Site Criteria."

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15.3.2 Design-Specific (Assumed) χ/Q Values

To support its accident analyses based on the ABWR as a surrogate design, the applicant used the assumed χ/Q values in the certified ABWR DCD. In evaluating the AP1000, the applicant used those χ/Q values in the proposed AP1000 DCD that were under review by the staff at the time the North Anna ESP application was submitted. Westinghouse subsequently revised the χ/Q values in the AP1000 DCD. Consequently, the assumed χ/Q values and the calculated design-specific doses used in the North Anna ESP application may differ from those associated with a certified AP1000 DCD. However, the staff determined that the PPE values for the assumed χ/Q values associated with the AP1000 design used by the applicant in its accident analyses are reasonable and, therefore, that they are adequate for the purpose of demonstrating that a reactor with design characteristics similar to an AP1000 could be sited at the proposed ESP site. Section 15.4 of the SSAR lists the χ/Q values the applicant used for the version of the AP1000 and the certified ABWR that it considered.

In Table 1.3-1 of the SSAR, the applicant also listed a set of design-specific assumed χ/Q values, some of which neither the applicant nor the staff used in their radiological consequence evaluations. The staff finds that the χ/Q values in Table 1.3-1, with the exception of those used in the applicant's dose assessments in Chapter 15 of the SSAR, are not needed to assess the suitability of the proposed site. Therefore, the staff did not review them.

15.3.3 Site-Specific χ/Qs

The staff reviewed the applicant's site-specific χ/Q values and performed an independent evaluation of atmospheric dispersion in accordance with the guidance provided in Section 2.3.4 of RS-002. The staff finds the χ/Q values to be acceptable, as described in Section 2.3.4 of this SER. The staff intends to include these site-specific χ/Qs in any ESP that the NRC may issue for the North Anna ESP site.

15.3.4 Source Terms and Radiological Consequence Evaluations

To evaluate the suitability of the site using the radiological consequence evaluation factors in 10 CFR 50.34(a)(1), the applicant provided the bounding reactor accident source terms as a set of PPE values based on (1) the surrogate AP1000 and 43~~00~~86 megawatt thermal (MWt) ABWR designs (as explained below) and (2) the site-specific χ/Qs based on the ESP footprint. The source terms are expressed as the timing and release rate of fission products to the environment from the proposed ESP site. The dose consequences are then derived from the source terms using established methods.

The AP1000 source terms are based on the guidance provided in RG 1.183. The methodologies and assumptions used by Westinghouse, the AP1000 vendor, in its radiological consequence analyses are consistent with the guidance provided in RG 1.183. The resulting doses calculated for the AP1000 design using assumed site parameters meet the dose consequence evaluation factors specified in 10 CFR 50.34(a)(1) (i.e., 25 rem TEDE). The methodologies and assumptions used by General Electric, the ABWR vendor, in its radiological consequence analyses for the ABWR design are consistent with the guidance provided in RGs 1.3 and 1.25. The ABWR source terms are based on the guidance in TID-14844. The resulting doses for the ABWR reactor design using assumed site parameters meet the dose

consequence evaluation factors specified in 10 CFR 100.11, "Determination of Exclusion Area, Low Population Zone, and Population Center Distance," which are 300 rem to the thyroid and 25 rem to the whole body. While the requirements of 10 CFR 100.11 are not applicable to ESPs, the staff notes that the final rule at Appendix A, "Design Certification Rule for the U.S. Advanced Boiling Water Reactor," to 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants," states the following:

> The Commission has determined that with regard to the revised design basis accident radiation dose acceptance criteria in 10 CFR 50.34, the ABWR design meets the new dose criteria, based on the NRC staff's radiological consequence analyses, provided that the site parameters are not revised.

Therefore, the staff concludes that the certified ABWR design, in conjunction with assumed site parameters, meets the dose consequence evaluation factors specified in 10 CFR 100.11, as well as those specified in 10 CFR 50.34(a)(1).

In its site-specific DBA radiological consequence analyses, the applicant scaled the ABWR source terms and the resulting doses from the power level, certified under Appendix A to 10 CFR Part 52, of 4005 MWt to 43~~00~~86 MWt for its version of the ABWR. The applicant used a linear scaling method. Because the fission product release rate is directly proportional to the fission product inventory if mitigating processes remain the same, and because the fission product inventory is directly proportional to reactor power, the staff finds this scaling methodology to be acceptable for the purposes of this evaluation.

In determining the potential radiological consequence doses resulting from DBAs at the proposed site, the applicant used the site-specific atmospheric dispersion factors (χ/Q values) in conjunction with the DBA radiological consequence doses and its postulated χ/Q values provided in the SSAR of the certified ABWR (SSAR/ABWR) and the proposed AP1000 DCD. The certified ABWR and the proposed AP1000 designs met the radiological consequence evaluation factors identified in 10 CFR 50.34 (a)(1) with their postulated χ/Q values.

The χ/Q values indicate the atmospheric dilution capability. Smaller χ/Q values are associated with greater dilution capability, resulting in lower radiological doses. The radiological consequence doses are directly proportional to the χ/Q values. The applicant provided the site-specific χ/Q values used in its radiological consequence analyses in Table 1.9-1 of the SSAR, and the staff discussed and evaluated their χ/Q values in Section 2.3.4 of this SER.

The applicant used the atmospheric dispersion computer code (PAVAN) to derive its site-specific χ/Q values and the staff has revised Section 2.3.4 of this SER to indicate that a copy of the input files used by the applicant to execute PAVAN can be found in the applicant's response to RAI 2.3.4-1. The staff described the PAVAN code calculations for the North Anna site in more detail in Section 2.3.4 of this SER.

The applicant used the ratios of the site-specific χ/Q values to those postulated in the SSAR/ABWR and AP1000 DCD to determine and demonstrate that the radiological consequence doses at the proposed site meet the requirements of 10 CFR 50.34. The estimated site-specific χ/Q values for the proposed site are lower than those postulated in the SSAR/ABWR and AP1000 DCD. The certified ABWR and the proposed AP1000 designs met the radiological consequence evaluation factors identified in 10 CFR 50.34 (a)(1) with their

RS-002 calls for the staff to perform a confirmatory radiological consequence calculation. However, the design-related inputs to the applicant's dose calculation were directly extracted from design documentation previously submitted to and reviewed by the NRC in connection with design certification applications. Because the applicant simply used the ratio of the site-specific χ/Q values to the postulated design χ/Q values, the staff did not consider an independent calculation to be useful or necessary and, therefore, did not perform one.

15.4 Conclusions

As set forth above, the applicant submitted its radiological consequence analyses using the site-specific χ/Q values and PPE source term values and concluded that the proposed site meets the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1).

Based on the reasons set forth above, the staff finds that the applicant's PPE values for source terms that it included as inputs to the radiological consequence analyses are reasonable. Further, the staff finds that the applicant's site-specific χ/Q values and dose consequence evaluation methodology are acceptable.

Therefore, the staff concludes that the proposed distances to the EAB and the LPZ outer boundary of the proposed ESP site, in conjunction with the fission product release rates to the environment provided by the applicant as PPE values, are adequate to provide reasonable assurance that the radiological consequences of the DBAs will be within the dose consequence evaluation factors set forth at 10 CFR 50.34(a)(1) for the proposed ESP site. This conclusion is subject to confirmation at the COL or CP stage that the design of the facility specified by the COL or CP applicant falls within the ESP PPE values.

The staff further concludes that (1) the applicant has demonstrated that the proposed ESP site is suitable for power reactors with source term characteristics bounded by those of the 43~~00~~86 MWt ABWR and AP1000 without undue risk to the health and safety of the public and (2) the applicant complies with the requirements of 10 CFR 52.17 and 10 CFR Part 100.

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18. REVIEW BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

The Advisory Committee on Reactor Safeguards (ACRS) completed its review of the application from Dominion Nuclear North Anna, LLC, for an early site permit (ESP) for the North Anna ESP site and the U.S. Nuclear Regulatory Commission (NRC) staff's ~~draft~~ safety evaluation report (~~DSER~~SER) for this application. The ACRS ESP subcommittee began its detailed review of the North Anna ESP application and the staff's draft safety evaluation report (DSER) in December 2004. The ACRS ESP subcommittee met with representatives from Dominion and the staff on March 2, 2005. The ACRS held its full committee meeting on the North Anna ESP DSER on March 3, 2005. The discussions during these meetings focused on the open items from the DSER. On the basis of its review, the ACRS issued an interim letter report, dated March 11, 2005, which addresses the portions of the North Anna ESP application that concern safety. The staff responded to the interim letter report in its letter dated June 3, 2005 (ADAMS Accession No. ML051260009). This ~~FSER~~report captures the actions that the staff has taken in response to the comments and recommendations identified by the ACRS in its interim report of March 11, 2005, as described in the staff's response letter of June 3, 2005. The staff issued its FSER after the resolution of open items discussed in the DSER and after receipt of the ACRS interim letter report to the Commission related to its review.

During its meeting with the ACRS on July 6, 2005, the staff ~~will~~ discussed the resolution of open items and the responses to ACRS comments on the major elements of the ESP review. At the ~~final ACRS~~524th meeting ~~for the North Anna ESP SER, the full committee will consider the staff's report~~of the ACRS, the full Committee considered the staff's FSER, as well as Dominion's North Anna ESP application, and ~~will~~ issued its final letter report to the ~~Commission. The staff issued its final SER (FSER) after the resolution of open items discussed in the DSER and after receipt of the ACRS interim letter report to the Commission related to its review. The staff will address any comments from the ACRS in~~NRC Chairman on July 18, 2005. That letter report is included as Appendix E to this report.

In its final letter report ~~to the Commission and will include the ACRS final letter report as an appendix to this report.~~
dated July 18, 2005, the ACRS concurred with the NRC staff's conclusions concerning Dominion's ESP application and concluded that the proposed site, subject to the permit conditions recommended by the staff, can be used for up to two nuclear power units each of up to 4300 MW thermal without undue risk to public health and safety.

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Appendix A

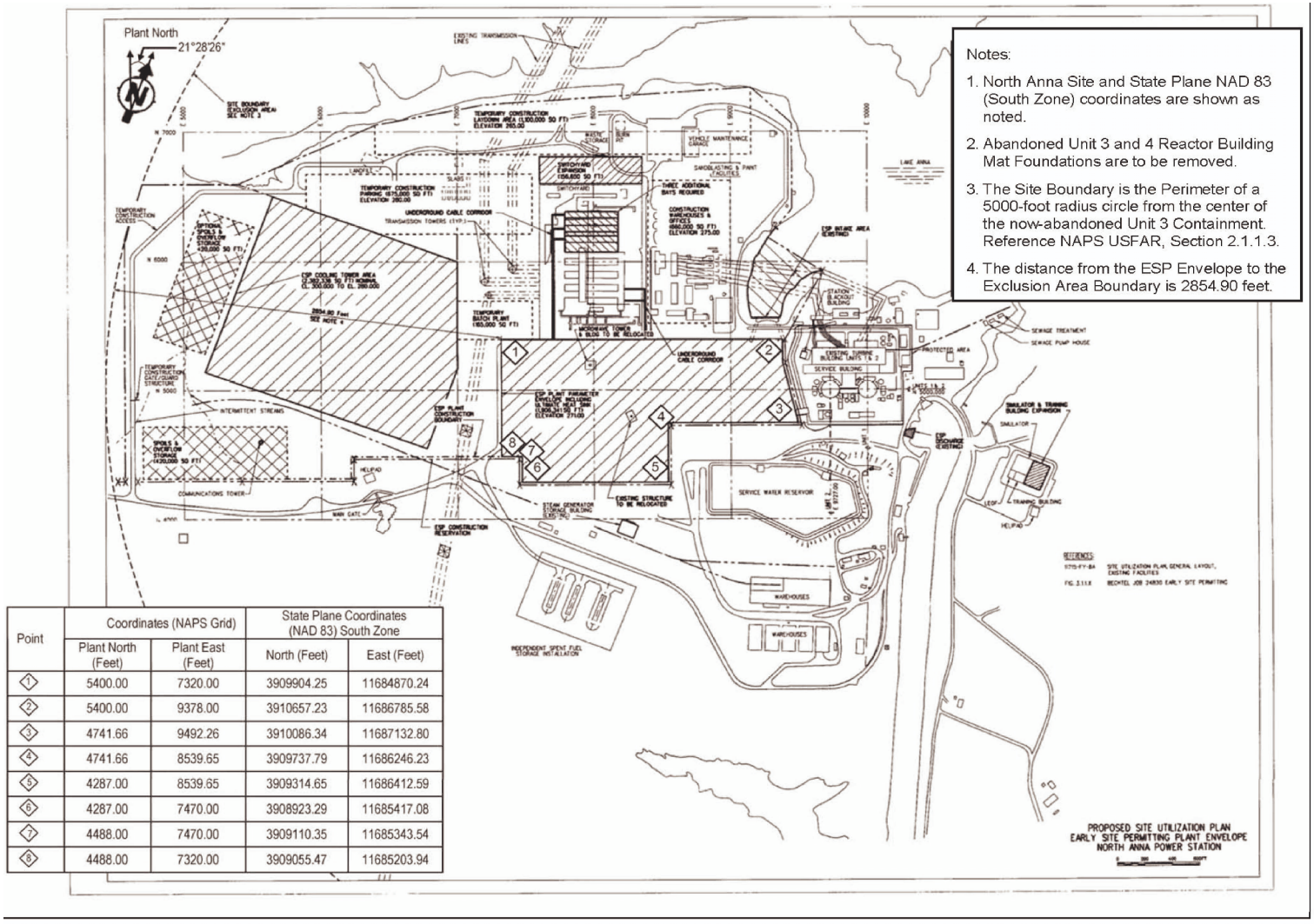
Permit Conditions, COL Action Items, Site Characteristics, and Bounding Parameters

2.5-8	2.5.4	A COL or CP applicant should provide specific plans for each proposed ground improvements technique it plans to employ so that the staff may determine whether the chosen techniques will ensure that Zone IIA saprolitic soils will be able to support safety-related foundations.	Exact unit locations and design not known at ESP stage.
2.5-9	2.5-4	A COL or CP applicant should determine the average shear-wave velocity of the material underlying the foundation for the reactor containment and verify that it is equal to or exceeds that of the chosen design.	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	A COL or CP applicant should conduct a 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	A COL or CP applicant should provide plot plans and cross sections/profiles of all safety-related slopes, and specify the measures that it will take to ensure the safety of slopes and any structures located adjacent to the slopes.	Locations of safety-related structures relative to the existing or new slopes not known at ESP stage.
~~3~~11.~~2~~1 - Radiological Effluent Release Dose Consequences from Normal Operations			
~~3~~11.~~2-1~~1-1	~~3~~11.~~2~~1.4	A COL or CP applicant should verify that the calculated radiological doses to members of the public from radioactive gaseous and liquid effluents for any facility to be built on the North Anna site are bounded by the radiological doses included in the ESP application and reviewed by the NRC.	Specific details of how the new facility will control, monitor, and maintain radioactive gaseous and liquid effluents not known at ESP stage.
13.6 - Industrial Security			
13.6-1	13.6	A COL or CP applicant should provide specific designs for protected area barriers.	Exact locations and design of barriers not known at ESP stage.

Local Intense Precipitation	46.61 cm (18.35in)/hour and 15.42 cm (6.~~07~~1 in) in 5 minutes	Maximum potential rainfall at the immediate ESP site.
Frazil and Anchor Ice	The ESP site has the potential for formation of frazil and anchor ice.	Accumulated ice formation in a turbulent flow condition.
Maximum Ice Thickness	43.4 cm (17.1 in) thick	Ice sheet thickness at Lake Anna (based on maximum cumulative degree-days below freezing of 178.8 EC (321.8 EF))
Maximum Cumulative Degree-Days Below Freezing	178.8 EC (32~~1.8 EF~~2 EF)	A measure of severity of winter weather conditions conducive to ice formation (computed using air temperature data from Piedmont Research Station)
Hydraulic Conductivity	1.0 m/d (3.4 ft/d)	Ground water flow rate per unit hydraulic gradient.
Hydraulic Gradient	0.03 m/m (0.~~1~~03 ft/ft)	Slope of ground water surface under unconfined conditions or slope of hydraulic pressure head under confined conditions.

2.5 - Geology, Seismology, and Geotechnical Engineering			
Basic Geologic and Seismic Information			
Capable Tectonic Structures		------	No fault displacement potential within the investigative area
Vibratory Ground Motion			
Design Response Spectra		Appendix A, Figure 2 (FSER Figure 2.5.2-6)	Site Specific response spectra
Stability of Subsurface Materials and Foundations			
Zone III Weathered Rock (205ft - 298ft)	Minimum Bearing Capacity	16 ksf	Allowable load-bearing capacity of layer supporting plant structures
	~~Minimum~~ Shear Wave Velocity	2000 ft/sec	Propagation of shear waves through foundation materials
Zone III - IV	Minimum Bearing Capacity	80 ksf	Allowable load-bearing capacity of layer supporting plant structures
	~~Minimum~~ Shear Wave Velocity	3300 ft/sec	Propagation of shear waves through foundation materials
Zone IV Bedrock (188ft - 298ft)	Minimum Bearing Capacity	160 ksf	Allowable load-bearing capacity of layer supporting plant structures
	~~Minimum~~ Shear Wave Velocity	6300 ft/sec	Propagation of shear waves through foundation materials

2.4 - Hydrology		
Maximum Cooling Water Flow Rate - Unit 3	2540 cfs	Total cooling water flow rate through the condensor (also the rate of withdrawal from Lake Anna and return to the WHTF)
Maximum Cooling Water Temperature Rise	18°F	Temperature rise across the condensor (temperature of water out minus the temperature of water in) ~~at full station load and full cooling water flow~~when the lake level is # 244 MSL
Maximum Inlet Temperature	95°F	Maximum temperature of water incoming into condenser ~~based on~~when the ~~site specific discharge temperature (113 F) and the cooling water temperature rise (18 F) at full station load and full cooling water flow~~lake level is # 244 MSL
Minimum Site Grade	82.6 (271 ft) MSL	Finished site grade



Point	Coordinates (NAPS Grid)		State Plane Coordinates (NAD 83) South Zone	
	Plant North (Feet)	Plant East (Feet)	North (Feet)	East (Feet)
1	5400.00	7320.00	3909904.25	11684870.24
2	5400.00	9378.00	3910657.23	11686785.58
3	4741.66	9492.26	3910086.34	11687132.80
4	4741.66	8539.65	3909737.79	11686246.23
5	4287.00	8539.65	3909314.65	11686412.59
6	4287.00	7470.00	3908923.29	11685417.08
7	4488.00	7470.00	3909110.35	11685343.54
8	4488.00	7320.00	3909055.47	11685203.94

Figure ~~1 (Figure 2~~2.4.~~14-1)~~ 14-1 The proposed facility boundary for the ESP site

WordPerfect Document Compare Summary

Original document: C:\Documents and Settings\cja2\Desktop\North Anna FSER\NA 6-2005 FSER\APPENDIX B Chron.wpd
Revised document: @PFDesktop\:MyComputer\G:\NRLPO\ESP\Dominion\FSER\FSER-Rev. 5 Application\APPENDIX B Chron.wpd
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APPENDIX B

CHRONOLOGY

This appendix contains a chronological listing of routine licensing correspondence between the staff of the U.S. Nuclear Regulatory Commission (NRC) and Dominion Nuclear regarding the review of the North Anna early site permit application under Project No. 719 and Docket No. 52-008.

Revisions to the North Anna Early Site Permit Application

Rev.	Date	Accession Number
0	September 25, 2003	ML032731517
1[5]	October 2, 2003	ML032731517
2	July 15, 2004	ML042010010
3	September 7, 2004	ML042590082
4	May 12, 2005	ML051450310
5	July 31, 2005	ML052150226

[5]Revision 0 and Revision 1 of the application are contained in the same ADAMS package. Revision 1 of the application provides changes to Revision 0 to remove proprietary information from the application.

WordPerfect Document Compare Summary

Original document: C:\Documents and Settings\cja2\Desktop\NewFSER8-05\NA 6-2005 FSER\APPENDIX C References.wpd
Revised document: @PFDesktop\NewFSER8-05\APPENDIX C Referencesnew.wpd
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Pratt, T. L., C. Coruh, and J. K. Costain, "A Geophysical Study of the Earth's Crust in Central Virginia — Implications for Appalachian Crustal Structure," *Journal of Geophysical Research*, Vol. 93, pp. 6649–6667, 1988.

Ramsdell, Jr., V. ~~A~~J., "Technical Evaluation Report on Design Basis Tornadoes for the North Anna ESP Site," Pacific Northwest National ~~Laboratories~~Laboratory: Richland, Washington, November 9, 2004. (ADAMS Accession No. ML043370303).

Savy, J. B. et al., UCRL-ID-115111, "Eastern Seismic Hazard Characterization Update," Lawrence Livermore National Laboratory: Livermore, CA, June 1993.

Seed, H. B., "Considerations in the Earthquake-Resistant Design of Earth and Rockfill Dams," *Geotechnique*, Volume 29, No. 3, 1979.

Seed, H. B. and I. M. Idriss, *Ground Motions and Soil Liquefaction During Earthquakes*, Earthquake Engineering Research Institute, Oakland, CA, 1982.

Seed, H. B., and I. M. Idriss, Report No. UCB/EERC-70/10, "Soil Moduli and Damping Factors for Dynamic Response Analyses," University of California: Berkeley, California, December 1970.

Seed, H. B., et al., Report No. UCB/EERC-84/14, "Moduli and Damping Factors for Dynamic Analyses of Cohesionless Soils," University of California: Berkeley, California, September 1984.

Sun, J. I., R. Golesorkhi, and H. B. Seed, Report No. UCB/EERC-88/15, "Dynamic Moduli and Damping Ratios for Cohesive Soils," University of California: Berkeley, California, August 1988.

Talwani, P. and W. T. Schaeffer, "Recurrence Rates of Large Earthquakes in the South Carolina Coastal Plain Based on Paleoliquefaction Fata," *Journal of Geophysical Research*, Vol. 106, No. B4, pp. 6621–6642, 2001.

Terzaghi, K., "Evaluation of Coefficients of Subgrade Reaction," *Geotechnique*, Volume 5, 1955.

Tokimatsu, K. and H. B. Sneed, "Evaluation of Settlements on Sands Due to Earthquake Shaking," *ASCE Journal of Geotechnical Engineering*, Volume 113, No. 8, August 1997.

Vesic, A. S., "Bearing Capacity of Shallow Foundations," Ed. H. F. Winterkorn and H-Y Fang, *Foundation Engineering Handbook*, Van Nostrand Reinhold Company: New York, 1975.

Wilson, B. W., "Seiches," *Advances in Hydoscience*, Vol. 8, Academic Press: New York, 1972.

Yakhot, V. and L. M. Smith, "The Renormalization Group, the e-Expansion and Derivation of Turbulence Models," *Journal of Scientific Computing*, Vol. 7. pp. 35-61, 1972.

Youd, T. L. et al., "Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction of Soils," *ASCE Journal of Geotechnical and Environmental Engineering*, Volume 127, No. 10, October 2001.

WordPerfect Document Compare Summary

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Revised document: @PFDesktop\NewFSER8-05\APPENDIX Dnew.wpd
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APPENDIX D

PRINCIPAL CONTRIBUTORS

Name	Responsibility
Anand, Raj	Project Management
Araguas, Christian	Project Management
Bagchi, Goutam	Hydrology
Campe, Kazimieras	Site Hazards
Harvey, Robert B.	Meteorology
Klementowicz, Stephen	Normal Radiological Dose Analyses
Lee, Jay	Accident Analyses
Munson, Cliff	Geology and Seismology
Musico, Bruce	Emergency Planning
Pichumani, Raman	Geotechinical Engineering
Prescott, Paul	Quality Assurance
Scott, Michael	Project Management
Segala, John	Project Management
Sosa, Belkys	Project Management
Tardiff, Albert	Security

Contractors	Technical Area
Federal Emergency Management Agency	Emergency Planning
Pacific Northwest National Laboratory	Hydrology, Meteorology, and Site Hazards
U.S. Geologic Survey	Geology and Seismology

APPENDIX E

REPORT BY THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

ACRSR-2141

July 18, 2005

The Honorable Nils J. Diaz
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

SUBJECT: DOMINION NUCLEAR NORTH ANNA, LLC, EARLY SITE PERMIT APPLICATION AND THE ASSOCIATED NRC FINAL SAFETY EVALUATION REPORT

Dear Chairman Diaz:

During the 524th meeting of the Advisory Committee on Reactor Safeguards, July 6-8, 2005, we met with representatives of the NRC staff and Dominion Nuclear North Anna, LLC (Dominion) and discussed the final safety evaluation report of the Dominion application for the North Anna early site permit (ESP). Our reviews of the application and the staff's safety evaluation report were conducted to fulfill the requirement of 10 CFR 52.23, which states that the ACRS shall report on those portions of an early site permit application that concern safety. We had the benefit of the documents referenced.

CONCLUSIONS

- The proposed site, subject to the permit conditions recommended by the NRC staff, can be used for up to two nuclear power units each of up to 4300 MW_{th} without undue risk to the public health and safety.

- The staff's final safety evaluation report of the Dominion early site permit application will contribute to the documentary basis for the mandatory public hearing concerning the proposed early site permit.

DISCUSSION

Dominion has submitted a first-of-a-kind application for an early site permit pursuant to the requirements of Subpart A, "Early Site Permits," of 10 CFR Part 52. The proposed site is entirely within the current North Anna Power Station site about 40 miles north-northwest of Richmond, Virginia. Years ago, this site was approved for four units, but only two units (3-loop Westinghouse pressurized water reactors) were constructed. Both of these units are now operating.

The Dominion application is to locate up to two nuclear power units on the proposed site. Each unit is to have a power of up to 4300 MW_{th}. The Dominion application is based on a set of conservative, enveloping parameters defined to allow flexibility in the selection of reactor technology should a decision be made in the future to actually develop the site.

- Nature of the Proposed Site

The vicinity of the proposed site is rural in nature. There are no significant industrial, transportation, or military facilities within five miles of the site center. The major water sources available to the site are the North Anna river and an artificial lake adjacent to the site. The dam for this lake is under the control of the applicant. The applicant has recognized that water availability may be insufficient for two water-cooled units and proposes air cooling for one unit on the proposed site. The staff proposes that this be made a permit condition.

- Population in the Vicinity of the Site

The permanent population around the site is quite low. The nearest population center, Mineral, Virginia, has a population of less than 500. The nearest significant cities are Fredericksburg (projected year 2065 population 20,950) at a distance of 22 miles, Charlottesville (year 2000 population 45,069) at 36 miles, and Richmond (year 2000 population 197,790) at 40 miles. The applicant used methods found acceptable by the staff to show that projected populations in the vicinity of the site through the year 2065 will still be within acceptable limits.

- Geology and Seismicity of the Site

The proposed site will have reactors founded on hard rock. Dominion has undertaken a thorough effort to update geologic and seismic information concerning the site and has made use of methods that are new since the construction of reactors now operating on the North Anna site to characterize the proposed site. The staff has approved these analyses as they have been amended in four revisions of the initial application. Because of the hard rock foundations, reactors on the site would be subject to significant seismically-induced accelerations at frequencies in excess of 10 Hz. Dominion originally proposed to use a new "performance-based" method described in its application to derive a safe shutdown earthquake spectrum that bounds what was determined by the staff using its own methods. The staff has not endorsed the proposed performance-based applicant's methods. Dominion has ultimately elected to use the staff's method as identified in Regulatory Guide 1.165. The staff concurs with conclusions reached by the applicant.

- Meteorology

The applicant has done a thorough examination of historical meteorological data to set design constraints for such things as maximum rainfall, wind velocities, snow pack and temperature extremes. The staff has found these findings to be acceptable. The design constraints posed by the proposed site meteorology are not severe in comparison to design parameters for candidate reactor technologies considered in the development of the early site permit application.

- Potential Radionuclide Releases

For the studies of radiological source terms at the proposed site, Dominion has selected two advanced reactors that could be located on the site. These example plants (AP1000 and the Advanced Boiling Water Reactor) have very low predicted core damage frequencies relative to those predicted for the extant plants on the North Anna site. Dominion has used staff-approved methods to deduce that consequences of radionuclide release at the proposed site will be less than considered in the applications for the design certifications of the example plants. The staff has verified these conclusions with its own evaluations.

- Emergency Plans

The applicant has elected to submit for review just the "major features" of emergency planning for the proposed site as is allowed by the regulations. The staff has found these major features to be acceptable and concludes that the proposed site does not pose significant impediments to the development of adequate emergency plans should a decision be made to develop the site.

The staff has identified a number of items that are treated either as permit conditions or as actions that must be addressed at the combined license (COL) stage. The staff has developed criteria to identify permit conditions. Permit conditions are recommended by the staff when:

- evaluations of the site rest on an assumption that can be justified only after a site permit has been issued,
- a physical attribute exists for the site that is not acceptable for the design of systems, structures and components important to safety, or
- evaluations can be completed only after some future act has taken place.

We conclude that these are appropriate criteria for the imposition of permit conditions.

The staff has prepared a high-quality, detailed, yet readable, safety evaluation report on the Dominion application. All open items have been resolved. The staff concludes that the site is adequate for the proposed use subject to eight permit conditions.

The staff has also identified 30 items that need to be considered in conjunction with reviews of a COL application should the early site permit be granted and a decision to develop the site be made.

We concur with the staff's conclusions concerning the Dominion application for an early site permit. This first use of the early site permit process has revealed several areas where the process can be refined and streamlined. We look forward to working with the staff to improve the early site permit process.

Sincerely,

/RA/

Graham B. Wallis
Chairman

References :

1. U.S. Nuclear Regulatory Commission, Final Safety Evaluation Report, "Safety Evaluation of Early Site Permit Application in the Matter of Dominion Nuclear North Anna, LLC, for the North Anna Early Site Permit', June 16, 2005.

2. North Anna Early Site Permit Application, Revision 3, September 2004, NRC Docket No. 51-008.

3. U.S. Nuclear Regulatory Commission, Review Standard, RS-002, "Processing Applications for Early Site Permit Applications", May 3, 2004.

4. Memorandum from Luis A. Reyes, NRC Executive Director for Operations, to Graham B. Wallis, Chairman, ACRS, Subject: Interim Letter: Draft Safety Evaluation Report on North Anna Early Site Permit Application, dated June 3, 2005.

5. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.165, "Identification and Characterization of Seismic Sources and Determination of Safe Shutdown Earthquake Ground Motion," dated March 1997.