2. SITE CHARACTERISTICS

2.1 <u>Introduction</u>

2.1.1 Site Location and Description

2.1.1.1 Technical Information in the Application

In Section 2.1.1.1 of the site safety analysis report (SSAR), the applicant presented information concerning the site location and site area that would affect the design of structures, systems, and components (SSCs) important to safety of a nuclear power plant or plants falling within the applicant's plant parameter envelope (PPE) that might be constructed on the proposed early site permit (ESP) site. The applicant did not provide latitude and longitude or Universal Transverse Mercator coordinates for new units in the proposed ESP site. However, the North Anna Units 1 and 2 Updated Final Safety Analysis Report (UFSAR) for the existing North Anna Power Station (NAPS) does include them. The proposed ESP site is located within the existing NAPS site.

The applicant provided the following information on site location and site area:

- the site boundary for new units in the proposed ESP site with respect to the existing units
- the site layout for new units in the proposed ESP site with respect to the current and future developments
- the site location with respect to political subdivisions and prominent natural and manmade features of the area within the 6-mile (mi) low-population zone (LPZ) and 50-mile population zone
- the topography surrounding the proposed ESP site
- the distance from the proposed ESP site to the nearest exclusion area boundary (EAB), including the direction and distance
- the potential radioactive material release points and their locations for the proposed new units
- the distance of the proposed site from regional U.S. and State highways
- the confirmation that no physical characteristics unique to the proposed ESP site were identified that could pose a significant impediment to the development of emergency plans

2.1.1.2 Regulatory Evaluation

Sections 1.8 and 2.1.1 of the SSAR identify the applicable U.S. Nuclear Regulatory Commission (NRC) regulations and guidance regarding site location and description as defined in Title 10, Section 52.17, “Contents of Applications,” of the *Code of Federal Regulations* (10 CFR 52.17); 10 CFR Part 100, “Reactor Site Criteria”; 10 CFR 50.34(a)(1); and NRC Review Standard (RS)-002, “Processing Applications for Early Site Permits,” issued May 2004. The staff reviewed this portion of the application for conformance with the applicable regulations, and considered the corresponding regulatory guidance, as identified above.

The staff considered the following regulatory requirements in reviewing the site location and site area:

- 10 CFR Part 100, insofar as it requires consideration of factors relating to the size and location of sites

- 10 CFR 52.17, insofar as it requires the applicant’s submission of information needed to evaluate factors involving the characteristics of the site environs

According to Section 2.1.1 of RS-002, an applicant has submitted adequate information if it satisfies the following criteria:

- The site location, including the exclusion area and the proposed location of a nuclear power plant or plants of specified type falling within a PPE that might be constructed on the proposed site, is described in sufficient detail to determine that the requirements of 10 CFR Part 100 and 10 CFR 52.17 are met, as discussed in Sections 2.1.2 and 2.1.3 and Chapter 15 of this safety evaluation report (SER).

- Highways, railroads, and waterways which traverse the exclusion area are sufficiently distant from planned or likely locations of structures of a nuclear power plant or plants of specified type falling within a PPE that might be constructed on the proposed site so that routine use of these routes is not likely to interfere with normal plant operation.

2.1.1.3 Technical Evaluation

The proposed ESP site is located within the existing NAPS site. The ESP site boundary, as shown in Figure 2.1-1, “Site Boundary,” of the SSAR, is the same as the site boundary for the existing NAPS units.

The staff has verified the following coordinates of the existing NAPS units provided in the North Anna UFSAR:

	Latitude	Longitude	Universal Transverse Mercator
Unit 1	38E3'36"N	77E47'23"W	4,215,990 mN—255,240 mN—zone 18S
Unit 2	38E3'38"N	77E47'26"W	4,215,960 mN—255,170 mN—zone 18S

The staff will review the exact coordinates of the new units at the time of a combined license (COL) or construction permit (CP) application when the applicant selects new units in the proposed ESP site. This is **COL Action Item 2.1-1**.

The applicant has defined the EAB envelope at a radius of 5000 feet (ft) from the now abandoned Unit 3 containment and the LPZ at a radius of 6 miles from the existing Unit 1 containment building. The applicant established the EAB and the LPZ to ensure that the radiological consequence evaluation factors identified in 10 CFR 50.34(a)(1) and the siting evaluation factors in Subpart B, "Evaluation Factors for Stationary Power Reactor Site Applications on or After January 10, 1997," of 10 CFR Part 100 are met. No persons live within the EAB.

NAPS is located in the northeastern portion of Virginia in Louisa County. Louisa County includes two incorporated towns, Louisa and Mineral. The proposed ESP site is on a peninsula on the southern shore of Lake Anna at the end of State Route 700. Lake Anna was created to serve the needs of NAPS. It is about 17 miles long and has 272 miles of irregular shoreline with various contour and scenic views. The proposed ESP site lies along the lake shoreline. The NAPS property comprises 1803 acres (ac), of which about 760 ac are covered by water. Virginia Electric and Power Company (Virginia Power) and Old Dominion Electric Cooperative (ODEC) own the NAPS site, which includes the existing two nuclear power units and the proposed ESP site, as tenants in common (see Section 2.1.2 of this SER).

The largest community within 10 miles of the proposed ESP site is the town of Mineral with a population of 424, according to the 2000 census. It is situated about 6 miles west-southwest of the proposed ESP site. Regionally, as shown in Figure 2.1-3, "Fifty-Mile Surrounding Area," of the SSAR, the proposed site is approximately 40 miles north-northwest of Richmond, Virginia; 36 miles east of Charlottesville, Virginia; 22 miles southwest of Fredericksburg, Virginia; and 70 miles southwest of Washington, D.C. Highways U.S. 1 and I-95 pass within 15 and 16 miles, respectively, east of the proposed site. No highways, railroads, or waterways traverse the proposed ESP exclusion area site boundary.

The staff has verified that the exclusion area distance is consistent with the distance the applicant used in its radiological consequence analyses described in Chapter 15, "Accident Analyses," of the SSAR. The applicant stated that, consistent with the licenses for the existing units, the gaseous effluent release limits for the proposed units would apply at or beyond the proposed ESP EAB; the liquid effluent release limits for the new units would apply at the end of the discharge canal, which is designated as the release point to unrestricted areas. The staff finds that these release points are acceptable for determining the radiation exposures to the public to meet the criterion "as low as reasonably achievable," cited in 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."

For the reasons set forth in Section 13.3 of this SER, the staff further finds that no physical characteristics unique to the proposed ESP site have been identified that could pose a significant impediment to the development of emergency plans.

2.1.1.4 Conclusions

As set forth above, the applicant has provided and substantiated information concerning the site location and site area that would affect the design of SSCs important to safety of a nuclear power plant or plants of specified type falling within the applicant's PPE that might be constructed on the proposed ESP site. The staff has reviewed the applicant's information as described above and concludes that it is sufficient for the staff to evaluate compliance with the siting evaluation factors in 10 CFR Part 100 and 10 CFR 52.17, as well as the radiological consequence evaluation factors in 10 CFR 50.34(a)(1). The staff further concludes that the applicant provided information concerning the site location and site area in sufficient detail to allow the staff to evaluate, as documented in Sections 2.1.2 and 2.1.3 and Chapter 15 of this SER, whether the applicant has met the relevant requirements of 10 CFR Part 100 and 10 CFR 52.17.

2.1.2 Exclusion Area Authority and Control

2.1.2.1 Technical Information in the Application

In SSAR Section 2.1.2, the applicant presented information concerning its plan to obtain legal authority to determine all activities within the designated exclusion area, if it decides to proceed with the development of new reactor units at the proposed ESP site. In Revision 3 of the SSAR, the applicant stated the following:

> If Dominion decides to proceed with the development of new units, it would enter into and obtain appropriate regulatory approvals to purchase or lease the ESP site from Virginia Power and ODEC. The agreement or conveyance documents would provide for the mutual use of the NAPS site as a single exclusion area. As part of this agreement, each party would agree to immediately notify the other in the event of an emergency and to abide by the reasonable requests of the party declaring an emergency to exclude non-plant personnel and property from the exclusion area. The parties would also agree to work cooperatively to control third party activity that might otherwise present an unacceptable hazard to nuclear operations. Because the appropriate regulatory approvals of the conveyance and agreement (pursuant to Virginia Code, 56-77 and 56-580) would be a prerequisite to Dominion's development of the new units, such arrangements would be in place before issuance of a COL for the new units.

In Request for Additional Information (RAI) 2.1.2-1, the staff asked the applicant for additional information regarding its approach to obtaining appropriate regulatory approvals to purchase or lease the ESP site. In its response, the applicant stated the following:

> Virginia State Corporation and possibly North Carolina Utilities Commission approval [other than NRC] would be required [to purchase or lease the proposed ESP site]. The current NAPS exclusion area boundary (EAB) would continue to be the EAB for the existing units and any new units. This single exclusion area includes property that is not part of the ESP site. The use of the current exclusion area for the new units would be established by agreement between Dominion Nuclear North Anna and other NAPS owners. Dominion has not determined a specified term for any lease. However, any lease would provide that (1) the term of the lease would not expire until after termination of all NRC licenses for any facilities on the leased property, and (2) the lease may not be canceled or terminated, prior to the termination of all NRC licensees for any

> facilities on the leased property, except with prior written consent of the NRC (e.g., consent in connection with the transfer of licenses under 10 CFR 50.80).

In RAI 2.1.2-2, the staff asked for the application for additional information on how an agreement or conveyance document (e.g., a lease or deed) would provide for the use of NAPS as a single exclusion area, in the event that additional reactors are constructed on the site. In its response, in a letter to the NRC dated August 10, 2004, the applicant stated the following:

> Any lease or deed would provide mutual use of the existing site and the leased premises as a single exclusion area and single restricted area for all nuclear units at the North Anna site. Each party would agree to immediately notify the other in the event of an emergency and to abide by the reasonable request of the party declaring the emergency condition to exclude non-plant personnel and property from the exclusion area. The parties would agree to work cooperatively to control third party activity within the exclusion area and prevent any such activity that might otherwise present an unacceptable hazard to nuclear operations. This approach is consistent with the single exclusion area established by agreement for the Indian Point units (when Units 1 and 2 were owned by the Consolidated Edison Company and Unit 3 was owned by the Power Authority of the State of New York) and for the Nine Mile Point and Fitzpatrick plants.

2.1.2.2 Regulatory Evaluation

In SSAR Sections 1.8 and 2.1.2, the applicant identified the applicable NRC regulations and regulatory guidance regarding exclusion area authority and control related to Subpart A, “Early Site Permits,” of 10 CFR Part 52, “Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants,” 10 CFR Part 100, and RS-002. The staff finds that the applicant correctly identified the applicable regulations and guidance. The staff considered 10 CFR 100.21(a) and 10 CFR 100.3, “Definitions,” in reviewing the applicant’s legal authority to determine all activities within the designated exclusion area. Pursuant to 10 CFR 100.21(a), every site must have an exclusion area, defined in 10 CFR 100.3 as the following:

> That area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area. This area may be traversed by a highway, railroad or waterway, provided these are not so close to the facility as to interfere with normal operations of the facility and provided appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway, in case of emergency, to protect the public health and safety... Activities unrelated to operation of the reactor may be permitted in an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result.

As stated in Section 2.1.2 of RS-002, the applicant must demonstrate, before issuance of an ESP, that it has an exclusion area and an LPZ, as defined in 10 CFR 100.3 and in accordance with the requirements of 10 CFR Part 100. Furthermore, the applicant must show that it has the authority within the exclusion area, as required by 10 CFR 100.3, or it must provide reasonable assurance that it will have such authority before start of construction of a reactor or reactors that might be located on the proposed ESP site.

2.1.2.3 Technical Evaluation

As set forth in the application and in Section 2.1.2.1 of this SER, the exclusion area for the North Anna ESP site is identical to the exclusion area for the existing reactors at the site, North Anna Units 1 and 2. Further, the current owners of the ESP site, Virginia Power and ODEC, have the requisite control over the exclusion area, and such control is vested in Virginia Power. The applicant has stated that it intends to reach appropriate legal terms with the current owners of the ESP site to obtain the requisite control over the exclusion area. The applicant would enter into such an agreement with the current site owners at such time as the applicant elects to construct a nuclear power plant on the site.

The applicant has not attempted to demonstrate that it currently has the authority to determine all activities, including exclusion or removal of personnel and property from the area, as required by 10 CFR 100.3. To meet the exclusion area control requirements of 10 CFR 100.21(a) and 10 CFR 100.3, the applicant does not need to demonstrate total control of the property before issuance of the ESP. In the draft safety evaluation report (DSER), the NRC staff stated that the applicant must provide reasonable assurance that it can acquire the required control (i.e., that it has the legal right to obtain control of the exclusion area). The staff had not then obtained information sufficient to enable it to determine whether the applicant had such a legal right. Accordingly, the NRC staff identified DSER Open Item 2.1-1, which stated that the applicant should demonstrate that it has the legal right to control the exclusion area, or has an irrevocable right to obtain such control.

In its response to the open item, the applicant indicated as follows: In accordance with Virginia Code, §56-580 D, the ESP holder would be required to obtain the approval of the Virginia State Corporation Commission (SCC) to construct and operate any new unit at the North Anna ESP site, should it decide to do so. In such an event, SCC approval of any agreement between the CP or COL applicant and the current owners of the site providing for construction and operation of a new unit would be required pursuant to Virginia Code, §56-77. The same statute would require SCC approval of any agreement among these entities providing for joint control of the exclusion area. Other State approvals might also be required.

Based on the above information, the staff has determined that State approval would be required for the agreements described above, and no new nuclear power plant could be built in the absence of these approvals. Since the ESP holder would need to obtain the current owners' agreement to construct and operate any new nuclear power plant on the North Anna ESP site in order to seek State approval of such construction and operation, there does not appear to be any reason why the ESP holder could not obtain control of the exclusion area in a similar manner. Accordingly, for purposes of an ESP, there is reasonable assurance that the current owners would (as a corollary to any agreement for construction and operation) also agree to joint control of the exclusion area with the ESP holder, as proposed by the applicant, and seek the required State approvals of such an agreement or agreements. In addition, there does not appear to be any impediment to joint control of the exclusion area in the event State approval of such an arrangement is granted.

The State approvals described above would not be granted until sought upon a decision to seek a CP or COL, and do not currently vest a legal right in the applicant to obtain control of the exclusion area. Accordingly, the NRC staff proposes to include a condition in any ESP that 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 the permit. 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.

2.1.3 Population Distribution

2.1.3.1 Technical Information in the Application

In SSAR Section 2.1.3, the applicant estimated and provided the population distribution surrounding the proposed ESP site, up to a 50-mile radius, based on the most recent U.S. census. In this section, the applicant also provided the population densities, the resident population distribution within the LPZ, the nearest population center, and population densities up to a 50-mile radius from the proposed ESP site.

The population distribution provided by the applicant encompasses nine concentric rings at various distances out to 50 miles from the proposed ESP site and 16 directional sectors. The applicant also estimated and provided transient population data out to 50 miles based on recreational use of Lake Anna, Lake Anna State Park, two commercial campgrounds, the WHTF, and Paramount's King's Dominion Amusement Park.

In RAI 2.1.3-1, the staff asked the applicant to project population estimates, including weighted transient populations, up to 2065 (the projected year for the end of plant life). In its response, the applicant reestimated and provided resident and weighted transient populations up to 2065, thereby revising its original estimate of resident and weighted transient populations up to 2040. The applicant incorporated this response into the SSAR.

In the revised Figure 2.1-14 of the SSAR, the applicant provided the cumulative population in 2000 and the projected cumulative population in 2065, as functions of the 10-mile to 50-mile radial distance from the proposed ESP site, as well as the population density curves spanning the same radial distances. The population density curves also included 500-persons-per-square-mile lines and 1000-persons-per-square-mile lines as a function of distance up to 50 miles from the site.

The applicant established the LPZ to ensure that the radiological consequences of design-basis reactor accidents at the LPZ meet the dose consequence evaluation factors set forth in 10 CFR 50.34(a)(1). The applicant described the LPZ in Section 2.1.3.4 of the SSAR. The LPZ is defined in 10 CFR 100.3 as "the area immediately surrounding the exclusion area which contains residents, the total number and density of which are such that there is a reasonable probability that appropriate measures could be taken in their behalf in the event of a serious accident." The LPZ for the ESP site is the same as the LPZ for the existing North Anna units; it consists of a circle with a radius of 6 miles centered on the North Anna Unit 1 containment building. The applicant provided a map (Figure 2.1-2) of the LPZ and figures showing the current and projected population data for the LPZ, including transient persons.

The applicant described the population center in Section 2.1.3.5 of the SSAR. The population center is defined in 10 CFR 100.3 as "a densely populated center containing more than about 25,000 residents." The applicant stated that the nearest population center with a population greater than 25,000 people which is likely to exist over the lifetime of the proposed ESP site, is the city of Charlottesville, with a population of 45,049. The closest point of Charlottesville is

36 miles west of the ESP site. The next closest population center is Fredericksburg, which is 22 miles northeast of the proposed ESP site. Fredericksburg has a projected population of about 20,330 in 2065.

In RAI 2.1.3-2, the staff asked the applicant to describe appropriate protective measures that could be taken on behalf of the populace in the LPZ in the event of a radiological emergency. In its response, the applicant stated that, in the event of a radiological emergency, the plant staff would notify the Commonwealth of Virginia and local authorities. The plant staff would formulate protective action recommendations, as appropriate, and provide them to the Virginia Emergency Operations Center. The Commonwealth of Virginia would make a protective action decision and notify the affected populace.

2.1.3.2 Regulatory Evaluation

In SSAR Sections 1.8 and 2.1.3, the applicant identified the applicable NRC regulations and regulatory guidance regarding population distribution, as described in 10 CFR 52.17; 10 CFR Part 100; Regulatory Guide (RG) 4.7, Revision 2, "General Site Suitability Criteria for Nuclear Power Stations," issued April 1998; and RS-002. The staff finds that the applicant correctly identified the applicable regulations and guidance.

The staff considered the following regulatory requirements in its review of this section of the SSAR:

- 10 CFR 52.17, insofar as it requires each applicant to provide a description and safety assessment of the site, and insofar as it requires that site characteristics comply with 10 CFR Part 100

- 10 CFR Part 100, insofar as it establishes requirements with respect to population density

In particular, the staff considered the population density and use characteristics of the site environs, including the exclusion area, LPZ, and population center distance. The regulations in 10 CFR Part 100 provide definitions and other requirements for determining an exclusion area, LPZ, and population center distance.

As stated in Section 2.1.3 of RS-002, the applicable requirements of 10 CFR 52.17 and 10 CFR Part 100 are deemed to have been met if the population density and use characteristics of the site meet the following criteria:

- Either there are no residents in the exclusion area, or if residents do exist, they are subject to ready removal, in case of necessity.

- The specified LPZ is acceptable if it is determined that appropriate protective measures could be taken on behalf of the enclosed populace in the event of a serious accident.

- The population center distance is at least one and one-third times the distance from the reactor to the outer boundary of the LPZ. The population center distance is defined in 10 CFR 100.3 as the distance from the reactor to the nearest boundary of a densely populated center containing more than about 25,000 residents.

- The population center distance is acceptable if there are no likely concentrations of greater than 25,000 people over the lifetime (plus the term of the ESP) of a nuclear power plant or plants of specified type or falling within a PPE that might be constructed on the proposed site closer than the distance designated by the applicant as the population center distance. The boundary of the population center shall be determined upon considerations of population distribution. Political boundaries are not controlling.

- The population data supplied by the applicant in the safety assessment are acceptable if (1) they contain population data for the latest census, projected year(s) of startup of a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the proposed site (such date(s) reflecting the term of the ESP) and a projected year(s) of end of plant life, all in the geographical format given in Section 2.1.3 of RG 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants—LWR Edition," Revision 3, issued November 1978, (2) they describe the methodology and sources used to obtain the population data, including the projections, (3) they include information on transient populations in the site vicinity, and (4) the population data in the site vicinity, including projections, are verified to be reasonable by other means, such as U.S. Census Bureau publications, publications from State and local governments, and other independent projections.

- If the population density at the ESP stage exceeds the guidelines given in RG 4.7, Revision 2, special attention to the consideration of alternative sites with lower population densities is necessary. A site that exceeds the population density guidelines of Regulatory Position C.4 of RG 4.7, Revision 2, can nevertheless be selected and approved if, on balance, it offers advantages compared with available alternative sites when all of the environmental, safety, and economic aspects of the proposed and alternative sites are considered.

2.1.3.3 Technical Evaluation

The staff reviewed the data on the population in the site environs, as presented in the applicant's SSAR, to determine whether the exclusion area, LPZ, and population center distance for the proposed ESP site comply with the requirements of 10 CFR Part 100 and the acceptance criteria in Section 2.1.3.2 of this SER. The staff also evaluated whether, consistent with Regulatory Position C.4 of RG 4.7, Revision 2, the applicant should consider alternate sites with lower population densities. The staff also reviewed whether appropriate protective measures could be taken on behalf of the enclosed populace within the emergency planning zone (EPZ), which encompasses the LPZ, in the event of a serious accident.

The staff compared and verified the applicant's population data against U.S. Census Bureau Internet data. As documented in Section 13.3 of this SER, the staff reviewed the projected population data provided by the applicant. The information reviewed by the staff included the weighted transient populations for 2010, 2020, 2030, 2040, 2050, 2060, and 2065. If the NRC were to approve and issue the ESP in 2006 and a COL application submitted near the end of the ESP term, with a projected startup of new units in about 2025 and an operational period of 40 years for the new units, the projected year for end of plant life is about 2065. Accordingly, the staff finds that the applicant's projected population data cover an appropriate number of years and are reasonable.

The staff reviewed the transient population data provided by the applicant. The transient population up to a 50-mile radius is based on recreational use of Lake Anna, Lake Anna State Park, two commercial campgrounds, the WHTF, and Paramount's King's Dominion Amusement Park. The applicant stated that recreational use of Lake Anna, including Lake Anna State Park, is the greatest contributor to transient population in the area. The applicant collected information concerning transient population of the area from a number of contributing factors, including the number of boat ramps, wet slips, campsites, and picnic areas. Based on this information, the staff finds that the applicant's estimate of the transient population is reasonable.

The staff notes that no member of the public lives within the exclusion area.

The applicant evaluated representative design-basis accidents in Chapter 15 of the SSAR, and the staff independently verified the applicant's evaluation in Chapter 15 of this SER to demonstrate that the radiological consequences of design-basis reactor accidents at the proposed LPZ would be within the dose consequence evaluation factors set forth in 10 CFR 50.34(a)(1).

The distances to Charlottesville and Fredericksburg, the nearest population centers, are well in excess of the minimum population center distance of 7.8 miles (one and one-third times the distance of 6 miles from the reactor to the outer boundary of the LPZ). In addition, no population centers are closer than the population center distance specified by the applicant.

Therefore, the staff concludes that the proposed ESP site meets the population center distance requirement, as defined in 10 CFR Part 100. The staff has determined that no realistic likelihood exists that there will be a population center with 25,000 people within the 7.8-mile minimum population center distance during the lifetime of any new units that might be constructed on the site. This conclusion is based on projected cumulative resident and transient population within 10 miles of the site during the lifetime of any new units to 2065.

The staff evaluated the site against the criterion in Regulatory Position C.4 of RG 4.7, Revision 2, regarding whether it is necessary to give special attention to the consideration of alternative sites with lower population densities. The criterion is whether the population densities in the vicinity of the proposed site, including weighted transient population, projected at the time of initial site approval and within about 5 years thereafter, would exceed 500 persons per square mile averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the area at that distance). The staff has determined that such population densities for the proposed site would be well below this criterion. Therefore, the staff concludes that the site conforms to Regulatory Position C.4 in RG 4.7, Revision 2. Assuming construction of a new nuclear reactor or reactors at the proposed site beginning near the end of the term of the ESP, and based on its review of the applicant's population density data and projections, the staff finds that the site also meets the guidance of RS-002 regarding population densities over the lifetime of facilities that might be constructed at the site, in that the population density over that period would be expected to remain below 500 persons per square mile averaged out to 20 miles from the site.

The staff reviewed information provided by the applicant regarding its ability to take appropriate protective measures on behalf of the populace in the LPZ in the event of a serious accident. In its response to RAI 2.1.3-2, the applicant stated that, in the event of a radiological emergency, the plant staff would notify the Commonwealth of Virginia and local authorities. The plant staff would formulate protective action recommendations, as appropriate, and provide them to the Virginia Emergency Operations Center. The Commonwealth of Virginia would make a protective action decision and notify the affected populace.

The staff finds that the applicant's response is satisfactory because it is consistent with emergency planning for the 10-mile plume exposure EPZ. The LPZ is located entirely within the 10-mile EPZ. Comprehensive emergency planning for the protection of all persons within the 10-mile EPZ, as addressed in Section 13.3 of this SER, would include those persons within the LPZ. Based on the information the applicant presented on this subject, and on the staff's conclusions discussed in Section 13.3 of this SER, the staff concludes that appropriate protective measures could be taken on behalf of the enclosed populace within the LPZ in the event of a serious accident.

2.1.3.4 Conclusions

As set forth above, the applicant has provided an acceptable description of current and projected population densities in and around the site. These densities projected at the time of initial plant operation (if one were to be constructed on the site) and within about 5 years thereafter are within the guidelines of Regulatory Position C.4 of RG 4.7, Revision 2. The applicant has properly specified the LPZ and population center distance. The staff finds that the proposed LPZ and population center distance meet the definitions in 10 CFR 100.3. Therefore, the staff concludes that the applicant's population data and population distribution are acceptable and meet the requirements of 10 CFR 52.17 and 10 CFR Part 100. In Chapter 15 of this SER, the staff documents that the radiological consequences of bounding design-basis accidents at the outer boundary of the LPZ meet the requirements of 10 CFR 52.17.

2.2 Nearby Industrial, Transportation, and Military Facilities

2.2.1–2.2.2 Identification of Potential Hazards in Site Vicinity

For an ESP application, the applicant provides information on relative location and separation distance with respect to industrial, military, and transportation facilities and routes on the site and in its vicinity. Such facilities and routes may include air, ground, and water traffic; pipelines; and fixed manufacturing, processing, and storage facilities. Section 2.2 of the SSAR presents information concerning the industrial, transportation, and military facilities in the vicinity of the proposed ESP site. The staff's review focused on potential external hazards or hazardous materials that are present or which may reasonably be expected to be present during the projected lifetime of a nuclear power plant or plants that might be constructed on the proposed site. The staff has prepared Sections 2.2.1–2.2.2, 2.2.3, and 3.5.1.6 of this SER in accordance with the review procedures described in RS-002, using information presented in SSAR Section 2.2, responses to RAIs, and the reference materials described in the applicable sections of RS-002.

2.2.1.1–2.2.2.1 Technical Information in the Application

In SSAR Section 2.2.2.1, the applicant stated that Louisa County, Virginia, the location of the proposed site, is a rural and residential area. The applicant further stated that no substantial industrial activities occur within 5 miles of the proposed ESP site. According to the applicant, the county has granted its approval for a zoning ordinance allowing industrial development of about 620 ac near the proposed ESP site's EAB. The applicant also noted that several other areas located within 10 miles of the proposed site are zoned for industrial development, although no current plans for development exist.

Because the applicant identified a zoning ordinance, approved by the Louisa County Board of Supervisors, for industrial development of about 620 ac near the proposed site EAB, the staff requested clarification, in RAI 2.2.2-1, regarding the location of the 620-ac development. The applicant provided additional information describing the specific location of the development and the type of industrial activity that is covered by the zoning ordinance.

In Section 2.2.2.2 of the SSAR, the applicant stated that no mining activities occur within 5 miles of the proposed ESP site.

Section 2.2.2.3 of the SSAR describes the roads within 10 miles of the proposed ESP site. These consist of several Virginia State routes (Routes 208, 601, and 652), which pass no closer than 1.5 miles to the proposed site; U.S. Route 522, which passes within about 5 miles of the proposed site; and Virginia State Route 700, which provides access to the proposed site. SSAR Section 2.2.2.4 states that the Chesapeake and Ohio Railway passes within about 5.5 miles of the proposed site. In Section 2.2.2.5, the applicant stated that six marinas near the proposed ESP site provide access to pleasure craft on Lake Anna. The marina locations are between 1.4 and 2.3 miles from the proposed site. The applicant stated that no large boats or barges exist on Lake Anna.

With respect to aircraft activities in the vicinity of the proposed ESP site, the applicant described nearby airports and airways. Specifically, Table 2.2-1 of Section 2.2.2.6.1 of the SSAR lists the three airports that are within 15 miles of the proposed ESP site. Figure 2.2-1 of Section 2.2.2.6.1 of the SSAR illustrates the airport locations. Two of the three airports are within 10 miles of the proposed ESP site. In SSAR Section 2.2.2.6.2, the applicant stated that one civil airway (V223) and three military training routes (IR714, IR760, and VR1754) pass within less than 5 miles of the proposed ESP site.

In Section 2.2.2.7 of the SSAR, the applicant stated that no oil or gas pipelines are located within 5 miles of the proposed ESP site. Similarly, in Section 2.2.2.8 of the SSAR, the applicant stated that no military facilities exist within 5 miles of the proposed ESP site. Figure 2.2.1-1 illustrates the locations of nearby major roads, railroads, and gas pipelines relative to the ESP site.

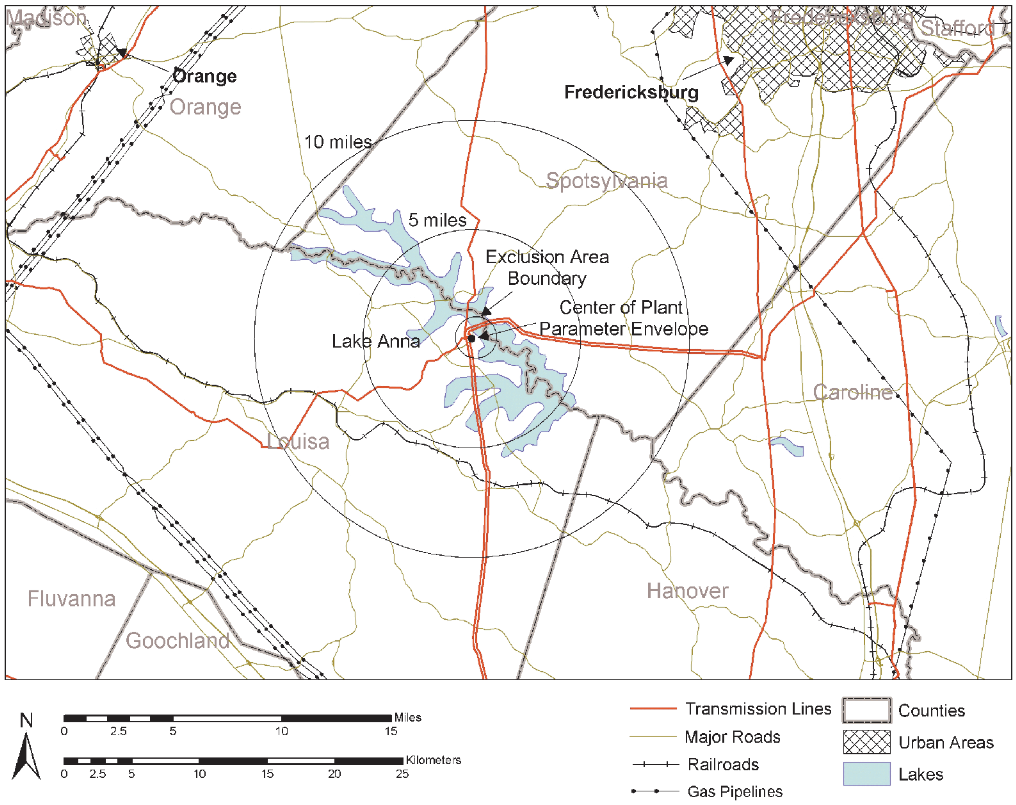

Figure 2.2.1-1 Major roads, railways, and gas pipelines in the vicinity of the ESP site

2.2.1.2–2.2.2.2 Regulatory Evaluation

In SSAR Section 1.8, the applicant identified 10 CFR 52.17(a)(1) and 10 CFR 100.20, “Factors to be Considered When Evaluating Sites,” as the regulations applicable to SSAR Sections 2.2.1 and 2.2.2. In the same section, the applicant identified the following applicable NRC guidance regarding potential hazards in the vicinity of the proposed ESP site:

- RG 1.91, Revision 1, “Evaluation of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plant Sites,” issued February 1978
- RG 1.78, Revision 1, “Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Chemical Release,” issued December 2001
- RG 1.70, Revision 3, “Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants, LWR Edition,” issued November 1978

- NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants”

- RS-002

The staff considered the following regulatory requirements in reviewing information regarding potential site hazards which would affect the safe design and siting of a nuclear power plant or plants falling within the applicant’s PPE that might be constructed at the proposed site:

- 10 CFR 52.17(a)(1)(vii), with respect to information on the location and description of any nearby industrial, military, or transportation facilities and routes

- 10 CFR 100.20(b), with respect to information on the nature and proximity of man-related hazards

The following RGs identify methods acceptable to the NRC staff to meet the Commission’s regulations identified above:

- RG 1.91, Revision 1
- RG 1.78, Revision 1

Sections 2.2.1–2.2.2, 2.2.3, and 3.5.1.6 of RS-002 and RG 1.70, Revision 3, provide guidance on information appropriate for identifying, describing, and evaluating potential manmade hazards.

2.2.1.3–2.2.2.3 Technical Evaluation

The staff evaluated the potential for manmade hazards in the vicinity of the proposed ESP site by reviewing (1) the information the applicant provided in Sections 2.2.1–2.2.2 of the SSAR, (2) the applicant’s responses to the staff’s RAIs, (3) information the staff obtained during a visit to the proposed ESP site and its vicinity, and (4) other publicly available reference material, such as U.S. Geological Survey topographic maps, satellite imagery, and geographic information system coverage files (Platts, 2004, POWER map Geographic Information System Spatial Data, including map layers of natural gas pipelines, railroads, and electric transmission lines; and Terraserver-usa.com, 2004, online 1-meter Aerial Imagery of the Lake Anna, Virginia, region). Using these data, the staff found no additional hazards beyond those the applicant identified.

The staff evaluated the information on the nearby 620-ac development that the applicant provided in its response to RAI 2.2.1-1. Included among the 30 industrial uses permitted for this area are “acetylene gas manufacture on a commercial scale,” “fireworks or explosives manufacture, nitrating process, the loading of explosives, or their storage in bulk,” “petroleum refining,” and “sulphurous, sulphuric, nitric or hydrochloric or other corrosive or offensive acid manufacture, or their use or storage, except on a limited scale (by conditional use permit) as accessory to a permitted industry.” Pursuant to this ordinance, an entity seeking permission for a specific industrial use must apply for and obtain a “conditional use permit” from the Louisa County Planning Commission. The request for a permit may be denied by the planning commission, the governing body, if there is a finding that the use would be detrimental to the health and safety of the public.

Currently, there have been no hazardous industrial facilities identified on this site. Hence, the site does not pose any industrial hazard at the present time. In the event that some industrial use were implemented on the site, any hazard determination would be based upon specific information regarding the nature of the hazard, as well as specific nuclear plant design parameters, neither of which are available at this time. On this basis, the staff finds that the 620 ac site currently does not present any identifiable hazards, and an evaluation of industrial hazards, if any, associated with the site can be performed, if warranted, should a CP or COL application referencing any ESP issued for the North Anna site be submitted. This is **COL Action Item 2.2-1**.

2.2.1.4–2.2.2.4 Conclusions

As set forth above, the applicant has provided information in the SSAR regarding potential site hazards in accordance with the guidance of RG 1.70, such that compliance with the requirements of 10 CFR 100.20 and 10 CFR 100.21, “Non-Seismic Site Criteria,” can be evaluated. The applicant has reviewed the nature and extent of activities involving potentially hazardous materials conducted on or in the vicinity of the site to identify hazards that might pose undue risk to a facility falling within the applicant’s PPE that might be constructed on the proposed site. Based on its evaluation of the information presented in the SSAR, as well as information the staff obtained independently, the staff concludes that all potentially hazardous activities on and in the vicinity of the site have been identified. Sections 2.2.3 and 3.5.1.6 of this SER discuss the evaluation of such hazards.

2.2.3 Evaluation of Potential Accidents

2.2.3.1 Technical Information in the Application

In SSAR Section 2.2.3, the applicant evaluated earth-bound and aircraft hazards. Section 3.5.1.6 of this SER discusses the staff’s evaluation of aircraft hazards.

Consistent with its identification of potential hazards in SSAR Sections 2.2.1 and 2.2.2, the applicant limited its evaluation of earth-bound hazards to the effects of explosion and formation of flammable vapor clouds from nearby sources. The applicant stated that the largest explosive load routinely transported by truck on Virginia highways contains 8500 gallons (gal) of gasoline. The explosive force of this quantity of gasoline is estimated to be equivalent to 50,700 pounds (lb) of TNT, using a simple TNT-equivalent yield formula. The applicant, citing the methodology of RG 1.91, concluded that, if this amount of gasoline were to explode, a peak overpressure of 1 pound per square inch (psi) would be experienced as far as 1900 ft away from the point of explosion. The closest point of Virginia Route 652 to the ESP site is 1.5 miles (6420 ft). The applicant noted that RG 1.91 cites 1 psi as a conservative value of peak positive incident overpressure, below which no significant damage would be expected. Thus, the applicant concluded that no significant damage would occur in the event of an explosion resulting from a gasoline truck traffic accident.

The applicant did not evaluate pipeline hazards because no natural gas pipeline or mining facilities are located within 10 miles of the ESP site, and no pipelines carrying potentially hazardous materials are located within 5 miles of the ESP site. Therefore, the applicant concluded that the potential for hazards from these sources that could adversely affect safe operation of the plant is minimal.

In RAI 2.2.3-1, the staff asked the applicant to describe whether the existing NAPS units pose any undue risk to a nuclear power plant or plants falling within the applicant's PPE that might be constructed and operated on the proposed ESP site. In its response, the applicant stated that no such hazards exist.

2.2.3.2 Regulatory Evaluation

In SSAR Sections 1.8 and 2.2, the applicant identified the following applicable NRC guidance regarding potential hazards in the vicinity of the proposed ESP site:

- RG 1.91, Revision 1
- RG 1.78, Revision 1
- RG 1.70, Revision 3
- NUREG-0800
- RS-002

In SSAR Section 1.8, the applicant identified the regulation applicable to SSAR Section 2.2.3 as 10 CFR 100.20. It also identified the requirements of RS-002 as applicable.

The staff considered the following regulatory requirements in reviewing information regarding potential site hazards which would affect the safe design and siting of a nuclear power plant or plants falling within the applicant's PPE that might be constructed at the proposed site:

- 10 CFR 52.17(a)(1)(vii), with respect to information on the location and description of any nearby industrial, military, or transportation facilities and routes

- 10 CFR 100.20(b), with respect to information on the nature and proximity of man-related hazards

- 10 CFR 100.21(e), with respect to the evaluation of potential hazards associated with nearby transportation routes and industrial and military facilities

The following RGs identify methods acceptable to the NRC staff to meet the Commission's regulations identified above:

- RG 1.91, Revision 1
- RG 1.78, Revision 1

Sections 2.2.1–2.2.2, 2.2.3, and 3.5.1.6 of RS-002 and RG 1.70 provide guidance on information appropriate for identifying, describing, and evaluating potential manmade hazards.

2.2.3.3 Technical Evaluation

The staff reviewed the applicant's analysis of the effects of potential explosions and the formation of flammable vapor clouds. The only potential source of explosions or flammable vapor clouds within 5 miles of the proposed site is truck traffic on the nearby highways. According to the applicant, the largest explosive load routinely transported by truck on Virginia highways contains 8500 gal of gasoline. The staff has previously reviewed and evaluated the explosive yield from this quantity of gasoline, as documented in the UFSAR for the existing NAPS. The resulting TNT equivalent was found to be 50,700 lb, which yields a peak overpressure of 1 psi at 1,900 ft from the point of explosion. Since the closest highway (Virginia Route 652) is 6429 ft from the proposed ESP site, the potential peak overpressure at the proposed site would be less than 1 psi. Hence, using the criteria of RG 1.91, no significant damage to safety-related SSCs that may be located on the proposed site would be expected.

The staff evaluated the information in the SSAR regarding the location of the ESP site relative to the location of the existing NAPS units and the applicant's response to RAI 2.2.3-1. In its response to this RAI, the applicant stated that it did not identify any hazards with respect to NAPS Units 1 and 2 that would pose an undue risk to a nuclear power plant or plants that might be constructed on the ESP site.

The staff independently reviewed possible hazards posed by the existing NAPS units. This review did not identify any hazards that would preclude the provision of protective or mitigative design features for a nuclear power plant or plants to be constructed on the ESP site. This view is supported by the fact that the staff found, during the licensing review for NAPS Units 1 and 2, that design features of those units would adequately protect the NAPS units against identified hazards (e.g., release of toxic or flammable materials, internal and external missiles). Design-specific interactions between the existing and new units would need to be evaluated and, if necessary, addressed at the COL stage. The need for consideration of design-specific hazards interactions is **COL Action Item 2.2-2**.

2.2.3.4 Conclusions

As set forth above, the applicant has identified potential accidents related to the presence of hazardous materials or activities on and near the proposed ESP site which could affect a nuclear power plant falling within the applicant's PPE. The staff finds that the applicant has selected those potential accidents which should be considered as design-basis events at the COL stage, in accordance with 10 CFR Part 100. The staff also finds that the applicant has identified and evaluated hazards from nearby facilities such that the staff concludes that such facilities pose no undue risk to the type of facility proposed for the site, subject to confirmation at the COL stage regarding design-specific hazards interactions. Therefore, the staff concludes that the site location is acceptable with regard to potential accidents that could affect such a facility and that it meets the requirements of 10 CFR 52.17(a)(1)(vii), 10 CFR 100.20(b), and 10 CFR 100.21(e).

2.3 <u>Meteorology</u>

To ensure that a nuclear power plant or plants could be designed, constructed, and operated on an applicant's proposed ESP site in compliance with the Commission's regulations, the NRC staff evaluates regional and local climatological information, including climate extremes and severe weather occurrences that may affect the design and siting of a nuclear plant. The staff reviews information concerning atmospheric dispersion characteristics of a nuclear power plant site to determine whether the radioactive effluents from postulated accidental releases, as well as routine operational releases, are within Commission guidelines. The staff has prepared Sections 2.3.1 through 2.3.5 of this SER in accordance with the review procedures described in RS-002, using information presented in SSAR Section 2.3, responses to staff RAIs, and generally available reference materials, as described in the applicable sections of RS-002.

2.3.1 Regional Climatology

2.3.1.1 Technical Information in the Application

In this section of the SSAR, the applicant presented information concerning the averages and the extremes of climatic conditions and regional meteorological phenomena that could affect the design and siting of a nuclear power plant that falls within the applicant's PPE and that might be constructed on the proposed site. The applicant provided the following information:

- a description of the general climate of the region with respect to types of air masses, synoptic features (high- and low-pressure systems and frontal systems), general airflow patterns (wind direction and speed), temperature and humidity, precipitation (rain, snow, and sleet), and relationships between synoptic-scale atmospheric processes and local (site) meteorological conditions

- seasonal and annual frequencies of severe weather phenomena, including tornadoes, waterspouts, thunderstorms, lightning, hail (including probable maximum size), and high air pollution potential

- meteorological site characteristics to be used as minimum design and operating bases, including the following:

    - the maximum snow and ice load (water equivalent) on the roofs of safety-related structures

    - — the ultimate heat sink (UHS) meteorological conditions resulting in the maximum evaporation and drift loss of water and minimum water cooling

    - — the tornado parameters, including translational speed, rotational speed, and the maximum pressure differential with the associated time interval

    - — the 100-year return period straight-line winds

    - — other meteorological conditions to be used for design- and operating-basis considerations

The applicant characterized the regional climatology pertinent to the North Anna ESP site using data reported by the National Weather Service (NWS) at the Richmond, Virginia, first-order weather station, as well as nearby cooperative observer stations, such as Louisa, Partlow, and

Piedmont, Virginia. The applicant obtained information on severe weather from a variety of sources, including publications by the National Climatic Data Center (NCDC), the American Society of Civil Engineers (ASCE), the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), and the American National Standards Institute (ANSI).

The North Anna ESP site is located in the eastern Piedmont climatic division of Virginia. According to the applicant, the climate can be described as modified continental; the summers are warm and humid, and the winters are generally mild. The Blue Ridge Mountains to the west act as a potential barrier to outbreaks of cold, continental air in winter. The open waters of the Chesapeake Bay and the Atlantic Ocean contribute to the humid summers and mild winters.

Temperatures in the site region rarely exceed 100 EF or fall below 0 EF. Table 2.3.1-1 presents the applicant's dry-bulb and wet-bulb site characteristics for the North Anna ESP site, based on temperature and humidity data recorded at the Richmond weather station.

Table 2.3.1-1 Applicant's Proposed Ambient Air Temperature and Humidity Site Characteristics

SITE CHARACTERISTIC		VALUE	DESCRIPTION
Maximum Dry-Bulb Temperature	2% annual exceedance	90 EF with 75 EF concurrent wet bulb	Wet-bulb and dry-bulb temperatures associated with the listed exceedance values and the 100-year return period
	0.4% annual exceedance	95 EF with 77 EF concurrent wet bulb	
	0% annual exceedance	104.9 EF with 79 EF concurrent wet bulb	
	100-year return period	109 EF	
Minimum Dry-Bulb Temperature	1% annual exceedance	18 EF	
	0.4% annual exceedance	14 EF	
	100-year return period	! 19 EF	
Maximum Wet-Bulb Temperature	0.4% annual exceedance	79 EF	
	0% annual exceedance	84.9 EF	
	100-year return period	88 EF	

The applicant stated that the area around the site receives an annual average rainfall of approximately 44 inches (in.). Rainfall is fairly well distributed over the entire year, with the exception of July and August when thunderstorm activity raises the monthly totals. Extra-tropical storms can also contribute significantly to precipitation during September.

Richmond, Virginia, averages about 12.4 in. of snow a year. Snow generally remains on the ground for only 1 or 2 days, although durations of a week or more have occurred as a result of heavy snowfall events immediately followed by cold weather patterns.

According to the applicant, the general synoptic conditions typically predominate in regard to climatic characteristics of the site region. However, during periods of extreme temperatures or light-wind conditions, the local conditions have an influence on the site's meteorology. Nearby Lake Anna has a moderating effect with respect to extreme temperatures in the immediate vicinity of the site. The Blue Ridge Mountains to the west also tend to channel winds along a general north-south orientation during light-wind conditions.

In Revision 0 to the SSAR, the applicant stated that the extreme fastest-mile wind speed at 30 ft above the ground (100-year return period) is 80 miles per hour (mi/hr), with a fastest-mile wind speed value of 68 mi/hr recorded at Richmond during the period 1958–1989. In RAI 2.3.1-1, the staff asked the applicant to provide a 3-second (s) gust wind speed that represents a 100-year return period. In response to RAI 2.3.1-1, the applicant provided a 3-s gust wind speed value of 96 mi/hr, which represents a 100-year return period at 33 ft above the ground.

In Revision 3 to the SSAR, the applicant revised its extreme fastest-mile 100-year return period wind speed value to 64 mi/hr, based on a calculated value reported for Richmond by ANSI A58.1-1982, "Minimum Design Loads for Buildings and Other Structures." In Revision 3 to the SSAR, the applicant identified the 64 mi/hr fastest-mile wind speed value as a basic wind speed site characteristic.

In Open Item 2.3-1, the staff stated that the applicant's revised 100-year return period fastest-mile basic wind speed site characteristic of 64 mi/hr is not conservative when compared to the minimum 50-year return period fastest-mile basic wind speed value of 70 mi/hr specified in Section 6.5.2 of ANSI A58.1-1982. The applicant's chosen fastest-mile basic wind speed site characteristic of 64 mi/hr is also not conservative when compared to the highest fastest-mile wind speed value of 68 mi/hr recorded at Richmond during the 32-year period 1958–1989. In its submittal dated March 3, 2005, the applicant responded to Open Item 2.3-1 by proposing that the 3-s gust wind speed value of 96 mi/hr be used as the basic wind speed site characteristic instead of the 64 mi/hr fastest-mile wind speed value. Table 2.3.1-2 presents the applicant's revised proposed basic wind speed site characteristic.

Table 2.3.1-2 Applicant's Proposed Basic Wind Speed Site Characteristic

SITE CHARACTERISTIC	VALUE	DESCRIPTION
Basic Wind Speed	96 mi/hr	3-s gust wind velocity associated with a 100-year return period at 33 ft above ground level in the site area

In RAIs 2.3.1-1 and 2.3.1-6, the staff asked the applicant to provide additional information regarding site characteristic tornado data and the methodology used for determining tornado characteristics. In its response, the applicant stated that a total of 235 tornadoes were reported within a 2-degree square area around the North Anna ESP site (i.e., an area enclosed by 2-degree longitudinal and latitudinal lines centered on the North Anna ESP site) during the period 1950–2003. The applicant used these data to calculate the annual probability of a tornado striking a point within this 2-degree square area as 5.94×10^{-5} per year. This is equivalent to a tornado mean recurrence interval of 16,835 years. The applicant also used these data to generate the tornado site characteristics (based on a 10^{-7} per year occurrence), shown in Table 2.3.1-3.

Table 2.3.1-3 Applicant's Proposed Tornado Site Characteristics

SITE CHARACTERISTIC	VALUE	DESCRIPTION
Maximum Wind Speed	260 mi/hr	Sum of the maximum rotational and maximum translation wind speed components at the site, due to passage of a tornado having a probability of occurrence of 10^{-7} per year
Maximum Translational Speed	52 mi/hr	Translation component of maximum wind speed at the site, due to the movement across ground of a tornado having a probability of occurrence of 10^{-7} per year
Maximum Rotational Speed	208 mi/hr	Rotation component of maximum wind speed at the site, due to passage of a tornado having a probability of occurrence of 10^{-7} per year
Radius of Maximum Rotational Speed	150 ft	Distance from the center of the tornado at which the maximum rotational wind speed occurs at the site, due to passage of a tornado having a probability of occurrence of 10^{-7} per year
Maximum Pressure Drop	1.5 lbf/in.^{2}	Decrease in ambient pressure from normal atmospheric pressure at the site, due to passage of a tornado having a probability of occurrence of 10^{-7} per year
Maximum Rate of Pressure Drop	0.76 lbf/in.^{2}/s	Maximum rate of pressure drop at the site, due to passage of a tornado having a probability of occurrence of 10^{-7} per year

The SSAR states that, on average, a tropical cyclone or its remnants can be expected to impact some part of Virginia each year. As stated in the SSAR, the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center hurricane database reports that 55 tropical cyclone centers or storm tracks have passed within a 100-nautical mile (nmi) radius of the North Anna ESP site from 1851 through 2003. Table 2.3.1-4 presents the storm classifications and respective frequencies of these tropical cyclone occurrences over this period.

Table 2.3.1-4 Tropical Cyclones Reported within 100-Nautical Mile Radius of the North Anna ESP Site from 1851 through 2003

CLASSIFICATION	NUMBER OF OCCURRENCES	MAXIMUM SUSTAINED WIND SPEED RANGE
Category 3 Hurricane	1	111–130 mi/hr
Category 2 Hurricane	1	96–110 mi/hr
Category 1 Hurricane	5	74–95 mi/hr
Tropical Storm	27	39–73 mi/hr
Tropical Depression	13	#38 mi/hr
Subtropical Depression	1	#38 mi/hr

Extra-Tropical Storm	7	undefined

According to the applicant, tropical cyclones are responsible for the following record rainfall events in the North Anna ESP site area:

- In August 1969, Hurricane Camille (a tropical depression by the time it passed within 100 nmi of the North Anna ESP site) resulted in a record 24-hour rainfall of 11.18 in. at the Louisa cooperative weather station. The SSAR notes that this is the overall highest 24-hour rainfall total recorded at any station in the North Anna ESP site area.

- In August 1955, Hurricane Connie (a tropical storm by the time it passed within 120 nmi of the North Anna ESP site) resulted in a record 24-hour rainfall total of 8.79 in. at Richmond.

According to the applicant, the occurrence of snowfalls greater than or equal to 1 in. in the North Anna ESP site area ranges from about 3 to 5 days per year. Daily snowfall totals greater than or equal to thresholds of 5 in. and 10 in. occur less than 1 day per year. The applicant reported maximum 24-hour and monthly snowfall totals for the North Anna ESP site region of 21.6 in. at Richmond in January 1940 and 41.0 in. at Partlow in January 1966, respectively. The applicant reported the weight of the 100-year return period snowpack for the North Anna ESP site area as 30.5 pound-force per square foot (lbf/ft^2) and the 48-hour winter probable maximum precipitation (also known as the probable maximum winter precipitation (PMWP)) as 20.75 in. In response to Open Item 2.3-2, the applicant also reported a maximum ground snow load of 45.4 lbf/ft^2 as the weight of the 100-year snowpack plus 48-hour maximum snowfall. As shown in Table 2.3.1-5, the applicant selected the 100-year return period snowpack value of 30.5 lbf/ft^2, the 100-year snowpack plus 48-hour maximum snowfall value of 45.4 lbf/ft^2, and the 48-hour PMWP value of 20.75 in. as winter precipitation site characteristics for use in the design of the roofs of safety-related structures.

Table 2.3.1-5 Applicant's Proposed Winter Precipitation Site Characteristics

SITE CHARACTERISTIC	VALUE	DESCRIPTION
100-Year Snowpack	30.5 lbf/ft^2	Weight, per unit area, of the 100-year return period snowpack at the site
100-Year Snowpack plus 48-Hour Maximum Snowfall	45.5 lbf/ft^2	48-hour maximum snowfall (28.5 in. . 15 lbf/ft^2 on top of 100-year return snowpack (30.5 lbf/ft^2)
48-Hour Winter Probable Maximum Precipitation	20.75 in.	Maximum probable winter rainfall in a 48-hour period

According to the applicant, data published by the NCDC show that Louisa and Spotsylvania Counties can expect, on average, hail with diameters greater than or equal to 0.75 in. about 1 day per year. Nearby counties to the south and east of the North Anna ESP site can expect hail with diameters greater than or equal to 0.75 in. to occur from 1 to 2 days per year. Hail events with diameters up to 1.75 in. have been reported in recent years in both Louisa and Spotsylvania Counties, four in Louisa County in 1998 and three in Spotsylvania County in 1993.

Softball-size hail (about 4.5 in. in diameter) has been observed in recent years at two locations in the general North Anna ESP site area—once in Free Union, Virginia (approximately 42 miles west of the ESP site) on June 4, 2002, and once in Lignum, Virginia (approximately 28 miles north-northwest of the ESP site), on May 4, 1996.

The applicant estimated that, on average, 36 thunderstorm-days per year occur in the site area, resulting in an estimated 11.2 lightning flashes to earth per square mile per year. Given the frequency of thunderstorms and the size of the North Anna ESP site PPE (site footprint within which any new reactors would be located) (0.068 mi^2), the expected frequency of lightning flashes in the PPE is 0.76 per year.

According to the applicant, low-level inversions in the North Anna ESP site region based at or below an elevation of 500 ft occur during approximately 30 percent of the year. Most of these inversions are nocturnal in nature, generated through nighttime cooling. These inversions occur most frequently during the autumn and winter seasons and least frequently during the spring and summer seasons. Likewise, the autumn and winter seasons have the greatest frequency of occurrence of shallow mixing depths, with autumn and winter having afternoon mean maximum mixing height depths of about 4600 ft and 3300 ft, respectively.

The applicant examined temperature and humidity data from Richmond (1978–2003) to determine the meteorological site characteristics for the UHS in accordance with RG 1.27, "Ultimate Heat Sink for Nuclear Power Plants," issued January 1976. The applicant stated that the controlling parameters for the type of UHS selected by the applicant (i.e., a mechanical draft cooling tower over a buried water storage basin or other passive water storage facility) are the wet-bulb temperature and the coincident dry-bulb temperature. The applicant considered the worst (i.e., highest) 30-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures to represent the meteorological conditions resulting in maximum evaporation and drift loss. Likewise, the applicant considered the worst (i.e., highest) 1-day and 5-day daily average of wet-bulb temperatures and coincident dry-bulb temperatures to conservatively represent the meteorological conditions resulting in minimum water cooling. Consequently, the applicant calculated the worst 1-day, worst 5-day, and worst 30-day daily average wet-bulb temperatures and coincident dry-bulb temperatures as UHS meteorological site characteristics values. Table 2.3.1-6 presents these results.

In Open Item 2.3-3, the staff identified the need for an additional UHS meteorological site characteristic for use in evaluating the potential for water freezing in the UHS water storage facility, a phenomenon which would reduce the amount of water available for use by the UHS. In its submittal dated March 3, 2005, the applicant responded to Open Item 2.3-3 by proposing use of the maximum cumulative degree-days below freezing as the relevant site characteristic. The applicant proposed a maximum cumulative degree-day below freezing site characteristic value of 322 EF degree-days, based on the maximum value derived from December 1 through March 31 for the period 1949–2001, using daily mean air temperatures recorded at Piedmont.

Table 2.3.1-6 Applicant's Proposed Ultimate Heat Sink Meteorological Site Characteristics

SITE CHARACTERISTIC	VALUE	DESCRIPTION
Worst 1-Day Daily Average of Wet-Bulb Temperatures and Coincident Dry-Bulb Temperatures	78.9 EF wet-bulb temperature with coincident 87.7 EF dry-bulb temperature	Meteorological conditions resulting in the minimum water cooling during any 1 day
Worst 5-Day Daily Average of Wet-Bulb Temperatures and Coincident Dry-Bulb Temperatures	77.6 EF wet-bulb temperature with coincident 80.9 EF dry-bulb temperature	Meteorological conditions resulting in the minimum water cooling during any consecutive 5 days
Worst 30-Day Daily Average of Wet-Bulb Temperatures and Coincident Dry-Bulb Temperatures	76.3 EF wet-bulb temperature with coincident 79.5 EF dry-bulb temperature	Meteorological conditions resulting in the maximum evaporation and drift loss during any consecutive 30 days
Maximum Cumulative Degree-Days Below Freezing	322 EF degree-days	Meteorological condition resulting in the maximum formation of surface ice in the UHS basin

2.3.1.2 Regulatory Evaluation

In SSAR Section 1.8.1, the applicant identified the following applicable NRC regulations regarding regional climatology:

- Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, General Design Criterion (GDC) 2, "Design Bases for Protection Against Natural Phenomena," with respect to information on severe regional weather phenomena that have historically been reported for the region and that are reflected in the design bases for SSCs important to safety

- Appendix A to 10 CFR Part 50, GDC 4, "Environmental and Dynamic Effects Design Bases," with respect to information on tornadoes that could generate missiles

- 10 CFR 100.20(c) and 10 CFR 100.21(d) with respect to the consideration that has been given to the regional meteorological characteristics of the site

In SSAR Sections 1.8.2 and 2.3.1, the applicant identified the following applicable NRC guidance regarding regional climatology:

- RG 1.27 with respect to the meteorological conditions that should be considered in the design of the UHS

- Section 2.3.1 of RG 1.70 with respect to the type of general climate and regional meteorological data that should be presented

- RG 1.76, "Design Basis Tornado for Nuclear Power Plants," issued April 1974, with respect to the characteristics of the design-basis tornado

The staff has reviewed this portion of the application in accordance with the guidance identified by the applicant, and to determine if the application is in compliance with the identified regulations, with the exception of the GDC. An ESP applicant need not demonstrate compliance with the GDC with respect to regional climatology.

Section 2.3.1 of RS-002 and Section 2.3.1 of RG 1.70 provide the following guidance on information appropriate for determining regional climatology:

- The description of the general climate of the region should be based on standard climatic summaries compiled by NOAA. Consideration of the relationships between regional synoptic-scale atmospheric processes and local (site) meteorological conditions should be based on appropriate meteorological data.

- Data on severe weather phenomena should be based on standard meteorological records from nearby representative NWS, military, or other stations recognized as standard installations that long periods of data on record. The applicability of these data to represent site conditions during the expected period of reactor operation should be substantiated.

- Tornado site characteristics may be based on RG 1.76 or the staff's interim position on design-basis tornado characteristics (see letter dated March 25, 1988, from the NRC to the Advanced-Light Water Reactor Utility Steering Committee). An ESP applicant may specify any tornado wind speed site characteristics that are appropriately justified, provided that a technical evaluation of site-specific data is conducted.

- Basic (straight-line) wind speed site characteristics should be based on appropriate standards, with suitable corrections for local conditions.

- The UHS meteorological data, as stated in RG 1.27, should be based on long-period regional records which represent site conditions. Suitable information may be found in climatological summaries for the evaluation of wind, temperature, humidity, and other meteorological data used for UHS design.

- Freezing rain estimates should be based on representative NWS station data.

- High air pollution potential information should be based on U.S. Environmental Protection Agency (EPA) studies.

- All other meteorological and air quality data to be used for safety-related plant design and operating bases should be documented and substantiated.

2.3.1.3 Technical Evaluation

The staff evaluated regional meteorological conditions using information reported by the NCDC, the National Severe Storms Laboratory (NSSL), the Southern Regional Climate Center (SRCC), ASHRAE, ASCE, and the Structural Engineering Institute (SEI). The staff reviewed statistics for the following climatic stations located in the vicinity of the North Anna ESP site:

- Partlow, Virginia, located approximately 5 miles east of the ESP site
- Louisa, Virginia, located approximately 11 miles west of the ESP site
- Piedmont, Virginia, located approximately 21 miles west-northwest of the ESP site
- Richmond, Virginia, located approximately 47 miles southeast of the ESP site
- Charlottesville, Virginia, located approximately 36 miles west of the ESP site

Normal climatic data for the period 1971–2000 reported by NCDC for the eastern Piedmont climatic division of Virginia indicate that the annual mean temperature in the area is about 56.6 °F and ranges from a low monthly mean value of about 35.9 °F in January to a high monthly mean value of about 76.8 °F in July (NCDC, "Eastern Piedmont, Virginia, Divisional Normals—Temperature, Period 1971–2000, Climatography of the United States No. 85"). One of the highest temperatures recorded in the site region was 106 °F at Partlow on both August 31 and September 2, 1953 (SRCC, "Partlow, Virginia, Period of Record Monthly Climate Summary, Period of Record: 06/01/1952 to 12/31/1976"); one of the lowest temperatures recorded in the site region was −21 °F at Louisa on February 5, 1996 (SRCC, "Louisa, Virginia, Period of Record Monthly Climate Summary, Period of Record: 08/01/1948 to 03/31/2004").

The annual mean wet-bulb temperature at Richmond is 52.3 °F, ranging from a high monthly mean value of 71.5 °F in July to a low monthly mean value of 34.3 °F in January. The annual mean relative humidity is 70 percent (NCDC, "Richmond, Virginia, 2002 Local Climatological Data, Annual Summary with Comparative Data").

For the reasons set forth below, the staff concurs with the temperature and humidity site characteristics presented by the applicant. The applicant's 2- and 0.4-percent annual exceedance maximum dry-bulb temperatures, the 1- and 0.4-percent annual exceedance minimum dry-bulb temperatures, and the 0.4 percent exceedance maximum wet-bulb temperatures are based on Richmond data published by the NCDC ("Engineering Weather Data CDROM").[1] The applicant's 0-percent annual exceedance maximum dry-bulb and maximum wet-bulb temperatures represent the highest values recorded at Richmond during the period 1973–2002. The 100-year return period maximum dry-bulb and maximum wet-bulb temperatures provided by the applicant were extrapolated from the Richmond 1973–2002 data using a least squares regression method, as described in the applicant's response to NRC RAI 2.3.1(b). In order to verify the applicant's 100-year return period data, the staff also calculated 100-year return period maximum dry-bulb and maximum wet-bulb temperatures using NCDC data for Richmond during the period 1961–1990 (NCDC, "Solar and Meteorological Surface Observational Network (SAMSON) for Eastern U.S. CDROM") and algorithms based on the Gumbel Type 1 extreme value distribution as defined in Chapter 27 of

[1]The data presented by the applicant as the 1- and 0.4-percent annual exceedance minimum dry-bulb temperatures are equivalent to the NCDC 99- and 99.6-percent annual exceedance (i.e., occurrence) values.

the 2001 ASHRAE Handbook—Fundamentals. The staff found that the 100-year return period maximum dry-bulb and maximum wet-bulb temperature values calculated by the applicant bound the equivalent values calculated by the staff.

The staff chose not to list the applicant's 0-percent annual exceedance maximum dry-bulb and wet-bulb temperatures as site characteristics because these values are dependent upon the length of the available period of record. The staff presented 100-year return period values instead.

According to the 1971–2000 normal climatic data reported by NCDC for the eastern Piedmont climatic division of Virginia ("Eastern Piedmont, Virginia, Divisional Normals—Precipitation, Period 1971–2000, Climatography of the United States No. 85"), precipitation is well distributed throughout the year, with monthly climate division normals for the North Anna ESP site region ranging from a minimum of about 3.18 in. in December to a maximum of about 4.36 in. in July. In September 1987, Charlottesville experienced one of the highest monthly amounts of precipitation observed in the area—17.96 in. (SRCC, "Charlottesville, Virginia, Period of Record Monthly Climate Summary, Period of Record: 08/05/1948 to 03/31/2004"). On August 20, 1969, Louisa recorded one of the highest 24-hour precipitation totals for the site region—11.18 in. (SRCC, "Louisa, Virginia, Period of Record Monthly Climate Summary, Period of Record: 08/01/1948 to 03/31/2004"). This rainfall was associated with Hurricane Camille.

Snowfall in the site vicinity averages approximately 16.6 in. per year, based on historical data collected during 1952–1976 at the Partlow cooperative weather station (SRCC, "Partlow, Virginia, Period of Record Monthly Climate Summary, Period of Record: 06/01/1952 to 12/31/1976"). Measurable snowfall has occurred from November through April, with the most snow typically falling in January (5.7 in. on average in Partlow).

Damaging storms occur mainly from snow and freezing rain in winter, and from hurricanes, tornadoes, and severe thunderstorms in other seasons (NCDC, "Richmond, Virginia, 2002 Local Climatological Data, Annual Summary with Comparative Data"). Damage may be caused by wind, flooding, or rain, or by any combination of these. Tornadoes are infrequent, but some occurrences have been observed within the area.

The applicant presented a 100-year return period fastest-mile wind speed value of 64 mi/hr in Revision 3 to the SSAR. The applicant's chosen 100-year return period fastest-mile wind speed is not conservative when compared to the minimum 50-year return period fastest-mile basic wind speed of 70 mi/hr specified in Section 6.5.2 of ANSI A58.1-1982. The applicant's chosen value is also not conservative when compared to the highest fastest-mile wind speed of 68 mi/hr recorded at Richmond during the 32-year period of record, 1958–1989. Consequently, the staff does not endorse the use of the 64 mi/hr 100-year return period fastest-mile wind speed value as a basic wind speed site characteristic. This concern resulted in Open Item 2.3-1.

In its response to Open Item 2.3-1, the applicant proposed using a 100-year return period 3-s gust wind speed value of 96 mi/hr as the basic wind speed site characteristic. The applicant determined this value in accordance with the guidance provided by the ASCE and the SEI industry standard on building loads ("Minimum Design Loads for Buildings and Other Structures," SEI/ASCE 7-02). Therefore, the staff concludes that a 3-s gust wind speed site characteristic of 96 mi/hr is acceptable.

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.A., "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").

RG 1.70 specifies both the weight of the 100-year return period snowpack and the weight of the 48-hour PMWP to assess the potential snow loads on the roofs of safety-related structures. The staff's interim position on winter precipitation loads (see memorandum dated March 24, 1975, from H. R. Denton to R. R. Maccary) provides clarification as to the load combinations to be used in evaluating the roofs of safety-related structures. Consistent with the staff's interim position on winter precipitation loads, the winter precipitation loads to be included in the combination of normal live loads to be considered in the design of a nuclear power plant or plants that might be constructed on a proposed ESP should be based on the weight of the 100-year snowpack or snowfall, whichever is greater, recorded at ground level. Likewise, the winter precipitation loads to be included in the combination of extreme live loads to be considered in the design of a nuclear power plant or plants that might be constructed on a proposed ESP should be based on the weight of the 100-year snowpack at ground level plus the weight of the 48-hour PMWP at ground level for the month corresponding to the selected snowpack. A COL or CP applicant may choose and justify an alternative method for defining the extreme winter precipitation load by demonstrating that the 48-hour PMWP could neither fall nor remain on the top of the snowpack and/or building roofs.

The applicant has identified a 100-year return period snowpack of 30.5 lbf/ft^2 for the North Anna ESP site. The applicant determined this value in accordance with the guidance of SEI/ASCE 7-02. Because the applicant performed its analysis in accordance with the appropriate guidance and the results bound the observations described above, the staff concludes that a 100-year return period snowpack site characteristic value of 30.5 lbf/ft^2 is acceptable.

The applicant has identified a 48-hour PMWP value of 20.75 in. of water for the North Anna ESP site. Because the applicant determined this value in accordance with the guidance of NUREG/CR-1486, "Seasonal Variation of 10-Square-Mile Probable Maximum Precipitation Estimates, United States East of the 105^{th} Meridian," issued April 1980, the staff concludes that a 48-hour PMWP site characteristic value of 20.75 in. of water is acceptable.

Open Item 2.3-2 requests that the applicant justify exclusive use of snowpack weight for calculating snowload or provide an alternative method. In response to Open Item 2.3-2, the applicant has proposed an additional winter precipitation site characteristic. The applicant defined this additional winter precipitation site characteristic as the sum of the 100-year return period snowpack and the 48-hour maximum winter snowfall event. The applicant used the maximum monthly snowfall recorded for Richmond (28.5 in. of snow, which is approximately equivalent to 15 lbf/ft^2) to conservatively define the 48-hour maximum winter snowfall event. The staff has chosen not to include the applicant's proposed sum of the 100-year return period snowpack (30.5 lbf/ft^2) and the 48-hour maximum winter snowfall event (15 lbf/ft^2), 45.5 lbf/ft^2, as an additional winter precipitation site characteristic. Once the roof design is known, the COL or CP applicant has the option to demonstrate that the 48-hour PMWP could neither fall nor remain entirely on top of the 100-year snowpack and/or building roofs.

The following discussion on freezing rain, hail, and lightning is intended to provide a general climatic understanding of the severe weather phenomena in the site region but does not result in the generation of site characteristics for use as design or operating bases.

The NCDC reports a 50-year return period uniform radial ice thickness of 0.75 in. resulting from freezing rain, with a concurrent 3-s gust wind speed of 30 mi/hr for the North Anna ESP site area (Jones, K., et al., “The Development of a U.S. Climatology of Extreme Ice Loads,” Technical Report 2002-01).

Hail often accompanies severe thunderstorms. According to the NCDC storm events database (NCDC Storm Event Database, “Storm Events for Virginia, 01/01/1950 through 07/31/2003”), 66 occurrences of hail with diameters of 0.75 in. or greater were reported in the five-county region surrounding the site between January 1, 1955, and July 31, 2003. Seventeen of these occurrences reported hail diameters of 1.5 in. or more. The largest reported size was 2.5 in. which occurred on July 9, 1977, in Caroline County, approximately 25–30 miles southeast of the site. According to NSSL (NCDC, “Severe Thunderstorm Climatology, Total Threat”), the threat of hail occurring within 25 miles of the North Anna ESP site is approximately 2 days per year for damaging hail or hail 0.75 in. in diameter or greater, and 0.25 to 0.50 days per year for hail 2 in. or more in diameter.

The applicant has estimated that approximately 11.2 lightning flashes per year per square mile occur around the site area. The applicant’s estimate is consistent with the mean annual ground flash density of 4 flashes per square kilometer (10.4 flashes per square mile) presented in NUREG/CR-3759, “Lightning Strike Density for the Contiguous United States from Thunderstorm Duration Records,” issued in 1984 for the North Anna ESP site region.

Large-scale episodes of atmospheric stagnation are not infrequent in the site region. Korshover (“Climatology of Stagnating Anticyclones East of the Rocky Mountains, 1936–1975”) reports that, during the 40-year period between 1936 and 1975, high-pressure stagnation conditions, lasting for 4 days or more, occurred about 49 times, with an average of 4.8 stagnation days per case. Five of these stagnation cases lasted 7 days or longer.

The staff found that, according to Holzworth (”Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution throughout the Contiguous United States”), seasonal mixing heights range from an average low of 400 meters (1300 ft) during autumn mornings to an average high of 1800 meters (5900 ft) during spring and summer afternoons. According to Hosler (“Low-Level Inversion Frequency in the Contiguous United States”), low-level, mostly nocturnal inversions are expected to occur approximately 30 percent of the time, with the greatest frequency during the fall and winter (approximately 34 percent of the time and 33 percent of the time, respectively) and with the least frequency during the spring and summer (approximately 28 percent of the time for each season).

The above discussion on atmospheric stagnation, mixing heights, and inversions is intended to provide a general climatic understanding of the air pollution potential in the region. Section 2.3.2 of this SER discusses the ESP air quality conditions considered for design and operating bases. Section 2.3.4 and 2.3.5 of this SER present the atmospheric dispersion site characteristics used to evaluate short-term postaccident airborne releases and long-term routine airborne releases, respectively.

In order to verify the applicant’s UHS meteorological site characteristic resulting in minimum water cooling and maximum evaporation and drift loss, the staff examined 30 years (1961–1990) of hourly temperature and humidity data from Richmond (“Solar and Meteorological Surface Observational Network (SAMSON) for Eastern U.S. CDROM”). The staff calculated 1-day, 5-day, and 30-day average wet-bulb temperatures from the hourly data and selected the periods with the highest average wet-bulb temperatures as the worst periods.

The resulting maximum 1-day, 5-day, and 30-day average wet-bulb temperature values were similar to the values presented by the applicant.

In Open Item 2.3-3, the staff identified the need for an additional UHS meteorological site characteristic for use in evaluating the potential for ice formation in the UHS water storage facility. In its response to Open Item 2.3-3, the applicant identified a maximum cumulative degree-days below freezing value of 322 EF degree-days as a UHS meteorological site characteristic for use in evaluating the potential for water freezing in the UHS water storage facility. Section 2.4.7 of this SER describes the staff's independent evaluation of the meteorological conditions resulting in the maximum formation of surface ice (and therefore the minimum initial volume of liquid water available to the UHS). Using daily temperature data from Piedmont, the staff was able to reproduce a maximum cumulative degree-days below freezing value similar to the value presented by the applicant.

Based on the discussion presented above, the staff concludes that the UHS meteorological site characteristics proposed by the applicant are acceptable.

The staff intends to include the regional climatic site characteristics listed in Table 2.3.1-7 in any ESP permit that might be issued for the North Anna ESP site.

Table 2.3.1-7 Staff's Proposed Regional Climatic Site Characteristics

SITE CHARACTERISTIC		VALUE	DESCRIPTION
Ambient Air Temperature and Humidity			
Maximum Dry-Bulb Temperature	2% annual exceedance	90 EF with 75 EF concurrent wet-bulb	The ambient dry-bulb temperature (and coincident wet-bulb temperature) that will be exceeded 2% of the time annually
	0.4% annual exceedance	95 EF with 77 EF concurrent wet-bulb	The ambient dry-bulb temperature (and coincident wet-bulb temperature) that will be exceeded 0.4% of the time annually
	100-year return period	109 EF	The ambient dry-bulb temperature that has a 1% annual probability of being exceeded (100-year mean recurrence interval)
Minimum Dry-Bulb Temperature	99% annual exceedance	18 EF	The ambient dry-bulb temperature below which dry-bulb temperatures will fall 1% of the time annually
	99.6% annual exceedance	14 EF	The ambient dry-bulb temperature below which dry-bulb temperature will fall 0.4% of the time annually
	100-year return period	! 19 EF	The ambient dry-bulb temperature for which a 1% annual probability of a lower dry-bulb temperature exists (100-year mean recurrence interval)
Maximum Wet-Bulb Temperature	0.4% annual exceedance	79 EF	The ambient wet-bulb temperature that will be exceeded 0.4% of the time annually
	100-year return period	88 EF	The ambient wet-bulb temperature that has a 1% annual probability of being exceeded (100-year mean recurrence interval)

SITE CHARACTERISTIC	VALUE	DESCRIPTION
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	History 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 opinion is available on the rapidity or nature of such changes. If in the future the ESP site is no longer in compliance with the terms and conditions of the ESP (e.g., new information shows that the climatic site characteristics no longer represent extreme weather conditions due to climate change), the staff may seek to modify the ESP or impose requirements on the site in accordance with the provisions of 10 CFR 52.39, “Finality of Early Site Permit Determinations,” if necessary, to bring the site into compliance with Commission requirements to assure adequate protection of the public health and safety.

2.3.1.4 Conclusions

As set forth above, the applicant has presented and substantiated information relative to the regional meteorological conditions important to the safe design and siting of a nuclear power plant or plants falling within the applicant’s PPE that might be constructed on the proposed site. The staff has reviewed the available information provided and, for reasons given above, concludes that the identification and consideration of the regional and site meteorological characteristics set forth above meet the requirements of 10 CFR 100.20(c) and 10 CFR 100.21(d).

The staff finds that the applicant has considered the most severe regional weather phenomena in establishing the site characteristics identified above. The staff has generally accepted the methodologies used to determine the severity of the weather phenomena reflected in these site characteristics, as documented in SERs for previous licensing actions. Accordingly, the staff concludes that the use of these methodologies results in site characteristics containing margin sufficient for the limited accuracy, quantity, and period of time in which the data have been accumulated. In view of the above, the site characteristics previously identified are acceptable for use as part of the design bases for SSCs important to safety, as may be proposed in a COL or CP application.

With regard to tornado wind speed, the applicant conducted a technical assessment of site-specific tornado data. The staff finds the assessment sufficient to justify the applicant’s proposed site tornado characteristics, which deviate from the staff’s interim position on design-basis tornado characteristics. In addition, the staff finds that these tornado site characteristics are acceptable for the design-basis tornado used for the generation of missiles.

The staff has reviewed the applicant’s proposed site characteristics related to climatology for inclusion in an ESP for the applicant’s site, should one be issued, and finds these characteristics to be acceptable. The staff has also reviewed the applicant’s proposed design parameters (PPE values) for inclusion in such an ESP (SSAR Section 1.3) and finds them to be reasonable. The staff did not perform a detailed review of these parameters.

2.3.2 Local Meteorology

2.3.2.1 Technical Information in the Application

In Section 2.3.2 of the SSAR, the applicant presented local (site) meteorological information. This SSAR section also addresses the potential influence of construction and operation of a nuclear power plant or plants falling within the applicant’s PPE on local meteorological conditions that might in turn adversely impact such a plant or plants or the associated facilities.

Finally, the applicant provided a topographical description of the site and its environs. The applicant presented the following information:

- a description of the local (site) meteorology in terms of airflow, temperature, atmospheric water vapor, precipitation, fog, atmospheric stability, and air quality

- an assessment of the influence on the local meteorology of construction and operation of a nuclear power plant or plants falling within the applicant's PPE that might be constructed on the proposed site and its facilities, including the effects of plant structures, terrain modification, and heat and moisture sources resulting from plant operation

- a topographical description of the site and its environs, as modified by the structures of a nuclear power plant or plants falling within the applicant's PPE that might be constructed on the proposed site

The applicant used data from the NWS first-order weather station at Richmond, Virginia, as well as data provided by NCDC from six nearby cooperative observer weather stations, to characterize temperature, rainfall, and snowfall for the North Anna ESP site area. The applicant also provided wind, humidity, and fog data collected at Richmond.

In general, the applicant considered the more extensive meteorological data available for Richmond to be fairly representative of conditions in the ESP site area. However, the applicant noted slight differences in the Richmond data with respect to minimum temperature extremes, diurnal temperature ranges, and average annual snowfall, as compared to corresponding data observed at nearby cooperative weather stations. The applicant attributed these differences to the consequences of urban heating for the more urban Richmond location.

The applicant also characterized local meteorological conditions using data collected from the meteorological monitoring program at the existing NAPS. According to the applicant, the meteorological variables collected by the NAPS monitoring program are appropriate for use in describing local meteorological conditions because of the proximity of the NAPS meteorological tower to the ESP site.

The applicant presented historical normals (e.g., 30-year averages) and extremes of temperature, rainfall, and snowfall for the seven nearby NWS and cooperative weather stations in the North Anna ESP site area. Daily mean temperatures among the observing stations are fairly similar, ranging from 54.2 EF to 57.6 EF. Extreme maximum temperatures have ranged from 100 EF to 107 EF, whereas extreme minimum temperatures have ranged from !10 EF to !21 EF. Normal annual precipitation totals are also fairly comparable among these observing stations, ranging from 42.24 in. to 48.87 in. Normal annual snowfall totals range from 12.4 in. to 18.8 in.

According to the applicant, an average of 27.2 days per year of heavy fog has been reported for Richmond, which is the location closest to the North Anna ESP site for which a fog data set exists. Low regions at the site and in the vicinity of Lake Anna would be expected to have a higher frequency of fog occurrences because of the accumulation of relatively cool surface air from flows draining from higher elevations, as compared to the relatively flat region of the Richmond weather station.

According to information provided by the applicant, onsite winds occur along a north-south orientation on an annual basis, with seasonal variations. Wind data taken from the 33-ft level of the onsite meteorological tower for the 14-year period between 1974 and 1987 indicate that the predominant wind directions are from the south-southwest (about 10 percent of the time), north (about 9 percent of the time), northwest (about 9 percent of the time), and west-northwest (about 8 percent of the time). Winds from the northeast clockwise through south-southeast and from the west-southwest and the west occur least frequently (each about 4 percent of the time). Wind direction distributions based on data from the 159-ft level are similar to those based on the lower-level data. The onsite annual average wind speeds are 6.3 mi/hr at the 33-ft level and 8.6 mi/hr at the 159-ft level.

The SSAR presents atmospheric stability data based on delta-temperature measurements between the 159-ft and 33-ft levels on the onsite meteorological tower. Neutral (Pasquill type “D”) and slightly stable (Pasquill type “E”) conditions predominate, occurring about 31 and 26 percent of the time, respectively. Moderately stable (Pasquill type “F”) and extremely stable (Pasquill type “G”) conditions occur about 8 and 5 percent of the time, respectively.

The applicant stated that the dimensions of the new plant structures and associated paved, concrete, and other improved surfaces would be insufficient to generate discernable impacts on local and regional meteorological conditions beyond the areas immediately adjacent to the site structures and improved surfaces. The applicant concluded that the small and localized surface water temperature increases on Lake Anna resulting from the operation of an open-cycle cooling system for the applicant’s proposed Unit 3 would not be expected to significantly impact the ongoing moderation of temperature extremes and alterations of local wind patterns by the lake. Induced fogging conditions under extreme humidity conditions during cooler seasons would most likely coincide with naturally occurring fogging conditions, and the applicant does not expect the proposed Unit 3 to significantly increase the occurrence of local fog. Similarly, the applicant expects that any increases in ambient temperatures resulting from the operation of a closed-loop dry tower system proposed for Unit 4 would be very localized to the ESP site and would not affect the ambient ground and atmospheric temperatures beyond the site boundary.

In Open Item 2.3-4, the staff stated that the applicant has not described the impact of potential increases in atmospheric temperature resulting from the operation of closed-cycle (dry) cooling towers associated with proposed Unit 4 on plant design and operation. In its response to Open Item 2.3-4, the applicant stated that the operation of the dry cooling towers would be expected to have minimal impact on the design and operation of the new Units 3 and 4. The dry cooling towers would be approximately 150 ft high and would consist of a series of modules, each containing air circulating fans. According to the applicant, the warm air plume from the dry cooling towers would tend to rise vertically, driven by the velocity imparted by the fans and thermal buoyancy. During most expected atmospheric conditions, the resulting heated plume would be expected to rise above the top of the tallest powerblock structures in the plant envelope area. Only a strong wind blowing across the bank of cooling towers could cause plume downwash because of building wake effects. This strong wind would also enhance the mixing with cooler air from outside the plume, resulting in negligible changes in temperature at ground level.

Since the specific design of the ESP facility is not known, the applicant stated that it is not possible to predict with certainty the impact of the warm air dry cooling tower plumes on specific plant features, such as heating, ventilation, and air-conditioning intakes. The applicant stated that potential impact of the dry cooling towers on the design and operation on the ESP facility would be considered as part of detailed engineering.

According to the applicant, the North Anna ESP site region is characterized by gently rolling terrain that rises to an average height of 50 to 150 ft above Lake Anna. The primary topographic influences on local meteorological conditions at the North Anna ESP site are Lake Anna and the North Anna River Valley. Because of the complex configuration of the lake, over-water trajectories would generally be less than 2.5 miles. As a result of the gently rolling terrain, cold air drains into low-lying areas at night. Some wind channeling along Lake Anna is expected during low wind speed conditions. The Blue Ridge Mountains, which are located 40 to 50 miles northwest of the site, also tend to channel the prevailing winds from the south and south-southwest during the summer months.

The applicant stated that, should additional units be constructed, a portion of the currently undeveloped area of the ESP site would be cleared of existing vegetation and subsequently graded to accommodate the new units and the ancillary structures. No large-scale cut and fill activities would be needed to accommodate the new units since a large portion of the area to be developed is already relatively level. Therefore, the applicant expects that terrain modifications associated with development of the ESP facility would be limited to the existing NAPS site and would not impact terrain features around the lake and valley nor significantly alter the site's existing gently undulating surface that is characteristic of its location in the Piedmont region of Virginia.

The applicant stated that it did not expect air quality characteristics to be a significant factor in the design and operating bases for any new facilities that might be constructed on the ESP site. The North Anna ESP site is located within the Northeastern Virginia Intrastate Air Quality Control Region, which has been designated as being in attainment or unclassified for all EPA-designated national ambient air quality standards. The nuclear steam supply system and related radiological systems associated with any new facilities that might be constructed on the ESP site would not be sources of criteria pollutants or other air toxics. Further, the applicant does not expect the addition of supporting auxiliary boilers, emergency diesel generators, station blackout generators, and other sources of nonradiological emissions to be significant sources of criteria pollutant emissions because these units will operate on an intermittent test and/or emergency basis.

2.3.2.2 Regulatory Evaluation

In SSAR Section 1.8.1, the applicant identified the following applicable NRC regulations regarding local meteorology:

- Appendix A to 10 CFR Part 50, GDC 2, with respect to information on severe regional weather phenomena that has historically been reported for the region and that is reflected in the design bases for SSCs important to safety

- 10 CFR 100.20(c) and 10 CFR 100.21(d), with respect to the consideration that has been given to the regional meteorological characteristics of the site

In SSAR Section 1.8.2, the applicant identified the following applicable NRC guidance regarding local meteorology:

- RG 1.23, Revision 0, "Onsite Meteorological Programs," dated February 1972 and proposed Revision 1, dated September 1980, with respect to the criteria for an acceptable onsite meteorological measurements program

- Section 2.3.2 of RG 1.70, with respect to the type of local meteorological information that should be presented, including the potential impact of the plant on local meteorology and the local meteorological and air quality conditions used for design and operating basis considerations

The staff has reviewed this portion of the application in accordance with the guidance identified by the applicant, and to determine if the application is in compliance with the identified regulations, with the exception of the GDC. An ESP applicant need not demonstrate compliance with the GDC with respect to local meteorology.

Section 2.3.2 of RS-002 and Section 2.3.2 of RG 1.70 provide the following guidance on information appropriate for presentation on local meteorology:

- Local meteorological data based on onsite measurements and data from nearby NWS stations or other standard installations should be presented in the format specified in Section 2.3.2 of RG 1.70. RG 1.23 provides guidance related to onsite meteorological measurements.

- A topographical description of the site and environs should be provided. Section 2.3.2.2 of RG 1.70 provides guidance on the topographical description.

- A discussion and evaluation of the influence of a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the proposed site and its facilities on local meteorological and air quality conditions should be provided. Potential changes in the normal and extreme values resulting from plant construction and operation should be discussed.

2.3.2.3 Technical Evaluation

The staff evaluated local meteorological conditions using data from the NAPS onsite meteorological monitoring system, as well as climatic data reported by NCDC. Section 2.3.3 of this SER provides a discussion of the representativeness of the NAPS onsite data.

Normal climatic data for the period 1971–2000 reported by NCDC for the eastern Piedmont climatic division of Virginia indicate that the annual mean temperature in the area is about 56.6 EF (NCDC, "Eastern Piedmont, Virginia, Divisional Normals—Temperature, Period 1971–2000, Climatography of the United States No. 85"). This value compares well with the range of daily mean temperatures reported by the applicant for nearby weather stations. Monthly mean temperatures for the eastern Piedmont climatic division range from a low monthly mean value of about 35.9 EF in January to a high monthly mean value of about 76.8 EF in July (NCDC, "Eastern Piedmont, Virginia, Divisional Normals—Temperature, Period 1971–2000, Climatography of the United States No. 85").

Precipitation for the Piedmont climatic division averages 45.00 in. per year (NCDC, "Eastern Piedmont, Virginia, Divisional Normals—Precipitation, Period 1971–2000, Climatography of the United States No. 85"). This value is compatible with the range of normal annual precipitation totals reported by the applicant for nearby weather stations. Precipitation is well distributed throughout the year, with monthly climate division normals for the North Anna ESP site region ranging from a minimum of about 3.18 in. in December to a maximum of about 4.36 in. in July.

The staff reviewed the applicant's description of the local meteorology and determined that the information is representative of conditions at and near the site. The wind and atmospheric stability data are based on onsite data recorded by the NAPS meteorological monitoring system. Section 2.3.3 of this SER provides a discussion of the NAPS onsite data. The other meteorological summaries are based on data from nearby stations with long periods of record. The applicant demonstrated that synoptic-scale conditions are generally responsible for periods of excessive heat and cold outbreaks that resulted in the recording of compatible extreme temperatures throughout the ESP site area. A review of these recorded extreme values shows that they are reflected in the site characteristics presented in SSAR Section 2.3.1.

The staff reviewed topographic maps and topographic cross sections to ensure that the information needed is well labeled and can be readily extracted.

Because of the limited and localized nature of the expected terrain modifications associated with the development of the ESP facility, the staff finds that these terrain modifications, along with the resulting plant structures and associated improved surfaces, will not have enough of an effect on local meteorological conditions to affect plant design and operation. Similarly, because the operation of an open-cycle cooling system for the applicant's proposed Unit 3 is not expected to significantly impact either atmospheric temperature extremes or increase the occurrence of local fog, the staff finds that the atmospheric impact of the operation of an open-cycle cooling system for the proposed Unit 3 will not affect plant design and operation.

In Open Item 2.3-4, the staff requested that the applicant describe the impact of potential increases in atmospheric temperature resulting from the operation of closed-cycle dry cooling tower and associated with proposed Unit 4 on plant design and operations. In its response to Open Item 2.3-4, the applicant noted that it is not possible to predict with certainty the warm air transport and dispersion from the cooling tower to specific plant features because the design of the plant is not known at this time.

Since the specific layout and design of the ESP facility is not known, the staff finds that it is not possible to accurately predict the impact of the Unit 4 dry cooling tower plumes on specific plant features. The potential impact of the dry cooling towers on the design and operation of the ESP facility should be considered as part of detailed engineering and will need further evaluation at the time of the COL application. This is **COL Action Item 2.3-1**.

Since the North Anna ESP site is located in an air quality control region that has been designated as being either in attainment or unclassifiable for all EPA-designated national ambient air quality standards, the staff agrees with the applicant that the ESP site air quality conditions should not be a significant factor in the design and operating bases for the new units.

2.3.2.4 Conclusions

As set forth above, the applicant has presented and substantiated information on local meteorological, air quality, and topographic characteristics of importance to the safe design and operation of a nuclear power plant or plants falling within the applicant's PPE that might be constructed on the proposed site. The staff has reviewed the available information provided and, for the reasons given, concludes that the applicant's identification and consideration of the meteorological, air quality, and topographical characteristics of the site and the surrounding area meet the requirements of 10 CFR Part 100, 10 CFR 100.20(c), and 10 CFR 100.21(d) and are sufficient to determine the acceptability of the site.

The staff has also reviewed available information relative to severe local weather phenomena at the site and in the surrounding area. As set forth above, the staff concludes that the applicant has identified the most severe local weather phenomena at the site and surrounding area.

2.3.3 Onsite Meteorological Measurements Program

2.3.3.1 Technical Information in the Application

In Section 2.3.3 of the SSAR, the applicant presented information concerning its Onsite Meteorological Measurements Program, including instrumentation and measured data. Specifically, the applicant provided the following information:

- description of meteorological instrumentation, including siting of sensors, sensor performance specifications, methods and equipment for recording sensor output, the quality assurance program for sensors and recorders, and data acquisition and reduction procedures

- meteorological data, including consideration of the period of record and amenability of the data for use in characterizing atmospheric dispersion conditions

The applicant used the existing Onsite Meteorological Measurements Program for the NAPS facility to collect data for the North Anna ESP site and intends to use it for the proposed ESP facility.

The applicant upgraded the existing NAPS monitoring program in June 1977, and, according to the applicant, it meets the system accuracy criteria presented in proposed Revision 1 to RG 1.23. Measurements are available from both a primary and backup system. The backup system is intended to function when the primary system is out of service, providing assurance that basic meteorological information will be available during and immediately following an accidental airborne radioactivity release.

The primary NAPS meteorological monitoring program consists of a guyed, triaxial, open-lattice 160-ft tower located approximately 1900 ft east of the NAPS Unit 1 reactor containment building. Wind speed, wind direction, and horizontal wind direction fluctuation (sigma theta) are measured at the 33-ft and 159-ft elevations. Ambient temperature and dew point temperature are measured at the 33-ft elevation, and vertical temperature difference (delta-temperature) is measured between the 160-ft and 33-ft elevations. Precipitation is monitored at the ground level.

The backup NAPS meteorological monitoring program consists of a freestanding 33-ft tower located approximately 1300 ft northeast of the NAPS Unit 1 reactor containment building. Wind speed, wind direction, and horizontal wind direction fluctuation (sigma theta) are measured at the top of the tower. The bases of both towers are at similar elevation to plant grade, and the ground cover at the base of the primary tower (which measures delta-temperature) is primarily native grasses.

Signal cables from both the primary and backup towers are routed through conduit into an instrument shelter at the base of each tower. Inside each shelter, the signals are provided as input to the appropriate signal-conditioning equipment, with output going to digital data recorders. These data are transmitted daily via modem to the applicant's corporate headquarters, where they are reviewed to identify anomalous data and then archived. Output from the signal-conditioning equipment is also sent to strip chart recorders in the control room and the emergency response facility data system for use in emergency response.

The primary tower wind sensors are mounted on booms approximately twice the tower face width and are positioned so that the tower will not influence the prevailing south-southwest wind flow. The ambient temperature, dew point temperature, and delta-temperature sensors are housed in motor-aspirated shields to insulate them from the effects of precipitation and thermal radiation.

The meteorological monitoring system is calibrated at least semiannually. Data recovery for the 1996–1998 period of record used to evaluate atmospheric dispersion exceeded 90 percent.

2.3.3.2 Regulatory Evaluation

In SSAR Section 1.8.1, the applicant identified the following applicable NRC regulations regarding the Onsite Meteorological Measurements Program:

- 10 CFR 50.47, "Emergency Plans," and Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities," to 10 CFR Part 50, as they relate to additional meteorological measurements taken for emergency preparedness planning

- Appendix I to 10 CFR Part 50, as it relates to meteorological data used to determine compliance with the numerical guides for doses in meeting the criterion of "as low as is reasonably achievable"

- 10 CFR 100.20(c) and 10 CFR 100.21(d), as they relate to meteorological data collected for use in characterizing the meteorological conditions of the site

In SSAR Sections 1.8.2 and 2.3.3, the applicant identified the following applicable NRC guidance regarding onsite meteorological measurements programs:

- RG 1.23, Revision 0, and proposed Revision 1, with respect to the criteria for an acceptable onsite meteorological measurements program

- Section 2.3.3 of RG 1.70, with respect to describing the meteorological measurements at the site and providing joint frequency distributions of wind speed and direction by atmospheric stability class

- Section 2.3 of RG 4.2, “Preparation of Environmental Reports for Nuclear Power Stations,” issued July 1976, with respect to providing at least one annual cycle of onsite meteorological data

- Appendix 2 to NUREG-0654, Revision 1, “Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants,” issued November 1980; NUREG-0696, “Functional Criteria for Emergency Response Facilities,” issued February 1981; and NUREG-0737, “Clarification of TMI Action Plan Requirements,” issued October 1980, with respect to meteorological measurements taken for emergency preparedness planning

The staff has reviewed this portion of the application in accordance with the guidance identified by the applicant, and to determine if the application is in compliance with the identified regulations. However, this section of the application did not address the requirements of 10 CFR 50.47 and Appendix E to 10 CFR Part 50. Consequently, the staff did not review this section for compliance with these requirements.

Both RG 1.23 and Section 2.3.3 of RS-002 document the criteria for an acceptable onsite meteorological measurements program. The onsite meteorological measurements program should produce data that describe the meteorological characteristics of the site and its vicinity for the purpose of making atmospheric dispersion estimates for both postulated accidental and expected routine airborne releases of effluents, and for comparison with offsite sources to determine the appropriateness of climatological data used for design considerations.

Section 2.3.3 of RS-002 and Section 2.3.3.7 of RG 1.70 provide guidance on information appropriate for presentation on an onsite meteorological measurements program. As set forth in this guidance, at least one annual cycle of onsite meteorological data should be provided. These data should be presented in the form of joint frequency distributions of wind speed and wind direction by atmospheric stability class in the format described in RG 1.23. If a site has a high occurrence of low wind speeds, a finer category breakdown should be used for the lower speeds so data are not clustered in a few categories. A listing of each hour of the hourly averaged data should also be provided on electronic media in the format described in Appendix A to Section 2.3.3 of RS-002. Evidence of how well these data represent long-term conditions at the site should be discussed.

2.3.3.3 Technical Evaluation

The staff evaluated the Onsite Meteorological Measurements Program by reviewing the program description presented in the SSAR, as well as conducting a site visit. The site visit consisted of reviewing the meteorological monitoring system location and exposure, sensor type and performance specifications, data transmission and recording, data acquisition and reduction, and instrumentation maintenance and calibration procedures. In addition, the staff reviewed an hourly listing of the 1996–1998 meteorological database provided by the applicant in its response to RAI 2.3.3-1.

The staff considers the meteorological data collected by the existing NAPS monitoring program to be representative of the dispersion conditions at the North Anna ESP site. The North Anna ESP site is within the existing NAPS site, and the proposed facility is intended to be in close proximity to the existing facility. The NAPS primary meteorological tower is located far enough away from existing plant structures to preclude any adverse impact on measurements. The base of the tower is at an elevation similar to plant grade at both NAPS and the proposed ESP facility. The ground cover at the base of the meteorological tower is primarily native grasses.

The staff reviewed the location of the primary and backup towers with respect to nearby ground features and potential obstructions to flow (e.g., trees, buildings), including existing plant structure layouts, and concluded that these features pose minimal adverse effects on the measurements taken at the towers. The nearby instrument shelters for both towers are less than 10 ft in height. Pine trees, previously 30–35 ft in height and located approximately 135 ft northwest and south of the primary tower, were cut in 2002 to 23–27 ft in height. Dominion Energy has put these trees on a 3-year pruning schedule to ensure they remain below 30 ft in height (i.e., below the lower measuring height on the primary tower), as recommended in proposed Revision 1 to RG 1.23.

The staff evaluated the types and heights of the meteorological variables being measured and found them to be compatible with the criteria of RG 1.23. During the site visit, the staff also reviewed the applicant’s sensor types and performance specifications, data transmission and recording methods, and the inspection, maintenance, and calibration procedures and frequencies. The staff found them to be consistent with RG 1.23.

The staff performed a quality review of the NAPS 1996–1998 hourly meteorological database provided by the applicant in response to RAI 2.3.3-1 using the methodology described in NUREG-0917, “Nuclear Regulatory Commission Staff Computer Programs for Use with Meteorological Data,” issued July 1982. The staff performed further review using computer spreadsheets. Examination of the data revealed generally stable and neutral atmospheric conditions at night and unstable and neutral conditions during the day, as expected. Wind speed, wind direction, and stability class frequency distributions for each measurement channel were similar from year to year, and the 1996–1998 wind direction and stability class frequency distributions were reasonably consistent with the 1974–1987 data presented in Section 2.3.2 of the NAPS UFSAR. A comparison between the joint frequency distribution used by the licensee as input to PAVAN and XOQDOQ and a staff-generated joint frequency distribution from the hourly database are compatible.

2.3.3.4 Conclusions

As set forth above, the applicant has provided and substantiated information on the Onsite Meteorological Measurements Program. The staff has reviewed the available information relative to the meteorological measurements program and the data collected by the program. On the basis of this review and as set forth above, the staff concludes that the system provides data adequate to represent onsite meteorological conditions, as required by 10 CFR 100.20. The onsite data also provide an acceptable basis for (1) making estimates of atmospheric dispersion for design-basis accident and routine releases from a nuclear power plant or plants falling within the applicant’s PPE that might be constructed on the proposed site and (2) meeting the requirements of 10 CFR Part 100 and Appendix I to 10 CFR Part 50.

2.3.4 Short-Term (Accident) Diffusion Estimates

2.3.4.1 Technical Information in the Application

In this section of the SSAR, the applicant presented atmospheric dispersion estimates for postulated accidental airborne releases of radioactive effluents to the EAB and LPZ. The applicant provided the following information:

- atmospheric transport and diffusion models to calculate relative concentrations for postulated accidental radioactive releases
- meteorological data summaries used as input to diffusion models
- specification of diffusion parameters
- probability distributions of relative concentrations
- determination of relative concentrations used for assessment of consequences of postulated radioactive atmospheric releases from design-basis and other accidents

The applicant used the NRC-sponsored computer code PAVAN (NUREG/CR-2858, "PAVAN: An Atmospheric Dispersion Program for Evaluating Design Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations," issued in 1982) to estimate relative concentration (χ/Q) values at the EAB and LPZ for potential accidental releases of radioactive material. The PAVAN model implements the methodology outlined in RG 1.145, Revision 1, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," issued November 1982.

The PAVAN code estimates χ/Q values for various time-averaging periods ranging from 2 hours to 30 days. The meteorological input to PAVAN consists of a joint frequency distribution of wind speed, wind direction, and atmospheric stability data. The PAVAN code computes χ/Q values at the EAB and LPZ for each combination of wind speed and atmospheric stability for each of the 16 downwind direction sectors. The code then ranks χ/Q values for each sector in descending order, and it derives an associated cumulative frequency distribution based on the frequency distribution of wind speed and stabilities for that sector. The χ/Q value that is equaled or exceeded 0.5 percent of the total time is determined for each sector, and the highest 0.5-percentile χ/Q value among the 16 sectors becomes the maximum sector-dependent χ/Q value. The code also ranks χ/Q values independent of wind direction into a cumulative frequency distribution for the entire site. The PAVAN program then selects the χ/Q value that is equaled or exceeded 5 percent of the total time. The larger of the two values, the maximum sector-dependent 0.5-percent χ/Q value and the overall site 5-percent χ/Q value, are used to represent the χ/Q value for a 0–2-hour time period.

To determine χ/Q values for longer time periods, PAVAN calculates an annual average χ/Q value. Logarithmic interpolation is then used between the 0–2-hour χ/Q values and the annual average χ/Q values to calculate the values for intermediate time periods (i.e., 8 hours, 16 hours, 72 hours, and 624 hours).

In RAI 2.3.4-1, the staff asked the applicant to rerun the PAVAN computer code using the wind speed categories discussed in Section 4.6 of NUREG/CR-2858 and provide a copy of the resulting input files used to execute PAVAN. The applicant complied with this request in its response to RAI 2.3.4-1.

The applicant used the following input data and assumptions in applying the PAVAN model for the North Anna site:

- The meteorological input to PAVAN consisted of a joint frequency distribution of wind speed, wind direction, and atmospheric stability data based on 3 years (1996–1998) of onsite meteorological data. The applicant used wind data from the 33-ft level of the onsite meteorological tower, and it derived the stability data from the vertical temperature difference (delta-temperature) measurements taken between the 159-ft and 33-ft levels of the onsite meteorological tower.

- The applicant modeled one conservative ground-level release point and took no credit for building wake effects.

- The EAB is the perimeter of a 5000-ft radius circle from the center of the abandoned Unit 3 containment. In order to calculate the χ/Q values for the EAB, the applicant used the shortest distances from the ESP plant envelope area boundary to the EAB. The LPZ is a 6-mi-radius circle centered at the Unit 1 containment building. Similarly, in order to calculate the χ/Q values for the LPZ, the applicant used the shortest distances from the ESP plant envelope area boundary to the LPZ.

Based on the PAVAN modeling results, the applicant proposed short-term (accident release) atmospheric dispersion site characteristics for inclusion in an ESP, as presented in Table 2.3.4-1, should one be issued for the applicant's proposed ESP site.

Table 2.3.4-1 Applicant's Proposed Short-Term (Accident Release) Atmospheric Dispersion Site Characteristics

SITE CHARACTERISTIC	VALUE	DEFINITION
0–2 hr χ/Q Value @ EAB	$2.26 \times 10^{!4}$ s/m^3	The atmospheric dispersion factor used in the safety analysis to estimate dose consequences of accidental airborne releases
0–8 hr χ/Q Value @ LPZ	$2.05 \times 10^{!5}$ s/m^3	The atmospheric dispersion factor used in the safety analysis to estimate dose consequences of accidental airborne releases
8–24 hr χ/Q Value @ LPZ	$1.36 \times 10^{!5}$ s/m^3	The atmospheric dispersion factor used in the safety analysis to estimate dose consequences of accidental airborne releases
1–4 day χ/Q Value @ LPZ	$5.58 \times 10^{!6}$ s/m^3	The atmospheric dispersion factor used in the safety analysis to estimate dose consequences of accidental airborne releases
4–30 day χ/Q Value @ LPZ	$1.55 \times 10^{!6}$ s/m^3	The atmospheric dispersion factor used in the safety analysis to estimate dose consequences of accidental airborne releases

2.3.4.2 Regulatory Evaluation

In SSAR Section 1.8.1, the applicant identified the applicable NRC regulation regarding short-term (accident release) diffusion estimates as 10 CFR 100.21, with respect to the meteorological considerations used in the evaluation to determine an acceptable exclusion area and LPZ.

In SSAR Sections 1.8.2 and 2.3.4, the applicant identified the following applicable NRC guidance regarding accident release diffusion estimates:

- RG 1.5, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Steam Line Break Accident for Boiling Water Reactors," issued March 1971; RG 1.24, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Pressurized Water Reactor Radioactive Gas Storage Tank Failure," issued March 1972; RG 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors," issued March 1972; RG 1.77, "Assumptions Used for Evaluating a Control Rod Ejection Accident for Pressurized Water Reactors," issued May 1974; and RG 1.78, Revision 1, with respect to an acceptable basis for implementing the requirements of 10 CFR Part 100

- RG 1.23, Revision 0, and proposed Revision 1, with respect to the criteria for an acceptable onsite meteorological measurements program

- Section 2.3.4 of RG 1.70, with respect to providing conservative and realistic estimates of atmospheric diffusion at the EAB and LPZ, based on the most representative meteorological data and impacts caused by local topography

- RG 1.111, “Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors,” issued July 1977, with respect to criteria for characterizing atmospheric transport and diffusion conditions for evaluating the consequences of routine releases

- RG 1.145, Revision 1, with respect to acceptable methods for choosing atmospheric dispersion factors (χ/Q values) for evaluating the consequences of potential accidents

- RG 4.7, with respect to discussing the major site characteristics related to public health and safety that the staff considers in determining the suitability of the site

The staff has reviewed this portion of the application in accordance with the guidance identified by the applicant, and to determine if the application is in compliance with the identified regulations.

Section 2.3.4 of RS-002 and Section 2.3.4 of RG 1.70 provide guidance on information appropriate for presentation on short-term (accident release) diffusion estimates. The application should present or describe the following:

- conservative estimates of atmospheric transport and diffusion conditions at appropriate distances from the source for postulated accidental releases of radioactive materials to the atmosphere

- a description of the atmospheric dispersion models used to calculate relative concentrations (χ/Q values) in air resulting from accidental releases of radioactive material to the atmosphere, with models documented in detail and substantiated within the limits of the model so that the staff can evaluate their appropriateness to site characteristics, plant characteristics (to the extent known), and release characteristics

- the meteorological data used for the evaluation (as input to the dispersion models), which represent annual cycles of hourly values of wind direction, wind speed, and atmospheric stability for each mode of accidental release

- an explanation of the variation of atmospheric diffusion parameters used to characterize lateral and vertical plume spread (σ_y and σ_z) as a function of distance, topography, and atmospheric conditions, as related to measured meteorological parameters, and description of a methodology for establishing these relationships that is appropriate for estimating the consequences of accidents within the range of distances that are of interest with respect to site characteristics and established regulatory criteria

- cumulative probability distributions of relative concentrations (χ/Q values) and the probabilities of these χ/Q values being exceeded, presented for appropriate distances (e.g., the EAB and LPZ) and time periods as specified in Section 2.3.4.2 of RG 1.70, as well as an adequate description of the methods used for generating these distributions

- the relative concentrations used for assessing the consequences of atmospheric radioactive releases from design-basis and other accidents

2.3.4.3 Technical Evaluation

The applicant generated its atmospheric diffusion estimates for postulated accidental airborne releases of radioactive effluents to the EAB and LPZ using the staff-endorsed computer code PAVAN. The staff evaluated the applicability of the PAVAN model and concluded that no unique topographic features preclude the use of the PAVAN model for the North Anna ESP site. The staff also reviewed the applicant's input to the PAVAN computer code, including the assumptions used concerning plant configuration and release characteristics and the appropriateness of the meteorological data input. The staff found that the applicant made conservative assumptions by ignoring building wake effects and treating all releases as ground-level releases. The staff made an independent evaluation of the resulting atmospheric diffusion estimates by running the PAVAN computer model and obtained similar results.

From this review, the staff concludes that the applicant has used an adequately conservative atmospheric dispersion model and appropriate meteorological data to calculate relative concentrations for appropriate offsite (EAB and LPZ) distances and directions from postulated release points for accidental airborne releases of radioactive materials.

In order to evaluate atmospheric dispersion characteristics with respect to radiological releases to the control room, detailed design information (e.g., vent heights, intake heights, and distance and direction from release vents to the room) is necessary. Because little detailed design information is available for the nuclear power plant or plants that might be constructed on the proposed site, the COL or CP applicant should assess the dispersion of airborne radioactive materials to the control room at the COL or CP stage. This is **COL Action Item 2.3-2**.

The staff intends to include the short-term (accident release) atmospheric dispersion factors listed in Table 2.3.4-2 as site characteristics in any ESP that might be issued for the North Anna ESP site.

Table 2.3.4-2 Staff's Proposed Short-Term (Accident Release) Atmospheric Dispersion Site Characteristics

SITE CHARACTERISTIC	VALUE	DEFINITION
0–2-hr χ/Q Value @ EAB	2.26×10^{-4} s/m^3	The 0–2-hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the EAB
0–8-hr χ/Q Value @ LPZ	2.05×10^{-5} s/m^3	The 0–8-hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ
8–24-hr χ/Q Value @ LPZ	1.36×10^{-5} s/m^3	The 8–24-hour atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ
1–4-day χ/Q Value @ LPZ	5.58×10^{-6} s/m^3	The 1–4-day atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ
4–30-day χ/Q Value @ LPZ	1.55×10^{-6} s/m^3	The 4–30-day atmospheric dispersion factor to be used to estimate dose consequences of accidental airborne releases at the LPZ

2.3.4.4 Conclusions

As set forth above, the applicant has made conservative assessments of postaccident atmospheric dispersion conditions using its meteorological data and appropriate diffusion models. The applicant has calculated representative atmospheric transport and diffusion conditions for the EAB and the LPZ. The staff has reviewed the applicant's proposed short-term atmospheric dispersion site characteristics for inclusion in an ESP for the applicant's site, should one be issued, and, as discussed above, finds these characteristics to be acceptable. Therefore, the staff concludes that the applicant's atmospheric dispersion estimates are appropriate for the assessment of consequences from radioactive releases for postulated (i.e., design-basis) accidents, in accordance with 10 CFR 100.21.

Based on these considerations, the staff concludes that the applicant's short-term atmospheric dispersion estimates are acceptable and meet the relevant requirements of 10 CFR Part 100. The staff will address atmospheric dispersion estimates used to evaluate radiological doses for the control room in its review of any COL or CP application that references this information.

2.3.5 Long-Term (Routine) Diffusion Estimates

2.3.5.1 Technical Information in the Application

In this section of the SSAR, the applicant presented its atmospheric diffusion estimates for routine releases of effluents to the atmosphere. Specifically, the applicant provided the following information:

- the atmospheric dispersion models used to calculate concentrations in air and the amount of material deposited as a result of routine releases of radioactive material to the atmosphere

- the meteorological data used as input to diffusion models

- diffusion parameters

- relative concentration (χ/Q) and relative deposition (D/Q) values used to assess the consequences of routine airborne radioactive releases

- points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations

The applicant used the NRC-sponsored computer code XOQDOQ (NUREG/CR-2919, "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," issued in 1982) to estimate χ/Q and D/Q values resulting from routine releases. The XOQDOQ model implements the methodology outlined in RG 1.111. The applicant used the following input data and assumptions in applying the XOQDOQ model for the North Anna ESP site:

- The meteorological input to XOQDOQ consisted of a joint frequency distribution of wind speed, wind direction, and atmospheric stability data based on 3 years (1996–1998) of onsite meteorological data. The wind data were from the 33-ft level of the onsite meteorological tower, and the stability data were derived from the vertical temperature difference (delta-temperature) measurements taken between the 159-ft and 33-ft levels of the onsite meteorological tower.

- The applicant modeled one conservative ground-level release point, assuming a minimum building cross-sectional area of 24,220 square ft.

- Because the PPE area proposed for the North Anna ESP site is an area, not a point, the applicant used the shortest distances from any point on the plant envelope to the receptors of interest as input to the XOQDOQ model.

The applicant calculated annual average undepleted/no decay, undepleted/2.26-day decay, and depleted/8.00-day decay χ/Q values and D/Q values for the site boundary and special receptors of interest (nearest resident, meat animal, and vegetable garden within 5 miles in each downwind sector), as identified in the North Anna Power Station 2001 Radiological Environmental Monitoring Program Annual Report.

Table 2.3.5-1 lists the long-term atmospheric dispersion estimates that the applicant derived based on the XOQDOQ modeling results.

Table 2.3.5-1 Applicant's Long-Term (Routine Release) Diffusion Estimates

TYPE OF LOCATION	X/Q VALUE (s/m^3)			D/Q VALUE (1/m^2)
	UNDEPLETED NO DECAY	UNDEPLETED 2.26-DAY DECAY	DEPLETED 8.00-DAY DECAY	
EAB	3.7×10^{-6} (0.88 mi ESE)	3.7×10^{-6} (0.88 mi ESE)	3.3×10^{-6} (0.88 mi ESE)	1.2×10^{-8} (0.62 mi S)
Residence	2.4×10^{-6} (0.96 mi NNE)	2.4×10^{-6} (0.96 mi NNE)	2.1×10^{-6} (0.96 mi NNE)	7.2×10^{-9} (0.96 mi NNE)
Meat Animal	1.4×10^{-6} (1.37 mi SE)	1.4×10^{-6} (1.37 mi SE)	1.2×10^{-6} (1.37 mi SE)	3.1×10^{-9} (1.56 mi NNE)
Vegetable Garden	2.0×10^{-6} (0.94 mi NE)	2.0×10^{-6} (0.94 mi NE)	1.8×10^{-6} (0.94 mi NE)	6.0×10^{-9} (0.94 mi NE)

2.3.5.2 Regulatory Evaluation

In SSAR Section 1.8.1, the applicant identified the applicable NRC regulations regarding long-term (routine release) diffusion estimates as Appendix I to 10 CFR Part 50, with respect to demonstrating compliance with the numerical guides for doses contained in this appendix by characterizing atmospheric transport and diffusion conditions in order to estimate the radiological consequences of routine releases of materials to the atmosphere.

The staff finds that the applicant should have also identified 10 CFR 100.21(c)(1), which requires that site atmospheric dispersion characteristics be evaluated and dispersion parameters established such that radiological effluent release limits associated with normal operation from the type of facility proposed to be located at the site can be met for any individual located offsite. Nonetheless, for the reasons set forth below, the staff finds that the applicant has met these regulatory requirements.

In SSAR Sections 1.8.2 and 2.3.5, the applicant identified the following applicable NRC guidance regarding routine release diffusion estimates:

- Section 2.3.5 of RG 1.70, with respect to providing realistic estimates of annual average atmospheric transport and diffusion characteristics to a distance of 50 miles from the plant, including a detailed description of the model used and a calculation of the maximum annual average atmospheric dispersion factor (χ/Q value) at or beyond the site boundary for each venting location

- RG 1.111, with respect to criteria for characterizing atmospheric transport and diffusion conditions for evaluating the consequences of routine releases

The staff also identified the following RGs as applicable NRC guidance regarding routine release diffusion estimates:

- RG 1.109, “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, with respect to the criteria to be used for specific receptors of interest (applicable to the extent the applicant provides receptors of interest at the ESP stage)

- RG 1.112, “Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Power Reactors,” issued May 1977, with respect to the criteria to be used to identify release points and release characteristics (applicable to the extent the applicant provides release points and release characteristics at the ESP stage)

As discussed below, the staff finds that the applicant has met the criteria in all applicable RGs for performing routine release diffusion estimates.

Section 2.3.5 of RS-002 and Section 2.3.5 of RG 1.70 provide the following guidance on information appropriate for presentation on long-term (routine release) diffusion estimates.

- The applicant should provide a description of the atmospheric dispersion models used to calculate concentrations in air and the amount of material deposited as a result of routine releases of radioactive material to the atmosphere. The models should be sufficiently documented and substantiated to allow a review of their appropriateness for site characteristics, plant characteristics (to the extent known), and release characteristics.

- The applicant should discuss the relationship between atmospheric diffusion parameters, such as vertical plume spread (σ_z), and measured meteorological parameters. The applicant should substantiate the use of these parameters in terms of the appropriateness of their use in estimating the consequences of routine releases from the site boundary to a radius of 50 miles from the plant site.

- The applicant should provide the meteorological data used as input to the dispersion models. Data used for this evaluation should represent hourly average values of wind speed, wind direction, and atmospheric stability, which are appropriate for each mode of release. The data should reflect atmospheric transport and diffusion conditions in the vicinity of the site throughout the course of a year.

- The applicant should provide the relative concentration (χ/Q) and relative deposition (D/Q) values used for assessing the consequences of routine radioactive gas releases, as described in Section 2.3.5.2 of RG 1.70.

- The applicant should identify points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations (if available at the ESP stage). Bounding values for these parameters may be provided at the ESP stage. In such a case, the applicant will need to confirm, at the COL or CP stage, that the parameters provided at the ESP stage bound the actual values provided at the COL or CP stage, and that the calculational methodology used for the confirmation is consistent with that employed at the ESP stage.

2.3.5.3 Technical Evaluation

The applicant generated its atmospheric diffusion estimates for routine airborne releases of radioactive effluents to the site boundary and special receptors of interest using the staff-endorsed computer code XOQDOQ. The staff evaluated the applicability of the XOQDOQ model and concluded that no unique topographic features preclude the use of the XOQDOQ model for the North Anna ESP site. The staff also reviewed the applicant's input to the XOQDOQ computer code, including the assumptions it used concerning plant configuration and release characteristics and the appropriateness of the meteorological data input. The staff found that the applicant made conservative assumptions by treating all releases as ground-level releases. The staff made an independent evaluation of the resulting atmospheric diffusion estimates by running the XOQDOQ computer model and obtaining similar results.

From this review, the staff concludes that the applicant used an appropriate atmospheric dispersion model and adequate meteorological data to calculate relative concentration and relative deposition at appropriate distances from postulated release points for the evaluation of routine airborne releases of radioactive material. Any COL or CP applicant referencing this information should verify that the specific release point characteristics (e.g., release height and building wake dimensions) and specific locations of receptors of interest (e.g., nearest resident or garden) used to generate the ESP long-term (routine release) atmospheric dispersion site characteristics bound the actual values provided at the COL or CP stage. This is **COL Action Item 2.3-3**.

The staff intends to include the long-term (routine release) atmospheric dispersion factors listed in Table 2.3.5-2 as site characteristics in any ESP that the NRC might issue for the North Anna ESP site.

Table 2.3.5-2 Staff's Proposed Long-Term (Routine Release) Atmospheric Dispersion Site Characteristics

SITE CHARACTERISTIC	VALUE	DEFINITION
Annual Average Undepleted/No Decay χ/Q Value @ EAB	3.7×10^{-6} s/m^3	The maximum annual average EAB undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ EAB	3.7×10^{-6} s/m^3	The maximum annual average EAB undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/8.00-Day Decay χ/Q Value @ EAB	3.3×10^{-6} s/m^3	The maximum annual average EAB depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ EAB	1.2×10^{-8} 1/m^2	The maximum annual average EAB D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Resident	2.4×10^{-6} s/m^3	The maximum annual average resident undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ Nearest Resident	2.4×10^{-6} s/m^3	The maximum annual average resident undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/8.00-Day Decay χ/Q Value @ Nearest Resident	2.1×10^{-6} s/m^3	The maximum annual average resident depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Resident	7.2×10^{-9} 1/m^2	The maximum annual average resident D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Meat Animal	1.4×10^{-6} s/m^3	The maximum annual average meat animal undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ Nearest Meat Animal	1.4×10^{-6} s/m^3	The maximum annual average meat animal undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual

SITE CHARACTERISTIC	VALUE	DEFINITION
Annual Average Depleted/8.00-Day Decay χ/Q Value @ Nearest Meat Animal	1.2×10^{-6} s/m^3	The maximum annual average meat animal depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Meat Animal	3.1×10^{-9} 1/m^2	The maximum annual average meat animal D/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/No Decay χ/Q Value @ Nearest Vegetable Garden	2.0×10^{-6} s/m^3	The maximum annual average vegetable garden undepleted/no decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Undepleted/2.26-Day Decay χ/Q Value @ Nearest Vegetable Garden	2.0×10^{-6} s/m^3	The maximum annual average vegetable garden undepleted/2.26-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average Depleted/8.00-Day Decay χ/Q Value @ Nearest Vegetable Garden	1.8×10^{-6} s/m^3	The maximum annual average vegetable garden depleted/8.00-day decay χ/Q value for use in determining gaseous pathway doses to the maximally exposed individual
Annual Average D/Q Value @ Nearest Vegetable Garden	6.0×10^{-9} 1/m^2	The maximum annual average vegetable garden D/Q value for use in determining gaseous pathway doses to the maximally exposed individual

2.3.5.4 Conclusions

As set forth above, the applicant has provided meteorological data and an atmospheric dispersion model that are appropriate for the characteristics of the site and release points. The applicant has calculated representative atmospheric transport and diffusion conditions for 16 radial sectors from the site boundary to a distance of 50 miles, as well as for specific receptor locations. The staff has reviewed the long-term atmospheric dispersion estimates that the applicant proposed for inclusion as site characteristics in an ESP for its site (should one be issued) and, for the reasons set forth above, finds these estimates to be acceptable. Therefore, the staff concludes that the applicant has provided the information needed to address the requirements of 10 CFR 100.21(c)(1).

Based on these considerations, the staff concludes that the applicant's characterization of long-term atmospheric transport and diffusion conditions is appropriate for use in demonstrating compliance with the numerical guides for doses contained in Appendix I to 10 CFR Part 50.

The applicant provided bounding values for points of routine release of radioactive material to the atmosphere, the characteristics of each release mode, and the location of potential receptors for dose computations. Any COL or CP applicant must confirm that the parameters provided at the ESP stage bound the actual values provided at the COL or CP stage, and that the calculational methodology used for the confirmation is consistent with that employed at the ESP stage.