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Environmental Impact Statement for an Early Site Permit (ESP) at the North Anna ESP Site

Final Report

Main Report

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cooling systems, Dominion has proposed using combination wet and dry cooling towers for Unit 3 and dry cooling towers for Unit 4. The proposed location for the cooling towers is illustrated in Figure 3-1.

3.2 Plant Parameter Envelope

An applicant for an ESP need not provide a detailed design of a reactor or reactors and the associated facilities, but should provide sufficient values for parameters for the reactor or reactors and the associated facilities so that an assessment of site suitability can be made. Consequently, the ESP application may refer to a PPE as a surrogate for a nuclear power plant and its associated facilities.

A PPE is a set of values of plant design parameters that an ESP applicant expects would bound the design characteristics of the reactor or reactors that might be constructed at a given site. The PPE values are surrogates for actual reactor design information. Analysis of environmental impacts based on a PPE approach permits an ESP applicant to defer the selection of a reactor design until the construction permit (CP) or combined construction and operating license (combined license or COL) stage. The PPE reflects the value of each parameter that it encompasses rather than the characteristics of any specific reactor design.

In its North Anna ESP application, Dominion used a composite of values from seven reactor designs to develop the PPE for the ESP application. The values in this EIS are not design-specific; rather, they are used to determine the environmental impacts of a reactor design that falls within the values used in this report. The reactor designs used to develop the PPE include the following five light-water reactor and two gas-cooled reactor types:

- Canada Deuterium Uranium Reactor (ACR-700) – This reactor, developed by Atomic Energy Canada Limited, is an evolutionary extension of the CANDU 6 plant using very slightly enriched uranium fuel and light-water cooling.

- Advanced Boiling Water Reactor (ABWR) – This reactor, developed by General Electric Company (GE), is a standardized plant that has been certified under the NRC requirements in Title 10 of the Code of Federal Regulations (CFR) Part 52, Appendix A. The ABWR is fueled with slightly enriched uranium and uses light-water cooling.

- Advanced Pressurized Water Reactor (AP1000) – This is an earlier version of the AP1000 reactor design developed by Westinghouse Electric Company, using slightly enriched uranium and light-water cooling. This design is not the standard AP1000 that has been certified by the NRC in 10 CFR Part 52, Appendix D; therefore, this design is referred to as the "surrogate AP1000."

The two proposed units employ considerably different cooling systems with different water needs (Dominion 2006). The proposed Unit 3 would use a closed-cycle, combination wet and dry cooling tower system.

The plant would primarily use wet towers to cool Unit 3 during periods of relative water surplus, which are defined as periods when the water surface elevation of Lake Anna is at or above elevation 76.2 m (250 ft) above mean sea level (MSL). In the ER, this cooling mode for Unit 3 is termed the Energy Conservation (EC) mode.

During periods when the elevation of Lake Anna is below 76.2 m (250 ft) MSL for a period of seven or more consecutive days, Unit 3 would be cooled with a closed-cycle, combination wet and dry cooling tower system to limit consumptive water use. Dominion terms this cooling mode for Unit 3 as the Maximum Water Conservation (MWC) mode. In this mode, all or part of the excess heat generated by Unit 3 operation would be dissipated using a dry cooling tower. If atmospheric conditions were such that Unit 3 dry cooling towers could not completely cool the circulating water, Dominion would employ wet towers to dissipate the remaining excess heat. The heat from the turbine generator is transferred to the cooling water in the surface condenser. The cooling water passes through the dry cooling tower and, in the MWC mode, transfers a minimum of one-third of the heat to the atmosphere. The dry cooling towers would be designed to remove at least one-third of the excess heat from Unit 3 under worst-case atmospheric conditions. Cooling water leaving the dry towers would then pass through the wet towers to remove the balance of condenser/heat exchanger rejected heat by spraying the water into a forced or induced air stream. After passing through the cooling towers, the cooled water would be recirculated back to the surface condenser to complete the closed-cycle cooling water loop. Make-up water to the circulating water system and service water cooling system would be obtained from Lake Anna. Blowdown (recirculating water removed from the cooling system to reduce the buildup of contaminants, such as dissolved solids) from the cooling systems would be discharged to the existing plant WHTF discharge canal.

Unit 4 would use a dry cooling system that transfers heat directly from the condenser to an air cooled heat exchanger without the use of Lake Anna cooling water.

3.2.2.1 Description and Operational Modes

The operating modes for the proposed Units 3 and 4 under normal operating and emergency/shutdown conditions are described in the following paragraphs. In the ER, Dominion states that the minimum lake level for operation of the proposed units would be an elevation of 73.8 m (242 ft) MSL. The calculated minimum lake level under drought conditions is 74.74 m (243.5 ft) MSL.

Unit 3 Normal Cooling

Dominion states that the bounding thermal power generated by Unit 3 would be 4500 MW(t), and that the bounding heat rejection rate to the environment would be 3020 MW (1.03×10^{10} Btu/hr). Excess heat generated by the unit would be dissipated through the use of a series of closed-cycle cooling towers that can operate in two modes: EC and MWC modes.

The EC mode of rejecting excess heat generated by Unit 3 would be employed when surplus water is available from Lake Anna. Surplus water would be considered available when (1) the lake level elevation of Lake Anna is at or above 76.2 m (250 ft) MSL or (2) the lake level elevation is below elevation 76.2 m (250 ft) MSL for a period of less than seven consecutive days.

In the EC mode, excess heat generated by Unit 3 would be dissipated by closed-cycle wet cooling towers. Makeup water would be supplied from Lake Anna at a maximum flow rate of 1405 L/s (22,268 gpm). The blowdown flow rate and the related evaporation rate associated with the wet cooling towers would vary depending on thermal output from the unit and environmental conditions. In its PPE, Dominion states that the maximum evaporation rate would be 1053 L/s (16,695 gpm) and the maximum blowdown discharge would be 351 L/s (5565 gpm) in the EC mode.

The MWC mode of rejecting excess heat generated by Unit 3 would be employed when water levels in the lake drop below elevation 76.2 m (250 ft) MSL for a period of one week or more. Under favorable meteorological conditions, the entire excess heat load from Unit 3 would be dissipated using closed-cycle dry cooling towers. These towers would be sized so that under the worst-case conditions (i.e., full power operation and a hot and humid atmosphere at tower level), a minimum of one-third of excess heat from Unit 3 would be dissipated via the dry tower system. The remaining excess heat would be dissipated by the wet tower system. Therefore, although the MWC mode uses less water than the EC mode, it is possible that up to two-thirds of the total heat load would be dissipated by wet cooling.

In the MWC mode, the maximum makeup flow rate from Lake Anna to the wet tower system would be 971 L/s (15,384 gpm). The maximum blowdown discharge and evaporation rate from the wet towers are 245 L/s (3844 gpm), and 728 L/s (11,532 gpm), respectively.

Unit 4 Normal Cooling

During normal operation, the proposed Unit 4 would use a system of closed-loop dry cooling towers. The makeup water flow rate to the circulating water system would be negligible (on the order of 0.06 L/s [1 gpm]). No blowdown would be generated by these towers.

Ultimate Heat Sink

For safety-related cooling, an ultimate heat sink (UHS) would be constructed to provide water for reactor cooling and safety-related components of Units 3 and 4. The same UHS design would be used for each unit. Each UHS would be composed of a mechanical draft cooling tower with a 71.6 m wide by 107 m long by 15.2 m deep (235 ft wide by 350 ft long by 50 ft deep) engineered underground basin constructed beneath each tower (Dominion 2004). These basins would be large enough to store a water volume of 1.16×10^5 m^3 (3.06×10^7 gal), which is adequate to hold a 30-day supply of emergency cooling water (Dominion 2006). During periods when the ultimate heat sink cooling towers are in operation, the towers would withdraw a maximum makeup flow of 110 L/s (1700 gpm) from the two basins. The blowdown from the UHS towers would be discharged into the WHTF.

During periods of normal plant operation, a negligible volume of makeup water would be used to offset any water losses from the UHS basins. This water would originate from Lake Anna (Dominion 2006).

3.2.2.2 Component Descriptions

The following sections describe the intake, discharge, and heat dissipation systems for proposed Units 3 and 4. Pursuant to Sections 316(a) and 316(b) of the Clean Water Act, an applicant for a CP or COL referencing an ESP for the North Anna ESP site would be required to obtain approval from the Commonwealth of Virginia by documenting plant design and conducting site-specific analyses regarding the impacts of the thermal discharges and operation of the intake systems on the Lake Anna aquatic environment.

Intake System

The proposed location of the intake structure for Unit 3 is shown in Figure 3-1. Any makeup water required for Unit 4 could be obtained from the Unit 3 intake. The location of the intake would be in the same approximate location as the intakes planned for the two additional power reactor units proposed at the time that NAPS Units 1 and 2 were licensed. The size of the proposed intake structure to support Unit 3 operation is 21 m (70 ft) long and 21 m (70 ft) wide. The intake system for Unit 3 would consist of a structure next to the lake with trash racks, traveling screens, and pump bays, similar to the design currently in use by Units 1 and 2. Dominion expects no major modifications to the shoreline or the existing intake channel. The existing cofferdam would be modified to allow water access from Lake Anna.

Discharge System

Blowdown discharge from the wet towers associated with Unit 3 would enter the WHTF via the discharge canal currently used by the existing units. The PPE maximum blowdown discharge from Unit 3 would be 351 L/s (5565 gpm). There would be no blowdown discharge from Unit 4. The discharge canal and WHTF canal system were designed to convey approximately 230,000 L/s (8000 cfs), and the maximum flow rate from the existing units is approximately 120,000 L/s (4300 cfs). The discharge canal and WHTF system could therefore easily accommodate the extra water discharged by the proposed units. Dominion stated that it may combine the blowdown flow from Unit 3 with the discharge from the existing NAPS units and use the current Unit 1 and 2 discharge structure, or utilize the partially completed discharge structure planned for the two additional power reactors proposed at the time NAPS Units 1 and 2 were licensed (see Figure 3-1) (Dominion 2006).

Heat Dissipation Systems

The normal cooling needs of Unit 3 would be provided by a closed-cycle, combination wet and dry tower system. The percentage of excess heat dissipated by the dry towers would depend on the availability of water from Lake Anna and ambient environmental conditions. If excess water were available, Unit 3 would be cooled entirely by use of the wet towers. Under times of relative drought and favorable meteorological conditions, the majority of the Unit 3 waste heat would be dissipated by the dry towers.

The normal cooling needs of Unit 4 would be provided solely by a closed-cycle dry tower system. Unit 4 would have a negligible consumptive water demand on Lake Anna.

Wet cooling tower systems rely primarily on evaporative heat transfer to the atmosphere to dissipate the rejected thermal load. Dry cooling tower systems rely entirely on sensible heat transfer between the fluid circulating in the condenser loop and the ambient air. Dry towers are completely closed systems and therefore use negligible amounts of makeup water and produce negligible blowdown water. Dry cooling towers use large fans to keep air flowing over their radiators, so there is an associated high energy cost that significantly reduces plant efficiency. The efficiency penalty of dry cooling towers can exceed 12 percent (EPA 2001). Dominion's combination wet and dry cooling system would have an energy efficiency penalty of 1.7 to 4 percent (Dominion 2006).

For safety-related cooling, the UHS for each of the proposed Units 3 and 4 would provide water to the reactor cooling systems and safety-related components. As proposed, both plants would use the same UHS design, which would be composed of a mechanical draft cooling tower with an engineered basin constructed underground beneath it (Dominion 2006). The basin would have a storage capacity adequate to hold a 30-day supply of emergency cooling water.