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Chapter 2 Site Characteristics

This chapter describes the Plant Parameters Envelope (PPE) and associated site characteristics and site-related design parameters, and the geological, seismological, hydrological, and meteorological characteristics of the proposed VCS site and vicinity. The site characteristics are described in conjunction with present and projected population distributions, land use, site activities, and controls. The site characteristics are developed in accordance with the relevant requirements of 10 CFR Parts 20, 50, 52, and 100, and are consistent with guidance provided in RG 1.206. The site location and description are provided in sufficient detail to support a safety assessment.

Chapter 2 is divided into six sections:

- Plant Parameters Envelope (Section 2.0)
- Geography and demography (Section 2.1)
- Nearby industrial, transportation, and military facilities (Section 2.2)
- Meteorology (Section 2.3)
- Hydrologic engineering (Section 2.4)
- Geology, seismology, and geotechnical engineering (Section 2.5)

2.0 Plant Parameters Envelope

The required contents of an ESP application are specified in 10 CFR 52.17. The application should specify the number, type and thermal power level of the facilities for which the ESP site may be used [10 CFR 52.17(a)(1)(i)]. The concept of a PPE is used to describe the bounding plant for which the ESP site is suitable. This PPE concept has been accepted by the NRC (Reference 2.0-1). The PPE, its development, and its use in this application are presented in the following sections. This PPE approach provides sufficient design details to support NRC review of the ESP application while also recognizing that technological developments may result in new reactor technologies becoming available that may not have been envisioned at the time of the ESP application submittal. The actual design selected would be reviewed at the time of a COL application to ensure that the design fits within the PPE envelope. Any differences would be addressed in the COL application.

2.0.1 Plant Parameters Envelope Approach

A listing of plant parameters necessary to define the plant-site interface—the PPE—was developed in the early 1990s based on work sponsored by the U.S. Department of Energy (DOE) and the nuclear industry, which included reactor vendors and utilities. The effort was intended to provide a

comprehensive list of plant parameters to accurately characterize a plant at a site. Over time, this list has evolved to encompass information needed to support development of an ESP application, including the SSAR and the Environmental Report.

The PPE developed in support of the VCS ESP application is based on data from selected light-water cooled reactor designs. To ensure that the resulting PPE has the flexibility to bound multiple reactor designs, these designs are selected to provide a broad cross section of available light-water reactors. Brief descriptions of each of these reactor types are included in Section 1.10. The VCS site is not intended to be limited to the designs selected to create the PPE, but rather to provide a broad overall outline of a design concept and to include other potential designs if they can be demonstrated to fall within the parameter values listed in Table 2.0-1 and discussed elsewhere in the SSAR.

2.0.2 Site Characteristics and Site-Related Design Parameters

Table 2.0-1 provides a summary listing of the proposed VCS site characteristics and site-related design parameters. Part 1 of the table lists important site characteristics that have been established by analyses presented throughout the SSAR and those that are necessary to establish the findings required by 10 CFR 52 and 10 CFR 100 on the suitability of the proposed VCS site. Part 2 of the table provides a listing of site-related design parameters and assumptions about the design of a nuclear power plant that might in the future be constructed on the VCS site. It is necessary to assume certain design parameters in order to assess site characteristics. The selected design parameter values are the single largest (or smallest) value for each category, applying engineering, safety and environmental conservatism as necessary to select the appropriate value. Definitions for each characteristic and parameter and references to where additional information may be found are also provided in Table 2.0-1. This summary listing is intended to support development of a Table of Site Characteristics and Plant Design Parameters for the Early Site Permit.

2.0.3 Liquid and Gaseous Releases

The liquid and gaseous activity releases (source terms) during normal plant operation are shown in Tables 11.2.3-2 and 11.3.3-2, respectively, for a single new unit, except for mPower. The mPower source terms are based on six units, as discussed in Chapter 11. The composite activities are based on the AP1000, APWR, ABWR, ESBWR, and mPower designs. The PPE conservative bounding composite source term values presented in Tables 11.2.3-2 and 11.3.3-2 are adopted as the bounding, site-specific PPE values. These bounding values were obtained by identifying the bounding activity for each radionuclide for the technologies identified in Section 1.10.

Table 11.2.3-3 shows the total liquid effluent concentrations from the new units and compares them to the effluent concentration limits (ECLs) in 10 CFR 20, Appendix B, Table 2, Column 2. Table 11.3.3-3 shows the maximum airborne activity concentrations at the site boundary from the proposed new units and compares them to the ECLs in 10 CFR 20, Appendix B, Table 2, Column 1. The gaseous

effluent concentrations are calculated based on the conservative bounding composite activity releases for the proposed new units and the respective atmospheric dispersion factors at the site boundary. The sum of the fractions of ECLs for liquid releases is less than 1, in conformance with 10 CFR 20. The sum of fractions of ECLs for gaseous releases is just above the regulatory limit of 1, using conservative, bounding composite source terms. As indicated in Chapter 11, the sum of fractions of ECLs will be confirmed to be less than 1 at the time of COL application stage, when the reactor technology has been selected.

2.0.4 References

2.0-1 Letter from James E. Lyons of USNRC to Dr. Ronald L. Simard of NEI, dated February 5, 2003.

Table 2.0-1 (Sheet 1 of 7)
Site Characteristics and Site-Related Design Parameters

Part 1 — Site Characteristics

Item	Site-Specific Value[(a)]	Description	References
Maximum Rainfall Rate	19.4 inches/hour 6.2 inches/5-minutes	PMP for 1-hour and for 5-minute durations at the site estimated from HMR 52.	Refer to Subsection 2.4.2.3.
Snow Load and Ice Load			
• Normal Winter Precipitation Event	9.4 psf	The maximum of the 1) 100-year return snowpack (snow cover), 2) historical snowpack (snow cover), 3) 100-year return snowfall event, or 4) historical maximum snowfall event.	Refer to Subsection 2.3.1.3.4.
• Extreme Frozen Precipitation Event	9.4 psf	The maximum of the 1) 100-year return snowfall event or 2) historical maximum snowfall event.	Refer to Subsection 2.3.1.3.4.
• Extreme Liquid Winter Precipitation Event	177 psf (equivalent to depth of 34.0 inches of precipitation)	The 48-hour maximum winter precipitation depth (assumes no roof drainage provided).	Refer to Subsection 2.3.1.3.4.
Design Response Spectra	Ground Motion Response Spectra	The free field surface ground motion at a depth of approximately 100 feet using the subsurface material properties characterization of Subsection 2.5.4 and the methodology specified in Subsection 2.5.2.6.	Refer to Subsection 2.5.2.
Peak Ground Acceleration	0.1 g	The acceleration corresponds to the zero periods in the response spectra taken in the free field at plant grade	Refer to Subsections 2.5.4.7.5, 2.5.4.8, 2.5.4.10.4, and 2.5.4.10.5.
Capable Tectonic Structures or Sources	No active tectonic structure within the plant zone	The assumption made in plant design about the presence of capable faults or earthquake sources in the vicinity of the plant site (e.g., no fault displacement potential within the investigative area).	Refer to Subsections 2.5.3.
Maximum Flood (or Tsunami)	91.0 feet NAVD 88	The predicted maximum flood level from external events, not including local PMP.	Refer to Subsections 2.4.2, 2.4.4, and 2.4.10.
Maximum Groundwater	85.0 feet NAVD 88	The maximum groundwater level under the power block area.	Refer to Subsection 2.4.12 and Appendix 2.4.12-C.

Table 2.0-1 (Sheet 2 of 7)
Site Characteristics and Site-Related Design Parameters

Part 1 — Site Characteristics

Item	Site-Specific Value[(a)]	Description	References
Soil Properties			
• Liquefaction	Negligible at site-specific response (PGA = 0.1g)	Liquefaction potential at the site.	Refer to Subsection 2.5.4.8.
• Minimum Bearing Capacity (Static)	Values in Table 2.5.4-88 (ESBWR example only)	Allowable load-bearing capacity of layer supporting plant structures.	Refer to Subsection 2.5.4.10, Table 2.5.4-88.
• Minimum Shear Wave Velocity	Values in Tables 2.5.4-51, 2.5.4-53, and 2.5.4-A-51.	Propagation velocity of shear waves through foundation materials.	Refer to Subsections 2.5.4.7.2.1 and 2.5.4.4.5 and Tables 2.5.4-51, 2.5.4-53, and 2.5.4-A-51.
• Dynamic Bearing Capacity	Values in Figures 2.5.4-135 and 2.5.4-136 (ESBWR example only)	Capacity of the foundation soil/rock to resist loads imposed by the structures in the event of an earthquake.	Refer to Subsection 2.5.4.10 and Figures 2.5.4-135 and 2.5.4-136.
• Minimum Soil Angle of Internal Friction	Greater than or equal to 35 degrees (foundations bearing on in-situ sands or compacted structural fill)	Minimum value of the internal friction angle of foundation soils, fill soils, or excavation slopes that would provide a safe design.	Refer to Subsection 2.5.4.2.1.4.1.
Tornado			
• Maximum Pressure Drop	0.9 psi	Decrease in ambient pressure from normal atmospheric pressure at the site, due to the passage of a tornado having a probability of occurrence of 10^{-7} per year.	Refer to Subsection 2.3.1.3.2.
• Maximum Rotational Speed	160 mph	Rotation component of maximum wind speed at the site, due to the passage of a tornado having a probability of occurrence of 10^{-7} per year.	Refer to Subsection 2.3.1.3.2.
• Maximum Translational Speed	40 mph	Translation component of maximum wind speed at the site, due to the movement across the ground of a tornado having a probability of occurrence of 10^{-7} per year.	Refer to Subsection 2.3.1.3.2.

Table 2.0-1 (Sheet 3 of 7)
Site Characteristics and Site-Related Design Parameters

Part 1 — Site Characteristics

Item	Site-Specific Value[(a)]	Description	References
• Maximum Wind Speed	200 mph	Sum of the maximum rotational and maximum translational wind speed components at the site, due to passage of a tornado having a probability of occurrence of 10^{-7} per year.	Refer to Subsection 2.3.1.3.2.
• Radius of Maximum Rotational Speed	150 feet	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.	Refer to Subsection 2.3.1.3.2.
• Maximum Rate of Pressure Drop	0.4 psi/sec	Maximum rate of pressure drop at the site, due to passage of a tornado having a probability of occurrence of 10^{-7} per year.	Refer to Subsection 2.3.1.3.2.
Basic Wind Speed	121 mph for a 3-second gust (105 mph fastest mile)	Wind velocity associated with a 100-year return period in the site area.	Refer to Subsection 2.3.1.3.1.
Site Characteristic Ambient Air Temperatures		Site characteristic wet bulb and dry bulb temperatures associated with the listed exceedance values and the 100-year return period.	Refer to Subsection 2.3.1.5.
• Maximum Dry Bulb Temperature			
2% Annual Exceedance	92.9˚F Dry Bulb 76.6˚F Coincident Wet Bulb		
1% Annual Exceedance	94.4˚F Dry Bulb 76.5˚F Coincident Wet Bulb		
0.4% Annual Exceedance	96.2˚F Dry Bulb 76.3˚F Coincident Wet Bulb		
0% Annual Exceedance	109.4˚F Dry Bulb 75.2˚F Coincident Wet Bulb		
100-Year Return Period	111.3˚F Dry Bulb 70.7˚F Coincident Wet Bulb		

Table 2.0-1 (Sheet 4 of 7)
Site Characteristics and Site-Related Design Parameters

Part 1 — Site Characteristics

Item	Site-Specific Value[(a)]	Description	References
• Maximum Non-Coincident Wet Bulb Temperature			
2% Annual Exceedance	78.7˚F		
1% Annual Exceedance	79.3˚F		
0.4% Annual Exceedance	80.0˚F		
0% Annual Exceedance	84.4˚F		
100-Year Return Period	86.1˚F		
• Minimum Dry Bulb Temperature			
2% Annual Exceedance	>33.3˚F		
1% Annual Exceedance	33.3˚F		
0.4% Annual Exceedance	29.1˚F		
0% Annual Exceedance	10˚F		
100-Year Return Period	3.6˚F		
Atmospheric Dispersion (X/Q) (Accident)		Atmospheric dispersion coefficients used in the design safety analyses to estimate dose consequences of accident airborne releases.	Refer to Subsection 2.3.4.2 and Chapter 15.
• 0–2 hr @ EAB	2.66×10^{-4} sec/ m^3		
• 0–8 hr @ LPZ	1.55×10^{-5} sec/ m^3		
• 8–24 hr @ LPZ	1.01×10^{-5} sec/ m^3		
• 1–4 day @ LPZ	4.20×10^{-6} sec/ m^3		
• 4–30 day @ LPZ	1.19×10^{-6} sec/ m^3		
Atmospheric Dispersion (X/Q) (Annual Average)	1.8×10^{-5} sec/m^3	Maximum annual average atmospheric dispersion coefficient at the EAB.	Refer to Subsection 2.3.5.

Table 2.0-1 (Sheet 5 of 7)
Site Characteristics and Site-Related Design Parameters

Part 1 — Site Characteristics

Item	Site-Specific Value[(a)]	Description	References
Dose Consequences (Gaseous Releases)			
• Normal	10 CFR 20, 10 CFR 50 Appendix I	The estimated design radiological dose consequences due to gaseous releases from normal operation of the plant.	Refer to Chapter 11.
• Post-Accident	10 CFR 50.34(a)(1), 10 CFR 100	The estimated design radiological dose consequences due to gaseous releases from postulated accidents.	Refer to Chapter 15.
Release Point (Gaseous Releases)			
• Minimum Distance to the Site Boundary	3274 feet	Minimum lateral distance from the release point to the site boundary.	Refer to Figures 2.1-3 and 2.1-6.
Source Term (Gaseous Releases)			
• Normal	Values in Table 11.3.3-2	The annual activity, by isotope, contained in routine plant airborne effluent streams.	Refer to Table 11.3.3-2.
Dose Consequences (Liquid Releases)			
• Normal	10 CFR 20 Appendix B, 10 CFR 50 Appendix I	The estimated design radiological dose consequences due to liquid effluent releases from normal operation of the plant.	Refer to Section 11.2.
• Post-Accident	10 CFR 20, 10 CFR 100	The estimated design radiological dose consequences due to liquid effluent releases from postulated accidents.	Refer to Subsection 2.4.13.
Source Term (Liquid Releases)			
• Normal	Values in Table 11.2.3-2	The annual activity, by isotope, contained in routine plant liquid effluent streams.	Refer to Table 11.2.3-2.
Exclusion Area Boundary (EAB)	10 CFR 100.21(a) Meets requirement	The perimeter of an oval, 9000 feet in the plant east-west direction, and 8000 feet in the plant north-south direction.	Refer to Figures 2.1-3 and 2.1-4.

Table 2.0-1 (Sheet 6 of 7)
Site Characteristics and Site-Related Design Parameters

Part 1 — Site Characteristics

Item	Site-Specific Value[(a)]	Description	References
Low Population Zone (LPZ)	10 CFR 100.21(a) Meets requirement	A 5-mile radius circle centered at the power block area reference point.	Refer to Subsection 2.1.3.4 and Figure 2.1-5.
Population Center Distance	10 CFR 100.21(b) Meets requirement	The distance from the power block area to the nearest boundary of a population center containing more than 25,000 residents. This distance should not be less than 1.33 times the distance from the power block area to the outer boundary of the LPZ (i.e., 6.7 miles for VCS).	Refer to Subsection 2.1.3.5 and Figure 2.1-16.

Table 2.0-1 (Sheet 7 of 7)
Site Characteristics and Site-Related Design Parameters

Part 2 — Site-Related Design Parameters			
Item	**Bounding Value[(a)]**	**Description**	**References**
Structure Height	230 feet	The height from finished grade to the top of the tallest power block structure, excluding stacks and cooling towers.	Refer to Subsection 2.3.3.2.3 and Table 2.3.3-2.
Structure Foundation Embedment	110 feet	The depth from finished grade to the bottom of the basemat for the most deeply embedded power block structure.	Refer to Subsections 2.4.12 and 2.5.4.5.2.
Plant Megawatts Thermal	425 MWt to 4500 MWt	The thermal power generated by one unit.	Refer to Section 1.10 and Subsection 1.2.2.
Maximum Cooling Water Flow Rate	1,280,000 gpm [2,560,000 gpm]	Design value for the maximum flow rate of the circulating water system through the condenser tubes	Refer to Subsection 2.4.8.1.
Minimum Site Grade	95.0 feet NAVD 88	Minimum finished ground elevation in the power block area.	Refer to Subsection 2.4.1.1.
Release Point Elevation			
• Post-Accident	Ground Level	The elevation above finished grade of the release point for releases due to an accident.	Refer to Subsection 2.3.4.

(a) Values shown are for a single unit, but would be the same value for each additional unit, unless a second bracketed number is provided. If a second bracketed number is provided, the first number represents the value for one unit and the bracketed number represents the value for two units.