STAFF EXHIBIT B

EXHIBIT B: NORTH ANNA ESP ENVIRONMENTAL QUESTIONS

No.	EIS Page	Inquiry	Answer (Including Author, SME, and Key Documents)
1	1-3 to 4	The FEIS states that an ESP "applicant may elect to use a PPE approach instead of supplying specific design information," and that the PPE "should provide sufficient bounding parameters and characteristics of the reactor or reactors and the associated facilities so that an assessment of the site suitability can be made." However, the Staff acknowledges that, in numerous instances, Dominion Nuclear North Anna, LLC (Dominion) failed to provide the necessary PPE information or the specific design information. For example, the FEIS states "Dominion did not or was unable to provide information and analysis for certain issues sufficient to allow the NRC Staff to complete its analysis. For such issues, Dominion did not offer, nor did the Staff identify, bases for assumptions that would allow resolution. The Staff was unable to determine a unique significance level for such issues, and therefore, these issues are not resolved for the North Anna ESP site." P 1-5. Some specific examples are listed on FEIS Appendix J.3. Under these circumstances:	
		A. Please explain why the Staff did not require the applicant to at least provide the PPE information on these matters.	With respect to the specific issues identified as unresolved in Table J-3 relating to design: **Water Quality-Chemical Concentrations of waste streams – FEIS Section 5.3.3 --** For Unit 3, this is a PPE value and it was requested of Dominion by the Staff in its March 2, 2006 letter requesting additional information. However, as stated in Section 5.3.3 of the FEIS, concentrations of waste streams other than Unit 3 blowdown to the WHTF were not defined. The reason is that design-level information is not available.

			Alternatives to Mitigate Severe Accidents -FEIS Section 5.10.3 -- For the North Anna ESP application, a design was not selected. Review Standard, RS-002, Processing Applications for Early Site Permits, states that the SAMA review can be deferred to the COL stage, at which time detailed design information will be available. Therefore, this issue would need to be resolved in review of the CP or COL application with the design is known. **Design and Severe Accident Impacts - FEIS Section 5.10.3** – Design and severe accident impacts are unresolved for gas-cooled reactors due to insufficient information concerning these designs. This issue would be resolved in the CP or COL application if a gas-cooled design is selected. **Fuel Cycle Impacts and Solid Waste Management - FEIS Section 6.1**– Environmental impacts from the uranium fuel cycle activities and solid waste management for other than light-water reactors are not resolved. **Transportation - FEIS 6.2.4** – For gas-cooled reactors, the impacts [of transporting fuel and radioactive waste to and from the reactor] are likely to be small, but this issue is not resolved because of the lack of verifiable information on these designs. Verifiable information is lacking about un-irradiated and spent fuel shipping cask designs, fuel performance under applied mechanical and thermal accident conditions, un-irradiated fuel initial core/refueling requirements, spent fuel generation rates, and radioactive waste generation rates. **Decommissioning - FEIS Section 6.3** – Because a design was not selected, this issue is to be resolved in a CP or COL application when a design is selected. **The chronic effect of electromagnetic fields** is unresolved (see the Staff's response to Board Question 5B) With regard to these issues, the Staff developed a reasonable estimate of the impacts for comparison purposes (see FEIS Chapter 9), but did not consider the information provided to be sufficient to resolve the issue. In accordance with Attachment 3 to Review Standard (RS)-002, the Staff requested that the applicant provide sufficient information to formulate a reasonable estimate of the impacts. The applicant did not have the information that would be necessary to resolve the issue.

			If this ESP is granted and a CP or COL application is submitted which references this ESP, then the applicant would have to submit a full evaluation of applicable unresolved issues. The applicant would not, at that time, evaluate gas-cooled reactor designs if it were to select a light-water reactor design. Author: John S. Cushing SME: Andrew Kugler Key Documents: NUREG-1811; RS-002, "Processing Applications for Early Site Permits," May 3, 2004.
		B. Legal Question: Given that the applicant has left many gaps in the PPE information, please explain why issuance of an ESP here does not violate the Commission's prohibition on issuing "partial ESPs" and the Commissions statement that "where adequate information is not available, early site permits will not be issued." 54 Fed. Reg. 15372, 15378 n.3 (April 18, 1989).	*See* the "NRC Staff Legal Brief in Response to Licensing Board's Environment-Related Questions."
		C. Legal Question: How should the NRC and this Board distinguish between ESP applications that should be denied because "adequate information is not available" and ESP applications that can still be granted, even though the applicant has failed to provide either the "specific design information" or the "sufficient bounding parameters" (i.e., the PPE)?	Historically, a key assumption behind the use of the "obviously superior" test for consideration of alternative sites is that the Staff will have considerably more information about the proposed site at its disposal than it will about the alternative sites. This continues to be true for construction permit ("CP") applications submitted pursuant to 10 C.F.R. Part 50 and combined license ("COL") applications submitted pursuant to 10 C.F.R. Part 52. For such applications, the Staff expects that the applicant will have evaluated the environmental impacts of the proposed action at the proposed site in detail. For an early site permit ("ESP"), the level of detail in the application is tempered by the recognition that much of the detailed information expected for a COL application may not be available at the time an ESP application is prepared. As discussed in Review Standard (RS)-002, "Processing Applications for Early Site Permits:" > The ESP application should include sufficient information for the staff to determine what the environmental impacts of constructing and operating nuclear power plant(s) could be. For an ESP application employing the PPE approach, site characteristics, PPE values, and analyses will comprise the ESP bases that will be the focus for comparison during a

			COL review with the design of the actual plant to be constructed on the site. Site-specific parameters (such as meteorology, demographics, and hydrology) should be provided in any ESP application. However, detailed design information pertaining to structures, systems, and components called for in the ESRP need not be submitted by the applicant in an ESP application employing the PPE approach. If PPE values are used as a surrogate for design-specific values, the ESP applicant need not provide a one-to-one replacement for the design-specific values, but should provide sufficient information for the staff to develop a reasonable independent assessment of potential impacts to specific environmental resources. The design-specific information called for in the ESRP may not exist for applicants using the PPE approach, so the NRC review staff should use their experience and judgment accordingly. PPE values do not reflect a specific design and are not to be reviewed by the NRC staff for correctness. However, the NRC staff must determine (1) whether the application is sufficient to enable the NRC staff to conduct its required environmental review, and (2) whether the PPE values are not unreasonable for consideration by the staff when making its findings in accordance with Subpart A of 10 CFR Part 52. The staff should use its judgment to determine whether sufficient information has been provided by the applicant in order for the staff to perform its independent assessment of the environmental impacts of constructing and operating nuclear power plant(s). If a reasonable estimate of the impact to a resource cannot be evaluated from the information provided in the environmental report, then the staff may request additional information so that a reasonable estimate can be made. Thus, the staff is permitted to exercise judgment in its application of the environmental standard review plan (NUREG-1555). This issue will be discussed further in the Staff's response to Board Question 2. In sum, there is an expectation that the level of information available at the ESP stage will be less than that expected to be included in a COL application. Regarding the alternative sites, the applicant is expected to gather

			reconnaissance level information, as stated in Regulatory Guide ("RG") 4.2, Section 9.2.2: > The applicant is not expected to conduct detailed environmental studies at alternative sites; only preliminary reconnaissance-type investigations need be conducted. ESRP 9.3, Section III, page 9.3-7, lists basic sources of this type of information, as follows: • review of the literature • reports from Federal, State, regional, local, and affected Native American tribal agencies such as State geological agencies, EPA, U.S. Department of Agriculture, or county extension offices • regional scientific, engineering, economic, and planning studies • aerial photographs and topographic maps of candidate sites • site-specific information from local citizens and from authorities associated with Federal, State, regional, local, and affected Native American tribal agencies, universities, and museums • onsite inspections (if any) by technical specialists. It is important to note that these sources do not involve new studies or the development of information that does not yet exist in some form. In reviewing the information available for a given resource at a proposed ESP site, the Staff can come to one of three conclusions. First, the Staff may conclude that the available information on a resource at the proposed site is sufficient to allow both the evaluation of the impacts to the resource for purposes of comparison to the alternative sites and the evaluation of the impact to the resource such that the Staff may reach a final conclusion on that impact (*i.e.*, the conclusion need not be revisited at a later licensing

stage unless significant new information is identified). Second, the Staff may conclude that the available information is sufficient to allow the evaluation of the impacts to the resource for purposes of comparison to the alternative sites, but that the information is insufficient to reach a final conclusion as to the impact to the resource at the proposed site. Third, the Staff may conclude that the available information regarding the resource at the proposed site is insufficient for purposes of comparison to the alternative sites, nor is it sufficient to reach a final conclusion on the impact to the resource. Either of the first two cases is acceptable for the purposes of an ESP EIS because the only conclusion that the Staff must reach in the FEIS is whether an obviously superior alternative site has been identified. In the second case, the Staff may compare the impacts to a particular resource at the proposed site with the impacts at the alternative sites based on the information that is available for the proposed site. Only in the third case would the information be so inadequate to warrant rejection of the application. In short, impacts to a particular resource may not be finally determined in an ESP EIS, but this does not prevent the Staff from comparing the proposed and alternative sites with respect to such a resource.

With respect to the application for the North Anna ESP, the Applicant supplied or the Staff obtained sufficient information for most issues to reach a final conclusion on impacts. For a handful of issues, the Staff determined that it could not reach a final conclusion. However, in all of these cases the Staff concluded that it had information sufficient to allow it to compare the impacts for the proposed and alternative sites, which in turn allowed the Staff to determine whether any of the alternative sites was obviously superior to the proposed site. In no instance was the information so inadequate that the Staff could not compare the proposed ESP site to the alternative sites.

For the remainder of the Staff's response to this Board Question, see the "NRC Staff Legal Brief in Response to Licensing Board's Environment-Related Questions."

Author: Andrew Kugler
SME: Andrew Kugler
Key Documents: Regulatory Guide 4.2, Revision 2, "Preparation of Environmental Reports for Nuclear Power Stations;" (RS)-002, "Processing Applications for Early Site Permits," May 3, 2004; NUREG-1555, Section 9.3.

		D. Legal Question: If an applicant fails to provide either specific design information or sufficient PPE information relating to its two proposed gas cooled nuclear reactors, leaving NRC unable to "resolve" numerous environmental and safety issues relating to the site (and given that 10 C.F.R. Part 51 Tables S-3 and S-4 and 10 C.F.R. Part 50 Appendix I do not cover gas cooled nuclear reactors), is it not more appropriate to simply exclude gas cooled reactors from the coverage of the ESP rather than to issue a "partial" ESP with so many unresolved issues?	*See* the "NRC Staff Legal Brief in Response to Licensing Board's Environment-Related Questions."
		E. Legal Question: NEPA requires that the EIS be complete and available to the decision-maker <u>before</u> the decision is made, <u>i.e.</u>, the ESP is issued. <u>See</u> 40 C.F.R. § 1500.1; <u>Private Fuel Storage LLC</u> (Independent Spent Fuel Storage Installation), CLI-02-25, 56 NRC 340 (2002). In addition, the EIS must be adequate. Please discuss whether, given the unresolved issues and information gaps in ER and EIS, the FEIS is complete and adequate as required by NEPA.	*See* the "NRC Staff Legal Brief in Response to Licensing Board's Environment-Related Questions."

2	1-4	The FEIS states that the Staff "adapted the ESRP review guidance to the PPE concept." The FEIS states at P 3-4 that "In some cases, the design specific information called for in the ESRP was not provided in the Dominion ESP application because it did not exist or was not available. Therefore the NRC Staff could not apply the Environmental Standard Review Plan (ESRP) guidance in those review areas. In such cases, the NRC Staff used its experience and judgment to adapt the review guidance in the ESRP and to develop assumptions necessary to evaluate impacts to certain environmental resources to account for this missing information." Please identify and explain each instance where the Staff adapted the ESRP (NUREG-1555, Standard Review Plans for Environmental Reviews for Nuclear Power Plants).	The Licensing Board, in its Order dated February 27, 2007, has granted the parties an extension of time until March 7, 2007, to answer Board Question 2. *See Dominion Nuclear North Anna, LLC* (Early Site Permit for North Anna ESP Site), unpublished Order (Reconsideration of Two Environmental Questions and Grant of Extension) (February 27, 2007). Pursuant to that Order, the Staff will provide its answer to Board Question 2 in a separate filing, no later than March 7, 2007.
3	1-5	Legal Question: Please provide a regulatory definition of the following two terms: "plant parameter envelope" and "postulated site parameters." 10 C.F.R. § 52.17(a)(2), states that the environmental report must focus on the effects of "construction and operation of a reactor or reactors which have the characteristics that are within the postulated site parameters," implying that the PSP concerns the characteristics of the reactors. Please explain.	*See* the "NRC Staff Legal Brief in Response to Licensing Board's Environment-Related Questions."
4	1-5	The FEIS states that the Staff relied on the information in the ER and that if the Staff ultimately determines that a representation or an assumption has not been satisfied at the CP/COL stage, "that information would be considered new and potentially significant, and the affected area could be subject to re-examination." However, 10 C.F.R. § 52.39(a)(i) specifies that, at the CP or COL stage, "a contention that a reactor does not fit within one or more of the site parameters included in the site permit may be litigated."	

		A. Legal Question: Please discuss how the FEIS statement comports with the regulation. Are you proposing the threshold for admission of a contention at the CP or COL stage also requires that the petitioner show that the failure of the reactor to fit the site parameters is "new and significant?" Please explain.	*See* the "NRC Staff Legal Brief in Response to Licensing Board's Environment-Related Questions."
		B. Legal Question: The cited regulation refers to "site parameters <u>included in the site permit</u>." Are all ER representations relied on by the Staff included within this category or only those that are specifically listed in FEIS Appendix I (ESP Site Characteristics and Plant Parameter Envelope) and Appendix J (Dominion Nuclear North Anna, LLC Permit Conditions, Commitments, Assumptions and Unresolved Issues). Please explain.	*See* the "NRC Staff Legal Brief in Response to Licensing Board's Environment-Related Questions."
5	1-5	The FEIS states "Dominion did not or was unable to provide information and analysis for certain issues sufficient to allow the NRC Staff to complete its analysis. For such issues, Dominion did not offer, nor did the Staff identify, bases for assumptions that would allow resolution. The Staff was unable to determine a unique significance level for such issues, and therefore, these issues are not resolved for the North Anna ESP site."	
		A. Please provide a list of each time the FEIS states that a matter or point is not resolved or unresolved (These may be readily located by a key-word search). The list should identify the matter or point in question and the page number of the FEIS or appendix.	See attached table. <u>Author</u>: John S. Cushing <u>SME</u>: John S. Cushing <u>Key Documents</u>: NUREG-1811, Vol. 1

		B. Appendix J-3 lists eight environmental issues as unresolved. Is this an exhaustive list? Why are these the only ones listed?	The table provided in response to Board Question 5A lists the unresolved issues in the FEIS. There is one issue described as unresolved that was not included in Appendix J in Table J-3 on page J-8, regarding the impacts resulting from the chronic effects of electromagnetic fields. As stated in 10 CFR 51, Subpart A, Appendix B, Table B-1, this issue has uncertain impacts because biological and physical studies of 60-Hz electromagnetic fields do not provide consistent evidence linking harmful effects with field exposures. Research in this area is continuing and a consensus scientific view has not been established. For these reasons, the Staff concluded that this issue is unresolved. <u>Author</u>: John S. Cushing <u>SME</u>: John S. Cushing <u>Key Documents</u>: NUREG-1811, Vol. 1
6	1-9	The FEIS states that the proposed ESP is for two "units" and that "each unit represents 4500 MW(t) . . . and would consist of one or more reactors or reactor modules."	
		A. Please confirm that, for the PBMR option, Dominion is asking for approval to site up to 16 additional nuclear reactors on the North Anna site. If not, how many is it?	Yes. For the PBMR option, Dominion is asking to site up to 16 additional reactors or modules on the North Anna site. From the PPE description in the SSAR (Section 1.3.2.7), the design of the PBMR groups one or more of these modules together using a common service building. Eight PBMR modules were grouped together to make one unit for purposes of developing the PPE. <u>Author</u>: John S. Cushing <u>SME:</u> Gregory A. Stoetzel <u>Key Documents</u>: SSAR; FEIS pg 6-22
		B. Please confirm that, for the GT-MHR option, Dominion is asking for approval to site up to 12 additional nuclear reactors on the North Anna site. If not, how many is it?	No. For the GT-MHR option, Dominion is asking to site up to 8 additional reactors or modules on the North Anna site. From the PPE description in the SSAR (Section 1.3.2.5), four GT-MHR modules were grouped together to make one unit for purposes of developing the PPE. <u>Author</u>: John S. Cushing

			SME: Gregory A. Stoetzel Key Documents: SSAR; FEIS pg 6-22

		C. Please confirm that, for the IRIS option, Dominion is asking for approval to site up to 6 additional nuclear reactors on the North Anna site. If not, how many is it?	Yes. For the IRIS option, Dominion is asking to site up to 6 additional reactors or modules on the North Anna site. From the PPE description in the SSAR (Section 1.3.2.6), individual IRIS modules are rated at 1000 MWt and are grouped two or three modules to each power block. Three IRIS reactors make up one unit for purposes of developing the PPE. Author: John S. Cushing SME: Gregory A. Stoetzel Key Documents: SSAR; FEIS pg 6-22
		D. Please confirm that, for the ACR-700 option, Dominion is asking for approval to site up to 4 additional nuclear reactors on the North Anna site. If not, how many is it?	Yes. For the ACR-700 option, Dominion is asking to site up to four additional reactors on the North Anna site. From the PPE description in the SSAR (Section 1.3.2.1), the ACR-700 design is configured in a two-reactor block with shared systems between the two reactors. This two-reactor block makes up one unit for purposes of developing the PPE. Author: John S. Cushing SME: Gregory A. Stoetzel Key Documents: SSAR; FEIS pg 6-22
		E. Define "module."	In this context, a "module" is a reactor. A specified number of "modules" comprise a "unit." A "unit," in turn, is one or more modules less than or equal to a specified power level (expressed in megawatts thermal). Author: John S. Cushing SME: Gregory A. Stoetzel Key Documents: NA
7	1-9	The FEIS states that "in the absence of an ESP, safety and environmental reviews of applications for OL's [sic] under 10 C.F.R. part 50 would take place during plant construction." Please explain and provide a citation to support this. How could construction commence prior to the completion of the safety and environmental reviews? Isn't this prohibited by the AEA and NEPA?	Under the Part 50 licensing process, the Staff performs safety and environmental reviews sufficient to allow issuance of the construction permit, at which point construction could commence. Remaining operational matters would then be addressed during the safety and environmental reviews of the application for an operating license ("OL"). By contrast, under Part 52 the combined license process resolves all issues before construction commences; the ESP process allows for even earlier resolution of certain issues related to the suitability of a site for one or more new nuclear reactor units.

			Author: John S. Cushing SME: Andrew Kugler Key Documents: 10 CFR Parts 50 and 51
8	1-11	What is the status of the Instream Flow Incremental Methodology Study (IFIM)?	As stated in an e-mail dated February 15, 2007, from Michael Murphy, Director, Division of Environmental Enhancement, Virginia Department of Environmental Quality: "A meeting was held on February 13, 2007, to lay out the framework and timeline for the study. Representatives from Dominion and its consulting contractor, and from the following state agencies attended the meeting: Game and Inland Fisheries Conservation and Recreation Environmental Quality The state is in the process of finalizing the study design. Expectations are that the study could commence as early as April 1, 2007." Author: John S. Cushing SME: John S. Cushing Key Documents: E-mail from VDEQ, ADAMS Accession No. ML0705303612
9	2-1	Two other NAPS units (units 3 and 4) received construction permits on July 26, 1974. To whom were they issued? What is the status of the construction permits?	Construction permits CPPR-114 and 115 for North Anna Units 3 and 4, respectively, were issued on July 26, 1974 to Virginia Electric and Power Company. The construction permits have both expired. Author: John S. Cushing SME: John S. Cushing Key Documents: NUREG 1350 Volume 18, Information Digest 2006 -2007 Appendix C
10	2-1	Virginia Power owns and operates the North Anna Hydroelectric Project, an 855-kW capacity hydroelectric power plant at the base of the North Anna Dam. Does the operation of the hydroelectric facility impact on the level of downstream discharges	The North Anna Hydroelectric Project consists of two water-driven generators with a combined maximum capacity of 855-kW. See the Environmental Report, Section 2.3.1.1. Both units may be operated when water level in the lake is greater than 250 ft MSL. Below 250 ft MSL, when the downstream release from the dam is reduced to 40 cfs, only the smaller

		from the dam? Is there a minimum flow requirement for hydroelectric plant operation?	hydroelectric unit is operated. This unit passes a flow of 40 cfs. When lake level drops below 248 ft MSL and the downstream release from the dam is reduced below 40 cfs, neither hydroelectric unit is operated and downstream flow is regulated through a bypass line. Author: Andrew Kugler SME: Andrew Kugler Key Documents: NA
11	2-3	Please provide the Board with five copies of a large (e.g., 3' x 3') map of the proposed ESP site and its 50 mile radius, similar to Figure 2-2. If possible, it should include relevant topographical information. Please mark this as a proposed exhibit.	Please see Dominion's response to Board Question 11.
12	2-4	Please provide the Board with five copies of a large (e.g., 3' x 3') map of the proposed ESP site and its 10 mile radius, similar to Figure 2-3. If possible, it should include relevant topographical information. Please mark this as a proposed exhibit.	Please see Dominion's response to Board Question 12.
13	2-4	The scale shown on the bottom right of Figure 2-3 appears to be wrong. Please explain.	The scale is, indeed, incorrect. The scale should be "2.5" and "5" miles, as opposed to the "1" and "2" miles shown. The map and 10-mile radius are scaled properly with respect to each other. Author: John S. Cushing SME: None Key Documents: NA
14	2-8	The FEIS states that "initial evaluations by Dominion show that any two of the 500-kV transmission lines together with the 230-kV line would have sufficient capacity to carry the total output of the proposed new units in addition to the existing new units. If Dominion were to decide to proceed with the development of the proposed ESP units, a system study (load flow) modeling these lines, including the additional power from the proposed new units, would be performed."	

		A. Given that transmission line impacts are an important part of an EIS for an ESP, please explain why the possible need for (and environmental impact of) additional transmission lines should not be studied and understood now.	Dominion has indicated that, based on the information it currently has, new transmission lines would not be needed from the North Anna site to deliver the power from two new units (up to 4500 MWt each) to the grid. It is possible that after a load flow study is done, the applicant might determine that one or more additional lines are needed. If the load flow study shows the need for additional transmission lines, these matters would be addressed in the CP or COL application and the NRC's review. The Commission's regulations do not prohibit this approach. Indeed, this type of flexibility in the application review is a fundamental part of the ESP process (e.g., allowing the use of a PPE). At the CP or COL stage, if the load flow study indicates that the transmission lines do not have sufficient capacity and new transmission lines are needed, that information would be considered new and potentially significant and the applicant would be required to submit the information in its application, and the Staff would evaluate it in its environmental review for the CP or COL. Author: John S. Cushing SME: Andrew Kugler Key Documents: NA
		B. Recent reports indicate that the Dominion group of companies is planning to build additional transmission lines in the State of Virginia. (Washington Post, P C3, January 28, 2007). Please explain whether the FEIS should include a discussion of the environmental impacts of these proposed new transmission lines.	From the Washington Post article, it appears that the proposed line is intended to carry power from points west (*e.g.*, West Virginia) to Northern Virginia. There is no indication that this proposed line is related to the North Anna site. The line is, in fact, a significant distance from the plant, originating northwest of Front Royal and roughly paralleling I-66 (*see* transmission line map, ADAMS accession number ML070530363). At any rate, NRC has typically only considered the environmental impacts of the transmission lines built to connect the power plant to the grid (typically out to the first existing substation). This line does not fall within that category, and the Staff believes that it is therefore not necessary to expand the environmental review to include such a line. Author: Andrew Kugler SME: NA Key Documents: Washington Post article, ADAMS Accession number ML070530363.

15	2-19	Please describe the radiological environmental monitoring program ("REMP") that is being conducted at the NAPS site. Please provide five copies of the latest annual report. Please mark this as a proposed exhibit.	The Staff concurs in Dominion's response to Board Question 15.
16	2-19	Please provide five copies of the Offsite Dose Calculation Manual ("ODCM").	See Dominion's response to Board Question 16.

17	2-22	The FEIS states that "Dominion records data from 19 groundwater wells." Please list the frequency and nature of the data recorded, including the chemical and radiological characteristics sampled for, and the detection limits of the analysis performed. Please explain how this statement comports with the statement at page 2-26 that "there are no site-specific data available for the non-radiological chemistry of the groundwater underlying the ESP site."	Quarterly water level measurements are made at the 19 wells mentioned in the FEIS. No chemical testing was performed at these wells in connection with the ESP application. Author: Lance W. Vail SME: Lance W. Vail Key Documents: NA
18	2-25	The FEIS states that a "public health advisory has been issued regarding the consumption of certain fish" in Lake Anna because their tissues contain polychlorinated biphenyls (PCBs) and that "the source of the PCBs is unknown at this time." FEIS Appendix E states, at page 3-35, "the staff did not find a relationship between PCBs in the lake and the existing nuclear facility." What is the basis for this statement? What monitoring or investigation, if any, has been or is being performed (by the Staff, Dominion, or any other entity) to study or define the PCB concentrations in the lake or to determine whether the NAPS could be the source of such PCB contamination in the lake? Will the proposed facilities involved in the ESP include any facilities or equipment containing PCBs?	The Staff consulted with VDEQ and reviewed information in VDEQ's 303(d) Report on Impaired Waters (available at http://www.deq.state.va.us/wqa/pdf/2006ir/2006irdoc/ir06_Full_Document.pdf). In the 303(d) report, PCBs were identified in tributaries upstream of areas that could be influenced by the proposed facilities. Neither VDEQ nor the Staff found data suggesting that NAPS was the source of the PCBs in Lake Anna. Because it is beyond the agency's regulatory purview, the NRC does not require that the licensee monitor for PCBs at NAPS. Further, VDEQ does not require Dominion to monitor for PCBs as part of its NPDES permit. Since the applicant did not propose a detailed reactor design at the ESP stage, the Staff does not know whether any proposed facility or equipment will include PCBs. Author: Lance W. Vail SME: Lance W. Vail Key Documents: http://www.deq.state.va.us/wqa/pdf/2006ir/2006irdoc/ ir06_Full_Document.pdf
19	2-26	The FEIS states "The applicant is able to consider an ongoing program associated with the existing Units 1 and 2 as part of the pre-application and pre-operational monitoring program at the ESP site." What does this mean? What significance does it have for the ESP? Are you proposing that the ESP include permit conditions or other assumptions or action items to include and mandate such an "ongoing program?"	The ongoing environmental monitoring programs at sites of existing nuclear plants provide a thorough and long-term characterization of the "existing environment," which is useful for consideration of additional nuclear facilities at those sites. The duration and scope of this ongoing monitoring is generally greater than what would be expected to be available for a greenfield site. An ESP applicant can utilize the data acquired through such ongoing environmental monitoring programs to characterize the environment of the proposed site. If this ESP and a subsequent CP or COL were issued

			for the North Anna site, monitoring of non-radiological effluents at the new facility would be regulated by the Commonwealth of Virginia, and not the NRC, because regulation of non-radiological discharges from the new facility is governed by the Clean Water Act. Therefore, the Staff does not propose any permit conditions or COL action items with respect to pre-operational monitoring. Author: John S. Cushing SME: Lance W. Vail Key Documents: NA
20	2-27	The FEIS states that "community based monitoring of Lake Anna and WHTF water quality has been performed by volunteers from the Lake Anna Citizens Association." Have the results of this monitoring been provided to the Applicant and Staff? Have you considered it in this FEIS?	The Staff reviewed the water quality information posted on the Lake Anna Civic Association's website. The results were not inconsistent with the information provided formally by Dominion to VDEQ as part of its environmental monitoring program. Author: Lance W. Vail SME; Lance W. Vail Key Documents: Application ER Pg 3-3-57
21	2-31	What is the source of the information in Table 2-2? What did the Staff do to verify this information?	The list of species listed in Table 2-2 as threatened or endangered by the US Fish and Wildlife Service ("FWS") or by the Virginia Department of Game and Inland Fisheries ("VDGIF") was assembled by the Staff using information obtained from the FWS, the VDGIF, and the Virginia Natural Heritage Program that is administered by the Virginia Department of Conservation and Recreation ("VDCR"). The FWS sources included a query of its website (FWS 2004a), and a letter received from the FWS Virginia Ecological Services Offices (FWS 2004b) that was in response to a Staff request for information. (The URL listed in the Chapter 2 reference section is incorrect, it should be http://ecos.fws.gov/tess_public/StateListing.do?status=listed&state=VA) Additionally, the Staff queried the databases maintained by the VDGIF and the VDCR. Once a draft list was compiled, it was forwarded to the VDGIF for review, and that agency confirmed that the list was correct (e-mail correspondence docketed in ADAMS at accession number ML042380101). The Staff also performed a site visit and prepared a Biological Assessment ("BA") that evaluated potential impacts to Federal threatened and endangered species; FWS concurred with the conclusions in the BA and did

			not indicate that additional species should be considered. During the course of the EIS preparation, information about bald eagle nests in the vicinity of the site was updated based on information obtained from the VDGIF and FWS. Author: Michael Sackschewsky SME: Michael T. Masnik Key Documents: Biological Assessment for the North Anna Early Site Permit Application, January 2005, ADAMS accession number ML050320461.
22	2-35	The third dike in the WHTF has a submerged weir regulating outflow allowing water to exit the WHTF into Lake Anna. The FEIS states that fish can move between the two bodies of water at the weir. The discharge velocity is reportedly high so as to rapidly mix the heated water from the WHTF with the cooler water of Lake Anna. Wouldn't the discharge velocity of the almost 2 million gallons per minute prevent all but the strongest swimmers from entering into the WHTF area? What is the average discharge velocity?	The ER states that discharge design velocity at the Dike 3 weir with both NAPS Units 1 and 2 operating is approximately 7 feet per second. This relatively high discharge velocity is designed to promote mixing with the Lake Anna receiving waters (ER Section 5.3.2.1). During NAPS two-unit operation, the high discharge flow over the submerged weir prevents almost all fish from entering the WHTF; however, during outage periods, when both units are not operating, the velocity at the submerged weir is essentially zero. With only one unit operating, the flow rate is no more than half the maximum flow rate, with a commensurate reduction in velocity at the submerged weir, assuming the stop logs are not repositioned. Author: Michael T. Masnik SME: Lance W. Vail Key Documents: ER
23	2-36	Have Asiatic clams ever created a problem in the water intakes? What was the basis for their decline in Lake Anna?	According to ER Revision 6, "...no condenser tube blockages have been reported since Asiatic clam appeared in the North Anna reservoir in the late 1970's." The basis for the decline of Asiatic clams in Lake Anna is not known. Author: Jeffrey Ward SME: Michael T. Masnik Key Documents: ER
24	2-48 to 49	In the FEIS, NRC projects that the annual growth rate of the population in the vicinity of the proposed ESP decreases. However, both Spotsylvania and Louisa Counties are among the fastest growing counties in Virginia. Please explain the reasoning behind these	In the official forecasts provided in 2003 by the Virginia Employment Commission, the population projections are developed at the locality level using base data from the two most recent census periods. Birth rates and survival rates were applied to the 1990 population to calculate a 2000 survived population. The difference between these calculations and the

		growth rates.	2000 census numbers is assumed to be migration, which is used to develop migration rates. Thus, implicitly, the migration rates in Table 2-7 are those that prevailed in the 1990s. These historical rates were quite rapid in the case of Spotsylvania County, but much lower in the case of Orange and Louisa Counties, which have been experiencing accelerating migration. The migration rates, along with birth and survival rates, are applied to the 2000 census numbers to project into the future. These rates survive and migrate the population as well as calculate new births. The birth rates and migration rates are calculated by locality, but survival rates are measured at the state level. The components are added together to yield locality projections and the locality projections are summed to produce state-level projections. These figures are compared with independently derived state level projections and adjustments are made to the locality projections to bring them in line with the state totals. The respective local governments and regional planning district commissions review population projections for each locality. In some instances, adjustments are made based on this review. The Virginia Employment Commission is currently revising the county-level forecasts shown in FEIS Table 2-7, and is reexamining population estimates from the Census Bureau, University of Virginia Weldon Cooper center, projections from Woods and Poole projections, and its own 2003 projections, and it is using input from regional planning district commissions. The revised forecasts are currently expected to be ready in March 2007. There is no inherent conflict between high current rates and longer run declining growth rates. The county growth rates in FEIS Table 2-7 on p. 2-49 show that actual county-level population growth rates in the region of the North Anna ESP site have varied in recent years. Inspection of the local cohort survival rates (births-deaths-net migration by 5-year age groups) in the 2003 forecast shows an aging of the Virginia population. With an aging population, overall birth rates fall and death rates rise, slowing population growth. Since migration rates continue in at the 1990-2000 rates in the county forecasts, the overall population growth rate also declines. The Virginia Employment Commission points out that these forecasts are meant to provide insight on what could occur in the absence of any major change. The projections should serve as common reference points in the planning, development, and implementation of state agency programs and facilities. They also point out that the Virginia projections have differing degrees of reliability. Generally speaking, projections for large localities are more reliable than for those areas experiencing rapid growth or decline. With respect to time span, the further into the future the projections are carried,

			the less accurate they may be. With respect to the individual counties, even though its growth rates have been much faster than Virginia's, Spotsylvania County showed steadily declining growth rates during the last three census periods: 7.7% per year during the 1970s, 5.2% per year during the 1980s, and 4.6% per year during the 1990s. It also is common for small area county population growth rates to vary considerably over short periods of time and thus diverge from forecasted rates. The most recent 2006 population estimates from the University of Virginia's Weldon Cooper Center for these counties show that the estimated growth rates for 2000-2006 have been higher than in Virginia as a whole, but three out of the five jurisdictions shown in the table have been lower than the corresponding rates during the 1990s, and are thus consistent with the long-run forecast of declining rates. From 2000 to 2006, Spotsylvania and Henrico Counties and the City of Richmond all grew more slowly than in the 1990s, while the much smaller (and harder to forecast) Louisa and Orange Counties grew faster than in the 1990s. Although Spotsylvania County grew faster than projected, the rate was slightly slower than in the 1990s. Commonwealth of Virginia county population forecasts are intended primarily for long-term planning purposes. Long-term population forecasts are developed by applying long-term trends in birth and death rates in population age cohorts and adding forecasted net migration. Migration can be difficult to forecast for small areas such as counties, and this likely accounts for most of the disparity between population forecasts and population estimates. In addition, see attached table. Author: Michael J. Scott SME: Michael J. Scott Key Documents: Virginia Employment Commission. 2003. VEC Final Local Population Projections. Accessed at http://www.vec.state.va.us/pdf/pop_projs.pdf on July 13, 2004. Virginia Employment Commission. 2005. Virginia's Electronic Labor Market Access. Accessed at http://velma.virtuallmi.com/analyzer/startanalyzer.asp on July 15, 2005. E-mail from Laura Adkins, Virginia Employment Commission.

25	2-76 to 77	NRC Environmental Justice policy specifies that if the percentage of minority or low income population in the impacted area exceeds [by 20%] that of the State or the County percentage . . . then EJ [an Environmental Justice review] will be considered in greater detail." 69 Fed. Reg. 52,040, 52,048 (Aug. 24, 2004).	
		A. Does the minority or low income population in the impacted area exceed by 20% that of the State or County? If so, please explain how this was determined.	Generally it does not, but using a GIS system (NRC's GEn&SIS), the Staff was able to determine that there are some Census block groups within 50 miles of the ESP site that meet the NRC's 20% criterion for minority or low-income status. These block groups are shown as FEIS Figures 2-6 and 2-7 on pp. 2-78 and 2-79, respectively. Author: Michael J. Scott SME: Michael J. Scott Key Documents: GEn&SIS. *See* /http://gensis.llnl.gov/

		B. If the answer to A is yes, then is the EJ analysis at pages 2-76 to 2-77 supposed to represent an environmental justice review "in greater detail?"	No. The more detailed analysis may be described as follows. Page 2-76 and 2-77 generally describe the process used for identifying minority and low income populations and part of the process that was used to try to identify adverse and disproportionate impacts on minority and low income populations. The location of these minority and low-income groups was identified in FEIS Section 2.10 as being beyond ten miles from the ESP site. Chapters 4 and 5 show a general lack of adverse environmental impacts on any populations except for recreation and aesthetic impacts on those populations living on Lake Anna. The lakeside population was not identified as either minority or low-income. Neither the interviews briefly mentioned on FEIS pp. 2-76, 4-36, 5-52 nor the public scoping meetings and public comments identified any pre-existing conditions, unusual resource dependencies, or practices among minority or low-income populations that would expose them or make them any more vulnerable to environmental impacts than the majority population. As a result, Sections 4.7 and 5.7 concluded that the environmental justice impact would be SMALL. Author: Michael J. Scott SME: Michael J. Scott Key Documents: NUREG-1811, Vol. 1
		C. Does the FEIS identify, discuss and evaluate whether and how the environmental impacts of the proposed ESP might have a peculiar, different, or special (qualitatively or quantitatively) impact on any such minority or low income population (e.g. greater reliance on fish consumption)? Is so, where?	No. See the Staff's response to Board Question 25B. Author: Michael J. Scott SME: Michael J. Scott Key Documents: NA
26	3-7	The FEIS states that "Because no specific design has been selected, the water treatment systems for the proposed Units 3 and 4 are not specified." Wasn't it possible for Dominion to provide a PPE, in lieu of a "specific design" for the water treatment systems? Why didn't the Staff require this information to be provided?	Dominion has not chosen a water treatment technology for proposed Units 3 and 4, and therefore did not provide any specific information regarding chemical effluents related to that system. As such, the Staff did not resolve this issue. However, as discussed in the Staff's Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437, Section 4.3.2.2), for existing plants the Staff has found that the impacts of these effluents are small. The Staff also found that existing plants generally operate within the limits of their NPDES permits and believes that new plants would do the same. Thus, the Staff determined that it could reasonably

			expect, for the purposes of the alternative site comparison, that the impacts of these chemical effluents would be small. Resolution of the issue, however, is withheld until an actual design, with its associated effluents, is defined. Author: Andrew Kugler SME: Lance W. Vail Key Documents: NA
27	3-8	Figure 3-2 appears to show that the dry cooling tower can be operated with fans turned off, providing some cooling with less energy consumption. What approximate percentage cooling could be obtained with an external temperature in the 80's with fans off and what would be the energy penalty to plant output for this operational mode?	The Staff considered only the bounding information provided in the PPE in performing its assessment. Therefore, the Staff did not assess the energy penalty of any specific plant cooling system design under various operational modes. Such an assessment was not performed because relevant detailed design information was not provided at the ESP stage, and, further, such an assessment was not necessary for the Staff to formulate an impact determination in the EIS. Author: Lance W. Vail SME: Lance W. Vail Key Documents: NA
28	3-8	Little discussion is provided related to the surface condenser diagramed in Figure 3-2. Is this an evaporative cooler and what approximate percentage contribution does it make to Unit 3 cooling?	The surface condenser identified in ER Figure 3-2 is a shell and tube heat exchanger that condenses to water the steam that is discharged from turbine-generator for reuse in the steam cycle. The steam is on the outside of the tubes and circulating water is on the inside of the tubes. The circulating water transfers the heat from the condensing steam to the wet and dry cooling towers where the heat is discharged to the atmosphere. The circulating water returns to the surface condenser to repeat the cycle. The surface condenser in Figure 3-2 is the component that transfers heat from the steam cycle to the station cooling system. The surface condenser rejects heat to the cooling system. Author: Lance W. Vail SME: Lance W. Vail Key Documents: ER p. 3-3-57

29	3-9	The FEIS states that the "calculated minimum lake level under drought conditions is 74.74 m (243.5 ft) MSL." What does this mean? Are you saying that, even in a drought, the lake will never go below 243.5 ft MSL? What is the significance of the FEIS statement? Is this a proposed permit condition?	The calculated minimum lake level is the lowest level that the Staff simulated the lake would drop based on the historical meteorological record. This does not mean that the lake could not drop below this lake level if future meteorological conditions were more severe than those in the period simulated. The simulated period includes data from the severe drought of October 2001 through December 2002. The Staff does not propose any permit condition based on the lake elevation. Author: Lance W. Vail SME: Lance W. Vail Key Documents: NA
30	3-9	Under the worst thermal efficiency conditions, the dry cooling tower for proposed Unit 3 will be designed to remove a minimum of one-third of the excess heat. Because there is interest in minimizing water consumption and thermal impact on Lake Anna, some interested parties have proposed using the Unit 3 dry towers all the time along with using the wet tower system as a helper system when the dry tower cannot handle the entire heat load. Have any estimates been made of the month to month fraction of heat load that could be handled by the dry tower system under such a scheme? Have any estimates been made of the savings in consumptive water loss? If so, please provide them.	The Staff only considered the bounding information provided in the PPE in performing its assessment. Therefore, the Staff did not assess the energy penalty of any specific plant cooling system design under various operational modes. Such an assessment was not performed because relevant detailed design information was not provided at the ESP stage, and, further, such an assessment was not necessary for the Staff to formulate an impact determination in the EIS. Author: Lance W. Vail SME: Lance W. Vail Key Documents: NA
31	3-9,3-10	The FEIS states that the plant would primarily use wet towers to cool Unit 3 during periods of relative water surplus (when the water surface elevation of Lake Anna is at or above elevation 250 MSL). This is termed the Energy Conservation (EC) mode.	
		A. Is this exclusive use of the wet towers when the lake is at or above 250' a hard and fast operating rule? Is it to be an express condition in the ESP?	No. It is not a hard and fast operating rule, and the Staff does not recommend it as a permit condition, should an ESP be issued. The Staff evaluated the impact of a 365-day rolling average evaporation rate of 8707 gpm on the water resources. The Staff did review Dominion's water budget calculations, which are based on the shift between EC and MWC operating modes at 250 ft MSL, and determined that the approach proposed by the

			applicant to meet the 8707 gpm requirement was not unreasonable. Author: Lance W. Vail, John S. Cushing SME: Lance W. Vail Key Documents: NA
		B. Would the dry cooling system ever be used when the lake surface elevation is at or above elevation 250?	Due to the efficiency penalty, it is unlikely that the dry cooling system would be used above 250 MSL, however, there is no prohibition on using the dry cooling systems above 250 MSL. The Commonwealth may ultimately place requirements on operation of the dry cooling system, as discussed in the Staff's response to 31C, below. Author: John S. Cushing SME: Lance W. Vail Key Documents: NA
		C. Does the Commonwealth of Virginia have any control over the operating mode of the cooling systems for Units 3 and 4 or is its authority limited to water releases to downstream at the dam?	The Commonwealth regulates water withdrawals and discharges. By linking requirements between withdrawal and discharge, the Commonwealth has the authority to regulate consumptive water losses through either forced or induced evaporation. As stated in an e-mail dated 2/15/07, from Michael Murphy, Director, Division of Environmental Enhancement, Virginia Department of Environmental Quality: Yes. The VPDES, and/or VWP, permit(s) will govern the flows in the North Anna River and lake levels. The operation of the cooling systems will have to be such that the flows and levels are not impacted beyond what the permit(s) allow to protect the beneficial uses of the lake and river. It is possible the permits will require the operation of MWC mode at particular times/conditions. In addition, the VPDES permit will require limits on the blowdown of the cooling system but this is not likely to have any significant impact as to when or how they operate the cooling system. Author: Lance W. Vail SME: Lance W. Vail Key Documents: E-mail from VDEQ, ADAMS Accession number ML0705303612
32	3-10	"Worst conditions" for operation of the dry cooling tower are cited as a "hot and humid atmosphere at	Humidity is not particularly important to dry cooling towers. In the statement in the FEIS on page 3-10, "worst case conditions" refers to worst case for the

		tower level." Why is humidity important to dry tower operation?	Unit 3 cooling system. The cooling system includes wet and dry components, not just the dry cooling system. Wet cooling tower component performance is at a minimum under high temperature, high humidity conditions, and the dry cooling tower component is at a minimum at high temperature conditions. Thus, for the cooling system, the worst case conditions are high temperature, high humidity conditions. Author: J. V. Ramsdell SME: W.F. Sandusky, J.V. Ramsdell Key documents: NUREG-1811, Vol. 1
33	3-10	It is stated on page 3-10 that when the water level in the Lake drops below elevation 250 for a period of one week or more, the closed -cycle dry cooling towers for Unit 3 would be employed. This is termed the Maximum Water Conservation (MWC) mode. Under favorable meteorological conditions, the entire excess heat load from Unit 3 could be dissipated via the dry cooling towers. Under worst case conditions, the dry towers would handle at least one-third of the excess heat. Is the above described procedure for initiating the MWC mode an operating rule? Does the Commonwealth have any say in the operation of the Unit 3 dry tower system?	The procedure is not an operating rule, but rather is an assumption that was used in the water budget model to evaluate the consumptive water use. The Commonwealth of Virginia's role in the operation of the Unit 3 dry cooling tower is explained in the response to Board Question 31C, *supra*. Author: Lance W. Vail SME: Lance W. Vail Key Documents: E-mail from VDEQ, ADAMS Accession number ML0705303612
34	3-12	On page 3-12, Dominion estimated that the combination wet and dry cooling system would have an energy efficiency penalty of 1.7 to 4%. What operating conditions were assumed to arrive at these energy efficiency penalty values? Is this based on the premise that only wet cooling will be used when the lake level is at elevation 250 or higher?	The Staff only considered the bounding information provided in the PPE in performing its assessment. Therefore, the Staff did not assess the energy penalty of any specific plant cooling system design under various operational modes. Such an assessment was not performed because relevant detailed design information was not provided at the ESP stage, and, further, such an assessment was not necessary for the Staff to formulate an impact determination in the EIS. Author: Lance W. Vail SME: Lance W. Vail Key Documents: NA
35	3-13	Legal Question: The FEIS states that "These systems would process radioactive liquid, gaseous and solid	Although identified as a legal question, the Staff has determined to treat this question as a technical question, and herein provides the response.

		effluents to maintain releases within regulatory limits." Please list all of the regulatory limits, with citations, specifying whether they apply on a per reactor, per unit, per facility, per license, or per NAPS and ESP site basis. Please specify which, if any, of these regulatory limits are expressly stated in, or conditions of, the proposed ESP.	Compliance with NRC and EPA regulations is required under 10 CFR Part 20. NRC requirements addressing effluent radionuclide concentration limits are contained in Appendix B, Table 2 to 10 CFR Part 20; dose limits to members of the public are covered in 10 CFR 20.1301 and 20.1302; and ALARA dose criteria are contained in Appendix I to 10 CFR Part 50. The requirements of 10 CFR 20.1301(e) are implemented through operational programs and procedures mandated under 10 CFR 50.36a, 10 CFR 50.34a, and Section IV of Appendix I to Part 50. Compliance with EPA's 40 CFR Part 190 environmental radiation standards is required under 10 CFR 20.1301(e). The key operational program documents are the Radiological Effluent Technical Specifications (RETS) or Standard Radiological Effluent Controls (SREC), Offsite Dose Calculation Manual (ODCM), and the Radiological Environmental Monitoring Program (REMP). Under 40 CFR Part 190, compliance with dose limits is assessed against the entire site and all sources of radioactivity and external radiation, regardless of the number of power plants. The sources of radioactivity include all liquid and gaseous effluent releases, and other sources of radiation. Compliance with the dose limits of 10 CFR 20.1301, effluent concentration limits of Appendix B (Table 2) to Part 20, and 40 CFR Part 190 environmental radiation standards is assessed against the whole site and not on the basis of individual plants. Compliance with Appendix I dose objectives is assessed on a per plant basis, but the total dose or effluent concentration limits of 10 CFR Part 20 are limiting for the whole site, regardless of the number of reactors. The implementation of these programs and license conditions are routinely inspected by NRC Regional Inspectors. If a plant were to exceed the dose limits of 40 CFR Part 190 or any other requirements of Part 20, the inspection would identify the cause and determine whether a proper response and corrective actions were taken by the licensee. Under the provisions of 10 Part 20.1301(f), the NRC may impose additional restrictions after evaluating the impacts on members of the public in light of commitments and characterizations contained in the CP or COL application. Table I- 1 of the FEIS lists the following regulatory requirements: 10 CFR Part 20; 10 CFR Part 50, Appendix I, Dose Objectives; and 40 CFR Part 190 dose limits,10 CFR 50.34(a)(1) and 10 CFR Part 100 dose limits. <u>Author</u>: Jean-Claude Dehmel <u>SME</u>: Jean-Claude Dehmel <u>Key Documents</u>: RETS or SREC; the ODCM, and the REMP.

36	3-13	The FEIS states that "Adequate design information to estimate liquid and gaseous radioactive effluents was available for four of the seven reactor designs considered in establishing PPE values" and that "limited information was available [with regard to] gas-cooled reactor designs." Is the Staff saying that it did not have adequate design information relating to 3 of the seven reactor designs, including the gas-cooled designs?	Using the PPE approach, the staff is not approving individual reactor designs but only PPE values. At the CP or COL stage, the applicant will provide specific details for the reactor design chosen, and as part of the environmental review, the Staff would evaluate whether the proposed design has gaseous and liquid effluent release source terms that are bounded by the PPE values evaluated in the FEIS. The Staff did not have adequate design information for three of the reactors, however, that does not mean that the Staff could not assess the four identified reactors with respect to gaseous and liquid radioactive effluents. PPE gaseous and liquid effluents were derived by the applicant using the most conservative release value for each radionuclide for the reactor designs where this information was available. Per Table 3.1-2 of the applicant's ER, PPE gaseous and liquid effluents were derived from the ABWR, AP1000, ACR-700, and ESBWR, as these were the only reactor types with adequate information on gaseous and liquid effluent releases available. The applicant provided a qualitative discussion in the ER as to why the other reactor designs (i.e., IRIS, GT-MHR, and PBMR) would be bounded by the PPE gaseous and liquid source term values developed from the ABWR, AP1000, ACR-700, and ESBWR designs. Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: ER
37	3-13	Why is the bounding solid radioactive waste activity from one ABWR reactor or one ESBWR reactor when two reactors are contemplated for the site?	This statement refers to the PPE (bounding) solid radioactive waste activity for one unit. As specified in Table I-2 of the FEIS (pg I-9) the bounding solid radioactive waste activity is 2700 Ci/yr for one unit, and 2700 Ci/yr for the second unit for a total of 5400 Ci/yr for the ESP site. Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel, Gregory A. Stoetzel Key Documents: ER Table 3.1-9, FEIS App I
38	4-13	Has Lake Anna demonstrated a proclivity for the buildup of sediment? Have any measurements of sediment buildup been made? If so, what are the results? Have any estimates of the potential problem of heavy metals from Contrary Creek deposits been	As a general matter, lakes tend to accumulate sediment due to the reduced velocity relative to the streams that feed into them. However, the Staff is unaware of any studies of sediment deposition in Lake Anna, much less any that would address deposition of heavy metals from Contrary Creek.

		made?	Author: Lance W. Vail SME: Lance W. Vail Key Documents: NA
39	4-33	Of the expected 5,000 workers required for construction, it is assumed that only 1,000 of these will establish new residences within a 50 mi. radius of the plant site. Please elaborate on the data or reasoning that supports this conclusion.	There are a number of reasons for reaching that conclusion. The first is that this was the conclusion reached by the applicant based on historical experience with projects of similar size (ER section 4.4.2.1.2, pp. 3-4-34 to p.3-4-35). Second, the Staff independently concluded that there is a large construction work force within the four nearest counties and the City of Richmond. Table FEIS Table 2-13 shows 27,242 construction workers. This number continues to grow. U.S. Bureau of Economic Analysis indicated that it was 29,057 in 2004. Third, more construction workers are available within the 50-mile region, which indicates relatively little need to import large numbers of construction workers. Author: Michael J. Scott SME: Michael J. Scott Key Documents: http://www.bea.gov/regional/reis/action.cfm (US Bureau of Economic Analysis Local Employment Website, Last accessed 2/21/07.)
40	4-33	Given that Louisa County schools are identified as "currently overcrowded with enrollment growing at 2% a year" what numerical and percentage increase in Louisa County school enrollments would be projected for 1,000 new residents?	Of the 1,000 additional residents moving to the 50-mile region, based on distribution of the current NAPS workers (who probably live closer to the site than would temporary construction workers) about 28.9% (289 workers) (FEIS p. 2-65) might be expected to live in Louisa County. Assume, conservatively, that each of those workers brought an average household with him/her. Based on the 2000 Census, the FEIS states that Louisa County had 9945 households (FEIS p. 2-66) and 4232 school children (FEIS p. 2-71) for a ratio of 0.43 school children per household. If these ratios were to prevail for the new residents with one worker per household, the potential enrollment would increase by 123 students. For perspective, in the year 2004-2005, Louisa County schools had 4434 students (March 31 Average Daily Membership), based on a collection of school statistics from the Commonwealth's Department of Education by the Weldon Cooper Center for Public Service at the University of Virginia. This implies growth of 102 students in 5 years. Author: Michael J. Scott SME: Michael J. Scott Key Documents:

			http://www.coopercenter.org/demographics/SCHOOL%20PROJECTIONS/ (Weldon Cooper Center for Public Service website. Last accessed 2/17/07.)
41	4-36	The FEIS states that the Staff identified the pathways which the environmental impacts associated with the construction of Units 3 and at the NAPS site could affect human populations. Where did the Staff identify the pathways?	The construction pathways are identified and are described in the various environmental topic areas in Chapter 4 of the FEIS and include land use, meteorology, and air quality, water-related impacts, socioeconomic impacts, historic and cultural resource impacts, non-radiological health impacts, and radiological health impacts for the population as a whole in the potentially impacted region. The only adverse environmental impacts that were not SMALL for any member of the public were lower water levels during drought years and their potential impacts on aesthetics and recreation. These impacts are most likely to affect lake-front property owners, who were not identified as either minority or low-income. In the environmental justice analysis, particularly since the nearest local areas with minority and low income populations are beyond ten miles from the ESP site, the Staff could identify no reason why these populations would be disproportionately adversely affected by construction and operation of two new nuclear reactors at the ESP site. Local interviews with public officials and the public scoping process also did not identify any unusual vulnerabilities in these populations or mention any potential impacts requiring further investigation from an environmental justice perspective. Author: Michael J. Scott SME: Michael J. Scott Key Documents: NA
42	4-40, 4-42	Section 4.9.1 gives a direct radiation exposure of 13 mrem/yr. from direct radiation exposure while Section 4.9.4 gives 24 mrem/yr. to construction workers, which is the sum of direct plus liquid and airborne exposure pathways. How will construction workers receive a liquid pathway exposure?	The construction workers would receive exposure from the liquid pathway primarily through the drinking water pathway. The applicant's approach (evaluated and accepted by the Staff) was conservative in estimating dose from the liquid pathway. The approach used the dose to the maximally exposed individual from liquid and gaseous effluents and adjusted for occupancy (a worker is only onsite ~2080 hours per year). The applicant then multiplied this dose by a factor of 10 to account for the worker being closer to the source term than the maximally exposed individual. Although this approach is appropriate for the gaseous effluent pathway, it is overly conservative for the liquid effluent pathway because during working hours, construction workers will not likely engage in activities such as swimming, fishing, and boating, that contribute to

			maximum individual dose. Section 4.9.1 of the FEIS provides an estimated dose of 23 mrem/yr to construction workers from direct radiation. This estimate was a sum of the estimated dose from the boron recovery tank and low-level contaminated storage area (13 mrem/yr) and the estimated dose from the ISFSI (9.8 mrem/yr). The total dose estimate of 24 mrem/yr in Section 4.9.4 of the FEIS includes a small contribution of 1 mrem/yr from the gaseous and liquid effluent pathways. Author: Gregory A. Stoetzel SME: Gregory A. Stoetzel, Charles Hinson Key Documents: ER Section 4.5; NUREG-1811, Vol. 1
43	4-42	The FEIS states that "Dominion estimated an annual dose to a site preparation worker of 0.24 mSv (24 mrem)" and that this estimate is "well within both the dose limits to individual members of the public found in 10 C.F.R. 20.1301 and occupational dose limits to workers found in 10 C.F.R. 20.1201." (Emphasis added). But the 24 mrem annual dose to the worker is very close to the 25 mrem annual dose for members of the public set by EPA at 40 C.F.R. Part 190. We recognize that, strictly speaking, the public dose limit does not apply to workers. But it is the Staff that has made this comparison. How can you say that the dose is "well within" this limit? Please discuss.	The staff was referring to the 0.1 rem dose limit in 10 CFR 20.1301(a)(1) in its comparison. 10 CFR 20.1301 (e) states that "a licensee subject to the provisions of EPA's generally applicable environmental radiation standards in 40 CFR Part 190 shall comply with those standards". However, the 24 mrem annual dose estimate to a site preparation worker from Units 1 and 2 would be dose received, primarily from direct radiation, by a worker located at the proposed site of Units 3 and 4. The 25 mrem/yr dose limit to the whole body specified in 40 CFR 190 applies to a member of the public at the site boundary or beyond. The direct dose contribution at the site boundary from Units 1 and 2 would be expected to be much less than 1 mrem/yr. Author: Gregory A. Stoetzel SME: Gregory A. Stoetzel, Charles Hinson Key Documents: ER Section 4.5; NUREG-1811, Vol. 1
44	4-42	The gaseous and liquid pathway exposures to construction workers is based upon measured results from 2001, cited as being "representative of typical releases." For a time interval of at least six years that includes 2001, what would be the highest and lowest annual releases measured?	The Staff did not review the data for the entire six year period. The Staff only reviewed data for the years 2001, 2003, 2004, and 2005. For liquid effluents, the highest and lowest whole body annual doses were 0.38 mrem and 0.14 mrem, respectively; the highest and lowest critical organ annual doses were 0.43 mrem and 0.24 mrem, respectively. For gaseous effluents, the highest and lowest whole body annual doses were 0.046 mrem and 0.0018 mrem, respectively; the highest and lowest critical organ annual doses were 0.22 mrem and 0.066 mrem, respectively. Based on data from the 2003, 2004, and 2005 annual effluent reports (shown

<table>
<tr><td></td><td></td><td></td><td>below), the value for the year 2001 appears to be representative.

Dose from Liquid Exposure Pathway
<table>
<tr><td>Year</td><td>Whole body dose (mrem/yr)</td><td>Critical organ dose (mrem/yr)</td></tr>
<tr><td>2001</td><td>0.31</td><td>0.35</td></tr>
<tr><td>2003</td><td>0.14</td><td>0.24</td></tr>
<tr><td>2004</td><td>0.32</td><td>0.43</td></tr>
<tr><td>2005</td><td>0.38</td><td>0.40</td></tr>
</table>

Dose from Gaseous Exposure Pathway
<table>
<tr><td>Year</td><td>Total body (mrem/yr)</td><td>Critical organ (mrem/yr)</td><td>Skin (mrem/yr)</td></tr>
<tr><td>2001</td><td>0.046</td><td>0.15</td><td>0.11</td></tr>
<tr><td>2003</td><td>0.0036</td><td>0.066</td><td>0.015</td></tr>
<tr><td>2004</td><td>0.0029</td><td>0.093</td><td>0.093</td></tr>
<tr><td>2005</td><td>0.0018</td><td>0.22</td><td>0.0036</td></tr>
</table>

<u>Author</u>: Gregory A. Stoetzel
<u>SME</u>: Gregory A. Stoetzel
<u>Key Documents</u>: Annual Radioactive Effluent Release Reports for 2003, 2004, and 2005</td></tr>
<tr><td>45</td><td>5-8</td><td>Legal Question: In order to maintain the environmental health of the North Anna River, the North Anna Dam is operated to maintain a minimum discharge of 40 cfs. However, when the level of water in Lake Anna drops below 248 MSL the “Lake Level Contingency Plan” (LLCP) is triggered and the dam discharges only 20 cfs. This adversely impacts the river below the dam. The Staff’s water budget analysis “assumed the NAPS Units 1 and 2 and the proposed Unit 3 would operate continuously” P 5-8, and that the “existing NAPS units are the largest users</td><td>The driver for the Lake Level Contingency Plan was not to maintain the environmental health of the North Anna River downstream of the dam but to provide stable pool elevations for aesthetic and recreation interests around the lakeshore. Indeed, more "normative flow" conditions with increased flow variability (lower low flows and higher high flows) would likely increase environmental health of native aquatic and riparian communities downstream of the dam. An In-stream Flow Incremental Methodology (“IFIM”) study will investigate the potential impacts on the proposed Unit 3 on the fishes and other aquatic resources of the Lake Anna Reservoir and the North Anna River downstream of the dam. The study will be conducted by Dominion, in cooperation and consultation with the Virginia Department of Game and</td></tr>
</table>

		of water in the region." P 5-9. The FEIS states that the incremental effect of "operation of Unit 3 would approximately <u>double</u> the duration of periods during drought conditions when the LLCP would be applied. P 5-11. Specifically, the Staff estimated that if Unit 3 were added to Units 1 and 2, then the amount of time that water discharges to the downstream river would be cut to 20 cfs would increase from 5.7% of the time to 11% of the time. P 5-10. Given the cumulative impact of Units 1, 2, 3, and 4, should the EIS alternatives analysis specified in Section 8 of the FEIS include alternatives analysis of Dominion trading more stringent water saving measures on Dominion's existing Units 1 and 2 in mitigation or return for the incremental water losses caused by Unit 3? Why isn't this a "reasonable" alternative or mitigation measure requiring consideration? Please explain.	Inland Fisheries ("VDGIF") and the Virginia Department of Environmental Quality ("VDEQ"), as part of the Virginia coastal zone consistency determination. Furthermore, imposing more stringent water-saving measures on existing Units 1 and 2 would likely result in derating the plants, thereby reducing generating capacity. Reducing the generating capacity of existing units, so that new units could be built to meet increased electrical needs, was not considered to be a reasonable alternative. *See* the Staff's response to Board Question 112A. The remainder of this question is addressed in the "NRC Staff Legal Brief in Response to Licensing Board's Environment-Related Questions." <u>Author</u>: Lance W. Vail <u>SME</u>: Lance W. Vail, Michael T. Masnik <u>Key Documents</u>: NA
46	5-9	With Unit 3 operating, the percentage of time that the water release from the dam would be at minimum allowed flow of 20 cuft./sec would roughly double from 5.7% of the time to 11% of the time. The FEIS is essentially silent on the effects of lowered flow on downstream aquatic species. Please discuss how this issue will be addressed by the environmental study ("IFIM") recently announced by Dominion.	As stated in the FEIS on Page 5-31, the Staff believes the existing biological communities in the North Anna River and the downstream waters experience a wide variation in seasonal and daily flow conditions and are able to tolerate potentially stressful situations created by these events. Because of this, the Staff believes it is unlikely that a 5% increase in the duration of 20 cfs flows would adversely affect these species. Striped bass rearing and spawning is not expected to be affected by the operation of Unit 3 because the low flow conditions are most likely to occur between the months of June to December when striped bass are not spawning at downstream locations. The IFIM study will investigate the potential impacts of the proposed Units 3 and 4 on the fishes and other aquatic resources of Lake Anna and downstream waters. As stated in the Staff's response to Board Question 45, the study will be conducted by Dominion in cooperation and consultation with the VDGIF and the VDEQ as part of the Coastal Zone Management Act certification process. Because the scope of work for this study is still in development, the Staff cannot comment at this time as to how the minimum flow issue will be addressed by this study.

			Author: Jeffrey Ward SEM: Jeffrey Ward, Michael T. Masnik Key Documents: Letter from Commonwealth of Virginia to Dominion, November 21, 2006 RE: Federal Consistency Certification under Coastal Zone Management Act, Virginia Coastal Resources Management Program: North Anna Early Site Permit Application DEQ05079F http://www.deq.virginia.gov/eir/documents/05-079FNAnna06ConsistencyResponse.pdf
47	5-9	On page 5-9, the FEIS states that the actual procedures controlling the operation of the cooling system will be determined by the Commonwealth of Virginia in the Clean Water Act, National Pollution Discharge Elimination System (NPDES) permit, which is not needed until the CP or COL stage. Please explain the level of control that will likely be exercised by Dominion and by the Commonwealth.	As indicated in an e-mail dated 2/15/07, from Michael Murphy, Director, Division of Environmental Enhancement, VDEQ, "it is possible that the permit will require operation in the MWC mode under certain circumstances. What the permit will say will be determined in large part by the IFIM." Dominion would develop the procedures to operate the system to comply with the VPDES permit. Author: John S. Cushing SME: Lance W. Vail Key Documents: E-mail from VDEQ, ADAMS Accession Number ML0705303612
48	5-10	With Unit 3 running, Dominion and Staff estimated the percentage of time that Lake Anna would drop below 248 ft. to be 7.3% of the time and 11% of the time respectively. In explaining the difference, Staff concluded that two primary causes were: first, that Dominion had used an evaporation rate of 8707 gpm at a capacity factor of 96%, while the Staff had used an evaporation rate of 8707 gpm over any 365 day period; and second, that the Staff had applied the average evaporation rate throughout the period, while Dominion applied an evaporation rate that varied depending on temperature. Which procedure would more accurately assess actual consumptive water use? Please explain.	The Staff limited its review to values specified in the PPE, and reviewed Dominion's water budget calculation, determining that the approach and conclusions were not unreasonable. If the Staff had utilized Dominion's operating assumptions in its assessment, the Staff would expect that the results would more closely match Dominion's results. However, the Staff would have then incorporated these operating assumptions explicitly into the PPE. Since the Staff's conclusion regarding impacts in this area would not have been appreciably changed, the Staff elected to not include them in its independent assessment. Author: Lance W. Vail SME: Lance W. Vail Key Documents: NUREG-1835, Vol. 1
49	5-11	The FEIS identifies at least one "potential conflict over water use" with regard to the North Anna River, but	Water conflicts are extremely common, and increase with population growth. Managing water resources involves balancing the tradeoffs among various

		fails to discuss or consider the environmental impacts or implications of this conflict, stating only that the conflict "falls within the regulatory authority of the Commonwealth of Virginia." Merely because a matter is regulated by another government entity does not mean that its environmental impacts can be ignored by the EIS. Similarly, merely because a matter is not within the direct jurisdiction of NRC does not mean the environmental impacts are to be excluded. See 40 C.F.R. § 1502.14(c) and 10 C.F.R. Part 51, Appendix A, Section 5. Should the FEIS discuss the known potential conflicts over water use? Given the population growth projections for the region and the potential long term of the ESP and subsequent COL (20 + 20 + 40 + 20 years), please explain why the FEIS does not discuss and analyze reasonably foreseeable conflicts over water use resulting from the proposed ESP?	and often conflicting uses. The Staff did not ignore the potential for water use conflicts; however, the NRC has no role in adjudicating water conflicts. The focus of the EIS is to disclose conflicts and to evaluate mitigation. The Staff identified a downstream water use based on the adjacent counties' growth management plans. This water use conflict will occur regardless of whether the proposed facility is operated or not. However, the Staff did acknowledge that the conflicts would likely be aggravated by additional consumptive water use and thus assigned it a value of MODERATE for drought years. Author: Lance W. Vail SME: Lance W. Vail Key Documents: NUREG-1835, Vol. 1
50	5-12	The percentage of time that water flow from the dam drops to 20 cfs from operation of only Units 1 and 2 is cited in the FEIS as "6 percent" (5-17) and "approximately 6 percent" (5-10). However, the percentage of time that Lake Anna would drop below 248 ft. is cited as "5.7 percent of the time" (5-10). Is the cited 6 percent simply a rounding of 5.7 or is there some period of 20 cfs flow above 248 ft? If the difference is simply rounding, it would be desirable to use consistent numbers throughout, given the importance of this specific number.	The Staff determined that the accuracy of the analysis only supported reporting the value as 6 percent. However, in discussing the differences between the Staff and Dominion's calculation, the Staff believed it was informative to the reader to show that the respective values were not identical before rounding but less than 1 percent different. *See also* the Staff's Response to Board Question 53, *infra.*. Author: Lance W. Vail SME: Lance W. Vail Key Documents: NUREG-1835, Vol. 1
51	5-13	Please explain why Dominion did not provide at least a PPE covering the chemical effluents that would be discharged by the proposed ESP Units. Why should this item be "unresolved" at this time?	This comment and response are similar to Board Question 26. Dominion has not chosen a water treatment technology for the Unit 3 cooling water and blowdown and, therefore, did not provide any specific information regarding chemical effluents related to the cooling system. Therefore, the Staff did not resolve this issue. However, as discussed in the Staff's Generic Environmental Impact Statement for License Renewal of Nuclear Plants (NUREG-1437, Section 4.3.2.2), for existing plants the Staff found that the impacts of these effluents were small. The Staff also found that the existing plants generally operated within the limits of their NPDES permits and

			believes that new plants would do the same. Thus the Staff felt it could reasonably expect, for the purposes of the alternative site comparison, that the impacts of these chemical effluents would be small. Resolution of the issue, however, is withheld until an actual design, with its associated effluents, is defined. Author: Andrew Kugler SME: Andrew Kugler Key Documents: NUREG-1437

52	5-15	Line 2 of the first paragraph states that "Current noise levels are occasionally as high as 100 decibels (measured at the security fence during outages)." Why are measurements made during outages? Wouldn't there be higher noise levels during operation?	The statement in question appears in Section 5.3.3.2.3 of the ER. According to Dominion, noise levels are not normally measured during non-outage periods, but are occasionally measured in support of specific tasks. The peak noise associated with outages can be higher than that occurring during normal operation. This is because during outages, there are more people on site, operating more vehicles and equipment for construction, maintenance, and test activities. Also, the site communications system tends to be in use more during outages than during normal operation. Thus, during periods of peak activity (during outages), the noise levels, which can be as high as 100 dB measured at the security fence, would be greater than during periods of normal operation. Author: J.V. Ramsdell SME: J.V. Ramsdell Key Documents: NUREG-1811, Vol. 1; Dominion ER, Chapter 5
53	5-17	Comment. Section 5.4.1.4 states that lake level would drop below 248 feet 5.7% of the time without Unit 3, while in Section 5.4.1.4 the 5.7% has been rounded to 6%. Given that these numbers are important, it would be desirable to use consistent numbers.	The Staff determined that the accuracy of the analysis only supported reporting the value as 6 percent. However, in discussing the differences between the Staff and Dominion's calculation, the Staff believed it was informative to the reader to show that the respective values were not identical before rounding but less than 1 percent different. Author: Lance W. Vail SME: Lance W. Vail Key Documents: NUREG-1835, Vol. 1
54	5-29	Striped bass are known to occur in the North Anna River downstream of the dam but these fish are believed to have passed through the dam from Lake Anna. Striped bass are known to occur and spawn successfully in the Pamunkey River but are unlikely to venture above the fall line during their spawning migrations. Please describe the fall line and why it would present an impediment to spawning striped bass. How far downstream of the dam do you find a	Two terms are used to describe the topographical area that separates the Coastal Plain and Piedmont provinces of Virginia: the "Fall Zone" and the "Fall Line." Jenkins and Burkhead (1993) define the Fall Zone as the "relatively narrow belt between Coastal Plain and the Piedmont provinces" and the Fall Line as the "eastern edge of the Fall Zone..." Geologically, the Fall Zone is recognized as an area where resistant metamorphic rocks associated with the Piedmont are present, and the river or stream elevations (slope) can change dramatically from west to east. Aquatic habitats in these areas may include the presence of large rocks or boulders within the streams

		tidal influence?	or rivers, waterfalls, and resting pools. In Virginia, the Fall Zone varies in width and slope, with the steepest portions in the Potomac and Rappahannock Rivers. The steep slopes and presence of rocks and boulders in these zones generally limit the upstream passage of boats and were often the location of human settlements during colonization. In some places, the Fall Zone can completely block upstream movement of fish, especially during low water conditions. Jenkins and Burkhead (1993) generally consider the Fall Line to be the upstream limit of striped bass migration in the Chesapeake basin of Virginia. The Fall Line on the North Anna River is located approximately 36 km (22 mi) downstream of the North Anna Dam. The most upstream record of a native striped bass was a single specimen collected in 1971 from the Pamunkey River some 90 km (56 mi) downstream of the dam. The furthest upstream that striped bass eggs and larvae have been collected is from the Pamunkey River at a location approximately 119 km (74 mi) downstream of the Lake Anna Dam. Even though Jenkins and Burkhead (1993) report that the Fall Line limits upstream migration of this species in the York River basin, the results of extensive sampling indicates that it is unlikely that returning striped bass travel that far upstream. The confluence of the North and South Anna Rivers is located approximately 34 miles below the North Anna dam. According to VDGIF (2007), "from the confluence of the North Anna River and South Anna River downstream to below Hanovertown, the Pamunkey is a narrow steep banked meandering stream with no upstream tidal flow (continuous downstream flow as opposed to ebb and flood flow). Although as you move closer to the Route 360 Bridge [some 129 km (80 mi) below the Lake Anna Dam] you may experience small fluctuations in river levels during periods of low flow due to tidal influences." Author: Jeffrey Ward SME: Jeffrey Ward, Michael T. Masnik Key Documents: Jenkins, R.E. and N.M. Burkhead. 1993. Freshwater Fishes of Virginia, American Fisheries Society, Bethesda, Maryland. VDGIF (Virginia Department of Game and Inland Fisheries). 2007. "Pamunkey River." Accessed at **http://www.dgif.virginia.gov/fishing/waterbodies/display.asp?id=167** on February 8, 2007.

55	5-30	In Section 5.4.2, which deals with "Downstream Impacts" the FEIS states that "the biological impacts of the Unit 3 closed cycle, combination wet and dry cooling system to the general aquatic community of the North Anna River and striped bass spawning and rearing areas in the Pamunkey would be indistinguishable from the effects of operations of NAPS Units 1 and 2." This appears equivalent to saying that the lowered down-stream flow would have no effect.	
		A. What is the basis for this conclusion?	The Staff believes the existing biological communities inhabiting rivers along the East Coast of North America, including the North Anna River and its associated downstream waters, have historically experienced a wide variation in seasonal and daily flow conditions. Biological communities inhabiting these watercourses have evolved to tolerate and flourish under both drought and flood conditions. Because of this, it is unlikely that a 5 percent increase in the duration of 20 cfs flows would adversely affect these communities. Given the large natural variations this ecosystem experiences, it is also unlikely that it would be possible to distinguish a statistically or biologically significant change in the ecosystem due to a 5 percent increase in the duration of the 20 cfs flow using available watershed evaluation techniques (*e.g.*, Index of Biological Integrity, GIS-based habitat mapping, diversity indices). Striped bass rearing and spawning are not expected to be effected because the low flow conditions are more likely to occur between the months of June to December, when striped bass are not spawning. Author: Jeffrey Ward SME: Jeffrey Ward, Michael T. Masnik Key Documents: NA
		B. Isn't this environmental effect one of the questions the pending Dominion study (IFIM) will address?	Yes. Based on the contents of the letter provided to Dominion by the Commonwealth of Virginia dated November 21, 2006, the IFIM study will investigate the potential impacts of the proposed Units 3 and 4 on the fishes and other aquatic resources of Lake Anna and downstream waters. The Staff's assessment of downstream impacts is described in the FEIS and in the Staff's response to Board Question 55A, above.

			Author: Jeffrey Ward SME: Jeffrey Ward, Michael T. Masnik Key Documents: Letter from Commonwealth of Virginia to Dominion, November 21, 2006 RE: Federal Consistency Certification under Coastal Zone Management Act, Virginia Coastal Resources Management Program: North Anna Early Site Permit Application DEQ05079F http://www.deq.virginia.gov/eir/documents/05-079FNAnna06ConsistencyResponse.pdf
		C. Shouldn't this effect be covered in the FEIS?	No. The IFIM study is not being prepared in order to quantify environmental impacts for an environmental impact statement. Rather, it is the Staff's understanding that the IFIM study is being conducted by Dominion for the VDEQ as part of the CZMA process, and to develop information VDEQ will use to establish the conditions for downstream flows and surface water management associated with plant operations. In its letter to Dominion of November 21, 2006, the Commonwealth of Virginia indicated that the Commonwealth (including VDGIF and VDEQ), Dominion, and the NRC have agreed that the commitment to conduct an IFIM study will be added as an enforceable permit condition should NRC approve the North Anna ESP. The letter indicates that the development of the scope of work for the study will begin in 2007, and that the IFIM study shall be completed prior to the issuance of a combined construction and operating license (COL) for this project. Dominion has agreed to consult with VDGIF and VDEQ regarding analysis and interpretation of the results of that study and to abide by the surface water management, release, and in-stream flow conditions prescribed by VDGIF and VDEQ upon review of the completed study. The November 21, 2006, letter also correctly states that a separate CZMA consistency certification would be required prior to the issuance of a COL. Thus, the issuance of the FEIS will not interfere with the use of the IFIM results to satisfy CZMA requirements imposed by the Commonwealth of Virginia through VDEQ. Author: Jeffrey Ward SME: Jeffrey Ward, Michael T. Masnik Key Documents: Letter from Commonwealth of Virginia to Dominion, November 21, 2006 RE: Federal Consistency Certification under Coastal Zone Management Act, Virginia Coastal Resources Management Program: North Anna Early Site Permit Application DEQ05079F

			http://www.deq.virginia.gov/eir/documents/05-079FNAnna06ConsistencyResponse.pdf
56	5-34	The FEIS states that "Overall, the [Lake Anna] fisheries have remained healthy and balanced despite shoreline development, NAPS operations, and increased fishing pressure." How developed is the shoreline of Lake Anna?	During site visits, the Staff observed that the shoreline of the Lake has a combination of rural tracts (some with cattle grazing on them), over 80 named low-density residential subdivisions of at least a few residential blocks each, two campgrounds, five small marinas, six additional public boat launches, a state park, and an industrial facility (NAPS). The shoreline still appears quite rural in character. Much of the shoreline in the subdivisions remains forested, with houses set well back from the water; in other cases, lawns reach down to the water's edge. A substantial number of the private shoreline properties have private docks, boathouses, or waterfront structures ranging from open gazebos to fully enclosed structures. Author: Michael J. Scott SME: Michael J. Scott, Jeffrey Ward Key Documents: "Trip Report – September 19-22, 2005, Tour of the North Anna River, Lake Anna, and the Surry Alternative Site," ADAMS accession number ML061720366.
57	5-39	The operation of the Unit 3 wet cooling tower would produce fogging at all times of the year (except for summer) up to a mile from the tower and nearby residents would also be exposed to modest salt deposition from the tower.	
		A. Have similar facilities at other sites produced accelerated vehicle corrosion, window fogging and gardening impacts?	The *Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS)*, NUREG-1437, addresses the observed impacts of mechanical draft wet cooling towers at nuclear plants and other facilities (e.g., coal-fired plants). The observed impacts on vegetation were mostly due to icing on trees near the cooling towers (<400 m). Some sulfate injury to trees was reported near the Palisades plant, but it decreased when the plant stopped adding sulfuric acid to cooling water. Section 4.3.4.3 of the GEIS states the following: "Monitoring results from the sample of nuclear plants and from the coal-fired Chalk Point plant, in conjunction with the literature review and information provided by the natural

			resource agencies and agricultural agencies in all states with nuclear power plants, have revealed no instances where cooling tower operation has resulted in measurable productivity losses in agricultural crops or measurable damage to ornamental vegetation." The GEIS does not discuss corrosion of automobile bodies or fogging of windows. However, given that the deposition rate decreases rapidly as distance from the cooling tower increases, it is unlikely that corrosion of automobile bodies would be noticeably increased by drift or that additional humidity due to evaporation would result in noticeable window fogging off site. Author: J. V. Ramsdell SME: J. V. Ramsdell, W. F. Sandusky, M. R. Sackschewsky Key Documents: NUREG-1811 Vol. 1, NUREG-1437, Vol. 1
		B. If effects have been observed, what can be said about the severity of the effects?	The impacts of cooling tower plumes and drift are not expected to be noticeable off site except for the visual presence of the plume. Author: J. V. Ramsdell SME: J. V. Ramsdell, W. F. Sandusky, M. R. Sackschewsky, Michael J. Scott. Key Documents: NUREG-1811 Vol. 1, NUREG-1437, Vol 1
58	5-47	In the second paragraph of 5-47, the FEIS states that raising the lake level (6 to 12 inches) could increase localized flooding potential and downstream flows, and would likely affect use of some residential and marina boat ramps and docks, including those at North Anna State Park. Has the Staff or Applicant evaluated the effect of raising the lake level 6 to 12 inches? How serious is the threat of increasing local flooding by raising the lake level by 6 to 12 inches when the expected high water level is considerably higher?	The threat is moderate. The Staff did not undertake a census of residential and marina boat docks, launch ramps, boat houses, nor did it perform a detailed evaluation of the impact of a 6 to 12 inch increase in lake operating level. At the VDEQ's request, Dominion evaluated a 6 to 12 increase in the lake level and concluded that some local flooding could occur. The Staff believes this was done primarily as a map exercise and did not include a detailed evaluation of docks and boat ramps. However, by visiting several of the marinas and subdivisions surrounding the lake, observing these facilities from a boat on the lake, and talking to many of the marina mangers and fishing guides, the Staff knows that many (perhaps the vast majority) of the docks, boat houses, boat ramps, etc., surrounding the lake are fixed facilities with no ability to be raised or lowered as Lake Anna is raised or lowered. To the Staff's knowledge, some of the fixed shore facilities have at least 6 to 12 inch clearance above the 250-foot normal lake level. It is likely, however, that some do not and would require modification or replacement if the normal

			operating level of the lake were raised. The expected high water level is largely irrelevant to this conclusion because shore facilities are adapted to the current 250-foot operating level. <u>Author</u>: Michael J. Scott <u>SME</u>: Michael J. Scott, Lance W. Vail <u>Key Documents</u>: NA
59	5-55	What does the term "hourly average values" mean when referring to the highest temperatures recorded at various locations in Lake Anna? Please describe the calculation.	In its response to this question, Dominion states that the ER is in error, and that none of the temperatures are averages. Dominion provides the following revised information related to the water temperatures: > Section 5.8 of the Environmental Report is incorrect in stating that these temperatures are hourly averages. Therefore, none of the temperatures reported on p. 5-55 of the EIS are average values. The manner in which water temperatures were recorded varied over the years and with the instruments used. The temperatures reported from 1974 to 1987 are the highest value recorded during the one-hour period. From 1987 to the present, only one temperature measurement was taken per hour. Pre-1987 temperatures represent the highest value in an hour. Post-1987 temperatures represent the only value in an hour. The highest temperature reported in the EIS for Lake Anna was recorded in 1977, when “conservative” values (the highest value observed over a one-hour period” were used. This correction by Dominion does not alter any of the conclusions in the FEIS. <u>Author</u>: J.V. Ramsdell <u>SME</u>: J.V. Ramsdell <u>Key Documents</u>: NA
60	5-57, 5-58	Because virtually everyone in the United States uses electricity and therefore is routinely exposed to ELF-EMF (extremely low frequency-electromagnetic field), NIEHS recommends that passive regulatory action is	It is the Staff’s understanding that, for many years, Dominion has provided information about electric and magnetic fields to customers and the public. Currently, the Company’s website has an EMF page dedicated to providing information about this issue along with links to other websites maintained by

		warranted, including a continued emphasis on educating both the public and the regulated community on means aimed at reducing exposures. Dominion's response is to assure that transmission lines carrying the additional power would not exceed the NESC criteria for electrical shock (Appendix J, Table J-2). Does Dominion have any plans to address any other aspects of NIEHS's recommendations?	the National Institutes of Environmental Health Sciences, the National Cancer Institute and the Virginia Department of Health. As noted in the EMF Update (located on Dominion's webpage; www.dom.com), Dominion continues to meet with customers and provide them with measurements of electric and magnetic fields. Author: J.V. Ramsdell SME: J.V. Ramsdell Key Documents: NA
61	5-58	Please explain why there was no consideration of a liquid effluent exposure pathway whereby leaks, releases or discharges to groundwater migrated into the adjacent surface water of the WHTF and lake.	The Staff did not consider leakage to the groundwater as a pathway for normal operating effluents because it is an accident scenario. While the Staff does have recent experience with inadvertent liquid effluent releases, it is not possible for the Staff to predict when or where such releases will occur. The NRC Task Force, which, in September 2006 issued the "Liquid Radioactive Release Lessons Learned Task Force Final Report," has evaluated the impact of such past releases and determined the impacts to be insignificant from a public dose standpoint (fraction of a mrem). The Staff, in its FSER, proposed a permit condition that would preclude accidental releases to groundwater. Author: Gregory A. Stoetzel SME: Gregory A. Stoetzel Key Documents: NUREG-1555; Task Force Final Report Appendix A of NUREG 1835 Supplement 1
62	5-59	The FEIS states that "Units 1 and 2 routinely release [radioactive] tritium into Lake Anna," that "tritium has concentrated in Lake Anna, " and that the "average tritium concentration in the lake for 2005 was reported as . . . 3,137 pCi/L." The FEIS also states that the proposed Units 3 and 4 will discharge additional tritium into Lake Anna.	
		A. Please describe the basic pathways and mechanisms by which tritium may be released from reactors into groundwater, the UHS, the WHTF and Lake Anna. Current and expected tritium concentrations are quoted for Lake Anna. Please	The basic pathways and mechanisms by which tritium may be released from existing reactors into groundwater are discussed in the Liquid Radioactive Release Lessons Learned Task Force Final Report (September 2006). Systems or structures can experience undetected radioactive leaks over a prolonged period of time. Systems or structures that are buried or that are in

		summarize any measured or calculated tritium levels in the other locations. If any values for any location (including any location or strata within Lake Anna) have exceeded the EPA drinking water standard for tritium, identify these locations and the time(s) they have exceeded the standard.	contact with soil, such as spent fuel pools, tanks in contact with the ground, and buried pipes, are particularly susceptible to undetected leakage. A review of past instances (none of the instances occurred at the NAPS site) where tritium was inadvertently released to the environment unmonitored were discussed in the Task Force's report. These included: 1) three incidences of leakage from vacuum breaker valves on the circulating water blowdown line, 2) three incidences of leakage from the spent fuel pool, 3) leakage from non-safety related HPCI suction and return line, 4) leakage from fuel transfer canal due to operator error, 5) leakage from condensate storage tank, 6) leakage from effluent release pipe and spent fuel pool transfer tube sleeve, 7) leakage from retention pond, 8) rain condensing onto property after a gaseous release, and 9) leakage from feedwater venture. The discussion above is for existing reactor designs. The Staff did not consider leakage to the groundwater as a pathway in the FEIS because of proposed Permit Condition 4, which will require the applicant to submit a radwaste system design with features to preclude any and all accidental releases of radionuclides into any potential liquid pathway. In addition, the PPE approach did not provide adequate information upon which to base this evaluation. The PPE does not contain detailed information on plant systems and components that will be used to treat radioactive liquid and gaseous process and effluent streams sent to radioactive waste reduction systems. As part of its Radiological Environment Monitoring Program ("REMP"), Dominion routinely samples for tritium in the surface waters of the WHTF, the North Anna River (5.8 miles downstream of the plant), and Lake Anna Upstream (12.9 miles upstream). An onsite well is also sampled quarterly and analyzed for tritium concentration. All tritium sample results at these locations have been less than the EPA drinking water standard. A review of the annual Radiological Environmental Operating Reports for the years 2000-2005 did not show any tritium concentrations that exceeded the EPA drinking water standard. <u>Author</u>: Gregory A. Stoetzel <u>SME</u>: Gregory A. Stoetzel <u>Key Documents</u>: Liquid Radioactive Release Lessons Learned Task Force Final Report (September 2006); Annual Radiological Environmental Operating Reports for the years 2000-2005
		B. The FEIS states that Dominion originally estimated	Dominion changed its PPE liquid effluent release value for tritium from 3100

		that each new unit of the ESP would release 3,100 Ci./yr and later reduced this amount to 850 Ci./yr. Please explain what Dominion will do to effect this large decrease in tritium release. Has NRC evaluated the feasibility of this reduction? How can NRC confirm that this commitment is being met?	Ci/yr to 850 Ci/yr in Rev 9 of the ER. This was done because the Staff's evaluation showed that the 3100 Ci/yr release could potentially result in tritium concentrations greater than EPA drinking water limits in Lake Anna and the North Anna River downstream of the plant. The 3100 Ci/yr tritium liquid release value was derived from the ACR-700 reactor design. The tritium value of 850 Ci/yr is a parameter in the PPE. The Staff intends to include the PPE in the ESP should one be issued. At the CP or COL stage, the applicant must demonstrate that the design selected will release less tritium than the PPE value, and the NRC Staff will verify that the design selected will release less than the PPE value and comply with the dose objectives of Appendix I to 10 CFR Part 50, effluent concentration limits of Appendix B (Table 2) to 10 CFR Part 20, and 40 CFR Part 190 dose standards. The NRC evaluated the impact of the reduced tritium liquid effluent release in Section 5.9 of the FEIS. Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: ER, Rev 9; NUREG-1811, Vol. 1
		C. For many periods of the year, the water release rate from the lake will be small enough to produce replacement of only a fraction of the total lake volume, raising the possibility of tritium stratification in the lake. If tritium concentrations have been measured as a function of lake depth and location, please submit representative values of these measurements.	Tritium concentrations have not been measured as a function of lake depth and location. All sampling has been done on the surface. Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: Annual Radiological Environmental Operating Reports for the years 2000-2005

		D. The quoted average tritium release (from Units 1 & 2 over a six-year period) is 814 Ci/yr. and the average annual lake concentration was 3,049 pCi/liter. (p. H-10). 1. What were the highest and lowest measured values over the six-year interval? 2. How was the tritium release determined?	The average annual tritium release was determined by averaging the tritium release values from the Annual Effluent Monitoring Reports for the years 2000-2005. The highest annual tritium release was 1115 Ci in 2004 and the lowest was 349 Ci in 2003. The average annual lake concentration was determined by averaging the tritium concentration values from the WHTF location for the years 2000-2005. These concentrations were taken from the annual Radiological Environmental Operating Reports. As part of the REMP, tritium concentration are measured quarterly at this location. The highest quarterly tritium concentration was 4500 pCi/L and the lowest was 940 pCi/L over the six-year period. The highest annual tritium concentration was 3908 pCi/L (2002) and the lowest was 2000 pCi/L (2003). Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: Annual Effluent Monitoring Reports for the years 2000-2005; annual Radiological Environmental Operating Reports for years 2000-2005
		E. The expected tritium level from all four units will be roughly 47% of the EPA drinking water standard of 20,000 pCi/L (p. H-10) Yet Section 5.9.2.1 states that inclusion of tritium in the dose calculations in Table 5-8 "resulted in minor changes to the estimates in Table 5-8 for the drinking water pathway and essentially no change to the estimates for other pathways." Do you deem Lake Anna average tritium levels at 47% of the EPA drinking water standard to be minor or inconsequential? Please explain.	The Staff does not deem elevated tritium levels in the lake as inconsequential. Indeed, the driver for Dominion revising its PPE tritium liquid effluent release value from 3100 Ci/yr to 850 Ci/yr was the Staff's concern about elevated tritium levels in the lake. Having said that, the tritium concentration in the lake at a concentration of 9400 pCi/L would still result in doses to the public well within regulatory limits as discussed in Section 5.9 of the FEIS. The statement "resulted in minor changes to the estimates in Table 5-8 for the drinking water pathway and essentially no change to the estimates for other pathways" specifically referred to the additional impact of the existing tritium concentration in Lake Anna from Units 1 and 2. Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: NUREG-1811, Vol. 1
		F. What monitoring will NRC require or Dominion carry out to confirm tritium concentrations and	Dominion will monitor for tritium in the environment as specified in its Radiological Environmental Monitoring Program (REMP). Currently,

		releases? Will there be any way to apportion tritium releases among the four units?	Dominion monitors for tritium at one location in the WHTF, at one location in Lake Anna, at one location in North Anna River, and at one onsite test well. The REMP was evaluated in Section 5.9.6 of the FEIS. The REMP results of tritium sample analyses will be compared with the requirements of the Offsite Dose Calculation Manual (ODCM), assessed for compliance against NRC and EPA regulatory requirements, and reported in the Annual Radioactive Effluent Release Report. Effluent releases associated with Units 1 and 2 are shared, and therefore treated as a common effluent pathway. Liquid waste processing for Units 3 and 4 would be independent from processing for Units 1 and 2. Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: NUREG 1811, Vol. 1
		G. Table H-5 quotes "per unit" tritium release rates of 3,500 Ci/y which is over four times the committed release cited above. What is the difference between the Dominion commitment and the numbers in the Table?	Table H-5 presents the gaseous tritium effluent release source term, which is correctly stated as 3500 Ci/yr. Table H-2 presents the liquid tritium effluent release source term, which is correctly stated as 850 Ci/yr. Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: NUREG 1811, Vol. 1
63	5-61, 5-62	Dominion is the source of all of the liquid pathway doses in Table 5-8. The FEIS states that "the staff determined that all input parameters used in Dominion's calculations were appropriate." Please describe what the Staff did to make this determination.	Table H-1 in Appendix H of the FEIS summarizes the process the Staff used in evaluating Dominion's input parameters. The liquid effluent release source term provided was the PPE value developed by the applicant. The basis for this source term was discussed in the Staff's response to Board Question 36, *supra*. The applicant specified a liquid discharge rate of 100 gpm with a dilution factor of 1000 for aquatic food, boating, shoreline use, swimming, and drinking water. The dilution factor of 1000 was based on 100 gpm discharge rate with a dilution flow of 100,000 gpm. The Staff determined this to be appropriate based on Section 5.4.1.1 of the ER, which states that the existing units' evaluation for effluent dilution is based on a flow of 430,000 gpm in the discharge canal; therefore, the 100,000 gpm dilution flow is conservative. The applicant assumed no impoundment for the hydrologic model. This is

			conservative and will result in the highest concentrations to the lake (receiving body of water). Many of the other factors such as shore width factor, consumption and usage factors, and exposure times for activities such as shoreline usage, swimming, and boating were obtained from the applicant's July 12, 2004 response to the Staff's May 17, 2004 RAI request. These were site-specific factors or default factors from NRC guidance documents such as RG 1.109 (Calculation of Annual Dose to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I). <u>Author</u>: Gregory A. Stoetzel <u>SME</u>: Jean-Claude Dehmel <u>Key Documents</u>: NUREG 1811, Vol. 1, RG 1.109
64	5-62	Are the doses in Table 5-8 for all isotopes or for all isotopes minus tritium? (Better labeling of this table would be helpful.)	The doses in Table 5-8 are for all liquid effluent isotopes, including tritium. <u>Author</u>: Gregory A. Stoetzel <u>SME</u>: Jean-Claude Dehmel <u>Key Documents</u>: NUREG 1811, Vol. 1
65	5-62	If Table H-8 includes tritium, it would appear that a calculation of dose from fish consumption would have to utilize different biological half-lives for the fraction of tritium in water and the fraction organically bound. What assumptions are made for this calculation?	Table 5-8 of the FEIS includes tritium. The Staff used the LADTAP II code as discussed in Section H.1.2 of the FEIS in calculating population dose from liquid effluents. The LADTAP II code is based on methodology from NRC RG 1.109. This code uses a single biological half-life for tritium (~10 days) and does not differentiate between the fraction of tritium in water and the fraction organically bound. It should be noted that the code includes bio-accumulation factors characterizing the relationship of the concentration of a radionuclide in water to that in fish tissues. Bio-accumulation factors are included for 31 elemental species in Table A-1 of RG 1.109, including one for hydrogen. The values of this table are used in the absence of site-specific data. The bio-accumulation factor for hydrogen (tritium) is 0.90 for fish and invertebrates in fresh water. <u>Author</u>: Gregory A. Stoetzel <u>SME</u>: Jean-Claude Dehmel <u>Key Documents</u>: NUREG/CR-4013 (LADTAP II – Technical Reference and

			User Guide; RG 1.109, "Calculation of Annual Dose to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I."
66	5-62 to 63	Dominion is the source of all of the gaseous pathway doses in Table 5-9. The FEIS states that "the staff performed an independent evaluation of gaseous pathway doses and found similar results." Please describe the Staff's independent evaluation and provide the results.	Section H.2 of the FEIS describes the Staff's dose estimate from gaseous effluents for the proposed Units 3 and 4. Table H-4 summarizes the source of all input parameters used in the code. Most parameters (*e.g.*, population, milk production rate, pathway receptor locations) were provided in the ER. Where site-specific values were not available, the Staff and Dominion used default values provided from NRC guidance documents such as RG 1.109. Dose results are provided in Tables H-6, H-7 and H-8, along with a comparison to the applicant's results. The GASPAR II code was used to calculate doses. Copies of the computer runs can be found in ADAMS (Accession No. ML063050600). Section H.3 of the FEIS describes the Staff's dose estimate from airborne tritium released from the proposed Unit 3 wet cooling towers. Here also, the GASPAR II code was used to calculate doses. Table H-4 summarizes the source of all input parameters used in the code, with the exception of the source term. The source term was derived as discussed in Section H.3.3. Dose results are provided in Table H-9. Copies of the computer runs can be found in ADAMS (Accession number ML063050600). <u>Author</u>: Gregory A. Stoetzel <u>SME</u>: Jean-Claude Dehmel <u>Key Documents</u>: NUREG 1811, Vol. 1, RG 1.109, ER
67	5-62	The FEIS states that the design objectives of 10 C.F.R. Part 50, Appendix I are applicable to "each reactor unit." As we understand it, Dominion's IRIS option would include three light water reactors at each Unit, for a total of six additional LWR to be covered by the proposed ESP. <u>See</u> FEIS Table 6-4, Note (h). What is your position as to how the Appendix I objectives apply to the IRIS option and proposal?	The Staff's evaluation in Section 5.9 of the FEIS considered impacts of the three IRIS reactors together when comparing to the 10 CFR Part 50, Appendix I dose objectives. In contrast to the requirements of Part 50 Appendix I, compliance with 40 CFR Part 190 dose limits is assessed against the entire site and all sources of radioactivity and external radiation, regardless of the number of power plants. The sources of radioactivity include all liquid and gaseous effluent releases, and other sources of radiation. The implementation of these programs and license conditions are routinely inspected by NRC Regional Inspectors. The inspection examines the licensee's radiological effluent monitoring and release programs to ensure these programs meet all NRC requirements and license conditions. If a plant were to exceed the dose

			limits of 40 CFR Part 190 or any other requirements of Part 20, the inspection would identify the cause and determine whether a proper response and corrective actions were taken by the licensee. Under the provisions of 10 CFR 20.1301(f), the NRC may impose additional restrictions after evaluating the impacts on members of the public in light of commitments and characterizations contained in the CP or COL application. Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: 10 CFR Part 50, Appendix I, 40 CFR Part 190

68	5-64	The FEIS states that "the direct radiation dose to the maximally exposed individual at the site boundary was determined to be negligible." Quantitatively, what is the direct radiation dose to the MEI at the site boundary?	In the FEIS, the Staff did not calculate the direct radiation dose to the MEI at the site boundary from Units 3 and 4. The Staff's conclusion that dose would be negligible at the site boundary was based on the following: 1) the conclusion in NUREG-1437 that direct radiation from normal operations results in "small contributions at site boundaries" and 2) the applicant's statement in the ER that the PPE reactor designs are expected to provide shielding that is at least as effective as existing light water reactors. Direct contribution from the new units would be negligible. Author: Gregory A. Stoetzel SME: Charles Hinson Key Documents: NUREG-1811, Vol. 1; NUREG-1437 (GEIS); ER
69	5-64	Legal Question: It would appear possible to meet the general public dose requirements of 10 C.F.R. § 20.1301 while simultaneously exceeding the dose limitations of 40 C.F.R. Part 190. Is it your position that the Part 190 doses are ALARA recommendations or that they are regulatory limits?	*See* the "NRC Staff Legal Brief in Response to Licensing Board's Environment-Related Questions."
70	5-64 to 65	The FEIS states that Dominion is the source of the data contained in Table 5-11 and that "the staff performed an independent evaluation of the cumulative dose as described in Appendix H and found similar results." Table 5-11 shows that the cumulative dose to any organ (other than thyroid) from the two existing NAPS units and the proposed units is 12 mrem, which is close to 50% of the limit imposed by the 40 C.F.R. Part 190 standards. Please explain whether there is a required or recommended level of statistical reliability associated with the determination of cumulative dose (i.e., confidence level) for 40 C.F.R. Part 190? Please explain the statistical reliability or confidence level for the 12 mrem figure from Table 5-11. Does this value have the same statistical reliability level required by Part 190? Please explain.	NRC regulations have no required or recommended level of statistical reliability associated with the determination of cumulative dose. The Staff's interpretation of 40 CFR Part 190 is that it does not specify a level of statistical reliability, other than a provision allowing a variance in instances when the limits of 40 CFR 190.10 are exceeded. Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: NA

71	5-66	The FEIS states that the Staff used the ICRP Publication 60 nominal probability coefficients for a "total detriment" consisting of "730 fatal cancers, nonfatal cancers and severe hereditary effects per 10,000 person Sv (1 million person-rem)." Please provide a breakdown, specifying the number of fatal cancers, non-fatal cancers, and severe hereditary effects that comprise the 730 figure.	The breakdown of the 730 fatal cancers, non-fatal cancer, and severe hereditary effects per 10,000 person-Sv (1 million person-rem) is the following: 1. 500 fatal cancers per 10,000 person-Sv (equivalent to $5x10^{-4}$ fatal cancer per person-rem) 2. 100 non-fatal cancers per 10,000 person-Sv (equivalent to $1x10^{-4}$ non-fatal cancer per person-rem) 3. 130 severe hereditary effects per 10,000 person-Sv (equivalent to $1.3x10^{-4}$ severe hereditary effects per person-rem) Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: ICRP Publication 60 (1990 Recommendations of the International Commission on Radiological Protection)
72	5-66	The FEIS states that "the staff concludes there would be no observable health impacts to the public from the normal operation of the proposed nuclear units and the radiologic health impacts would be small." Does NRC use epidemiological "observability" as the criterion for whether a health impact is small? How many incremental fatal cancers would need to occur in the 50 mile radius zone around the proposed new reactors in order for such cancers to be deemed "observable" or statistically significant? Would 1,000 additional fatal cancers spread across the population of the 50 mile radius zone over 40 years be "observable?"	No. NRC does not use epidemiological "observability" as the criterion for determining health impacts in NUREG-1811. Rather, the basis for the statement of "no observable impacts" and that radiological health impacts would be SMALL is derived from the regulatory standards from both NRC and EPA. As stated in Section 1.1.3 (ESP Application and Review) of NUREG-1811, information and analysis provided in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, is used in NUREG-1811 as appropriate. Based on the findings in NUREG-1437, Section 4.6 (Radiological Impacts of Normal Operation) establishes that the definition of the significance level of an environmental impact (small, moderate, or large), for health impacts for individual members of the population or an ecosystem, is not the same as other impacts for which the concern is with species preservation, ecological health, and condition of the attributes of the resource. NUREG-1437 states, "However, health impacts on individual humans are the focus of NRC regulation limiting radiological doses….For the purposes of assessing radiological impacts, the Commission has concluded that impacts are of small significance if doses and releases do not exceed permissible levels in the Commission's regulations. This definition of "small" applies to occupational doses as well as to doses to individual members of the public."

			In its evaluation of radiological health impacts in Chapter 5 and Chapter 6 of the FEIS, the Staff used the linear, no-threshold dose response model in determine health impacts. This model is supported by the findings of the recently completed BEIR VII report. Using this model, the Staff estimated less than 0.02 fatal cancers, non-fatal cancers, and severe hereditary effects annually from effluents during normal operation of proposed Units 3 and 4. The Staff does not assess how many fatal cancers in any particular radius would be "observable or significant". Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: NUREG-1437 (Generic Environmental Impact Statement for License Renewal of Nuclear Plants); NUREG-1811, Vol. 1; Health Risks for Exposure to Low Levels of Ionizing Radiation: BEIR VII – Phase 2
73	5-72 to 73	The FEIS states that the "DBA review focuses on three light-water reactor designs" but indicates that "because the source terms for accident analyses are generally proportional to the power level, for purposes of this site suitability evaluation, the potential consequences of accidents for the other reactor designs are expected to be bounded." What about the potential probabilities of DBAs for the other reactor designs? For example, the PBMR option seems to involve 16 reactors and the GT-MHR option involves 12 reactors. This factor alone might seem to indicate a 16X or 12X (respectively) greater probability of an accident. The differences in design might also make significant differences in the probabilities of such accidents. Please explain how the ER and FEIS analyze and consider these factors as applicable to the four other options not covered by the three light-water reactor designs.	The probability of design basis accidents is not considered in the FEIS analysis. Each accident is analyzed as if it were to occur. Given the releases from the reactor as a result of the accident, the predicted doses at the exclusion area boundary and outer edge of the low population zone are compared with regulatory limits. If, for the purposes of the ESP application, Dominion defines a "Unit" as consisting of several modules, but the modules are physically independent, then the DBA analysis would be based on an individual module. DBA analyses do not assume simultaneous accidents in two or more reactors, or in this case, modules. Author: J. V. Ramsdell SME: J. V. Ramsdell, J. Y. Lee Key Documents: NUREG-1811, Vol. 1; NUREG-1555 (ESRP Section 7.1, "Design Basis Accidents"); NUREG-0800 (SRP Chapter 15); Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors"
74	5-72	The section on design basis accidents does not consider the consequences to construction workers if a design basis accident should occur at Units 1 or 2 while 5,000 construction workers are present on site.	

		In Section 4.9.1, it was assumed that the X/Q for construction workers might be 10 times that for the LPZ. If this same extrapolation is applied to TEDE doses, the AP-1000 results for a loss-of-coolant accident would imply a construction worker TEDE of 1.7 rem. This would give a population exposure to construction workers of 8,500 person-rem which is sufficient to produce health effects. (Assumes Units 1 or 2 would exhibit the same release characteristics as the units under consideration).	
		A. Why has the potential for a DBA at one of the existing units while construction personnel are on site not been addressed?	Construction worker doses have not been calculated for DBAs for Units 1 and 2 because DBA calculations are made for the purpose of evaluating the performance of reactor safety systems in the event of postulated accidents against regulatory criteria. There are no regulatory criteria for evaluating individual or collective doses to onsite workers from DBAs and none of the regulatory guidance related to DBAs establishes a need to consider doses to onsite personnel. However, if or when construction of the postulated units begins, it will be necessary to update the Site Emergency Plans for Units 1 and 2 to account for the worker population and provide appropriate measures to protect the health and safety of the construction workers. Author: J.V. Ramsdell SME: J.V. Ramsdell, J.Y. Lee Key Documents: NUREG-1811, Vol. 1; NUREG-1555, Section 7.2, "Severe Accidents").
		B. What would be exposures to construction personnel on site from the various DBAs considered if they occurred at Units 1 or 2?	Exposures to construction workers at the new units from postulated accidents at the existing units have not been estimated because the guidance for DBAs, which is very specific, does not call for such analysis, for reasons stated in the Staff's response to Board Question 74A, above. However, if or when construction of the postulated units begins, it will be necessary to update the Site Emergency Plans for Units 1 and 2 to account for the worker population and provide appropriate measures to protect the health and safety of the construction workers. Author: J.V. Ramsdell SME: J.V. Ramsdell, J.Y. Lee Key Documents: NUREG-1811, Vol. 1; NUREG-1555 (ESRP 7.2 Severe Accidents)

		C. What would be the severe accident impacts for the above scenario?	The Staff has not estimated the potential impacts to construction workers of severe accidents at one of the existing units. Guidance does not suggest that construction worker doses should be calculated for severe accidents at existing plants. However, if or when construction of the postulated units begins, it will be necessary to update the Site Emergency Plans for Units 1 and 2 to account for the worker population and provide appropriate measures to protect the health and safety of the construction workers. Author: J.V. Ramsdell SME: J.V. Ramsdell, J.Y. Lee Key Documents: NUREG-1811, Vol. 1; NUREG-1555 (ESRP 7.2 Severe Accidents)
75	5-75	Tables 5-15 and 5-16 do not include person-rem values in addition to TEDEs. Please provide them. Tables 5-15 and 5-16 give TEDE values but not general population person-rem exposures. Please give the general population person-rem doses for the events listed.	In Question 75, the Board requests population doses in person-rem for the design basis accidents discussed in the FEIS. There is no direct correlation between an EAB dose or LPZ dose calculated in a DBA analysis and a population dose. The atmospheric conditions that would result in a high EAB or LPZ dose might not be associated with a high population dose because DBA analysis does not explicitly consider either wind direction or population distribution. Population dose calculations would need to account for the time and spatial variation in isotopic release rates, meteorological conditions, and population distribution. The results of the calculations would then have to be evaluated in terms of probability. There are no known computer codes that are designed for DBA calculations that have these capabilities, because there has not been a requirement for calculation of DBA population doses. Both the MACCS2 code, used for severe accident analyses, and the NRC's RASCAL code, used for consequence assessment in the event of an accident at a nuclear power plant, have many of the characteristics necessary to make population dose estimates for DBAs. However, both codes would require modification for this application. Finally, the Staff does not calculated population doses for design basis accidents because the existing regulations and guidance to the Staff and applicants with respect to DBA analysis are quite prescriptive. The regulations only require calculation of the worst two-hour dose for a hypothetical individual at the exclusion area boundary and the dose for the

			course of the accident (up to 30 days) for a hypothetical individual at the outer boundary of the low population zone. There is no suggestion in either regulations or guidance that population doses should be calculated. <u>Author</u>: J.V. Ramsdell <u>SME</u>: J.V. Ramsdell, J.Y. Lee <u>Key Documents</u>: NUREG-1811 Vol. 1; NUREG-1555 (ESRP 7.1 Design Basis Accidents); NUREG-0800 (SRP Chapter 15); Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors"
76	5-72 to 77	In evaluating the environmental impact of DBAs, the FEIS seems to focus primarily on whether a DBA would result in a short term regulatory violation, <u>i.e.</u>, whether it would cause an exceedance of the "review criteria" which are the regulatory standards of 10 C.F.R. §§ 50.34(a)(1) and 10 C.F.R. 100.11 or would exceed a short term Standard Review Plan criterion. The referenced standards only deal with short term exposures (<u>e.g.</u>, whether an individual located at the EAB would receive more than 25 rem TEDE over any two hour period). How did the FEIS consider any longer term environmental impacts resulting from a DBA? For example, what if a radioactive cloud from a DBA deposited a residue of radioactive materials in the area downwind of the event? What calculations, if any, have been performed to estimate the longer term environmental effects from the depositions and contamination that could result from the various DBAs? Are compliance with these short term "review criteria" the only bases for the statements, at 5-75 and 5-76, that the "environmental risks associated with [ALWR] DBAs . . would be small?" Please explain.	The Staff's DBA review did not address long-term environmental impacts of DBAs. In accordance with existing guidance to the Staff and applicants, the Staff only considered the worst two-hour dose for a hypothetical individual at the exclusion area boundary, and the dose for the course of the accident (up to 30 days) for a hypothetical individual at the outer boundary of the low population zone. There are no environmental criteria related to DBAs; the only criteria are those related to safety reviews. Those criteria are cited in the FEIS only to provide a reference point for evaluating the magnitude of the impacts of postulated DBAs. > The Commission has evaluated DBAs at existing reactors and has determined (Table B-1 of 10 C.F.R. Part 51, Subpart A, Appendix B-1) ". . . that the environmental impacts of design basis accidents are of small significance for all plants." The regulatory criteria related to DBAs for new plants at the proposed ESP site are the same as the criteria for existing plants. Therefore, the reasoning that leads to the conclusion that the impacts of DBAs are small for existing plants is equally applicable to new plants. <u>Author</u>: J.V. Ramsdell <u>SME</u>: J.V. Ramsdell, J.Y. Lee. <u>Key Documents</u>: NUREG-1811, Vol. 1; NUREG-1437 Vol. 1; NUREG-1555 (ESRP 7.1 Design Basis Accidents); NUREG-0800 (SRP Chapter 15); Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors"

77	5-73	Please provide five copies of table 3.1-9 of the PPE and explain why these χ/Q values "are not appropriate for environmental reviews."	The χ/Q values for DBAs listed in Table 3.1-9 of the ER are not appropriate for environmental reviews because they are not a complete set of the required values. NRC guidance for DBA reviews clearly indicates that a 0 to 2 hr χ/Q should be used for calculation of doses at the EAB, and that a set of 4 χ/Q should be used for calculating doses at the outer boundary of the low population zone. The Staff considers the χ/Q value listed in Table 3.1-9 for the EAB to be acceptable, and the χ/Q listed in the table for the LPZ is acceptable for use during the 0 to 8 hour period following the accident. The LPZ χ/Q value listed in the table is not appropriate for the 8 to 24 hour period, the 24 to 96 hour period, or the 96 to 720 hour period. Use of the listed value for these periods is unduly conservative and inconsistent with the NEPA philosophy of making a realistic assessment of impacts. Therefore, the Staff considered the χ/Q values in list in Table 3.1-9 to be inappropriate and calculated a full set of DBA χ/Qs for use in its independent evaluation of the environmental impacts of DBAs. Please find attached five copies of Table 3.1-9. Author: J.V. Ramsdell SME: J.V. Ramsdell, J.Y. Lee. Key Documents: NUREG-1811, Vol. 1; NUREG-1555, Section 7.1, "Design Basis Accidents"
78	5-73 to 75	The FEIS refers to "realistic (50th percentile) X/Q values" used by Dominion. Does Table 5-14, use such 50th percentile χ/Q values? Please provide a table, equivalent to Table 5-14, using more protective 90th percentile χ/Q values.	Questions 78 and 80 request a comparison of the 50% χ/Qs and DBA doses calculated for the environmental review with more protective χ/Qs and DBA doses than were calculated for the safety review. The attached tables provide those comparisons. The 50% χ/Qs and DBA doses are taken directly from the FEIS. The more protective χ/Qs (~95% values) are found in both the FSER and Dominion's SSAR. The protective DBA doses (~95% values) are found in Dominion's SSAR. The Staff reviewed Dominion's DBA analyses and found it to be acceptable. For some DBAs, Dominion's SSAR indicates that the consequences of the DBA are bounded by the consequences of another DBA and does not provide numerical values. Values are provided for all accidents in the attached tables. Where Dominion did not provide a value, the Staff has inserted the bounding value. See attached tables.

			Author: J.V. Ramsdell SME: J.V. Ramsdell, J.Y. Lee. Key Documents: NUREG-1811, Vol. 1; NUREG-1555, Section 7.1, "Design Basis Accidents."
79	5-74	The FEIS states that "The staff intends to verify that the χ/Q values used in analyzing the reactor design proposed at the CP/COL stage are equal to or greater than the χ/Q values specified in the ESP." Shouldn't this sentence read "less than?"	The statement is not clear, but it is correct. There are two sets of χ/Q values addressed. The first is a site characteristic, and the second is a reactor design value. The site characteristic χ/Q describes atmospheric dispersion at the site. The reactor design χ/Q describes the atmospheric dispersion characteristics that must be equal to or greater than that of a site on which the reactor would be built to ensure that DBA doses will be within regulatory limits. What the statement in question is attempting to say is that if a reactor design is proposed for the site that has a design χ/Q (*e.g.*, a certified design), the Staff will compare the design χ/Q with the site χ/Q to determine if the design is suitable for the site. The logic of the comparison is as follows: A large site χ/Q indicates that a site does not have good dispersion, and a small χ/Q indicates it has good dispersion. A large design χ/Q indicates that a site does not have to have good dispersion characteristics, while a small design χ/Q indicates that the site has to have good dispersion. When comparing a design χ/Q and a site χ/Q, the site is acceptable for the design if the design χ/Q is larger than the site χ/Q. These comparisons for the three surrogate reactors considered and the North Anna site show that the site has better dispersion characteristics than would be required for the surrogate reactor designs. Author: J.V. Ramsdell SME: J.V. Ramsdell, J.Y. Lee. Key Documents: NUREG-1811, Vol. 1
80	5-75 to 76	Please provide revised versions of tables 5-15, 5-16 and 5-17 using the more protective 90th percentile χ/Q values, if readily available or calculable.	As clarified at the pre-hearing conference held on February 14, 2007, it is the Staff's understanding that the Licensing Board will accept the 95th percentile values in the FEIS, instead of the 90th percentile values requested. The requested tables are included in the Staff's response to Board Question 78. Author: J.V. Ramsdell SME: J.V. Ramsdell, J.Y. Lee. Key Documents: NUREG-1811, Vol. 1

81	5-76	For Table 5-16, what would be the total cumulative person-rem resulting from the calculated TEDE of 1.4 rem at the EAB for a Loss-of-Coolant Accident? Given that an ESP has a potential future life of 60 years assuming construction delays and license extensions, what would be the estimated person-rem for this accident with the expanded population sixty years in the future?	The Staff has not calculated population doses for DBAs, either for the current population or for the population projected for 60 years in the future. There is no requirement to calculate such doses, nor does relevant NRC guidance recommend such calculations. Further, there are no criteria against which to evaluate population doses, even if calculated. There is no direct correlation between an EAB dose calculated in a DBA analysis and a population dose. The atmospheric conditions that give a high EAB dose might not be associated with a high population dose because DBA analysis does not explicitly consider either wind direction or population distribution. To be useful, population doses would have to be addressed in the context of risk, which is inconsistent with the approach set forth in the guidance under which the FEIS was prepared. The affected population depends on meteorological conditions at the time of the accident; therefore, it would be necessary to calculate DBA doses for all combinations of meteorological conditions. Author: J.V. Ramsdell SME: J.V. Ramsdell, J.Y. Lee. Key Documents: NUREG-1811, Vol. 1; NUREG-1555, Section 7.1, "Design Basis Accidents"
82	5-78 to 86	The penultimate paragraph on page 5-78 of the FEIS states that "Risk is the product of the frequency of an accident, also called the core damage frequency, and the consequence of an accident." Risk cannot be estimated without using a value for both frequency and consequence. Table 5-18 provides only one of the variables - the frequency. However, the preparation of Table 5-18 (estimating risk) necessarily required Dominion and/or the Staff to estimate, and use values for the consequences of each of the severe accidents covered. Thus, this information is readily available but was not provided.	Environmental Question 82 was withdrawn by the Licensing Board in its Order dated February 27, 2007. *See Dominion Nuclear North Anna, LLC* (Early Site Permit for North Anna ESP Site), unpublished Order (Reconsideration of Two Environmental Questions and Grant of Extension) (February 27, 2007).
		A. Please provide a table, or revision to Table 5-18, which includes the values used (e.g., person-rem values) as the consequences of each of the events,	n/a

		and each of the types of consequences, for which a risk value is provided. For example, for the "Release Category Description" for event # 7, "LOCA followed by failure of high water pressure coolant makeup water," please provide the consequences (not probability weighted) for each column on Table 5-18, e.g., the cumulative population dose (expressed in person-Sv or person - rem), the number of early fatalities, the number of latent fatalities, the cost, the amount of land that would require decontamination, and the cumulative population dose from water ingestion that would be the consequences of such an event.	
		B. With regard to the "cost" column of Table 5-18, footnote d indicates that this includes condemnation of land. In the requested revised table providing the values you used for consequences (not probability weighted), please include the acres of land condemned.	n/a
		C. Please provide a similar table or revision (covering items A and B above) to Tables 5-19, 5-20, 5-21, and 5-22.	n/a
83	5-80	What is the source of the consequences data used in Tables 5-18 to 5-20? Is this site specific or generic? If generic, how can generic information be reasonable, given that the site of a reactor (population density, prevailing winds, land use patterns) are a critical element of estimating the consequences and risks of a severe accident?	The MACCS2 computer code was used to obtain the consequences data that are implicit in Tables 5-18, 5-19, and 5-20. The code input included site-specific information on meteorology, and site-specific spatial distributions of population, land fraction, watershed characterization, agricultural characteristics, and economic information. Author: J.V. Ramsdell SME: J.V. Ramsdell, D.L. Strenge. Key documents: NUREG-1811, Vol. 1; Jow, et al. 1990. MELCOR Accident Consequences Code System (MACCS), NUREG/CR-4691; Chanin and Young. 1997. Code Manual for MACCS2: Volume 1. User's Guide. SAND97-0594
84	5-80	Tables 5-18 through 5-22 tabulate risk and core	The probability of accidents is routinely expressed in terms of events per

		damage frequencies in units of probability or dose per reactor-yr. Why isn't it more understandable to tabulate as "per year" rather than per "reactor-year?" If one takes numbers expressed as per reactor year and multiplies by the total US or total world reactor-years, they will obtain numbers that are completely illogical. It would appear that this error is less likely to occur if the numbers are simply expressed as annual probabilities per reactor.	reactor year, where a reactor year is one full calendar year of experience for one reactor, including contributions from events occurring during power operation as well as other plant operating states. When one is discussing a specific reactor, the difference between per year and per reactor year is insignificant in evaluating environmental consequences. The per reactor year units are important when considering the total risk of severe accidents at a site with more than one reactor. If the reactors are essentially identical, the total risk for the site is the product of the risk for 1 reactor times the number of reactors. If the reactors are different, the total risk is the sum of risks for individual reactors. The calculation posed in the question does not account for the fact that the risks presented in Tables 5-18, 5-19 and 5-20 are for specific reactor designs at a specific location. However, if one were to consider a specific reactor design, it might be reasonable to estimate the probability of a severe accident in any year as the product of core damage frequency for the design and the number of reactors of the design in operation, regardless of the location of the reactors. <u>Author</u>: J.V. Ramsdell <u>SME</u>: J.V. Ramsdell, R.L. Palla. <u>Key Documents</u>: NUREG-1811, Vol. 1; Jow, et al. 1990. MELCOR Accident Consequences Code System (MACCS), NUREG/CR-4691. Chanin and Young. 1997. Code Manual for MACCS2: Volume 1. User's Guide. SAND97-0594
85	5-80 to 84	Tables 5-18 to 5-20 provide the "mean" environmental risks associated with severe accidents at the three types of reactors covered. Do you have, or can you readily calculate, the environmental risks based on a more protective 90th percentile approach? If so, please provide it. If not, please explain why the mean is the only indicator used.	The Staff considers risks based on 90th percentile or higher consequence estimates to be inconsistent with NEPA. Historically, the NRC has interpreted "realistic" to be associated with some measure of central tendency, such as the median or mean. The Commission, in its Safety Goal Policy Statement (51 Fed. Reg. 30,028 (Aug. 21, 1986)), adopted the use of mean estimates for implementing the quantitative objectives of the safety goal policy. In its policy statement on the use of probabilistic risk assessment ("PRA") in nuclear regulatory activities, the Commission affirmed that "PRA evaluations in support of regulatory decisions should be as realistic as practicable…" 60 Fed. Reg. 42,622 (Aug. 16, 1995). <u>Author</u>: J.V. Ramsdell <u>SME</u>: J.V. Ramsdell, R.L. Palla. <u>Key Documents</u>: NUREG-1811, Vol. 1; 51 FR 30028 "Safety Goals for the

			Operation of Nuclear Power Plants; Policy Statement; Republication." August 21, 1986; 60 FR 42622. "Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities; Final Policy Statement." August 16, 1995.
86	5-80 to 84	Is the "land risk" covered by the column "Land Requiring Decontamination" in Tables 5-18 to 5-20 limited to "farm land requiring decontamination prior to resumption of agricultural usage," as stated in footnote e of each table? If so, why? Given that the 50 mile radius region includes cities, towns, residential, commercial and industrial use land, please describe why the environmental impacts to such land should be excluded from consideration.	Tables 5-18, 5-19, and 5-20 consider impacts to all types of land. The MACCS2 code divides area in the vicinity of the release into land and water, and the land area is further divided into farm land and other uses. The land risk describes the impact of a severe accident on farmland in terms of area requiring decontamination before crop production can resume. The impacts of the accident on other land categories are summarized in monetary terms. The factors considered in arriving at a monetary value include the cost of relocation of people, decontamination, interdiction, and condemnation (see footnote d to the tables). Author: J.V. Ramsdell SME: J.V. Ramsdell, D.L. Strenge, R.L. Palla. Key Documents: NUREG-1811, Vol. 1; Jow, et al. 1990. MELCOR Accident Consequences Code System (MACCS), NUREG/CR-4691. Chanin and Young. 1997. Code Manual for MACCS2: Volume 1. User's Guide. SAND97-0594
87	5-80 to 84	What standard or criterion is used in Tables 5-18 to 5-20 to determine whether land or property is condemned? What standard or criterion is used to determine that land has been sufficiently decontaminated?	The MACCS2 code uses a habitability criterion to determine if decontamination or interdiction of non-farm land is necessary. The default criterion (used by Dominion) is 0.04 Sv effective dose equivalent in a 5 yr period following decontamination or interdiction. The origin of the 0.04 Sv is not stated in the MACCS2 code documentation, but it is equal to the EPA 1 yr Relocation Protective Action Guide plus 4 times the EPA 2nd year long-term dose objective. Dominion postulated 2 levels of decontamination. If neither level of decontamination reduces the dose rate sufficiently to meet the habitability criterion, the code determines the interdiction time necessary following decontamination for decay to reduce the dose rate sufficiently to meet the criterion. If the time exceeds 30 years, the land/property is condemned. If the land/property is not condemned on this basis, the code evaluates the cost-effectiveness of decontamination or decontamination plus interdiction. If the cost of decontamination plus any necessary interdiction exceeds the value of the land/property, the land/property is condemned. Otherwise, the land/property is decontaminated with interdiction as necessary. The costs associated with decontamination and interdiction, and the value of land and property, are supplied by the user.

			For farmland, MACCS2 applies two criteria. The first is the 0.04 Sv habitability criterion, the second criterion is related to residual surface contamination and ingestion doses from root uptake. If the habitability criterion is met, then the ingestion criteria are evaluated. Those criteria are that the annual ingestion dose from root uptake be less than 0.005 Sv effective dose equivalent, and 0.015 Sv thyroid dose. If these criteria can not be met with decontamination and an interdiction period of 8 years or less, the land is condemned. If these criteria can be met, the cost effectiveness of decontamination and any necessary interdiction is evaluated. If decontamination and any necessary interdiction are not cost effective, the land is condemned. Otherwise the land is decontaminated with interdiction as necessary. Costs associated with decontamination and interdiction of farmland, and with the value of farmland, are supplied by the user. Author: J.V. Ramsdell SME: J.V. Ramsdell, D.L.Strenge Key Documents: Jow, et al. 1990. MELCOR Accident Consequences Code System (MACCS), NUREG/CR-4691; Chanin and Young. 1997. Code Manual for MACCS2: Volume 1. User's Guide. SAND97-0594; Sandia National Laboratories. 2003. FRMAC Assessment Manual- Methods. SAND2003-1071P.
88	5-84	In Table 5-21, why does the AP-1000 reactor have a similar core damage frequency to the ABWR but a factor of thirteen higher population dose risk for siting at North Anna?	The AP1000, ABWR, and ESBWR have similar total core damage frequencies. However, the distribution of core damage frequencies among the accident release sequences is significantly different. For the ABWR, the three sequences having the largest releases combined contribute less than 1% to the total CDF. The two accident sequences for the AP1000 reactor having the largest releases contribute almost 7.5% to the total CDF. The population dose calculated for the AP1000 containment bypass (BP) sequence is about 20% larger than the dose calculated for the ABWR LOCA followed by failure of the high-pressure water makeup system sequence. However, the population risk associated with the AP1000 accident sequence is about 31 times the risk associated with the ABWR sequence because the CDF for the AP1000 sequence is almost 26 times the CDF for the ABWR sequence. Author: J.V. Ramsdell

			SME: J.V. Ramsdell, Key Documents: NUREG-1811, Vol. 1
89	5-86	Table 5-22 tabulates a "Current Reactor Maximum" Core Damage Frequency of 2.4E(-4) but Table 5-21 shows at least one reactor with a higher core damage frequency (Zion). Please explain.	Tables 5-21 and 5-22 are presented to provide a context for evaluation of the severe accident risks associated with the postulated new reactors at the ESP site. Table 5.21 compares risks associated with the new reactor with risks estimated for 5 reactors in NUREG-1150, which was completed in 1990. Table 5-22 compares risk for the new reactors with risks associated with reactors undergoing license renewal. These risk assessment were performed between 1996 and 2004. The Zion plant, which was included in Table 5-21, has been permanently shutdown and is not undergoing license renewal. Therefore, it is not included in the set of reactors considered in Table 5-22. It is important to note that the relevant comparisons in Table 5-21 and 5-22 are between the risk of the new reactors at the ESP site and the best (lowest risk) of other reactors. The addition of Zion to the reactors considered in Table 5-22 would not alter the relevant comparisons. Author: J.V. Ramsdell SME: J.V. Ramsdell Key Documents: NUREG-1811, Vol. 1
90	5-86	The prompt fatality probability for auto accidents is cited as (about) 5E(-4) per year which corresponds to about 150,000 auto fatalities annually for a population of roughly 300 million. This value appears to be roughly three times the auto fatality rate for recent years. Since auto death rates have been one of the factors used to guide the adoption of a 0.1% fatality goal for reactor accidents, haven't we adopted a reactor fatality goal that is higher than what it should be?	The fatal accident rate cited on page 5-86 includes, but is not limited to, automobile fatalities. According to the National Safety Council, the probability of dying from all unintentional injuries (accidents) is 1 in 2662 ($\sim 3.8 \times 10^{-4}$ yr^{-1}) (see http://www.nsc.org/lrs/statinfo/odds.htm). According to the US Department of Transportation Bureau of Transportation Statistics, the probability of dying in a highway accident is 14.7 per 100,000 US residents (($\sim 1.5 \times 10^{-4}$ yr^{-1}) (see http://www.bts.gov/publications/transportation_statistics_annual_report/2005/html/chapter_02/figure_03_01.html). Thus, transportation accidents account for less than 40 percent of accident fatalities. In the instant application, the magnitude of the value is important, as opposed to the exact value, because the risks associated with the postulated reactors are far lower than those associated with the safety goals. Therefore, the Staff believes that the $\sim 3.8 \times 10^{-4}$ yr^{-1} probability cited above is sufficiently close to the 5×10^{-4} yr^{-1} value used in the FEIS to determine that, with respect to the Commission's quantitative safety objectives, the difference is inconsequential and the

			objectives are still appropriate. Author: J.V. Ramsdell SME: J.V. Ramsdell Key Documents: NUREG-1811, Vol. 1; 51 FR 30,028, "Safety Goals for the Operation of Nuclear Power Plants"
91	5-86	A dose objective for reactors is a cancer risk that is less than 0.1% of the cancer risk from other causes. Table 5-22 states that the person-rem dose for North Anna Units 1 & 2 is 25 person-rem per year. On page 5-87, it is calculated that the individual cancer risk from a nuclear power plant should be limited to 2E(-6) per year per person. If the Unit 1 and 2 person-rem dose is distributed among approximately 5000 persons and the probability of cancer is 4E(-4) per rem, aren't the Unit 1 & 2 cancer probabilities at or above the cancer probability goal? If true, does this have regulatory implications?	The population dose risk listed for North Anna Units 1 and 2 in FEIS Table 5-22 is from Table 5-4 of the Supplemental EIS for renewal of the Unit 1 and 2 operating licenses (NUREG-1437 Supplement 7). That dose risk is for population within a 50 mi radius of the plant as are the other population dose risks in the table. The Commission's cancer dose risk objective is based on the population dose risk for population within a 10 mi radius of the plant. Consequently, the Unit 1 and 2 population dose risk numbers in the table cannot be used to estimate the cancer risk for comparison with the Commission's safety goal. Author: J.V. Ramsdell SME: J.V. Ramsdell Key Documents: NUREG-1437, Supplement 7; NUREG-1811, Vol. 1; 51 FR 30028, "Safety Goals for the Operation of Nuclear Power Plants"
92	5-86 to 87	The FEIS states that "the following quantitative health objectives are used in determining achievement of the safety goals." Please provide citations and explanation of the source of these objectives. Please explain why these safety goals are relevant or dispositive when evaluating the environmental impacts (both short and long term) of a severe accident?	The safety goals and discussion on pages 5-86 and 5-87 follow directly from the Commission's 1986 Safety Goal Policy Statement (51 Fed. Reg. 30,028 (Aug. 21, 1986)). The relevance of these goals to the evaluation of environmental impacts is that they provide a quantitative value against which some of the risks of new plants at the ESP site can be compared. If the predicted risk closely approached the risks derived from the goals there would be cause for concern. As it is, Table 5-21 indicates that the fatality risks for each of the three surrogate new reactors are several orders of magnitude lower than risks derived from the goals in the policy statement. Author: J.V. Ramsdell SME: J.V. Ramsdell Key Documents: NUREG-1811, Vol. 1; 51 Fed. Reg. 30,028, "Safety Goals for the Operation of Nuclear Power Plants" (Aug. 21, 1986).
93	5-88	The FEIS states that "Virginia Power controls the land to the high water mark of Lake Anna within the NAPS	

		site. In the event of a large release of radioactive material, Virginia Power and the Commonwealth of Virginia could control access to the lake [and thus] reduce exposures."	
		A. Is this a realistic response to the problem, given that hundreds of homes, many with piers and boats, line the shores of Lake Anna? Please explain how exposures to these people would be realistically controlled by the fact that Virginia Power has title up to the high water mark.	It is realistic to expect that access to Lake Anna could and would be restricted, if the lake became contaminated as the result of a severe accident. It is likely that the restriction would be imposed by local, state and Federal officials regardless of ownership of the land, the number of homes, or the number of docks. Access control of the lake, whether by Virginia Power (to the high water mark) or the Commonwealth of Virginia (beyond the high water mark), would serve to prevent radiological exposures by denying access into actual or potentially contaminated areas. This would be the same as blocking a road in order to prevent people from entering an area believed to be contaminated. Thus, control (or ownership) would only determine who might establish the actual access control. In general, the ownership title up to the high water mark is inconsequential to actions taken in response to an emergency. People affected by protective action recommendations from the State would include all of those surrounding the site, including persons near or on the lake. Emergency preparedness and response for the North Anna ESP site is addressed in SER section 13.3, "Emergency Planning." Author: J.V. Ramsdell SME: J.V. Ramsdell, Bruce Musico Key Documents: NUREG 1835; NUREG-1811,Vol. 1; Dominion Environmental Report

		B. At what elevation is the "high water mark?"	According to the Dominion ER, the high water mark is 255 ft above msl. Author: J.V. Ramsdell SME: J.V. Ramsdell Key Documents: NUREG-1811, Vol. 1; Dominion Environmental Report
94	5-88	The surface water pathway doesn't appear to consider the uptake of radioactivity through consumption of fish that have ingested radioactive materials. Could this pathway increase the projected exposure?	The MACCS2 code does not include doses from consumption of fish. Thus consumption of aquatic food is a pathway that is not accounted for. However, GEIS Sections 5.3.3.3.2 and 5.3.3.3.3 did estimate the potential population dose from consumption of uninterdicted aquatic foods for small river sites (North Anna is considered a small river site). The GEIS estimate of population dose is 0.4 person rem per reactor year. The GEIS also states that "Risk associated with the aquatic food pathway is found to be small relative to the atmospheric pathway for most sites and essentially the same as the atmospheric pathway for the few sites with large annual aquatic food harvests." Author: J.V. Ramsdell SME: J.V. Ramsdell Key Documents: NUREG-1811, Vol. 1; NUREG-1437, Vol. 1; Jow et al. 1990. *MELCOR Accident Consequences Code System (MACCS)*, NUREG/CR-4691.
95	5-89	The FEIS "assumes a 1 x 10^{-4} Ryr probability of occurrence of a severe accident with a basemat melt-through leading to potential groundwater contamination." The FEIS goes on to state that "the groundwater pathway is more tortuous and affords a greater time for implementing protective actions" and therefore the Staff concluded that "the risks associated with releases to groundwater are small for the North Anna ESP site." It appears that this discussion focuses solely on the human health effects of drinking radioactively contaminated groundwater. However, the proposed ESP site is located above a "sole source aquifer," a type of aquifer designated by EPA as needing special protection. Once	The FEIS states, at 2-22, "No aquifer in the Piedmont province of Virginia has been identified as a sole-source aquifer." Therefore, the Staff did not evaluate the impact to water use and needs patterns. However, in response to a Board question on SERI (Grand Gulf) ESP application, the Staff has re-evaluated the assumption of a 10^{-4} Ryr^{-1} probability of a basemat melt-through. That assumption was taken from the GEIS for renewal of licenses of existing power plants. The Staff now believes that the 10^{-4} probability is too large for postulated new plants. The probability of core melt with basemat melt-through should be no larger than the total core damage frequency estimate for the reactor. FEIS Tables 5-18, 5-19 and 5-20 give total core damage frequency estimates of 1.6x10^{-7}, 2.4x10^{-7} and 2.9x10^{-8} Ryr^{-1} for the ABWR, AP1000, and ESBWR, respectively. NUREG-1150 indicates that the conditional probability of a

		contaminated, such an aquifer might be very difficult to remediate and might result in it becoming unuseable for an extended period of time. Did you evaluate the adverse impacts that might result to water use and need patterns if this sole source aquifer were contaminated and unuseable? Please explain.	base mat melt through ranges from 0.05 to 0.25 for current generation reactors. New designs include features to reduce the probability of basemat melt-through in the event of a core melt accident. On this basis, the Staff believes that a basemat melt-through probability of 10^{-7} Ryr^{-1} is more realistic than 10^{-4} Ryr^{-1} and is still conservative. Author: J.V. Ramsdell SME: J.V. Ramsdell, R.L. Palla Key Documents: NUREG-1811, Vol. 1; NUREG-1437, Vol. 1; NUREG-1150, *Severe Accident Risks: An Assessment for Five U.S. Nuclear Plants*; Attachment A to "NRC Staff Response to Licensing Board's Order of October 3, 2006" (Oct. 23, 2006), ADAMS accession number ML062980539.
96	5-89	Radioactivity release to the groundwater pathway is believed to be greater than the airborne pathway during a severe accident for the surrogate reactors considered. However, the groundwater pathway is presumed to present a lower risk because the transport path is tortuous and a longer time period is available for protective actions. Is this conclusion based just on the slow movement of groundwater or is absorption/desorption on solid substrates a consideration? If the slow transport is influenced by absorption, how were distribution coefficents for NA soils obtained?	The Staff review leading to the groundwater pathway discussion in the FEIS did not involve calculations or the consideration of site-specific absorption/desorption characteristics. Author: J.V. Ramsdell SME: J.V. Ramsdell, L.W. Vail Key Documents: NUREG-1811, Vol. 1
97	5-89	What is the basis for saying "the environmental risks associated with severe accidents if an ALWR were to be located at the North Anna ESP site would be small compared to risks associated with operation of the current generation reactors at the North Anna site." Is this based solely on the estimated lower probability of core damage frequency of the ALWRs as indicated on Table 5-22? Please explain.	The judgment that the risk of new reactors at the North Anna site would be smaller than that of current generation reactors is based on the risk comparisons shown in Tables 5-21 and 5-22, not on the core damage frequencies. Core damage frequency is not mentioned in Section 5.10.2.4. In addition, the question inserts the word "the" into the quote, in such a way as to limit the comparison only to the current-generation reactors at the North Anna site. However, the text of the FEIS does not limit the comparison to only those reactors. Author: J.V. Ramsdell SME: J.V. Ramsdell Key Documents: NUREG-1811, Vol. 1

98	5-90 to 91	The FEIS states that the Staff relied upon the "feasible and adequate measures/controls" specified in Table 5.10-1 in the ER. Do these constitute "terms of the ESP" and/or "acceptance criteria" within the meaning of 10 C.F.R. § 52.39(a)(2)? If not, how do they relate to this regulation?	No. ER Table 5.10-1 does not constitute "terms of the ESP" and/or "acceptance criteria" within the meaning of 10 C.F.R. 52.39(a)(2). FEIS Section 5.11 references ER Table 5.10-1. FEIS Table J-1 lists as an assumption, "Mitigation of Operational Impacts," and states, "An applicant referencing this EIS will demonstrate the application contains the mitigation measures contained in section 5.11 of the FEIS." Author: John S. Cushing SME: John S. Cushing Key Documents: NUREG-1811, Vol. 1
99	6-1	Why wasn't the PPE approach used for evaluating gas cooled reactors?	Dominion did not use the PPE approach for evaluating gas-cooled reactors primarily because of a lack of verifiable information about the design and operation of the reactors and associated fuel and waste transportation systems. This approach is not precluded by NRC regulations and the Staff's review of Dominion's analyses was adjusted accordingly. In its evaluation of uranium fuel cycle impacts for the North Anna ESP site, Dominion used the PPE approach for the advanced LWR designs but not for the two gas-cooled reactor designs. They evaluated each gas-cooled reactor design individually by comparing key parameters (e.g., energy usage, material involved) for each design to those used to generate impacts in Table S-3. The Staff evaluated this approach and determined that impacts for gas-cooled reactor designs were unresolved due to insufficient information on fuel fabrication facility design, enrichment facility design, and solid low-level waste operation during decontamination and decommissioning. In its evaluation of the impacts from transportation of radioactive materials, Dominion did not use the PPE approach but rather evaluated each reactor design individually. Dominion conducted a detailed analysis of the environmental effects of transportation of fuel and waste to and from the reactor in accordance with 10 CFR 51.52(b). NRC regulations do not preclude the approach taken by Dominion and, therefore, a PPE for transportation is not required by NRC regulations. Dominion's analysis was judged by the NRC Staff to be reasonable, yet bounding, and confirmatory reviews conducted by the NRC Staff concluded that Dominion's results were similar to those developed by the Staff.

			Author: Gregory A. Stoetzel SME: Philip M. Daling Key Documents: NUREG-1811, Vol. 1; 10 CFR 51.52(b)
100	6-3	In Table 6-1 the water discharged to air from Unit 3 is quoted as 160 million gallons or 2% of a model 1000 MW(e) reactor with (evaporative) cooling tower. Since 2/3 of the Unit 3 cooling can be through the wet cooling tower, how is it possible that the averaged value for the two units can be as low as 2%? (This table contains data on tritium and Kr-85 release so it presumably does include reactor operation as a part of the fuel cycle.)	Table 6-1 is a reproduction of Table S-3 from 10 CFR 51.51(b). This table does not include environmental impacts from reactor operation. It includes environmental impacts from uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low level wastes and high level wastes related to uranium fuel cycle activities (10 CFR Part 51.51(a)). Based on guidance for the environmental review, the Staff accepted the values in Table S-3 and did not adjust the values in any way. The tritium and Kr-85 in Table 6-1 are principally from reprocessing activities (see WASH-1248 and NUREG-0116). The operational impacts from water discharged to the atmosphere from Unit 3 cooling are addressed in FEIS Section 5.3. Author: Gregory A. Stoetzel SME: Gregory A. Stoetzel, Jean-Claude Dehmel Key Documents: 10 CFR 51.51(b); WASH-1248 (Environmental Survey of the Uranium Fuel Cycle); NUREG-0116 (Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle); NUREG-1811, Vol. 1
101	6-3	Shouldn't the numbers for radioactive wastes specify a BWR or PWR in Table 6-1 since BWRs typically dispose of larger volumes of contaminated ion exchange resins than PWRs?	As stated in the Staff's response to Board Question 100, Table 6-1 is a reproduction of Table S-3 from 10 CFR 51.51(b). Radioactive waste numbers from WASH-1248 and NUREG-0116 provided the basis for this table. Table S-3 was developed to include the maximum value for radioactive wastes. Based on guidance for the environmental review, the Staff accepted the values in Table S-3 and did not adjust the values in any way. Author: Gregory A. Stoetzel SME: Gregory A. Stoetzel, Jean-Claude Dehmel Key Documents: 10 CFR 51.51(b); WASH-1248 (Environmental Survey of the Uranium Fuel Cycle); NUREG-0116 (Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle)
102	6-3	Why do the tritium release numbers in Table 6-1	Environmental impacts of gaseous tritium effluent releases during

		bound CANDU type reactors which typically produce larger quantities of tritium than LWR's?	normal reactor operations (including the CANDU reactor) were not evaluated in Table 6-1. These impacts were evaluated in Section 5.9 of the FEIS using the PPE approach for the gaseous tritium effluent releases. Table 6-1 of the FEIS (i.e., Table S-3) does not include environmental impacts from reactor operation. It includes environmental impacts from uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials, and management of low level wastes and high level wastes related to uranium fuel cycle activities (10 CFR Part 51.51(a)). The tritium gaseous effluent release number in Table 6-1 is principally from reprocessing (see WASH-1248 and NUREG-0116). Author: Gregory A. Stoetzel SME: Gregory A. Stoetzel, Jean-Claude Dehmel Key Documents: WASH-1248 (Environmental Survey of the Uranium Fuel Cycle); NUREG-0116 (Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle); NUREG-1811, Vol. 1.

103	6-8 to 9	The FEIS states that, with regard to fuel cycle, transportation and decommissioning, the 1000 MW(e) LWR scaled model would cause the permanent commitment of 52 acres of land per year and the temporary commitment of 400 acres of land per year. This represents the permanent commitment of 4,160 acres of land over a 40 year life span for two Units. The FEIS states "[i]n comparison, a coal-fired power plant with the same MW(e) output and that uses strip-mined coal requires the disturbance of about 324 ha (800 ac) per year for fuel alone. The Staff concludes that the impacts on land use to support the 1000-MW(e) LWR scaled model would be SMALL." The FEIS uses such relativistic comparisons at numerous points.	
		A. Isn't this relativistic approach contrary to the CEQ standards of significance found at 40 C.F.R. § 1508.27, which the Staff stated it was using in this FEIS. Please explain.	A detailed review of the fuel cycle environmental impacts to include land use impacts was provided in Chapter 6 of the GEIS, NUREG-1437. As stated in Section 1.1.3 of the FEIS, information and analysis provided in NUREG-1437 is used in the FEIS, as appropriate. The Staff concluded that Chapter 6 of NUREG-1437 was applicable to new reactor licensing. (Chapter 6 of the GEIS provides an evaluation of the environmental impacts from Table S-3. Per 10 CFR 51.51(a), the applicant is to use Table S-3 as the basis for environmental impacts from the uranium fuel cycle.) Section 6.2.2.6 of NUREG-1437 described the land use requirement for the fuel cycle supporting a model 1000 MW(e) LWR, and concluded that it did not represent a significant impact. NUREG-1437 also provided, for comparison purposes, land use requirements for a coal-fired power plant of 1000 MW(e) capacity using strip-mined coal. This information is provided for reference, and is not the basis for the Staff's conclusion that impacts would be SMALL. The Staff simply finds that it is often useful to provide comparisons in order to put impacts into perspective. Removing the comparative information would not have changed the Staff's conclusion regarding the impact level category in this case (SMALL). Author: Andrew Kugler, Gregory A. Stoetzel SME: Gregory A. Stoetzel

			Key Documents: 10 CFR 51.51(a)

		B. The CEQ and the Staff define "MODERATE" as "Environmental effects are sufficient to alter noticeably, but not destabilize, important attributes of the resource." FEIS P 1-8. Under this definition, doesn't the permanent commitment of 4160 acres of land at least qualify as "large" or "moderate?" Please explain.	The resource in question is land. The Staff believes that a finding of SMALL is appropriate because the permanent commitment of 4160 acres in the context of the available land within the U.S. would be undetectable or, at worst, so minor that it would neither destabilize nor noticeably alter any important attribute of the resource. The 1000 MW(e) LWR scaled model includes both units; therefore, the permanently committed land would be 2080 acres, not 4160 acres. A discussion on how the "1000 MW(e) LWR scaled model" concept was derived is provided in Section 6.1.1 of the FEIS. Author: Andrew Kugler SME: Gregory A. Stoetzel Key Documents: NUREG-1811, Vol. 1
		C. By selecting other activities with obviously larger environmental impacts for any given type of impact, doesn't this necessarily result in the impact of the proposed ESP being (relatively) smaller? Is this the appropriate way to address such matters in an EIS?	As discussed above in the Staff's Response to Board Question 103A, the information provided for land use for a coal-fired plant was provided for purposes of comparison, and was not the basis for the Staff's conclusion that the impacts are SMALL. Removing the comparative information would not have changed the Staff's conclusion regarding the impact level category (SMALL in this case). The Staff believes that the approach it used to evaluate the impacts to resources is appropriate and in accordance with CEQ guidance. Author: Andrew Kugler SME: Gregory A. Stoetzel Key Documents: NA
		D. Why weren't the definitions provided at the beginning of the FEIS used when the Staff reached and articulated its conclusions (at numerous places) as to whether an impact was small, moderate, or large? Please explain.	The staff believes the significance levels (SMALL, MODERATE, and LARGE) defined in Section 1.1.3 of the FEIS are used appropriately throughout the FEIS, including Chapter 6, *Fuel Cycle, Transportation, and Decommissioning*. The significance levels apply to a broad range of environmental effects that, according to CEQ guidance (40 CFR 1508), include economic, social, natural, or physical environmental effects, and the relationship of people to that environment, where "effects" include direct, indirect, and cumulative effects on ecological, aesthetic, historic, cultural,

			economic, social, and health resources, among others. The staff believes that the term “resources,” as used in the definition of the significance levels, is broad enough to include conclusions for reviews of land use, water use, fossil fuel, effluents, wastes, doses, transportation, and accidents. The staff recognizes and articulates in the FEIS the uniqueness of these resources and their review requirements by describing the review process that includes comparison to 10 CFR 51.51 (Table S–3); 10 CFR 51.52 (Table S–4), and NUREG-0586. Discussions on how the definitions of small, moderate, or large were applied for selected sections of the FEIS are discussed below. **Socioeconomics:** Section 5.5.1.3 (Roads): The physical impact on roads from operations is based on the standard definitions of SMALL, MODERATE, and LARGE. The comparative language was used to further explain the staff's reasoning. Because there was expected to be much more traffic over local roads during construction than during operations, the bulk of the roads analysis was detailed in Section 4.5.1.3. That section concluded that the physical impacts on the road net was likely to be SMALL. The staff further stated that some upgrades of the roads and intersections most likely to be affected might be necessary and that damage would be repaired to pre-existing conditions. Since the roads would be repaired as necessary during and after construction, and since a much larger traffic influx was expected to result in a SMALL (i.e., not noticeable) impact, it was difficult to see how the smaller operations workforce could have a noticeable (MODERATE) or disruptive (LARGE) physical impact on roads. Section 5.5.3.6 (Public Services): The impact on public services from operations is based on the standard definitions of SMALL, MODERATE, and LARGE. The problem in identifying impacts on public services is that communities are typically quite dynamic, constantly coping with population and economic changes during the process of identifying and providing for public services. Thus, in determining whether a change in demand for services related to a specific facility is not noticeable, noticeable, or disruptive (SMALL, MODERATE, or LARGE), the analysis needs to consider the context of regional growth or decline taking place for other reasons. For example, if a region is largely stagnant, a large influx of

			families (relative to existing population) may overwhelm available local housing, school system, and utilities and might have a LARGE (i.e., disruptive) impact. If the region is declining, the same influx might have a LARGE or MODERATE BENEFICIAL impact on the housing sector by filling vacancies, while the school system might avoid having to close schools, and utilities would benefit from having additional rate payers. In a situation where the region is growing rapidly, the question is whether the same influx would significantly accelerate growth (and thus cause coping problems with housing, eructation, utilities and other public services and thus have MODERATE or LARGE impacts, depending on the significance of the coping problems), or not significantly accelerate growth and therefore simply be lost in the "noise" of a dynamic, growing region. In the case of the North Anna ESP, because the group of operations workers is small enough and expected to be residing over a large and growing area, it is unlikely that the impacts of the operations workers would be noticeable on public services. **Nonradiological Health Impacts** <u>Section 5.8.2 (Occupational Health)</u>: The FEIS did not assign an impact level to the workers from nonradiological emissions, noise, and [acute] electromagnetic fields. These impacts were included in Section 5.8.6 (Summary of Nonradiological Health Impacts) for which the staff assigned a SMALL impact. The staff concludes the impact level would be SMALL based on the workers and their work environment being monitoring and controlled in accordance with applicable Occupational Safety and Health Administration regulations. **Radiological Health Impacts - Human Health** <u>Sections 5.9 and 5.10</u>: As stated in Section 1.1.3 of the FEIS, information and analysis provided in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437, is used in the FEIS as appropriate. Section 4.6 (Radiological Impacts of Normal Operation) of NUREG-1437 establishes that the definition of the significance level of an environmental impact (small, moderate, or large), for health impacts for individual members of the population or an ecosystem is not the same as other impacts in which the concern is with species preservation, ecological health, and condition of the attributes of the resource. NUREG-1437 states, "However, health impacts on individual humans are the focus of

			NRC regulation limiting radiological doses….For the purposes of assessing radiological impacts, the Commission has concluded that impacts are of small significance if doses and releases do not exceed permissible levels in the Commission's regulations. This definition of "small" applies to occupational doses as well as to doses to individual members of the public." **Radiological Health Impacts - Biota Health** Section 5.9.5.3 (Impacts of Estimated Biota Dose): The staff based it's conclusion that the health impacts on biota from routine operation of the proposed Units 3 and 4 would be SMALL on a comparison to national and international guidance documents on effects of radiation on terrestrial and aquatic organisms. The staff believes this is an appropriate basis as no regulatory limits exist for dose to biota. **Uranium Fuel Cycle and Transportation** Section 6.1.1.1 (Land Use): A detailed review of the fuel cycle environmental impacts to include land use impacts was provided in Chapter 6 of NUREG-1437 (Generic Environmental Impact Statement for License Renewal of Nuclear Plants). As stated in Section 1.1.3 of the FEIS, information and analysis provided in NUREG-1437 is used in the FEIS, as appropriate. The staff concluded that portions of Chapter 6 of NUREG-1437 were applicable to new reactor licensing. Section 6.2.2.6 of the NUREG-1437 described the land use requirement for the fuel cycle supporting a model 1000-MW(e) LWR, and concluded that they do not represent a significant impact. NUREG-1437 also provided, for comparison purposes, land use requirements for a coal-fired power plant of 1000-MW(e) capacity using strip-mined coal. This information is provided for reference and is not the basis for the staff's conclusion that the impacts are SMALL. The staff simply finds that it is often useful to provide comparisons in order to put impacts into perspective. Removing the comparative information would not have changed the staff's conclusion regarding the impact level category (SMALL in this case). Section 6.1.1.2 (Water Use): The environmental impacts of water withdrawal and discharge from Units 3 and 4 were reviewed in Section 5.3.2, and these discharges were found to have small environmental impacts based on the

			standard definition of SMALL, during normal water years. Given that the water discharged to water bodies and to the ground from fuel cycle facilities for an RRY is only a small fraction of the discharge from the proposed Units 3 and 4 (i.e.,~6 percent), the environmental consequences will be even smaller, which still fits within the standard definition of SMALL. Section 6.1.1.3 (Fossil Fuel Impacts): The basis for the staff's conclusion that fossil fuel impacts would be small is derived from NUREG-1437, Section 6.2.4. This section concludes – "The fossil fuel (coal and natural gas) consumed to produce electrical energy and process heat during the various phases of the uranium fuel cycle results in a considerable net saving in the use of resources and chemical effluents over the use that would occur if the electrical output from the LWR were supplied by a coal-fired plant. The use of coal and natural gas in the uranium fuel cycle allows the production of electricity with nuclear fuel, which results in a substantial reduction in the requirements for coal and natural gas as fuels to produce electricity. Not only are the fossil fuel requirements small per RRY; there is a net saving in the use of fossil fuel compared to replacing the nuclear-generating capacity with coal-fired capacity." Section 6.1.1.4 (Chemical Effluents): The basis for the staff's conclusion that environmental impacts from chemical effluents would be small is derived from NUREG-1437, Section 6.2.4. This section concludes - "The gaseous effluents SO_x, NO_x, hydrocarbons, CO, and particulates listed in Table S-3 are the consequence of the coal-fired electrical energy used in the uranium fuel cycle. The volume of effluent is equivalent to that of a quite small [45-MW(e)] coal-fired plant; thus the contribution to the degradation of air quality is small. The generation of electricity with nuclear rather than coal-fired power will result in a net improvement in air quality. For these reasons the impact of these effluents is considered small. Gaseous releases of fluorine and hydrogen chloride are at concentrations below state standards and below levels that impact human health. The impact of these effluents is small." Section 6.1.1.5 (Radioactive Effluents): The staff relied on dose estimates from NUREG-1437 in concluding that human health impacts would be small from operation of uranium fuel cycle facilities. Section 6.2.4 of NUREG-1437 states – "The radiological impacts of the uranium fuel cycle on individuals off

			site have been considered within the framework of Table S-3 and supplemental analyses of ^{222}Rn and ^{99}Tc. Given the available information applicable regulatory requirements, the Commission has concluded that, other than for the disposal of spent fuel and high-level waste, these impacts on individuals from radioactive gaseous and liquid releases will remain at or below the Commission's regulatory limits. Accordingly, the Commission concludes that off-site radiological impacts of the fuel cycle (individual effects from other than the disposal of spent fuel and high-level waste) are small. ALARA efforts will continue to apply to fuel-cycle activities." Section 6.1.1.6 (Radioactive Wastes): The basis for the staff's conclusion that environmental impacts from disposal of spent fuel and high-level waste would be small is derived from NUREG-1437, Section 6.2.4. This section concludes – "Despite all the uncertainty surrounding the effects of the disposal of spent fuel and high-level waste, some judgment as to the regulatory NEPA implications of these matters should be made, and it makes no sense to repeat the same judgment in every case. Even taking the uncertainties into account, the Commission concludes that these impacts are acceptable in that these impacts would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR 54 should be eliminated." Section 6.1.2 (Gas-Cooled Reactors): The staff's conclusions on impact levels for gas-cooled reactors designs were based on an evaluation of the methodology provided by the applicant in their ER. Table 6-3 of the FEIS was derived from Table 5.7-1 of the applicant's ER. Table 5.7-1 of the ER had an additional column that showed impacts from the reference LWR (1000 MW(e)) used in developing Table S-3 (10 CFR 51.51(b)). The information on the reference LWR was taken directly from NUREG-0116. The applicant obtained corresponding information for gas-cooled reactor designs from reactor vendors which they normalized to 1000 MW(e) for purposes of comparison to the reference reactor. Their approach was to show for example that if 272,000 MT/yr of ore had to be mined to supply the 1000 MW(e) reference reactor and the gas-cooled designs required less ore to be mined annually, then the environmental impacts would fall within those defined in Table S-3. If the impacts fell within those defined in Table S-3, the staff concluded that the impacts would be small.

			The staff's review was divided into the individual phases of the fuel cycle (i.e., mining, milling, conversion, enrichment, fuel fabrication, and waste management). For each phase, the staff reached a conclusion on impact level. An overall conclusion was reached in Section 6.1.2.8 of the FEIS. The staff determined that impacts from mining, milling, and conversion to be small. However, impacts from fuel fabrication, enrichment, and waste management were unresolved. For example, the staff considered the fuel fabrication impacts to be unresolved because environmental data was not available on a large-scale, fuel fabrication facility for gas-cooled reactors. Therefore, overall the staff determined the impacts from the uranium fuel cycle to be unresolved for gas-cooled reactors. Section 6.2 (Transportation of Radioactive Material): The staff's conclusion statements in Sections 6.2.2.3, 6.2.3, and 6.2.4 of the FEIS that the impact level for LWR designs would be small were based on comparisons to Table S-4 and being consistent with the risks associated with transportation of unirradiated fuel, spent fuel, and waste from current generation reactors as specified in Table S-4. Author: Gregory A. Stoetzel. SME: Andrew Kugler Key Documents: 10 CFR 51.51 (Table S–3); 10 CFR 51.52 (Table S–4), and NUREG-0586; NUREG-1437 (Generic Environmental Impact Statement for License Renewal of Nuclear Plants)
104	6-11	Why are 100 year committed doses given for those isotopes with low health consequences but not for Rn-222, which could have a significant health impact?	The 100-year committed doses are given in Section 6.1.1.5 of the FEIS for Rn-222. The statement on p. 6-11 of the FEIS reads "The estimated population dose commitment from mining, milling, and tailings before stabilization for each year of operation for the 1000 MW(e) LWR scaled model (assuming the 1000 MW(e) LWR scaled model) would be approximately 37 person-Sv (3700 person-rem) to the whole body." This statement should have specified this as a 100-year committed dose as discussed in NUREG-1437. Section 6.1.1.5 provides an estimate of health impacts from waste management activities and certain other phases of the fuel cycle process including impacts from Rn-222. Author: Gregory A. Stoetzel

			SME: Gregory A. Stoetzel, Jean-Claude Dehmel Key Documents: NUREG 1811, Vol. 1; NUREG-1437 (Generic Environmental Impact Statement for License Renewal of Nuclear Plants)
105	6-12	A calculation of 4.8 health effects per year from mining and milling radiation releases is presented. Is this number for a single 1,000 MW(e) reactor or for both proposed North Anna units? Does this consequence derive almost exclusively from Rn-222 release?	The 4.8 health effects per year from fuel cycle radioactive effluents were for both proposed North Anna units. Approximately 57% of this consequence is from Rn-222. A summary of the 100 year committed dose estimates discussed in Section 6.1.1.5 of the FEIS is presented below (all these values were derived from NUREG-1437): 1. Gaseous effluents (excluding reactor releases and Rn-222 and Tc-99) – 1600 person-rem 2. Liquid effluents (excluding reactor releases) – 800 person –rem 3. Rn-222 (Mining/milling and tailings other than stabilized) – 3700 person-rem 4. Rn-222 (Stabilized tailing piles) – 71 person-rem 5. Tc-99 – 400 person-rem 6. Total = 6600 person-rem Author: Gregory A. Stoetzel SME: Gregory A. Stoetzel, Jean-Claude Dehmel Key Documents: NUREG 1811, Vol. 1; NUREG-1437 (Generic Environmental Impact Statement for License Renewal of Nuclear Plants)
106	6-17	What is the basis for the information contained in Table 6-3? Was this provided by Dominion? What, if anything, did the Staff do to verify the data or the calculations? Does Table 6-3 represent the Staff's professional opinion as to the fuel cycle environmental impacts from gas cooled reactor designs for the North Anna ESP site? Please explain.	Table 6-3 of the FEIS was derived from Table 5.7-1 of the applicant's ER. Table 5.7-1 of the ER had an additional column that showed impacts from the reference LWR (1000 MW(e)) used in developing Table S-3 (10 CFR 51.51(b)). The information on the reference LWR was taken directly from NUREG-0116. The applicant obtained corresponding information for gas-cooled reactor designs from reactor vendors, which the applicant normalized to 1000 MW(e) for purposes of comparison to the reference reactor. The applicant's approach was to show, for example, that if 272,000 MT/yr of ore had to be mined to supply the 1000 MW(e) reference reactor and the gas-cooled designs required less ore to be mined annually, then the environmental impacts would fall within those defined in Table S-3. The Staff reviewed NUREG-0116 to verify the validity of the reference LWR data. The Staff did not validate data obtained from vendors.

			Yes, Table 6-3 does represent the Staff's professional opinion as to the fuel cycle environmental impacts from gas cooled reactor designs. The Staff's review was divided into the individual phases of the fuel cycle (i.e., mining, milling, conversion, enrichment, fuel fabrication, and waste management). For each phase, the Staff reached a conclusion on impact level. An overall conclusion was reached in Section 6.1.2.8 of the FEIS. The Staff determined impacts from mining, milling, and conversion to be small. However, impacts from fuel fabrication, enrichment, and waste management were unresolved. Notably, the Staff considered the fuel fabrication impacts to be unresolved because environmental data were not available on a large-scale, fuel fabrication facility for gas-cooled reactors. Therefore, overall, the Staff determined the impacts from the uranium fuel cycle to be unresolved for gas-cooled reactors. Author: Gregory A. Stoetzel SME: Gregory A. Stoetzel, Jean-Claude Dehmel Key Documents: ER, Rev.9; WASH-1248 (Environmental Survey of the Uranium Fuel Cycle); NUREG-0116 (Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle)
107	6-18 to 19	The FEIS states that fuel cycle, transportation, and decommissioning environmental impacts of "other-than LWR designs are not resolved because of lack of information to validate values and impacts." P 6-15. However, the Staff also states at various places that it "expects that the environmental impacts [from fuel fabrication for gas cooled reactors] would be small" (P 6-18) and that it "expects that, on balance, the environmental impacts of enriching gas cooled fuels by comparison . . . would likely be small." P 6-19. Please clarify - has the Staff performed an environmental impact assessment with regard to the fuel cycle, transportation, and decommissioning impacts of "other-than LWR designs" or not?	Yes. The Staff performed an environmental impact assessment with regard to the fuel cycle, transportation, and decommissioning impacts of "other-than LWR designs." For the uranium fuel cycle evaluation, the Staff reviewed the approach used by the applicant for determining environmental impacts from gas-cooled reactors. The review was divided into the individual phases of the fuel cycle (i.e., mining, milling, conversion, enrichment, fuel fabrication, and waste management). For each phase, the Staff reached a conclusion on the impact level. An overall conclusion was reached in Section 6.1.2.8 of the FEIS. The Staff determined impacts from mining, milling, and conversion to be small. However, impacts from fuel fabrication, enrichment, and waste management were unresolved. In particular, the Staff considered the fuel fabrication impacts to be unresolved because environmental data were not available on a large-scale, fuel fabrication facility for gas-cooled reactors. Therefore, overall the Staff determined the impacts from the uranium fuel cycle to be unresolved for gas-cooled reactors. In making the determination of whether the applicant's assessment was adequate, the Staff used guidance in a July 21, 2003 letter to the Nuclear Energy Institute. This letter stated that an ESP applicant referencing non-

			LWRs who uses impacts from supporting documents to Table S-3 and Table S-4 (i.e., WASH-1238 and WASH-1248) bears the burden of demonstrating that the impacts and methods used to determine those impacts are accurate and appropriate for the reactors (or PPE intended to represent the reactors) proposed by the applicant. The Staff stated that when discussing impacts of a new technology (e.g., enrichment or mining technologies), applicants should comprehensively address impacts of that technology and should not just address impacts of earlier technologies that are lessened by the new technology. Author: Gregory A. Stoetzel SME: Gregory A. Stoetzel, Philip M. Daling Key Documents: July 21, 2003 letter from J.E. Lyons, NRC, to the Nuclear Energy Institute, ADAMS accession number ML03154069.
108	6-20	The FEIS states that "Gas-cooled reactor technologies are projected to generate 4.8 x 10^{12} Bq to 1.2 x 10^{14} Bq (131 to 3300 Ci) of low level waste scaled annually." Is this the Staff's projection? Please explain the source and basis for this projection.	The low-level waste estimates of 131 Ci for the PBMR and 3300 Ci for the GT-MHR were derived from Table 5.7-1 of the ER. The Staff multiplied the applicant's estimates for low level waste by the number of PBMR units or the number of GT-MHR units that could be placed on the ESP site and still remain within the PPE power level. As discussed in Section 6.1.2 of the FEIS, three GT-MHR units and two PBMR units could be placed on the ESP site and still remain within the PPE power level. The applicant obtained the low level waste estimates in Table 5.7-1 of the ER from reactor vendors. This reactor vendor information was found in an Idaho National Engineering and Environmental Laboratory (INEEL) engineering design file entitled "Early Site Permit Environmental Report Sections and Supporting Documentation" (ADAMS accession number ML040580285). Author: Gregory A. Stoetzel SME: Gregory A. Stoetzel, Jean-Claude Dehmel Key Documents: ER, NUREG-1811, Vol. 1; Idaho National Engineering and Environmental Laboratory (INEEL) engineering design file entitled "Early Site Permit Environmental Report Sections and Supporting Documentation"
109	6-26	Why is a cancer probability of 7.3E(-4) per rem used here when, elsewhere in the FEIS, 4E(-4) was used as the individual cancer probability per rem?	The cancer probability coefficient of 7.3E-4/person-rem was used throughout the FEIS when referring to health impacts from normal reactor operations (Section 5.9 of the FEIS), uranium fuel cycle (Section 6.1 of the FEIS), and

			transportation activities (Section 6.2 of the FEIS). This coefficient is from ICRP 60 and represents the total detriment (fatal cancers, non-fatal cancers, and severe hereditary effects). The response to Board Question 71 provides additional information on the ICRP coefficient of 7.3E-4 total detriment per person-rem. The Staff did not use the cancer probability coefficient of 4E-4 in the FEIS. Author: Gregory A. Stoetzel SME: Gregory A. Stoetzel, Jean-Claude Dehmel Key Documents: NUREG-1811, Vol .1; ICRP Publication 60 (1990 Recommendations of the International Commission on Radiological Protection)
110	6-28	The focus of the transportation section is on radiological impacts with little or no information on accidents associated with spent fuel, LLW and fresh fuel transport. Appendix G to the FEIS is referenced as a source of this type of information but it addresses exclusively radiological impacts. What accident frequencies would be associated with the activities related to the construction and operation of Units 3 and 4?	See attached file. Author: Philip M. Daling SME: Philip M. Daling Key Documents: ER, NUREG-1811, Saricks, C.L., and M.M. Tompkins. 1999. *State-Level Accident Rates for Surface Freight Transportation: A Reexamination*. ANL/ESD/TM-150. Argonne National Laboratory, Argonne, Illinois.
111	6-42	The FEIS states that "At the ESP stage, applicants are not required to submit information regarding the process of decommissioning, such as the method chosen for decommissioning." Is it your position that the FEIS for an ESP does not need to cover the decommissioning environmental impacts of the proposed federal action? Or are you merely saying that these matters must be covered in the FEIS, even if the precise process or method of decommissioning need not? Please explain.	According to the review guidance in the ESRP, there is a statement under 5.9, DECOMMISSIONING, III. REVIEW PROCEDURES that states: "NRC regulations do not require the applicant to submit detailed plans for decommissioning and, in the absence of such plans, no detailed analysis of decommissioning is necessary." This is the basis for the statement referenced in Board Question 111. At the CP or COL stage, a report containing a certification of financial assurance for radiological decommissioning must be provided to meet the requirements in 10 CFR 50.33. Author: Eva Eckert Hickey SME: Eva Eckert Hickey Key Documents: NUREG-1555, Section 5.9, "Decommissioning."
112	7-3	In the section on "Cumulative Impacts" the FEIS	

		states "There are three basic approaches considered by the Staff to mitigate water conflicts including (1) alternative design of the Unit 3 cooling system, (2) alternative operation of the proposed Unit 3, and (3) alternative operating procedures for the North Anna Dam."	
		A. Given that the Dominion group of companies owns existing Units 1 and 2, as well as proposed Units 3 and 4, and that these four units will certainly have cumulative impacts, please explain why the Staff did not consider the possibility of additional equipment or operating procedures on existing Units 1 and 2 which could compensate or mitigate against the incremental adverse environmental impacts of proposed Units 3 and 4. Please discuss whether this alternative was considered, and if not, why not.	The alternative of additional equipment or operating procedures on existing Units 1 and 2 to compensate for or mitigate against the incremental adverse environmental impacts of proposed Units 3 and 4 was not considered a reasonable alternative. The additional equipment that would reduce consumptive water use would be dry cooling towers, by themselves or in combination with wet cooling towers. The addition of this equipment would reduce the generating capacity of the existing units. The operating procedures to reduce water use would require derating the plants, also reducing generating capacity. Reducing the generating capacity of existing units, so that new units could be built to meet electrical needs, was not considered to be a reasonable alternative. The change to the cooling systems for proposed Units 3 and 4 essentially eliminated the thermal impacts and greatly reduced consumptive water use, entrainment, and impingement. <u>Author</u>: Lance W. Vail <u>SME</u>: Lance W. Vail <u>Key Documents</u>: NA
		B. Legal Question: Even if the imposition of such modifications related to Units 1 and 2 might be considered beyond the Commission's jurisdiction, if it is a reasonable alternative, shouldn't the NRC consider it? <u>See</u> <u>NRDC v. Morton</u>, 458 F.2d 827, 834-36 (D.C. Cir. 1972) and 10 C.F.R., Part 51, Appendix A, Section 5 ("An otherwise reasonable alternative will not be excluded from discussion solely on the ground that it is not within the jurisdiction of the NRC.").	*See* the "NRC Staff Legal Brief in Response to Licensing Board's Environment-Related Questions."

		C. As noted above, NRC considered three approaches to lowering water usage by Unit 3 - alternative design, alternative operation and alternative operation of the dam. The first and third approaches were briefly discussed in the FEIS; the second was not. What were the assumptions and conclusions of this option?	Alternative operation would involve an increase in the frequency of utilization of the system in MWC mode. The system could operate exclusively in MWC mode as a bounding alternative. However, the Staff determined that the benefits would be marginal since there normally is a surplus of water during these times. Author: Lance W. Vail SME: Lance W. Vail Key Documents: NUREG-1811, Vol. 2, Appendix K
113	7-3	In concluding that a combination wet and dry cooling system design for Unit 3 is preferable to a wet cooling tower design, why wasn't the energy penalty inherent in dry cooling towers one of the factors given consideration?	The Staff's analysis determined that a wet cooling tower design by itself (i.e., not part of a combination wet and dry cooling system) has too large a consumptive water use and would result in much lower lake levels and downstream impacts than a combination wet and dry cooling system. The lake level with Units 1 and 2 operating and a wet cooling tower design for Unit 3 during the critical drought period would drop to 242.5 MSL, versus 243.5 MSL for the combination wet and dry cooling system. The period of low flow would increase from 11% with Units 1, 2 and proposed Unit 3 with a combination wet and dry cooling system, to 18 % with a wet cooling system design. Therefore, there was no need to analyze the energy penalty of the combination wet-dry cooling system in a comparing wet and dry cooling system for Unit 3 to a wet cooling tower design. Author: John S. Cushing SME: Christopher B. Cook Key Documents: NUREG-1811, Vol. 1
114	7-7	In the FEIS the Staff includes discussions of certain socioeconomic benefits of the proposed ESP. Is it permissible for the Staff to consider the benefits (or lack thereof)? If so, is it permissible for the Board to consider benefits (or the lack thereof) in its NEPA decision - making on this proposed ESP?	The socioeconomic effects of construction and operation of a reactor or reactors on a proposed ESP site are an integral part of the impacts considered in the Staff's environmental evaluation of an ESP application. Under NEPA and CEQ guidance interpreting NEPA, it is permissible for EIS preparers to consider both harmful and beneficial environmental effects, including socioeconomic effects. *See* 40 CFR 1508.8. Although it is an independent agency, NRC generally follows CEQ guidance with respect to implementation of NEPA. *See* 10 CFR 51.10. Accordingly, it is permissible

			for the Staff to consider beneficial socioeconomic impacts in the FEIS on the North Anna ESP application. The remainder of this response is addressed in the "NRC Staff Legal Brief in Response to Licensing Board's Environment-Related Questions." <ins>Author</ins>: Michael J. Scott <ins>SME</ins>: Michael J. Scott <ins>Key Documents</ins>: 10 CFR 51.10, 40 CFR 1508.8
115	8-1	A reduction in plant efficiency as a result of a dry cooling or mixed cooling requirement could be viewed as an environmental impact in that some replacement power source is required to produce the missing MW-hrs and this source would have clear impacts on the environment. Alternative sites that could employ more efficient cooling methods could therefore have an advantage over the North Anna site, other factors being equal. Why wasn't this considered in the assessment?	Wet cooling systems are more efficient than a mixed or dry-cooling system and an alternative site using a more efficient cooling system would be preferable, other factors being equal. However, the other factors are <ins>not</ins> equal. Once-through cooling systems and wet cooling tower systems are not environmentally preferable systems to a mixed cooling system or a dry cooling system in the area of aquatic impacts. Both of these more efficient cooling systems consume more water than a mixed system or a dry cooling system. The increased consumption of water by the more efficient cooling systems has greater adverse environmental impacts in the areas of entrainment, impingement, and thermal impacts than a mixed system or a dry cooling system. This was not considered in the FEIS because the Staff's review of alternative sites consists of a two-part sequential test to determine an "obviously superior" site. The first part of the test determines whether there are "environmentally preferred" sites among the candidate ESP sites. The Staff considers whether the applicant has (1) reasonably identified alternative sites, (2) evaluated the likely environmental impacts of construction and operation at these sites, and (3) used a logical means of comparing sites that has led to the applicant's selection of the proposed site. Based on its independent review, the Staff then determines whether any of the alternative sites are environmentally preferable to the applicant's proposed ESP site. If the Staff determines that one or more alternative sites is environmentally preferable, it would then compare the estimated costs (e.g., environmental, economic, and time) of constructing the proposed plant at the proposed site and at the environmentally preferable site or sites (NRC 2000). To find an obviously superior alternative site, the Staff must determine that (1) one or more important aspects, either singly or in combination, of a reasonably available alternative site are obviously superior to the corresponding aspects

			of the applicant's proposed site and (2) the alternative site does not have offsetting deficiencies in other important areas. A Staff conclusion that an alternative site is obviously superior to the applicant's proposed site would normally lead to a recommendation that the application for the ESP be denied. Because none of the alternative sites to the North Anna ESP site was determined to be environmentally preferable, the Staff did not proceed to step (2) of the analysis, and therefore, the issue raised by the Board did not need to be assessed. Author: John S. Cushing SME: John S. Cushing Key Documents:
116	8-2	The FEIS states that the "[T]he no action alternative would not achieve the benefits intended by the ESP process, which would include (1) early resolution of siting issues prior to large investments of financial capital and human resources in new plant design and construction (2) early resolution of issues on the environmental impacts of construction and operation of reactors that fall within the site parameters, (3) the ability to bank sites on which nuclear power plants may be located and (4) facilitation of future decisions on whether to build new nuclear power plants." Has the Staff considered the considerable costs, time, and effort, both by the applicant and by the NRC, devoted to applying for and processing an early site permit that may never be used? For example, in the 1970s, Dominion (or its predecessor) applied for and obtained a permit to construct Units 3 and 4 on the NAPS site, but never used this permit. Should the FEIS include the "lost-opportunity costs" incurred when a company, and more particularly, the NRC, devote its limited and considerable time and resources to processing an ESP application where there is no indication that the applicant will ever use it?	The Staff does not believe that the FEIS should include "lost opportunity costs" because the cost of the NRC resources in evaluating the proposed action and comparing it to the alternatives can not be separated and assigned to one alternative (i.e., the no action alternative). The purpose of an ESP is early resolution of siting issues to allow a permit holder to "bank a site" for up to 20 years for future reactor siting (FEIS pg 1-2). Therefore, if approved, the applicant will have early resolution of a large number of issues and it can use the ESP to bank a site, and the ESP will have achieved its purpose. There is the expectation that an applicant will use an ESP. The Commission, in issuing the Part 52 rule expressed its expectation that, "[p]ersons are not likely to go to the expense of applying for an early site permit, unless there is a good prospect that the site will be used for a nuclear power plant." (54 FR 15,378) In addition, in this particular case, the applicant has indicated that it is exploring submitting a COL application that would reference the ESP should one be granted (see the Staff's response to Board Question 132). Finally, the Staff believes that it is beyond its regulatory purview to inquire into the business planning of the applicant concerning the immediacy of using any permit granted. Author: John S. Cushing SME: Andrew Kugler Key Documents: NUREG-1811; 54 FR 15,378

117	8-2 to 5	In considering alternatives for handling the excess heat load for proposed Unit 3, three alternatives were discussed: once-through cooling; wet cooling; and dry cooling. Dominion estimated that induced evaporation from once-through cooling could result in water loss at an annual rate of 28cfs (12,600 gpm). Dominion also estimated that the combined-cycle wet and dry cooling system proposed in its Environmental Report (ER) would induce evaporative losses of about 20 cfs (9,000 gpm). Please provide the results of any calculations made estimating the evaporative losses associated with:	
		A. The operation of Units 1 and 2 operating alone;	The Staff estimated the average induced evaporation rate for the period between 1978 and 2003 from Units 1 and 2 alone to be approximately 50 cfs. Additional details regarding calculation of this rate can be found in Cook et al. (2005). Author: Christopher B. Cook SME: Christopher B. Cook, Lance W. Vail Key Documents: PNNL-14944; Cook, CB, LW Vail, and D.L. Ward (2005) "Report on the North Anna Early Site Permit Water Budget Model (LakeWBT) for Lake Anna", PNNL-14944, Pacific Northwest National Laboratory, 52 pp, ADAMS accession number ML043210217.
		B. Each of the Units 1, 2, and 3 (with Unit 3 operating with once-through cooling);	The induced evaporation rate for Unit 3 operating with a once-through cooling system was assigned in the Staff''s independent water budget assessment at the PPE value. The Staff did not compute an independent verification of the PPE-reported induced evaporation rate. Author: Christopher B. Cook SME: Christopher B. Cook, Lance W. Vail Key Documents: PNNL-14944 (ADAMS accession number ML043210217).

		C. Each of the Units 1, 2 and 3 (with Unit 3 using a wet cooling tower system).	The forced evaporation rate for Unit 3 operating with a wet cooling tower system was assigned in the Staff's independent water budget assessment at the PPE value. The Staff did not compute an independent verification of the PPE reported induced evaporation rate. Author: Christopher B. Cook SME: Christopher B. Cook, Lance W. Vail Key Documents: PNNL-14944 (ADAMS accession number ML043210217).
118	8-4	The FEIS states that "The use of a dry cooling design versus the proposed combination wet and dry cooling system design for Unit 3 would largely eliminate the impacts on aquatic biota in Lake Anna and the North Anna River downstream. The lake would not be heated by rejected heat from Unit 3, and there would be no additional consumptive water use." The primary objection to this option seems to be that it would be more expensive to build and would consume approximately 150 MW(e) per year. Dominion is using dry cooling for proposed Unit 4.	
		A. Is it the Staff's conclusion that dry cooling for Unit 3 is the best environmental alternative (i.e., the option with the least environmental impact, other than no action)? Please discuss.	No. It is the Staff's conclusion that a combination wet and dry cooling system is preferable to a dry cooling system for Unit 3. The FEIS page 8-4 and 8-5 discusses Unit 3 dry cooling (See below). **8.2.3 Plant Cooling System: Unit 3 Dry Cooling System** The use of a dry cooling design versus the proposed combination wet and dry cooling system design for Unit 3 would largely eliminate the impacts on aquatic biota in Lake Anna and the North Anna River downstream. The lake would not be heated by rejected heat from Unit 3, and there would be no additional consumptive water use. A dry cooling tower designed to dissipate heat may reduce water-related impacts of operating Unit 3, but it also has some disadvantages. In particular, dry cooling systems are more expensive to build and are not as efficient as wet cooling systems. To achieve the necessary cooling, dry

			systems move a large amount of air through a heat exchanger, and the fans that force the air through the heat exchanger use a significant amount of power. Dominion estimates that the power needed to operate dry cooling towers would be 8.5 to 11 percent of the plant power output (Dominion 2006). The power needed to operate a dry tower for Unit 3 would be about 150 MW(e). This power demand reduces the net power output of the plant. The power needed for operating the combination wet and dry cooling system would be 1.7 to 4 percent. This, in turn, would increase the environmental impacts of fuel use and spent fuel transport and storage. The fans and the large volume of air required for cooling also result in elevated noise levels. The dry cooling tower would also occupy more land than a once-through or wet tower cooling system. The Staff concludes that based on its analysis that Lake Anna could support Unit 3 using a combination wet and dry cooling system and given the environmental impact of increased use of resources needed by using a less efficient dry cooling system, a combination wet and dry cooling system is preferable to a dry cooling system for Unit 3. <u>Author</u>: John S. Cushing <u>SME</u>: John S. Cushing <u>Key Documents</u>: NUREG-1811, Vol. 1
		B. The FEIS states at P 10-9 that "The Staff concluded in Section 8.2 that the proposed combination of wet and dry cooling for Unit 3 is preferable to the three cooling alternatives." Where is that statement made in Section 8.2?	Each of the three subsections in 8.2 (8.2.1, 8.2.2, and 8.2.3) concludes with a statement that the wet and dry cooling system is preferable to the alternative. <u>Author</u>: Lance W. Vail <u>SME</u>: Lance W. Vail <u>Key Documents</u>: NUREG-1811, Vol. 1
119	8-7 to 10	<u>Numerous</u> nuclear and non-nuclear power plants are located within the "region of interest" (ROI) [the Mid-Atlantic, Northeast, and Midwest regions] defined by Dominion. Did the Staff consider these alternative sites in its alternatives analysis under NEPA? Within this ROI Dominion only evaluated the North Anna site, two DOE sites, and the Dominion Surrey Power Station site. Assuming the validity of the ROI, please	The ROI defined by Dominion in its application, while broad, does not appear to be unreasonable to the Staff. Many applicants can no longer define the ROI based on a service area because of deregulation in the power industry (*i.e.*, commonly the owner of the power generation facility is not the owner of the transmission and distribution facilities). The power generating companies of today often own generating stations spread over a wide geographic area, often in non-contiguous parts of the country.

		explain how the Staff determined these four sites were the only reasonable alternative sites within the ROI to be considered. Note that Dominion's "45 site suitability/screening criteria" were only used by it to select between these four sites, not as criteria for eliminating all other suitable sites located within the ROI.	With the ROI established, the question then becomes what is a reasonable slate of candidate sites. The Environmental Standard Review Plan (NUREG-1555), 9.3, "Alternative Sites," states the following on page 9.3-10: Although there can be no specific criteria for determining that an adequate number of candidate sites have been identified, the reviewer should make such a determination, based on the ROI, the number of candidate areas, and the number and type of alternative sites evaluated by the applicant. In general, however, the identification of two or more different areas and three to five alternative sites in addition to the proposed site could be viewed as adequate. With respect to this portion of the guidance, the applicant identified a broad geographic area for consideration and, in its initial review considered a total of six sites (the four discussed in the ER and the EIS, plus the Millstone plant site and the Idaho National Laboratory site). The latter two sites were eliminated from consideration for the ER as discussed in Section 9.3.3.4.2 of the ER (for Millstone) and Section 6 of Chapter 2 of the Dominion Energy, Inc. and Bechtel Power Corp. *Study of Potential Sites for the Deployment of New Nuclear Plants in the United States* (for INEEL). In addition, the INEEL site falls outside the ROI upon which Dominion eventually decided and was, therefore, not considered as an alternative site in Dominion's ER. The ESRP provides additional guidance on pages 9.3-6 to 7: Recognize that there will be special cases in which the proposed site was not selected on the basis of a systematic site-selection process. Examples include plants proposed to be constructed on the site of an existing nuclear power plant previously found acceptable on the basis of a NEPA review and/or demonstrated to be environmentally satisfactory on the basis of operating experience, and sites assigned or allocated to an applicant by a State government from a list of State-approved power-plant sites. For such cases, the reviewer should analyze the applicant's site-selection process only as it applies to candidate sites other than the proposed site, and the site-comparison process may be restricted to a site-by-site comparison of these candidates with the proposed site. As a corollary, all nuclear power plant sites within the identified region of interest having an operating nuclear power

			plant or a construction permit issued by the NRC should be compared with the applicant's proposed site. This portion of the guidance indicates that it is reasonable to use existing sites as a source of candidate sites. Applicants typically also limit their consideration to sites over which they do, or could reasonably expect to, exert control. So, for example, applicants do not consider sites that are owned by a different power generation company. This approach comports with the guidance provided by the Commission in CLI-77-8, dated March 31, 1977, for the Seabrook site. In this decision, the Commission addressed in particular the issue of the consideration of sites owned by other companies. The Commission was responding to a contention that a number of superior sites (owned by other companies) existed within the ROI. The Commission stated, in part: But this Commission sits to license, or not to license, a nuclear power plant proposed by a particular applicant. It is not within our power to order that a different plant be built by another utility. The fact that a possible alternative is beyond this Commission's power to implement, does not absolve us from any duty to consider it, but our duty is subject to a "rule of reason," NRDC v. Morton, 458 F.2d 827 (D.C. Cir. 1972); Concerned About Trident v. Rumsfeld, ---- F.2d ----, 9 ERC 1370, 1380 (D.C. Cir. 1976). And NEPA does not require that we reformulate a discrete licensing question in terms as broadly as intervenors suggest. Based on the discussion above, the Staff concluded that Dominion had selected a reasonable ROI and a reasonable set of candidate sites for evaluation. As the Staff would expect (and as the ESRP indicates), all of the candidate sites evaluated in the ER would be suitable locations for the construction of a new nuclear power plant. But the Staff determined that none of the alternative sites was environmentally preferable to the proposed site, and, therefore, that none was obviously superior. Author: Andrew Kugler SME: Andrew Kugler Key Documents: NUREG-1555 Section 9.3, "Alternative Sites."
120	8-8	Under NEPA, the Staff, not the applicant, is obliged to	The primary source of Staff guidance regarding the evaluation of alternative

	to 9	consider all reasonable alternatives to the proposed action. Is the Staff's alternatives analysis limited by Dominion's 45 "site suitability criteria?" Is it appropriate for the Staff to consider Dominion's numerous "economic" and " engineering" criteria, such as "electricity projections" and "site development costs" in performing its alternatives analysis? Please explain.	sites is ESRP 9.3, "Alternative Sites." The Staff is not directed to perform a de novo review for alternative sites. Rather, the Staff is directed to review the process used by the applicant, review (and collect as necessary) reconnaissance-level information for the alternative sites, and evaluate the reasonableness of the applicant's results. Regarding the screening process in particular, on page 9.3-10 the ESRP states, in part: Alternative Site Evaluation—The objective of this phase of the evaluation procedure is (1) to determine if the applicant has reasonably identified alternative sites, predicted the environmental impacts of construction and operation at these sites, and developed and used a logical, reproducible means of comparing sites that has led to the applicant's selection of the proposed site, to determine if it is environmentally preferable, and (2) to determine if any alternative site can be shown to be obviously superior to the applicant's proposed site. This analysis may be documented in a table such as Table 9.3.2, which records summary environmental information on each alternative site; the conclusion of environmental preferability for any sites; consideration of cost, institutional, and other factors; and any identification of an obviously superior site. Many of the following evaluation steps must be based on the reviewer's judgment. For these evaluations, the principal criterion will be that of reasonableness of the applicant's data and procedures. In addition, on page 9.3-8 the ESRP lists facility costs and institutional constraints, as they affect site availability, as factors for consideration, among others. The ESRP also refers to information on areas that are deficient in power as an issue for consideration (see pages 9.3-3 and 9.3-8). With that said, the primary focus of the Staff's evaluation of the proposed versus the alternative sites was based on the impact areas discussed for each site in Chapter 8 and compared in Chapter 9. These factors do not include the applicant's engineering and economic criteria (e.g., groundwater, site costs). Rather, they are focused on the environmental impacts of constructing and operating new nuclear power plants at the proposed and alternative sites. (Note, however, that some of the applicant's engineering criteria are inextricably linked to the environmental impact analyses. Examples include "environmentally sensitive areas," "labor supply," and "cooling water source". Each of these criteria served as an input to the

			environmental analyses performed by the applicant which, in turn, served as a starting point for the Staff's analyses.) As discussed in ESRP Section 9.3, factors such as site development costs do not come into play unless one of the alternatives sites is judged by the Staff to be environmentally preferable to the proposed site. These factors are then considered in the determination of whether the environmentally preferable site is obviously superior to the proposed site. See page 9.3-5 of ESRP 9.3. Author: Andrew Kugler SME: Andrew Kugler, Mary Ann Parkhurst Key Documents: NUREG-1555, Section 9.3
121	8-10	The FEIS states that "Dominion also considered other existing nuclear power plant, greenfield, and brownfield sites within the ROI. In as much as sites of current nuclear facilities have space for additional units, the greenfield and brownfield sites were determined not to be environmentally preferable because of the large land area that would need to be disturbed to build a new plant and to support necessary transmission line rights of way." What about the many "other existing nuclear power plant sites" within the ROI? They suffer from none of the mentioned detriments of the greenfield and brownfield sites and have the same benefits as the three alternatives considered by Dominion. Aren't many of them located in areas of significantly lower population density? Are these not reasonable alternative sites that warrant inclusion in the NEPA alternatives analysis? The FEIS fails to even discuss this. Did you dismiss these sites solely because Dominion does not own them? Is this a legitimate basis under NEPA? (Note that Dominion does not own the proposed North Anna ESP site.) Please explain.	NRC regulations (10 CFR 51, App. A) require that an EIS present the environmental impacts of the proposed action and reasonable alternatives. There are clearly many potential alternative sites, including sites with lower population densities than the proposed site, for a new nuclear power plant within Dominion's region of interest. CEQ guidance (46 Fed. Reg. 18,027) provides that "when there are potentially a very large number of alternatives, only a reasonable number of examples, covering the full spectrum of alternatives, must be analyzed and compared in the EIS." The alternative sites examined in Ch. 8 of the FEIS included one site (Surry) with an operating nuclear power station owned by Dominion and two U.S. Department of Energy sites (Portsmouth and Savannah River) with existing nuclear facilities. The Staff determined that these three alternative sites were a reasonable number of sites and that they adequately covered the spectrum of alternative sites. The Staff notes that siting a new nuclear power station at the site of an existing nuclear power station operated by another utility would likely present logistical, competitive, and regulatory complications. The North Anna ESP site is on land owned by Virginia Power and Old Dominion Electric Cooperative, an entity with an existing corporate relationship with Dominion (ER p. 3-1-2). Author: Andrew Kugler SME: Paul Hendrickson Key Documents: 10 CFR Part 51, App A; CEQ guidance (46 Fed. Reg. 18,027)
122	8-10	The FEIS refers to "Generic Issues Consistent Among Alternative Sites" and states that "In evaluating the alternative sites, the NRC staff found that certain	Yes. The consequences of severe accidents are a function of population, both total population and distribution of the population around the site. The MACCS2 code includes population distribution in its calculations. However,

		<u>impact areas would not vary significantly among sites</u> and as a result would not affect the evaluation of whether an alternative site is environmentally preferable to the proposed site. These impact areas include . . . <u>radiological health during</u> . . . operation for members of the public . . . [and] <u>postulated accidents</u>." (emphasis added). This is surprising. Do you agree that the radiological health consequences of a severe accident that resulted in the release of a substantial amount of radioactive material from a site could be substantially different depending on the number of people living and working downwind of the site (<u>e.g.</u>, New York City vs. Nevada)? Are you ignoring these different consequences because you deem the possibility of such an accident to be so remote as to make the location of a new reactor near large populations to be environmentally irrelevant for purposes of severe accident considerations? Please explain.	none of the alternate sites discussed in the application or considered by the Staff is so close to a major population center that the risks associated with a severe accident would likely be determined to be other than small. In addition, it should be noted that the relevant guidance on evaluation of alternate sites is that the evaluation is to be based on "reconnaissance-level" information. The MACCS2 computer code requires input that is more detailed than reconnaissance-level information. <u>Author</u>: J.V. Ramsdell <u>SME</u>: J.V. Ramsdell <u>Key Documents</u>: NUREG-1811, Vol. 1; NUREG-1555, Section 9.3, "Alternative Sites;" Regulatory Guide 4.2, Rev. 2, "Preparation of Environmental Reports for Nuclear Power Stations. Jow, et al. 1990. MELCOR Accident Consequences Code System (MACCS), NUREG/CR-4691. Chanin and Young. 1997. Code Manual for MACCS2: Volume 1. User's Guide. SAND97-0594, Sandia National Laboratories. 2003.
123	8-17	Please provide an estimate of the total population living within a 50 mile radius of the proposed ESP site and the three other alternative sites evaluated in the FEIS. Please advise, if you know, whether the populations in the similar 50 mile radius areas around any of the other existing nuclear reactor sites in the ROI are 25% (or more) lower.	Year 2000 Census Data (NRC GEn&SIS website analysis of 2000 Census data) shows the following data: <u>Site Residents within 50 miles</u> <u>25% or more lower?</u> North Anna ESP Site 1,628,649 -- Surry Alternative Site 2,188,186 no Portsmouth Alternative Site 732,578 yes Savannah River Alternative Site 771,854 yes The Staff is aware of several other sites within the region of interest that have 25% fewer residents within 50 miles. Table 2.1 of NUREG-1437 (attached) lists the population within 50 mi. of all U.S. nuclear power plants based on the 1990 census. Dominion defined its region of interest as the Mid Atlantic, Northeastern, and Mid Western regions of the US. There are several existing nuclear power plant sites in these regions that have a total population within 50 mi that is less than 75% of the population within 50 mi of the North Anna Site.

			Author: J.V. Ramsdell SME: J.V. Ramsdell, R.L. Palla, Michael J. Scott Key Documents: NUREG-1811, Vol. 1; NUREG-1437, Vol. 1; http://gensis.llnl.gov/ (NRC Gen&SIS website)
124	8-17	In the analysis of the Surry Power Station Site, why was closed-cycle cooling assumed? If once-through cooling at this site were possible, would the NRC analysis of alternative sites have found the Surry site to be superior to the North Anna site? Why or why not?	Based on the recent issuance of EPA's Clean Water Act Section 316(b) Phase I and II rules for Cooling Water Intake Structures, the Staff determined that once-through cooling designs are unlikely to be a viable option for new nuclear plants located on an estuary. Therefore, the Staff determined that a once-through cooling design at the Surry site was not likely. The Staff considered once-through cooling at North Anna in view of the specific requirements in the EPA Phase II regulations at the time the EIS was prepared. Author: Michael T. Masnik SME: Michael T. Masnik, Lance W. Vail Key Documents: EPA 316(b) rule
125	D-9	A public comment identified impacts that would need to be considered in the EIS, including "All impacts arising from the increase in the routine discharge of chemicals, heavy metals, cleaning solvents, biocides and radioactive isotopes into Lake Anna arising from the operation of additional nuclear power units." The NRC response stated "Surface water impacts of the types described in the comments will be evaluated by the NRC staff in Chapter 5 of the EIS." Aside from radiological impacts, it appears that this has not been done. Why haven't the above issues been addressed in the FEIS?	In Section 5.3.3 of the EIS, the Staff determined that the issue of water quality impacts is unresolved. An applicant for a CP or COL referencing an ESP for North Anna will need to provide further information on the non-radiological effluents. At the time of this scoping meeting comment, the Staff expected to be able to resolve this issue and provide a discussion of these impacts in Chapter 5. Author: Lance W. Vail SME: Lance W. Vail Key Documents: NUREG-1811, Vol. 1
126	H-10	Dominion elected to lower the released tritium levels to 850 Ci/yr. to ensure that tritium in the water would not exceed EPA standards. This value contrasts with a projected value in the applications prior to Rev. 9 of 3,100 Ci./yr. (Based on ACR-700 design). How can Dominion arbitrarily designate the tritium release rate?	Dominion provided the Staff with PPE values for key parameters in Table 3.1-1 of the ER. It changed the parameter for liquid effluent release rate for tritium as noted in the Board's question to prevent a possible situation where tritium concentration in Lake Anna might exceed EPA drinking water standards. The change was driven by discussions with the Staff to ensure tritium concentration in Lake Anna would not exceed EPA drinking water standards. The revised tritium liquid effluent release source term became part of the PPE in Table 3.1-1 of the ER, and the applicant and Staff revised

			their evaluations accordingly. Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: NUREG-1811, Vol. 1; ER, Rev. 9
127	H-10	Section H 3.3 states "the average annual tritium release (from Units 1 & 2 over a six-year period) was 814 Ci/yr. and the average annual concentration (in the Lake) was 3,049 pCi/L. Assuming this same relationship for the two units, the estimated tritium concentration in the lake from the new units would be 6,368 pCi/L."	
		A. How was the average release rate from Units 1 & 2 determined?	The average annual tritium release was determined by averaging the tritium release values from the Annual Effluent Monitoring Reports for the years 2000-2005. The highest annual tritium release was 1115 Ci in 2004 and the lowest was 349 Ci in 2003. The average annual lake concentration was determined by averaging the tritium concentration values from the WHTF location for the years 2000-2005. These concentrations were taken from the annual Radiological Environmental Operating Reports. As part of the REMP, tritium concentration are measured quarterly at this location. The highest quarterly tritium concentration was 4500 pCi/L and the lowest was 940 pCi/L over the six-year period. The highest annual tritium concentration was 3908 pCi/L (2002) and the lowest was 2000 pCi/L (2003). Author: Gregory Stoetzel SME: Jean-Claude Dehmel Key Documents: Annual Effluent Monitoring Reports for the years 2000-2005; annual Radiological Environmental Operating Reports for years 2000-2005
		B. What were the highest and lowest measured tritium concentrations in the six year interval chosen?	The average annual tritium release was determined by averaging the tritium release values from the Annual Effluent Monitoring Reports for the years 2000-2005. The highest annual tritium release was 1115 Ci in 2004 and the lowest was 349 Ci in 2003. The average annual lake concentration was determined by averaging the tritium concentration values from the WHTF location for the years 2000-2005. These concentrations were taken from the annual Radiological Environmental Operating Reports. As part of the REMP,

			tritium concentration are measured quarterly at this location. The highest quarterly tritium concentration was 4500 pCi/L and the lowest was 940 pCi/L over the six-year period. The highest annual tritium concentration was 3908 pCi/L (2002) and the lowest was 2000 pCi/L (2003). Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: Annual Effluent Monitoring Reports for the years 2000-2005; annual Radiological Environmental Operating Reports for years 2000-2005
		C. Since the lake volume appears to be larger than the volume of water exiting the lake in an average year, it could take a long time for the tritium in the lake to reach equilibrium. Does Dominion believe that the measured tritium concentrations are at equilibrium?	Figure 4-4 and Figure 4-5 of the 2005 Annual Radiological Environmental Operating Report for North Anna Station are graphs that trend tritium surface water concentrations at the North Anna River location and the WHTF location from ~1985 to present. The data shows relatively constant tritium concentrations over this 20 year time period, indicating that tritium has reached an equilibrium concentration in Lake Anna. Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: 2005 Annual Radiological Environmental Operating Report for North Anna Station
		D. Since water from the heat exchanger and water exiting the dam are near the lake surface, there could be significant tritium stratification with depth. Have tritium samples been taken at different lake depths and if so, what do they show?	Tritium concentrations have not been measured as a function of lake depth and location. All sampling has been done on the surface. Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: Annual Radiological Environmental Operating Reports for the years 2000-2005
128	H-10	Table H-5 quotes "per unit" tritium release rates of 3,500 Ci/y which is over four times the committed release cited above. What is the difference between the Dominion commitment and the numbers in the Table?	Table H-5 presents the gaseous tritium effluent release source term, which is correctly stated as 3500 Ci/yr. Table H-2 presents the liquid tritium effluent release source term, which is correctly stated as 850 Ci/yr. Author: Gregory A. Stoetzel SME: Jean-Claude Dehmel Key Documents: NUREG-1811, Vol. 1

129	K-6	Table K-1 provides surface areas and water volumes for various regions of the Lake Anna cooling lake. Dividing the volume by the surface area for selected areas should yield the average water depth for the feature cited but this calculation produces puzzling results. For example, a decrease of thirty feet in water elevation at the dam from 250' to 220' produces a change in average water depth for Lake Anna of 13.2' (from 31.47' to 18.28' average depth), but a similar calculation for the reservoir produces a depth change of only 8.7' (from 23.88' to 15.17').	
		A. Why doesn't a 30' drop at the dam produce essentially the same drop elsewhere?	The results indicate that the reservoir shape between elevation bands 250' and 220' is not correctly approximated by a square prism. In fact, the shape is much close to that of a frustum of a right circular cone. Using the equation for a square prism, the ratio (actual change in height) divided by (computed change in height) is about 3 for most sections of the reservoir (30'/8.7'= 3.44 for the entire reservoir; 30'/13.2'=2.27 for the main lake; 30'/9.19'=3.27 for the WHTF; 30'/8.42=3.56 for the lake arms). Using the equation for a frustum of a cone based on the reported areas and volume, the back-computed heights are: 37.3' (entire reservoir), 42.6' (main lake), 34.02' (WHTF), 31.75 (Lake Arms). Similar actual height/computed height ratios using the frustum equation are just slightly under 1.0 (0.7 to 0.94). Therefore, although the shape of the frustum better approximates the shape, it is not a perfect match. Author: Christopher B. Cook SME: Christopher B. Cook, Lance W. Vail Key Documents: NA
		B. Are there any lake contours that could produce the above result?	It appears that few of the contours produce an area-to-volume ratio that approximates a square prism. The shape is much better approximated using a frustum of a right circular cone. Author: Christopher B. Cook SME: Christopher B. Cook, Lance W. Vail Key Documents: NA

		C. How were the reservoir volumes determined?	Digital 1:24,000 scale digital raster graphic (DRG) quadrangles of Lake Anna were downloaded from the Department of Geography at Radford University. A mosaic of the raw images was used to generate a geo-referenced base map that was then digitized using the ESRI software package ArcMap 9.0. Once the base map was created, the software package also was used to compute the Table K-1 areas and volumes. See Cook (2005) for additional details. Author: Christopher B. Cook SME: Christopher B. Cook, Lance W. Vail Key Documents: PNNL-14944 Cook, C.B., L.W. Vail, and D.L. Ward (2005) "Report on the North Anna Early Site Permit Water Budget Model (LakeWBT) for Lake Anna", PNNL-14944, Pacific Northwest National Laboratory, 52 pp, ADAMS accession number ML050400293)
130	K-14	This section states an equivalence between an evaporation rate of 47,462 cubic meters per day and 8,707 gpm. Given that one U.S. gallon is 4.405E(-3) cubic meters and there are 1,440 minutes per day, why isn't 8,707 gpm equal to 55,230 cubic meters per day?	As stated in several places within the appendix, all calculations were performed using the rate of 8,707 gpm. The metric equivalent was provided in this paragraph to assist the reader. The native units used in the computation were gallons per minute. According to the CRC Handbook of Mathematical Sciences, 6th Edition, edited by William Beyers (1988), CRC Press, the conversion from gallons (U.S.)/minute to cubic meter/hour is 0.2271247. Multiplying this result by 24 (hours to days), the conversion from gpm to cubic meters/day is 5.4509928. We therefore correctly stated the equivalence between 8707 gpm and 47,461.79 cubic meters/day. Author: Lance W. Vail SME: Christopher B. Cook, Lance W. Vail Key Documents: NUREG-1811, Vol. 1
131	K-14	The Staff calculates that lake level would fall below 248 feet 11% of the time with Unit 3 operating while the comparable calculation by Dominion was 7.3%, a twenty percent variance from a mean value. A following discussion implies that the Staff calculation presumed PPE values while the Dominion calculation used numbers more representative of actual	The Staff limited its review to values specified in the PPE. If Dominion had embedded the proposed operating rules and design specifications of the cooling system in the PPE, then the Staff conclusions likely would have matched Dominion's more closely. The Staff reviewed Dominion's water budget calculation and concluded that the approach and conclusions were not unreasonable. However, the Staff did not assume specific operating policies discussed by Dominion in their application because the Staff did not

		conditions. Please comment.	assume that the assumptions were proffered as conditions for operation. If the Staff had used those operating assumptions as the basis for its independent assessment, the Staff would have had to define those assumptions as permit conditions, which was deemed unnecessary because it would not have appreciably changed the impact conclusion. Author: Lance W. Vail SME: Lance W. Vail Key Documents: NUREG-1835, Vol. 1
131	K-15	In Appendix K at page K-15, Dominion stated that the condenser heat load would be serviced by the dry tower if the air temperature was below 67 degrees Fahrenheit.	
		A. Does this mean that Dominion will operate the Unit 3 dry tower system whenever the temperature is below 67 degrees F?	Dominion's analysis did assume that below 67 degrees F the plant was able to discharge 100% of the reject heat load using only the dry portion of the wet and dry cooling system. This means no consumptive water loss below 67 degrees F in MWC mode. However, the Staff analysis only reflected the 8707 gpm limit for a rolling 365 day average and did not rely on the values not included in the PPE. The Staff did not propose a permit condition limiting all consumptive use of water below 67 degrees F. Author: Lance W. Vail SME: Lance W. Vail Key Documents: NA
		B. Has continuous operation of the Unit 3 dry cooling towers been considered?	The Staff did not evaluate operation of the dry tower when the lake is above the normal pool elevation. [Note that the dry towers operate continuously in MWC mode. The only time the dry towers go off is during EC mode.] Author: Lance W. Vail SME: Lance W. Vail, Christopher B. Cook Key Documents: NA
		C. Has any estimate been made of the energy efficiency penalty associated with continuous use of the Unit 3 dry towers?	The Staff has not made such an assessment. Author: Lance W. Vail SME: Christopher B. Cook, Lance W. Vail

			Key Documents: NA
		D. Has any estimate been made of the difference in water consumption when the Unit 3 dry towers are in continuous use?	The Staff has not made such an assessment. Author: Lance W. Vail SME: Christopher B. Cook, Lance W. Vail Key Documents: NA
132	General	At the winter ANS meeting, the following remarks were attributed to Eugene Grecheck, vice president of nuclear support services for Dominion Generation: "Dominion officials have stated that the company would not decide whether to apply for a COL until just before the scheduled submission date in November... He noted, however, that to be ready to build new nuclear capacity at North Anna, Dominion will have to order the large forgings necessary for fabrication of ESBWR hardware before it decides whether to submit. These forgings would be generic enough that they could, if necessary, be resold later to someone else who might need them, so such an order would not be a firm commitment to build." Nuclear News, Jan 2007, P 50. It would appear that Dominion has made the decision to adopt an ESBWR steam supply system if it elects to request a COL. Why should not approval of the ESP be withheld pending the submission of all of the missing reactor specific information in the current ESP?	An ESP applicant is not required to identify a specific reactor design in its ESP application, and Dominion chose not to do so. Dominion has requested that the Commission approve an ESP for a range of designs enveloped by its PPE. That is the action before the Commission. Late in the review process Dominion did indicate that it is using the ESBWR design as the basis for a COL application under development. However, this application has not been submitted, and Dominion's statement about the use of the ESBWR is non-binding. In addition, Dominion has not provided any indication regarding what design might be selected for Unit 4, if Dominion decides to proceed with the fourth unit. Therefore, the Staff does not believe it would be appropriate to withhold approval of the application, or require the applicant to modify the application, to specify the ESBWR for Unit 3. Author: John S. Cushing SME: Andrew Kugler Key Documents: NUREG-1811, Vol. 1

Additional Staff Response to Board Question 5A

Page Number	Not Resolved Topic/Issue	Appendix J Issue
1-4	The ER is not required to include, nor does it include, an assessment of the benefits of the proposed action (e.g., the need for power) or a discussion of energy alternatives.	Issue 1 - Need for Power
1-5	The Commission's regulations recognize that certain matters need not be resolved at the ESP stage (e.g., an assessment of the benefits, need for power) and, thus, may be deferred until an applicant decides to apply for a CP or COL.	Issue 1 - Need for Power
1-10	The Commission determined that evaluation of energy alternatives is not required for an ESP and will need to be considered at CP or COL stage.	Issue 2 - Energy Alternatives
5-13	Based on the information of chemical effluents provided to NRC the staff's review concludes that the issue of water quality impacts at the North Anna ESP site is not resolved	Issue 3 - Water Quality
5-58	The issue of chronic effects of electromagnetic fields is not resolved at the proposed North Anna site.	Not listed in Appendix J and it should have been listed as unresolved.
5-89	The environmental impacts of severe accidents for designs not evaluated in this EIS, including gas-cooled designs are not resolved at the proposed North Anna site because necessary design information is lacking. Consequently these impacts would need to be evaluated at the CP/COL stage. For this evaluation to bound a LWR reactor design selected at the CP/COL stage, the staff would need to verify that the environmental impacts of severe accidents at the North Anna ESP site remain bounded by the environmental impacts from the surrogate designs	Issue 5 - Design and Severe Accident
5-90	The staff did not explicitly evaluate the design basis or severe accident impacts for gas-cooled reactors because of the lack of necessary design information. Consequently, the impacts involving gas-cooled reactor designs are not resolved.	Issue 5 -Design and Severe Accident
5-92	Table 5-22 Characteristics of Operational Impacts at the North Anna ESP Site: Water Quality - Water effluents would be regulated by the VPDES permit, but their exact composition would depend on information not yet available. Not resolved.	Issue 3- Water Quality
5-94	Table 5-22 Characteristics of Operational Impacts at the North Anna ESP Site: Nonradiological health impacts - Chronic health impacts of electromagnetic fields. Not resolved	Not listed in Appendix J and it should have been listed

5-94	Table 5-22 Characteristics of Operational Impacts at the North Anna ESP Site: If gas-cooled reactor is selected at the CP/COL stage then the staff will evaluate the severe accident impacts for gas-cooled reactors. Severe accident mitigation alternatives are unresloved	Issue 4 - Alternatives to Mitigate Severe Accident and Issue 5 -Design and Severe Accident
6-1	Issues related to fuel cycle impacts and solid waste management are not resolved because data to validate impacts from gas-cooled designs were not available.	Issue 6 - Fuel Cycle Impacts and Solid Waste Management
6-15	Issues related to reactors based on other-than LWR designs are not resolved because of the lack of information to validate values and impacts.	Issue 6 - Fuel Cycle Impacts and Solid Waste Management, Issue 7 - Transportation, and Issue 8 - Decommissioning
6-19	By comparison with the fuel fabrication impacts for LWR technologies, the staff expects that the environmental impacts from producing gas-cooled reactor fuel likely would be SMALL, but these impacts will need to be assessed at the CP or COL stage when the staff will consider the environmental data that become available on a large-scale, fuel fabrication facility for gas-cooled reactors.	Issue 6 - Fuel Cycle Impacts and Solid Waste Management
6-20	The staff expects that the environmental impacts from solid low-level radioactive waste generated during decontamination and decommissioning for gas-cooled reactors would likely be SMALL, but these impacts will need to be assessed at the CP or COL stage.	Issue 8 - Decommissioning
6-20	The staff concludes that the environmental impacts from the uranium fuel cycle activities and solid waste management activities for gas-cooled reactors are not resolved. Should an applicant reference one of these designs, additional reviews would be needed at the CP or COL stage in the following areas: fuel fabrication, enrichment, and solid low-level waste operation during decontamination and decommissioning.	Issue 6 - Fuel Cycle Impacts and Solid Waste Management
6-26	Impacts associated with radiological doses to transport workers and the public are not resolved for other-than-LWR designs and would need to be assessed at the CP or COL stage when specific information is available regarding other-than-LWR fuel performance and shipping containers, if the applicant selects such a design	Issue 7 - Transportation
6-29	For other-than-LWR fuel performance ,these impacts are not considered to be resolved, and would need to be assessed at the CP or COL stage when specific information becomes available	Issue 6 - Fuel Cycle Impacts and Solid Waste Management

6-30	Spent fuel shipping cask designs for gas-cooled reactor designs need to evaluated at the CP or COL stage if applicant chooses such a design	Issue 6 - Fuel Cycle Impacts and Solid Waste Management
6-38	The fuel performance characteristics, shipping casks, and accident risks for other-than-LWR designs would need to be assessed at the CP or COL stage if the applicant references such designs.	Issue 7 - Transportation
6-39	Impacts of transporting radioactive waste from advanced reactor sites for designs other-than-LWR designs are not resolved	Issue 7 - Transportation
6-39 to 6-41	Impacts of transporting fuel and radioactive waste for gas-cooled designed reactors are not resolved.	Issue 7 - Transportation
6-41	If an applicant for a CP or COL referencing the North Anna ESP applies for a license to operate one or more additional units at the North Anna ESP site, there is a requirement to certify that sufficient funds will be available to assure radiological decommissioning at the end of power operations.	Issue 8 - Decommissioning
6-42	The impacts from decommissioning for any design reactor are not resolved and would need to be assessed at the CP or COL stage	Issue 8 - Decommissioning
7-3	Cumulative water quality impacts is unresolved	Issue 3 - Water Quality
7-8	Cumulative chronic effects from electromagnetic fields are not resolved	Not listed in Appendix J and it should have been listed
7-9	Cumulative fuel cycle impacts for other-than-LWR designs are not resolved	Issue 6 - Fuel Cycle Impacts and Solid Waste Management
7-9	Cumulative impacts of transportation for operating both units 1 and 2 and the proposed units 3 and 4 for other than light-water reactor designs are not resolved	Issue 7 - Transportation
7-10	Decommissioning impacts are not resolved for all sites (proposed North Anna ESP Site and alternatives)	Issue 8 - Decommissioning
8-11	Decommissioning impacts for all sites (proposed North Anna ESP Site and alternatives) were not resolved	Issue 8 - Decommissioning
8-11	In Chapter 5 the staff concluded that severe accident mitigation alternatives (SAMAs) are unresolved for North Anna ESP site, because the reactor design is not known at the ESP stage. SAMAs are also unresolved at all the alternative sites for the same reason.	Issue 4 - Alternative to Mitigate Severe Accident
9-2	For all sites (proposed North Anna ESP Site and alternatives) the fuel cycle impacts are unresolved	Issue 6 - Fuel Cycle Impacts and Solid Waste Management

9-2	Decommissioning impacts for all sites (proposed North Anna ESP Site and alternatives) are unresolved	Issue 8 - Decommissioning
9-5	Table 9-2 Comparison of the Operational Impacts at the Proposed ESP and Alternative Sites: Water Quality at North Anna ESP Site are unresolved but likely SMALL	Issue 3 - Water Quality
9-5	Table 9-2 Comparison of the Operational Impacts at the Proposed ESP and Alternative Sites: Health effects of electromagnetic fields is unresolved	Not listed in Appendix J and it should have been listed as unresolved.
9-7	The impacts are unresolved for the North Anna ESP site for water quality	Issue 3 - Water Quality
9-9	Title 10 of the Code of Federal Regulations (CFR) Part 52 does not require an ER or EIS for an ESP to include consideration of energy alternatives or the benefits of construction and operation of a reactor or reactors at the ESP site, Dominion did not address those matters in its ER, and this EIS does not consider such matters.	Issue 1 - Need for Power and Issue 2 - Energy Alternatives
10-4	Table 10-1 Comparison of Environmental Impacts of Constructing and Operating Two Units at North Anna ESP Site and the Alternatives: Footnote a: Impacts on water quality are unresolved for the North Anna ESP site	Issue 3 - Water Quality

Additional Staff Response to Board Question 24. Table of population growth.

	Henrico County		Louisa County		Orange County		City of Richmond		Spotsylvania County	
Year	Population	Ann. % Growth	Population	Ann. % Growth	Population	Ann. % Growth	Population	Ann. % Growth	Population	Ann. % Growth
1990	217,880	--	20,325	--	21,421	--	203,056	--	57,405	--
2000	262,300	1.9%	25,627	2.3%	25,881	1.9%	197,790	-0.3%	90,395	4.6%
2006	286,842	1.5%	30,242	2.8%	31,387	3.3%	192,032	-0.5%	117,737	4.5%
2010	301,000	1.4%	29,100	1.3%	30,000	1.5%	191,600	-0.3%	125,000	3.3%

Additional Staff Response to Board Question 44.

Dose from Liquid Exposure Pathway

Year	Whole body dose (mrem/yr)	Critical organ dose (mrem/yr)
2001	0.31	0.35
2003	0.14	0.24
2004	0.32	0.43
2005	0.38	0.40

Dose from Gaseous Exposure Pathway

Year	Total body (mrem/yr)	Critical organ (mrem/yr)	Skin (mrem/yr)
2001	0.046	0.15	0.11
2003	0.0036	0.066	0.015
2004	0.0029	0.093	0.0093
2005	0.0018	0.22	0.0036

Additional Staff Response to Board Question 77

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 1 - Site Characteristics	
Atmospheric Dispersion (χ/Q) (Accident)		• Atmospheric dispersion coefficients used to estimate dose consequences of accident airbome releases. • Refer to Section 2.7.5; Tables 2.7-11 & 2.7-12.
• EAB	3.34E-5 sec/m^3 [Same for 2nd unit/group]	
• LPZ	2.17E-6 sec/m^3 [Same for 2nd unit/group]	
Gaseous Effluents Dispersion, Deposition (Annual Average)		
• Atmospheric Dispersion (χ/Q)	χ/Q values in Table 2.7-14 [Same for 2nd unit/group]	• The atmospheric dispersion coefficients used to estimate dose consequences of normal airborne releases. • Refer to Section 2.7.6; Table 2.7-14.
• Ground Deposition (D/Q)	D/Q values in Table 2.7-14 [Same for 2nd unit/group]	• The ground deposition coefficients used to estimate dose consequences of normal airborne releases. • Refer to Section 2.7.6; Table 2.7-14.
Dose Consequences		
• Normal	10 CFR 20, 10 CFR 50 Appendix I, and 40 CFR 190 dose limits [Same for 2nd unit/group]	• Radiological dose consequences due to gaseous releases from normal operation of the plant. • Refer to Section 5.4.3; Tables 5.4-7, 5.4-10 & 5.4-11.
• Post-Accident	10 CFR 50.34(a)(1) and 10 CFR 100 dose limits [Same for 2nd unit/group]	• Radiological dose consequences due to gaseous releases from postulated plant accidents. • Refer to Sections 7.1.2 & 7.1.4.
• Minimum Distance to Site Boundary	2854.9 ft [Same for 2nd unit/group]	• Minimum lateral distance from the ESP Plant Parameter Envelope boundaries to the Exclusion Area Boundary • Refer to Figure 3.1-3.
Liquid Radwaste System		
• Normal Dose Consequences	10 CFR 50 Appendix I, 10 CFR 20, and 40 CFR 190 dose limits [Same for 2nd unit/group]	• The radiological dose consequences due to liquid effluent releases from normal operation of the plant. • Refer to Section 5.4.3; Tables 5.4-6, 5.4-10 & 5.4-11.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 1 - Site Characteristics (continued)	
Population Density		
• Population density at the time of initial site approval and within about 5 years thereafter	Population density meets the guidance of RS-002, Section 2.1.3 for RG 4.7, Regulatory Position C.4 [Both units/groups]	• At the time of initial site approval and within about 5 years hereafter, the population densities, including weighted transient population, averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the circular area at that distance), would not exceed 500 persons per square mile. • Refer to Section 2.5.1.5; Figure 2.5-13.
• Population density at the time of initial operation	Population density meets the guidance of RS-002, Section 2.1.3 [Both units/groups]	• The population densities, including weighted transient population, averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), would not exceed 500 persons per square mile at the time of initial operation. • Refer to Section 2.5.1.5; Figure 2.5-13.
• Population density over the lifetime of the new units until 2065	Population density meets the guidance of RS-002, Section 2.1.3 [Both units/groups]	• The population densities, including weighted transient population, averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), would not exceed 1000 persons per square mile over the lifetime of new units. • Refer to Section 2.5.1.5; Figure 2.5-13.
Population Center Distance	10 CFR 100.21(b) Meets requirement [Both units/groups]	• The distance from the ESP plant parameter envelope to the nearest boundary of a densely populated center containing more than about 25,000 residents is not less than one and one-third times the distance from the ESP plant parameter envelope to the outer boundary of the LPZ. • Refer to Section 2.5.1.2.
Exclusion Area Boundary (EAB)	10 CFR 100.21(a) Meets requirement [Both units/groups]	• The exclusion area boundary is the perimeter of a 5000-ft-radius circle from the center of the abandoned Unit 3 containment. • Refer to Sections 2.7.5, 2.7.6, 3.1.5, 4.1.1, 4.4.1.3, 5.1.1, 5.3.3.2.3, 5.3.4, 5.3.4.2, 5.4.1.3, 5.4.2.2, 5.5.1.3, 5.8.1.1, 5.8.1.2, 5.8.1.4, 5.8.3.1, 7.1.2, 7.1.4; Tables 2.7-10, 2.7-11, 2.7-14, 4.4-2, 7.1-1, 7.1-2, 7.1-4, 7.1-6, 7.1-8, 7.1-10, 7.1-11, 7.1-13, 7.1-15, 7.1-17, 7.1-19, 7.1-20, 7.1-22, 7.1-24, 7.1-26, & 7.1-28; Figures 1.1-1 & 2.1-2.
Low Population Zone (LPZ)	10 CFR 100.21(a) Meets requirement [Both units/groups]	• The LPZ is a 6-mile-radius circle centered at the Unit 1 containment building. • Refer to Sections 2.7.5, 2.7.6, 5.8.3.1, 7.1.2, 7.1.4; Tables 2.7-12, 7.1-1, 7.1-2, 7.1-4, 7.1-6, 7.1-8, 7.1-10, 7.1-11, 7.1-13, 7.1-15, 7.1-17, 7.1-19, 7.1-20, 7.1-22, 7.1-24, 7.1-26, & 7.1-28.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters	
Structure Height	≤234 ft [Same for 2nd unit/group]	• The height from finished grade to the top of the tallest power block structure, excluding cooling towers • Refer to Sections 2.7.5, 3.1.2.2, & 6.4.1.1.
Structure Foundation Embedment	≤140 ft [Same for 2nd unit/group]	• The depth from finished grade to the bottom of the basemat for the most deeply embedded power block structure • Refer to Section 4.2.1.2.
Normal Plant Heat Sink		
• Condenser/Heat Exchanger Duty	≤1.03 E10 Btu/hr [Additional 1.03 E10 Btu/hr for 2nd unit/group]	• Waste heat rejected from the main condenser and the auxiliary heat exchangers during normal plant operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3, 3.4.2.3, 5.3.2.1, & 5.3.2.1.2.
• Maximum Inlet Temperature Condenser/ Heat Exchanger	100°F [Same for 2nd unit/group]	• Maximum water temperature at condenser and heat exchanger inlet • Refer to Section 3.4.1.3.2.
• Unit 3 Closed-Cycle, Dry and Wet Tower		
Height	≤180 ft	• The height above finished grade of the cooling towers • Refer to Sections 3.1.2.2, 5.3.3.2.4, & 5.8.1.5.
Make-Up Flow Rate	15,384 gpm, maximum (MWC mode) 22,268 gpm, maximum (EC mode)	• The expected rate of removal of water from Lake Anna to replace water losses from the closed-cycle cooling water system • Refer to Sections 3.4.1.1, 3.4.2.1, 3.4.2.2, 5.2.1.1, 5.2.2.1.2, 5.3.1, 5.3.1.1, 5.3.1.1.2, 5.3.2.1.2, & 5.3.2.1.3; Table 3.3-1; Figure 3.3-1.
Evaporation Rate	8707 gpm, average (96% plant capacity factor with wet tower cooling) 11,532 gpm, maximum (MWC mode) 16,695 gpm, maximum (EC mode)	• Expected rates at which water is lost by evaporation resulting from operation of the plant cooling towers. • Refer to Section 5.2.1.1; Tables 3.3-1 & 5.2-1; Figure 3.3-1.
Drift Rate	8 gpm, maximum (MWC mode) 8 gpm, maximum (EC mode)	• Expected rates at which water is lost by drift resulting from operation of the plant cooling towers based on 0.001% of cooling water flow. • Refer to Table 3.3-1; Figure 3.3-1.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Normal Plant Heat Sink (continued)		
• Unit 3 Closed-Cycle, Dry and Wet Tower (continued)		
Blowdown Flow Rate	3844 gpm, maximum (MWC mode) 5565 gpm, maximum (EC mode)	• Flow rate of the blowdown stream from the closed-cycle cooling water system to the WHTF • Refer to Sections 3.4.1.1, 3.4.2.1, 3.4.2.2, 5.2.1.1, 5.2.2.1.2, 5.3.1, 5.3.1.1, 5.3.1.1.2, 5.3.2.1.2, & 5.3.2.1.3; Table 3.3-1; Figure 3.3-1.
Blowdown Temperature	100°F	• The maximum expected temperature of the cooling tower blowdown stream to the WHTF • Refer to Sections 3.4.1.1 & 5.3.2.2.2
Blowdown Constituents and Concentrations		• The maximum expected concentrations for anticipated constituents in the cooling water system blowdown to the WHTF • Refer to Section 5.5.1.1.
• Free Available Chlorine	<0.3 ppm	
• Copper	<1 ppm	
• Iron	<1 ppm	
• Sulfate	<300 ppm	
• Total Dissolved Solids	<3000 ppm	
Heat Rejection Rate	≤1.03 E10 Btu/hr	• The expected maximum heat rejection rate to the atmosphere during normal operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3.1, 3.4.2.3, 5.3.2.1 & 5.3.2.1.2.
Noise	<65 dbA at EAB	• Maximum expected sound level produced by operation of the cooling towers • Refer to Sections 3.1.5, 5.3.3.2.3, 5.3.4.2, & 5.8.1.2.
• Unit 4 Dry Cooling Towers		
Evaporation Rate	None or negligible (on the order of 1 gpm, average)	• The expected rate at which water is lost by evaporation from the cooling water system • Refer to Sections 1.1.4, 2.3.1.1, 3.1.5, 3.3.1, 3.4.1.1, 5.2.1, 5.2.2.1.2, 5.3.3.1, & 5.3.3.2.1; Table 3.3-2; Figure 3.3-2.
Height	≤150 ft	• The vertical height above finished grade of the cooling towers • Refer to Sections 3.1.2.2, 5.3.3.2.4, & 5.8.1.5.
Make-Up Flow Rate	None or negligible (on the order of 1 gpm, average)	• The expected rate of removal of water from Lake Anna to replace evaporative water losses from the cooling water system • Refer to Sections 2.3.1.1, 2.3.3.1, 3.3.1, 3.4.1.1, 3.4.2.1, 5.2.1, 5.2.1.1, 5.2.1.4, 5.3.1, 5.3.1.1, 5.3.1.2.2 & 5.3.3.1; Table 3.3-2; Figure 3.3-2.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Normal Plant Heat Sink (continued)		
• Unit 4 Dry Cooling Towers (continued)		
Noise	<60 dbA at EAB	• Maximum expected sound level produced by operation of the cooling towers • Refer to Sections 3.1.5, 5.3.3.2.3, 5.3.4.2 & 5.8.1.2.
Heat Rejection Rate	≤1.03 E10 Btu/hr	• Waste heat rejected to the atmosphere from the cooling water system, during normal plant operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3.1, & 3.4.2.3.
Ultimate Heat Sink Mechanical Draft Cooling Towers		
• Blowdown Constituents and Concentrations • Free Available Chlorine • Copper • Iron • Sulfate • Total Dissolved Solids	[Values same for both units/group] <0.3 ppm <1 ppm <1 ppm <300 ppm <3000 ppm	• The maximum expected concentrations for anticipated constituents in the UHS blowdown to the WHTF • Refer to Section 5.5.1.1.
• Blowdown Flow Rate	144 gpm expected, 850 gpm maximum [288 gpm expected, 1700 gpm maximum]	• The normal expected and maximum flow rate of the blowdown stream from the UHS system to the WHTF • Refer to Sections 3.4.1.2, 3.4.2.2, & 5.3.2.1; Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Evaporation Rate	411 gpm normal, 850 gpm shutdown [822 gpm normal, 1700 gpm shutdown]	• The expected (and maximum) rate at which water is lost by evaporation from the UHS system • Refer to Section 3.4.1.2; Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Height	≤60 ft [Same for 2nd unit/group]	• The vertical height above finished grade of mechanical draft cooling towers associated with the UHS system. • Refer to Section 3.1.5.
• Maximum Consumption of Raw Water	850 gpm, nominal [1700 gpm]	• The expected maximum short-term consumptive use of water from Lake Anna by the UHS system (evaporation and drift losses) • Refer to Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Monthly Average Consumption of Raw Water	411 gpm [822 gpm]	• The expected normal operating consumption of water from Lake Anna by the UHS system (evaporation and drift losses) • Refer to Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Release Point		
▪ Elevation	Ground Level	• The elevation above finished grade of the release point for routine operational and accident sequence releases
Source Term		
• Gaseous (Normal)	Values in Table 5.4-7 (maximum values) [Double values in Table 5.4-7]	• The annual activity, by isotope, contained in routine plant airborne effluent streams • Refer to Section 5.4.2.2; Table 5.4-7.
• Gaseous (Post-Accident)	Values in Section 7.1 tables (maximum values) [Same for 2nd unit/group]	• The activity, by isotope, contained in post-accident airborne effluents • Refer to Section 7.1.4; Tables 7.1-3, 7.1-5, 7.1-7, 7.1-9, 7.1-12, 7.1-14, 7.1-16, 7.1-18, 7.1-21, 7.1-23, 7.1-25, & 7.1-27.
▪ Tritium	3500 Ci/y [7000 Ci/yr] (maximum values)	• The annual activity of tritium contained in routine plant airborne effluent streams • Refer to Section 5.4.2.2; Table 5.4-7.
Liquid Radwaste System		
• Release Point Dilution Factor	1000 (minimum) [Same for 2nd unit/group]	• The ratio of liquid potentially radioactive effluent streams discharged at 100 gpm to liquid non-radioactive effluent streams from plant systems to the WHTF through the discharge canal used for NAPS Units 1 and 2 • Refer to Section 5.4.1.1; Table 5.4-1.
• Liquid	Values in Table 5.4-6 (maximum values) [Double the values in Table 5.4-6]	• The annual activity, by isotope, contained in routine plant liquid effluent streams • Refer to Section 5.4.2.1; Table 5.4-6.
• Tritium	≤850 Ci/yr [≤1700 Ci/yr]	• The annual activity of tritium contained in routine plant liquid effluent streams • Refer to Section 5.4.2.1; Table 5.4-6.
Solid Radwaste System		
• Activity	≤2700 Ci/yr [≤5400 Ci/yr]	• The annual activity contained in solid radioactive wastes generated during routine plant operations • Refer to Section 3.5.3.
• Volume	≤9041 cu ft/yr [≤18,646 cu ft/yr]	• The expected volume of solid radioactive wastes generated during routine plant operations • Refer to Section 3.5.3.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Plant Characteristics		
• Acreage	Approximately 128.5 acres [Both units/groups]	• Approximate area on the NAPS site that would be affected on a long-term basis as a result of additional permanent facilities • Refer to Section 4.1.1.4.
• Megawatts Thermal	≤4500 MWt [≤9000 MWt]	• The thermal power generated by one unit (may be the total of several modules) • Refer to Sections 1.1.3, 3.1.2.2, 3.1.5, 3.2.1, 3.8.1, 5.7.1, 7.1.3 & 7.1.4; Tables 3.8-1, 5.4-6, & 5.4-7.
• Plant Population – Operation	Approximately 720 permanent employees [Both units/groups]	• Anticipated number of new employees that would be required for operation of the new units • Refer to Sections 2.5.2, 5.8.2, & 5.8.2.2.
• Plant Population – Refueling / Major Maintenance	Approximately 700–1,000 temporary workers during planned outages [Same for 2nd unit/group]	• Anticipated number of additional workers onsite during planned outages of the new units • Refer to Sections 2.5.2 & 5.8.2.1.2.
• Plant Population – Construction	5,000 people maximum [simultaneous construction]	• Peak workforce of 5,000 for construction of both new units/groups • Refer to Sections 2.5.2, 4.4.2, 4.4.2.2.1, 4.5.4, 5.8.2.2, & 5.8.2.2.2.
• Maximum Fuel Enrichment for Light-Water-Cooled Reactors	5% [Same for 2nd unit/group]	• Concentration of U-235 in fuel • Refer to Sections 3.2.1 & 3.8; Table 3.8-1.
• Maximum Fuel Burn-up for Light-Water-Cooled Reactors	62,000 MWd/MTU [Same for 2nd unit/group]	• The value derived by calculating the reactor thermal power multiplied by the time of irradiation divided by fuel mass (expressed as megawatt-days per metric ton of irradiated fuel) • Refer to Sections 3.2.1 & 3.8; Table 3.8-1.
• Maximum Fuel Enrichment for Gas-Cooled Reactors	19.8% [Same for 2^{nd} unit/group]	• Concentration of U-235 in fuel • Refer to Sections 3.2.1 & 3.8; Table 3.8-2.
• Maximum Fuel Burn-up for Gas-Cooled Reactors	133,000 MWd/MTU [Same for 2nd unit/group]	• The value derived by calculating the reactor thermal power multiplied by the time of irradiation divided by fuel mass (expressed as megawatt-days per metric ton of irradiated fuel) • Refer to Sections 3.2.1 & 3.8; Table 3.8-2.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 1 - Site Characteristics	
Atmospheric Dispersion (χ/Q) (Accident)		• Atmospheric dispersion coefficients used to estimate dose consequences of accident airborne releases. • Refer to Section 2.7.5; Tables 2.7-11 & 2.7-12.
• EAB	3.34E-5 sec/m^3 [Same for 2nd unit/group]	
• LPZ	2.17E-6 sec/m^3 [Same for 2nd unit/group]	
Gaseous Effluents Dispersion, Deposition (Annual Average)		
• Atmospheric Dispersion (χ/Q)	χ/Q values in Table 2.7-14 [Same for 2nd unit/group]	• The atmospheric dispersion coefficients used to estimate dose consequences of normal airborne releases. • Refer to Section 2.7.6; Table 2.7-14.
• Ground Deposition (D/Q)	D/Q values in Table 2.7-14 [Same for 2nd unit/group]	• The ground deposition coefficients used to estimate dose consequences of normal airborne releases. • Refer to Section 2.7.6; Table 2.7-14.
Dose Consequences		
• Normal	10 CFR 20, 10 CFR 50 Appendix I, and 40 CFR 190 dose limits [Same for 2nd unit/group]	• Radiological dose consequences due to gaseous releases from normal operation of the plant. • Refer to Section 5.4.3; Tables 5.4-7, 5.4-10 & 5.4-11.
• Post-Accident	10 CFR 50.34(a)(1) and 10 CFR 100 dose limits [Same for 2nd unit/group]	• Radiological dose consequences due to gaseous releases from postulated plant accidents. • Refer to Sections 7.1.2 & 7.1.4.
• Minimum Distance to Site Boundary	2854.9 ft [Same for 2nd unit/group]	• Minimum lateral distance from the ESP Plant Parameter Envelope boundaries to the Exclusion Area Boundary • Refer to Figure 3.1-3.
Liquid Radwaste System		
• Normal Dose Consequences	10 CFR 50 Appendix I, 10 CFR 20, and 40 CFR 190 dose limits [Same for 2nd unit/group]	• The radiological dose consequences due to liquid effluent releases from normal operation of the plant. • Refer to Section 5.4.3; Tables 5.4-6, 5.4-10 & 5.4-11.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 1 - Site Characteristics (continued)	
Population Density		
• Population density at the time of initial site approval and within about 5 years thereafter	Population density meets the guidance of RS-002, Section 2.1.3 for RG 4.7, Regulatory Position C.4 [Both units/groups]	• At the time of initial site approval and within about 5 years hereafter, the population densities, including weighted transient population, averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the circular area at that distance), would not exceed 500 persons per square mile. • Refer to Section 2.5.1.5; Figure 2.5-13.
• Population density at the time of initial operation	Population density meets the guidance of RS-002, Section 2.1.3 [Both units/groups]	• The population densities, including weighted transient population, averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), would not exceed 500 persons per square mile at the time of initial operation. • Refer to Section 2.5.1.5; Figure 2.5-13.
• Population density over the lifetime of the new units until 2065	Population density meets the guidance of RS-002, Section 2.1.3 [Both units/groups]	• The population densities, including weighted transient population, averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), would not exceed 1000 persons per square mile over the lifetime of new units. • Refer to Section 2.5.1.5; Figure 2.5-13.
Population Center Distance	10 CFR 100.21(b) Meets requirement [Both units/groups]	• The distance from the ESP plant parameter envelope to the nearest boundary of a densely populated center containing more than about 25,000 residents is not less than one and one-third times the distance from the ESP plant parameter envelope to the outer boundary of the LPZ. • Refer to Section 2.5.1.2.
Exclusion Area Boundary (EAB)	10 CFR 100.21(a) Meets requirement [Both units/groups]	• The exclusion area boundary is the perimeter of a 5000-ft-radius circle from the center of the abandoned Unit 3 containment. • Refer to Sections 2.7.5, 2.7.6, 3.1.5, 4.1.1, 4.4.1.3, 5.1.1, 5.3.3.2.3, 5.3.4, 5.3.4.2, 5.4.1.3, 5.4.2.2, 5.5.1.3, 5.8.1.1, 5.8.1.2, 5.8.1.4, 5.8.3.1, 7.1.2, 7.1.4; Tables 2.7-10, 2.7-11, 2.7-14, 4.4-2, 7.1-1, 7.1-2, 7.1-4, 7.1-6, 7.1-8, 7.1-10, 7.1-11, 7.1-13, 7.1-15, 7.1-17, 7.1-19, 7.1-20, 7.1-22, 7.1-24, 7.1-26, & 7.1-28; Figures 1.1-1 & 2.1-2.
Low Population Zone (LPZ)	10 CFR 100.21(a) Meets requirement [Both units/groups]	• The LPZ is a 6-mile-radius circle centered at the Unit 1 containment building. • Refer to Sections 2.7.5, 2.7.6, 5.8.3.1, 7.1.2, 7.1.4; Tables 2.7-12, 7.1-1, 7.1-2, 7.1-4, 7.1-6, 7.1-8, 7.1-10, 7.1-11, 7.1-13, 7.1-15, 7.1-17, 7.1-19, 7.1-20, 7.1-22, 7.1-24, 7.1-26, & 7.1-28.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters	
Structure Height	≤234 ft [Same for 2nd unit/group]	• The height from finished grade to the top of the tallest power block structure, excluding cooling towers • Refer to Sections 2.7.5, 3.1.2.2, & 6.4.1.1.
Structure Foundation Embedment	≤140 ft [Same for 2nd unit/group]	• The depth from finished grade to the bottom of the basemat for the most deeply embedded power block structure • Refer to Section 4.2.1.2.
Normal Plant Heat Sink		
• Condenser/Heat Exchanger Duty	≤1.03 E10 Btu/hr [Additional 1.03 E10 Btu/hr for 2nd unit/group]	• Waste heat rejected from the main condenser and the auxiliary heat exchangers during normal plant operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3, 3.4.2.3, 5.3.2.1, & 5.3.2.1.2.
• Maximum Inlet Temperature Condenser/ Heat Exchanger	100°F [Same for 2nd unit/group]	• Maximum water temperature at condenser and heat exchanger inlet • Refer to Section 3.4.1.3.2.
• Unit 3 Closed-Cycle, Dry and Wet Tower		
Height	≤180 ft	• The height above finished grade of the cooling towers • Refer to Sections 3.1.2.2, 5.3.3.2.4, & 5.8.1.5.
Make-Up Flow Rate	15,384 gpm, maximum (MWC mode) 22,268 gpm, maximum (EC mode)	• The expected rate of removal of water from Lake Anna to replace water losses from the closed-cycle cooling water system • Refer to Sections 3.4.1.1, 3.4.2.1, 3.4.2.2, 5.2.1.1, 5.2.2.1.2, 5.3.1, 5.3.1.1, 5.3.1.1.2, 5.3.2.1.2, & 5.3.2.1.3; Table 3.3-1; Figure 3.3-1.
Evaporation Rate	8707 gpm, average (96% plant capacity factor with wet tower cooling) 11,532 gpm, maximum (MWC mode) 16,695 gpm, maximum (EC mode)	• Expected rates at which water is lost by evaporation resulting from operation of the plant cooling towers. • Refer to Section 5.2.1.1; Tables 3.3-1 & 5.2-1; Figure 3.3-1.
Drift Rate	8 gpm, maximum (MWC mode) 8 gpm, maximum (EC mode)	• Expected rates at which water is lost by drift resulting from operation of the plant cooling towers based on 0.001% of cooling water flow. • Refer to Table 3.3-1; Figure 3.3-1.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Normal Plant Heat Sink (continued)		
• Unit 3 Closed-Cycle, Dry and Wet Tower (continued)		
Blowdown Flow Rate	3844 gpm, maximum (MWC mode) 5565 gpm, maximum (EC mode)	• Flow rate of the blowdown stream from the closed-cycle cooling water system to the WHTF • Refer to Sections 3.4.1.1, 3.4.2.1, 3.4.2.2, 5.2.1.1, 5.2.2.1.2, 5.3.1, 5.3.1.1, 5.3.1.1.2, 5.3.2.1.2, & 5.3.2.1.3; Table 3.3-1; Figure 3.3-1.
Blowdown Temperature	100°F	• The maximum expected temperature of the cooling tower blowdown stream to the WHTF • Refer to Sections 3.4.1.1 & 5.3.2.2.2
Blowdown Constituents and Concentrations		• The maximum expected concentrations for anticipated constituents in the cooling water system blowdown to the WHTF • Refer to Section 5.5.1.1.
• Free Available Chlorine	<0.3 ppm	
• Copper	<1 ppm	
• Iron	<1 ppm	
• Sulfate	<300 ppm	
• Total Dissolved Solids	<3000 ppm	
Heat Rejection Rate	≤1.03 E10 Btu/hr	• The expected maximum heat rejection rate to the atmosphere during normal operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3.1, 3.4.2.3, 5.3.2.1 & 5.3.2.1.2.
Noise	<65 dbA at EAB	• Maximum expected sound level produced by operation of the cooling towers • Refer to Sections 3.1.5, 5.3.3.2.3, 5.3.4.2, & 5.8.1.2.
• Unit 4 Dry Cooling Towers		
Evaporation Rate	None or negligible (on the order of 1 gpm, average)	• The expected rate at which water is lost by evaporation from the cooling water system • Refer to Sections 1.1.4, 2.3.1.1, 3.1.5, 3.3.1, 3.4.1.1, 5.2.1, 5.2.2.1.2, 5.3.3.1, & 5.3.3.2.1; Table 3.3-2; Figure 3.3-2.
Height	≤150 ft	• The vertical height above finished grade of the cooling towers • Refer to Sections 3.1.2.2, 5.3.3.2.4, & 5.8.1.5.
Make-Up Flow Rate	None or negligible (on the order of 1 gpm, average)	• The expected rate of removal of water from Lake Anna to replace evaporative water losses from the cooling water system • Refer to Sections 2.3.1.1, 2.3.3.1, 3.3.1, 3.4.1.1, 3.4.2.1, 5.2.1, 5.2.1.1, 5.2.1.4, 5.3.1, 5.3.1.1, 5.3.1.2.2 & 5.3.3.1; Table 3.3-2; Figure 3.3-2.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Normal Plant Heat Sink (continued)		
• Unit 4 Dry Cooling Towers (continued)		
Noise	<60 dbA at EAB	• Maximum expected sound level produced by operation of the cooling towers • Refer to Sections 3.1.5, 5.3.3.2.3, 5.3.4.2 & 5.8.1.2.
Heat Rejection Rate	≤1.03 E10 Btu/hr	• Waste heat rejected to the atmosphere from the cooling water system, during normal plant operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3.1, & 3.4.2.3.
Ultimate Heat Sink Mechanical Draft Cooling Towers		
• Blowdown Constituents and Concentrations	[Values same for both units/group]	• The maximum expected concentrations for anticipated constituents in the UHS blowdown to the WHTF • Refer to Section 5.5.1.1.
• Free Available Chlorine	<0.3 ppm	
• Copper	<1 ppm	
• Iron	<1 ppm	
• Sulfate	<300 ppm	
• Total Dissolved Solids	<3000 ppm	
• Blowdown Flow Rate	144 gpm expected, 850 gpm maximum [288 gpm expected, 1700 gpm maximum]	• The normal expected and maximum flow rate of the blowdown stream from the UHS system to the WHTF • Refer to Sections 3.4.1.2, 3.4.2.2, & 5.3.2.1; Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Evaporation Rate	411 gpm normal, 850 gpm shutdown [822 gpm normal, 1700 gpm shutdown]	• The expected (and maximum) rate at which water is lost by evaporation from the UHS system • Refer to Section 3.4.1.2; Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Height	≤60 ft [Same for 2nd unit/group]	• The vertical height above finished grade of mechanical draft cooling towers associated with the UHS system. • Refer to Section 3.1.5.
• Maximum Consumption of Raw Water	850 gpm, nominal [1700 gpm]	• The expected maximum short-term consumptive use of water from Lake Anna by the UHS system (evaporation and drift losses) • Refer to Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Monthly Average Consumption of Raw Water	411 gpm [822 gpm]	• The expected normal operating consumption of water from Lake Anna by the UHS system (evaporation and drift losses) • Refer to Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Release Point		
▪ Elevation	Ground Level	• The elevation above finished grade of the release point for routine operational and accident sequence releases
Source Term		
• Gaseous (Normal)	Values in Table 5.4-7 (maximum values) [Double values in Table 5.4-7]	• The annual activity, by isotope, contained in routine plant airborne effluent streams • Refer to Section 5.4.2.2; Table 5.4-7.
• Gaseous (Post-Accident)	Values in Section 7.1 tables (maximum values) [Same for 2nd unit/group]	• The activity, by isotope, contained in post-accident airborne effluents • Refer to Section 7.1.4; Tables 7.1-3, 7.1-5, 7.1-7, 7.1-9, 7.1-12, 7.1-14, 7.1-16, 7.1-18, 7.1-21, 7.1-23, 7.1-25, & 7.1-27.
▪ Tritium	3500 Ci/y [7000 Ci/yr] (maximum values)	• The annual activity of tritium contained in routine plant airborne effluent streams • Refer to Section 5.4.2.2; Table 5.4-7.
Liquid Radwaste System		
• Release Point Dilution Factor	1000 (minimum) [Same for 2nd unit/group]	• The ratio of liquid potentially radioactive effluent streams discharged at 100 gpm to liquid non-radioactive effluent streams from plant systems to the WHTF through the discharge canal used for NAPS Units 1 and 2 • Refer to Section 5.4.1.1; Table 5.4-1.
• Liquid	Values in Table 5.4-6 (maximum values) [Double the values in Table 5.4-6]	• The annual activity, by isotope, contained in routine plant liquid effluent streams • Refer to Section 5.4.2.1; Table 5.4-6.
• Tritium	≤850 Ci/yr [≤1700 Ci/yr]	• The annual activity of tritium contained in routine plant liquid effluent streams • Refer to Section 5.4.2.1; Table 5.4-6.
Solid Radwaste System		
• Activity	≤2700 Ci/yr [≤5400 Ci/yr]	• The annual activity contained in solid radioactive wastes generated during routine plant operations • Refer to Section 3.5.3.
• Volume	≤9041 cu ft/yr [≤18,646 cu ft/yr]	• The expected volume of solid radioactive wastes generated during routine plant operations • Refer to Section 3.5.3.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Plant Characteristics		
• Acreage	Approximately 128.5 acres [Both units/groups]	• Approximate area on the NAPS site that would be affected on a long-term basis as a result of additional permanent facilities • Refer to Section 4.1.1.4.
• Megawatts Thermal	≤4500 MWt [≤9000 MWt]	• The thermal power generated by one unit (may be the total of several modules) • Refer to Sections 1.1.3, 3.1.2.2, 3.1.5, 3.2.1, 3.8.1, 5.7.1, 7.1.3 & 7.1.4; Tables 3.8-1, 5.4-6, & 5.4-7.
• Plant Population – Operation	Approximately 720 permanent employees [Both units/groups]	• Anticipated number of new employees that would be required for operation of the new units • Refer to Sections 2.5.2, 5.8.2, & 5.8.2.2.
• Plant Population – Refueling / Major Maintenance	Approximately 700–1,000 temporary workers during planned outages [Same for 2nd unit/group]	• Anticipated number of additional workers onsite during planned outages of the new units • Refer to Sections 2.5.2 & 5.8.2.1.2.
• Plant Population – Construction	5,000 people maximum [simultaneous construction]	• Peak workforce of 5,000 for construction of both new units/groups • Refer to Sections 2.5.2, 4.4.2, 4.4.2.2.1, 4.5.4, 5.8.2.2, & 5.8.2.2.2.
• Maximum Fuel Enrichment for Light-Water-Cooled Reactors	5% [Same for 2nd unit/group]	• Concentration of U-235 in fuel • Refer to Sections 3.2.1 & 3.8; Table 3.8-1.
• Maximum Fuel Burn-up for Light-Water-Cooled Reactors	62,000 MWd/MTU [Same for 2nd unit/group]	• The value derived by calculating the reactor thermal power multiplied by the time of irradiation divided by fuel mass (expressed as megawatt-days per metric ton of irradiated fuel) • Refer to Sections 3.2.1 & 3.8; Table 3.8-1.
• Maximum Fuel Enrichment for Gas-Cooled Reactors	19.8% [Same for 2nd unit/group]	• Concentration of U-235 in fuel • Refer to Sections 3.2.1 & 3.8; Table 3.8-2.
• Maximum Fuel Burn-up for Gas-Cooled Reactors	133,000 MWd/MTU [Same for 2nd unit/group]	• The value derived by calculating the reactor thermal power multiplied by the time of irradiation divided by fuel mass (expressed as megawatt-days per metric ton of irradiated fuel) • Refer to Sections 3.2.1 & 3.8; Table 3.8-2.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 1 - Site Characteristics	
Atmospheric Dispersion (χ/Q) (Accident)		• Atmospheric dispersion coefficients used to estimate dose consequences of accident airborne releases. • Refer to Section 2.7.5; Tables 2.7-11 & 2.7-12.
• EAB	3.34E-5 sec/m^3 [Same for 2nd unit/group]	
• LPZ	2.17E-6 sec/m^3 [Same for 2nd unit/group]	
Gaseous Effluents Dispersion, Deposition (Annual Average)		
• Atmospheric Dispersion (χ/Q)	χ/Q values in Table 2.7-14 [Same for 2nd unit/group]	• The atmospheric dispersion coefficients used to estimate dose consequences of normal airborne releases. • Refer to Section 2.7.6; Table 2.7-14.
• Ground Deposition (D/Q)	D/Q values in Table 2.7-14 [Same for 2nd unit/group]	• The ground deposition coefficients used to estimate dose consequences of normal airborne releases. • Refer to Section 2.7.6; Table 2.7-14.
Dose Consequences		
• Normal	10 CFR 20, 10 CFR 50 Appendix I, and 40 CFR 190 dose limits [Same for 2nd unit/group]	• Radiological dose consequences due to gaseous releases from normal operation of the plant. • Refer to Section 5.4.3; Tables 5.4-7, 5.4-10 & 5.4-11.
• Post-Accident	10 CFR 50.34(a)(1) and 10 CFR 100 dose limits [Same for 2nd unit/group]	• Radiological dose consequences due to gaseous releases from postulated plant accidents. • Refer to Sections 7.1.2 & 7.1.4.
• Minimum Distance to Site Boundary	2854.9 ft [Same for 2nd unit/group]	• Minimum lateral distance from the ESP Plant Parameter Envelope boundaries to the Exclusion Area Boundary • Refer to Figure 3.1-3.
Liquid Radwaste System		
• Normal Dose Consequences	10 CFR 50 Appendix I, 10 CFR 20, and 40 CFR 190 dose limits [Same for 2nd unit/group]	• The radiological dose consequences due to liquid effluent releases from normal operation of the plant. • Refer to Section 5.4.3; Tables 5.4-6, 5.4-10 & 5.4-11.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 1 - Site Characteristics (continued)	
Population Density		
• Population density at the time of initial site approval and within about 5 years thereafter	Population density meets the guidance of RS-002, Section 2.1.3 for RG 4.7, Regulatory Position C.4 [Both units/groups]	• At the time of initial site approval and within about 5 years hereafter, the population densities, including weighted transient population, averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the circular area at that distance), would not exceed 500 persons per square mile. • Refer to Section 2.5.1.5; Figure 2.5-13.
• Population density at the time of initial operation	Population density meets the guidance of RS-002, Section 2.1.3 [Both units/groups]	• The population densities, including weighted transient population, averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), would not exceed 500 persons per square mile at the time of initial operation. • Refer to Section 2.5.1.5; Figure 2.5-13.
• Population density over the lifetime of the new units until 2065	Population density meets the guidance of RS-002, Section 2.1.3 [Both units/groups]	• The population densities, including weighted transient population, averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), would not exceed 1000 persons per square mile over the lifetime of new units. • Refer to Section 2.5.1.5; Figure 2.5-13.
Population Center Distance	10 CFR 100.21(b) Meets requirement [Both units/groups]	• The distance from the ESP plant parameter envelope to the nearest boundary of a densely populated center containing more than about 25,000 residents is not less than one and one-third times the distance from the ESP plant parameter envelope to the outer boundary of the LPZ. • Refer to Section 2.5.1.2.
Exclusion Area Boundary (EAB)	10 CFR 100.21(a) Meets requirement [Both units/groups]	• The exclusion area boundary is the perimeter of a 5000-ft-radius circle from the center of the abandoned Unit 3 containment. • Refer to Sections 2.7.5, 2.7.6, 3.1.5, 4.1.1, 4.4.1.3, 5.1.1, 5.3.3.2.3, 5.3.4, 5.3.4.2, 5.4.1.3, 5.4.2.2, 5.5.1.3, 5.8.1.1, 5.8.1.2, 5.8.1.4, 5.8.3.1, 7.1.2, 7.1.4; Tables 2.7-10, 2.7-11, 2.7-14, 4.4-2, 7.1-1, 7.1-2, 7.1-4, 7.1-6, 7.1-8, 7.1-10, 7.1-11, 7.1-13, 7.1-15, 7.1-17, 7.1-19, 7.1-20, 7.1-22, 7.1-24, 7.1-26, & 7.1-28; Figures 1.1-1 & 2.1-2.
Low Population Zone (LPZ)	10 CFR 100.21(a) Meets requirement [Both units/groups]	• The LPZ is a 6-mile-radius circle centered at the Unit 1 containment building. • Refer to Sections 2.7.5, 2.7.6, 5.8.3.1, 7.1.2, 7.1.4; Tables 2.7-12, 7.1-1, 7.1-2, 7.1-4, 7.1-6, 7.1-8, 7.1-10, 7.1-11, 7.1-13, 7.1-15, 7.1-17, 7.1-19, 7.1-20, 7.1-22, 7.1-24, 7.1-26, & 7.1-28.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters	
Structure Height	≤234 ft [Same for 2nd unit/group]	• The height from finished grade to the top of the tallest power block structure, excluding cooling towers • Refer to Sections 2.7.5, 3.1.2.2, & 6.4.1.1.
Structure Foundation Embedment	≤140 ft [Same for 2nd unit/group]	• The depth from finished grade to the bottom of the basemat for the most deeply embedded power block structure • Refer to Section 4.2.1.2.
Normal Plant Heat Sink		
• Condenser/Heat Exchanger Duty	≤1.03 E10 Btu/hr [Additional 1.03 E10 Btu/hr for 2nd unit/group]	• Waste heat rejected from the main condenser and the auxiliary heat exchangers during normal plant operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3, 3.4.2.3, 5.3.2.1, & 5.3.2.1.2.
• Maximum Inlet Temperature Condenser/ Heat Exchanger	100°F [Same for 2nd unit/group]	• Maximum water temperature at condenser and heat exchanger inlet • Refer to Section 3.4.1.3.2.
• Unit 3 Closed-Cycle, Dry and Wet Tower		
Height	≤180 ft	• The height above finished grade of the cooling towers • Refer to Sections 3.1.2.2, 5.3.3.2.4, & 5.8.1.5.
Make-Up Flow Rate	15,384 gpm, maximum (MWC mode) 22,268 gpm, maximum (EC mode)	• The expected rate of removal of water from Lake Anna to replace water losses from the closed-cycle cooling water system • Refer to Sections 3.4.1.1, 3.4.2.1, 3.4.2.2, 5.2.1.1, 5.2.2.1.2, 5.3.1, 5.3.1.1, 5.3.1.1.2, 5.3.2.1.2, & 5.3.2.1.3; Table 3.3-1; Figure 3.3-1.
Evaporation Rate	8707 gpm, average (96% plant capacity factor with wet tower cooling) 11,532 gpm, maximum (MWC mode) 16,695 gpm, maximum (EC mode)	• Expected rates at which water is lost by evaporation resulting from operation of the plant cooling towers. • Refer to Section 5.2.1.1; Tables 3.3-1 & 5.2-1; Figure 3.3-1.
Drift Rate	8 gpm, maximum (MWC mode) 8 gpm, maximum (EC mode)	• Expected rates at which water is lost by drift resulting from operation of the plant cooling towers based on 0.001% of cooling water flow. • Refer to Table 3.3-1; Figure 3.3-1.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Normal Plant Heat Sink (continued)		
• Unit 3 Closed-Cycle, Dry and Wet Tower (continued)		
Blowdown Flow Rate	3844 gpm, maximum (MWC mode) 5565 gpm, maximum (EC mode)	• Flow rate of the blowdown stream from the closed-cycle cooling water system to the WHTF • Refer to Sections 3.4.1.1, 3.4.2.1, 3.4.2.2, 5.2.1.1, 5.2.2.1.2, 5.3.1, 5.3.1.1, 5.3.1.1.2, 5.3.2.1.2, & 5.3.2.1.3; Table 3.3-1; Figure 3.3-1.
Blowdown Temperature	100°F	• The maximum expected temperature of the cooling tower blowdown stream to the WHTF • Refer to Sections 3.4.1.1 & 5.3.2.2.2
Blowdown Constituents and Concentrations		• The maximum expected concentrations for anticipated constituents in the cooling water system blowdown to the WHTF • Refer to Section 5.5.1.1.
• Free Available Chlorine	<0.3 ppm	
• Copper	<1 ppm	
• Iron	<1 ppm	
• Sulfate	<300 ppm	
• Total Dissolved Solids	<3000 ppm	
Heat Rejection Rate	≤1.03 E10 Btu/hr	• The expected maximum heat rejection rate to the atmosphere during normal operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3.1, 3.4.2.3, 5.3.2.1 & 5.3.2.1.2.
Noise	<65 dbA at EAB	• Maximum expected sound level produced by operation of the cooling towers • Refer to Sections 3.1.5, 5.3.3.2.3, 5.3.4.2, & 5.8.1.2.
• Unit 4 Dry Cooling Towers		
Evaporation Rate	None or negligible (on the order of 1 gpm, average)	• The expected rate at which water is lost by evaporation from the cooling water system • Refer to Sections 1.1.4, 2.3.1.1, 3.1.5, 3.3.1, 3.4.1.1, 5.2.1, 5.2.2.1.2, 5.3.3.1, & 5.3.3.2.1; Table 3.3-2; Figure 3.3-2.
Height	≤150 ft	• The vertical height above finished grade of the cooling towers • Refer to Sections 3.1.2.2, 5.3.3.2.4, & 5.8.1.5.
Make-Up Flow Rate	None or negligible (on the order of 1 gpm, average)	• The expected rate of removal of water from Lake Anna to replace evaporative water losses from the cooling water system • Refer to Sections 2.3.1.1, 2.3.3.1, 3.3.1, 3.4.1.1, 3.4.2.1, 5.2.1, 5.2.1.1, 5.2.1.4, 5.3.1, 5.3.1.1, 5.3.1.2.2 & 5.3.3.1; Table 3.3-2; Figure 3.3-2.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Normal Plant Heat Sink (continued)		
• Unit 4 Dry Cooling Towers (continued)		
Noise	<60 dbA at EAB	• Maximum expected sound level produced by operation of the cooling towers • Refer to Sections 3.1.5, 5.3.3.2.3, 5.3.4.2 & 5.8.1.2.
Heat Rejection Rate	≤1.03 E10 Btu/hr	• Waste heat rejected to the atmosphere from the cooling water system, during normal plant operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3.1, & 3.4.2.3.
Ultimate Heat Sink Mechanical Draft Cooling Towers		
• Blowdown Constituents and Concentrations • Free Available Chlorine • Copper • Iron • Sulfate • Total Dissolved Solids	[Values same for both units/group] <0.3 ppm <1 ppm <1 ppm <300 ppm <3000 ppm	• The maximum expected concentrations for anticipated constituents in the UHS blowdown to the WHTF • Refer to Section 5.5.1.1.
• Blowdown Flow Rate	144 gpm expected, 850 gpm maximum [288 gpm expected, 1700 gpm maximum]	• The normal expected and maximum flow rate of the blowdown stream from the UHS system to the WHTF • Refer to Sections 3.4.1.2, 3.4.2.2, & 5.3.2.1; Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Evaporation Rate	411 gpm normal, 850 gpm shutdown [822 gpm normal, 1700 gpm shutdown]	• The expected (and maximum) rate at which water is lost by evaporation from the UHS system • Refer to Section 3.4.1.2; Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Height	≤60 ft [Same for 2nd unit/group]	• The vertical height above finished grade of mechanical draft cooling towers associated with the UHS system. • Refer to Section 3.1.5.
• Maximum Consumption of Raw Water	850 gpm, nominal [1700 gpm]	• The expected maximum short-term consumptive use of water from Lake Anna by the UHS system (evaporation and drift losses) • Refer to Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Monthly Average Consumption of Raw Water	411 gpm [822 gpm]	• The expected normal operating consumption of water from Lake Anna by the UHS system (evaporation and drift losses) • Refer to Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Release Point		
▪ Elevation	Ground Level	• The elevation above finished grade of the release point for routine operational and accident sequence releases
Source Term		
• Gaseous (Normal)	Values in Table 5.4-7 (maximum values) [Double values in Table 5.4-7]	• The annual activity, by isotope, contained in routine plant airborne effluent streams • Refer to Section 5.4.2.2; Table 5.4-7.
• Gaseous (Post-Accident)	Values in Section 7.1 tables (maximum values) [Same for 2nd unit/group]	• The activity, by isotope, contained in post-accident airborne effluents • Refer to Section 7.1.4; Tables 7.1-3, 7.1-5, 7.1-7, 7.1-9, 7.1-12, 7.1-14, 7.1-16, 7.1-18, 7.1-21, 7.1-23, 7.1-25, & 7.1-27.
▪ Tritium	3500 Ci/y [7000 Ci/yr] (maximum values)	• The annual activity of tritium contained in routine plant airborne effluent streams • Refer to Section 5.4.2.2; Table 5.4-7.
Liquid Radwaste System		
• Release Point Dilution Factor	1000 (minimum) [Same for 2nd unit/group]	• The ratio of liquid potentially radioactive effluent streams discharged at 100 gpm to liquid non-radioactive effluent streams from plant systems to the WHTF through the discharge canal used for NAPS Units 1 and 2 • Refer to Section 5.4.1.1; Table 5.4-1.
• Liquid	Values in Table 5.4-6 (maximum values) [Double the values in Table 5.4-6]	• The annual activity, by isotope, contained in routine plant liquid effluent streams • Refer to Section 5.4.2.1; Table 5.4-6.
• Tritium	≤850 Ci/yr [≤1700 Ci/yr]	• The annual activity of tritium contained in routine plant liquid effluent streams • Refer to Section 5.4.2.1; Table 5.4-6.
Solid Radwaste System		
• Activity	≤2700 Ci/yr [≤5400 Ci/yr]	• The annual activity contained in solid radioactive wastes generated during routine plant operations • Refer to Section 3.5.3.
• Volume	≤9041 cu ft/yr [≤18,646 cu ft/yr]	• The expected volume of solid radioactive wastes generated during routine plant operations • Refer to Section 3.5.3.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Plant Characteristics		
• Acreage	Approximately 128.5 acres [Both units/groups]	• Approximate area on the NAPS site that would be affected on a long-term basis as a result of additional permanent facilities • Refer to Section 4.1.1.4.
• Megawatts Thermal	≤4500 MWt [≤9000 MWt]	• The thermal power generated by one unit (may be the total of several modules) • Refer to Sections 1.1.3, 3.1.2.2, 3.1.5, 3.2.1, 3.8.1, 5.7.1, 7.1.3 & 7.1.4; Tables 3.8-1, 5.4-6, & 5.4-7.
• Plant Population – Operation	Approximately 720 permanent employees [Both units/groups]	• Anticipated number of new employees that would be required for operation of the new units • Refer to Sections 2.5.2, 5.8.2, & 5.8.2.2.
• Plant Population – Refueling / Major Maintenance	Approximately 700–1,000 temporary workers during planned outages [Same for 2nd unit/group]	• Anticipated number of additional workers onsite during planned outages of the new units • Refer to Sections 2.5.2 & 5.8.2.1.2.
• Plant Population – Construction	5,000 people maximum [simultaneous construction]	• Peak workforce of 5,000 for construction of both new units/groups • Refer to Sections 2.5.2, 4.4.2, 4.4.2.2.1, 4.5.4, 5.8.2.2, & 5.8.2.2.2.
• Maximum Fuel Enrichment for Light-Water-Cooled Reactors	5% [Same for 2nd unit/group]	• Concentration of U-235 in fuel • Refer to Sections 3.2.1 & 3.8; Table 3.8-1.
• Maximum Fuel Burn-up for Light-Water-Cooled Reactors	62,000 MWd/MTU [Same for 2nd unit/group]	• The value derived by calculating the reactor thermal power multiplied by the time of irradiation divided by fuel mass (expressed as megawatt-days per metric ton of irradiated fuel) • Refer to Sections 3.2.1 & 3.8; Table 3.8-1.
• Maximum Fuel Enrichment for Gas-Cooled Reactors	19.8% [Same for 2nd unit/group]	• Concentration of U-235 in fuel • Refer to Sections 3.2.1 & 3.8; Table 3.8-2.
• Maximum Fuel Burn-up for Gas-Cooled Reactors	133,000 MWd/MTU [Same for 2nd unit/group]	• The value derived by calculating the reactor thermal power multiplied by the time of irradiation divided by fuel mass (expressed as megawatt-days per metric ton of irradiated fuel) • Refer to Sections 3.2.1 & 3.8; Table 3.8-2.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 1 - Site Characteristics	
Atmospheric Dispersion (χ/Q) (Accident)		• Atmospheric dispersion coefficients used to estimate dose consequences of accident airborne releases. • Refer to Section 2.7.5; Tables 2.7-11 & 2.7-12.
• EAB	3.34E-5 sec/m^3 [Same for 2nd unit/group]	
• LPZ	2.17E-6 sec/m^3 [Same for 2nd unit/group]	
Gaseous Effluents Dispersion, Deposition (Annual Average)		
• Atmospheric Dispersion (χ/Q)	χ/Q values in Table 2.7-14 [Same for 2nd unit/group]	• The atmospheric dispersion coefficients used to estimate dose consequences of normal airborne releases. • Refer to Section 2.7.6; Table 2.7-14.
• Ground Deposition (D/Q)	D/Q values in Table 2.7-14 [Same for 2nd unit/group]	• The ground deposition coefficients used to estimate dose consequences of normal airborne releases. • Refer to Section 2.7.6; Table 2.7-14.
Dose Consequences		
• Normal	10 CFR 20, 10 CFR 50 Appendix I, and 40 CFR 190 dose limits [Same for 2nd unit/group]	• Radiological dose consequences due to gaseous releases from normal operation of the plant. • Refer to Section 5.4.3; Tables 5.4-7, 5.4-10 & 5.4-11.
• Post-Accident	10 CFR 50.34(a)(1) and 10 CFR 100 dose limits [Same for 2nd unit/group]	• Radiological dose consequences due to gaseous releases from postulated plant accidents. • Refer to Sections 7.1.2 & 7.1.4.
• Minimum Distance to Site Boundary	2854.9 ft [Same for 2nd unit/group]	• Minimum lateral distance from the ESP Plant Parameter Envelope boundaries to the Exclusion Area Boundary • Refer to Figure 3.1-3.
Liquid Radwaste System		
• Normal Dose Consequences	10 CFR 50 Appendix I, 10 CFR 20, and 40 CFR 190 dose limits [Same for 2nd unit/group]	• The radiological dose consequences due to liquid effluent releases from normal operation of the plant. • Refer to Section 5.4.3; Tables 5.4-6, 5.4-10 & 5.4-11.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 1 - Site Characteristics (continued)	
Population Density		
• Population density at the time of initial site approval and within about 5 years thereafter	Population density meets the guidance of RS-002, Section 2.1.3 for RG 4.7, Regulatory Position C.4 [Both units/groups]	• At the time of initial site approval and within about 5 years hereafter, the population densities, including weighted transient population, averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the circular area at that distance), would not exceed 500 persons per square mile. • Refer to Section 2.5.1.5; Figure 2.5-13.
• Population density at the time of initial operation	Population density meets the guidance of RS-002, Section 2.1.3 [Both units/groups]	• The population densities, including weighted transient population, averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), would not exceed 500 persons per square mile at the time of initial operation. • Refer to Section 2.5.1.5; Figure 2.5-13.
• Population density over the lifetime of the new units until 2065	Population density meets the guidance of RS-002, Section 2.1.3 [Both units/groups]	• The population densities, including weighted transient population, averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), would not exceed 1000 persons per square mile over the lifetime of new units. • Refer to Section 2.5.1.5; Figure 2.5-13.
Population Center Distance	10 CFR 100.21(b) Meets requirement [Both units/groups]	• The distance from the ESP plant parameter envelope to the nearest boundary of a densely populated center containing more than about 25,000 residents is not less than one and one-third times the distance from the ESP plant parameter envelope to the outer boundary of the LPZ. • Refer to Section 2.5.1.2.
Exclusion Area Boundary (EAB)	10 CFR 100.21(a) Meets requirement [Both units/groups]	• The exclusion area boundary is the perimeter of a 5000-ft-radius circle from the center of the abandoned Unit 3 containment. • Refer to Sections 2.7.5, 2.7.6, 3.1.5, 4.1.1, 4.4.1.3, 5.1.1, 5.3.3.2.3, 5.3.4, 5.3.4.2, 5.4.1.3, 5.4.2.2, 5.5.1.3, 5.8.1.1, 5.8.1.2, 5.8.1.4, 5.8.3.1, 7.1.2, 7.1.4; Tables 2.7-10, 2.7-11, 2.7-14, 4.4-2, 7.1-1, 7.1-2, 7.1-4, 7.1-6, 7.1-8, 7.1-10, 7.1-11, 7.1-13, 7.1-15, 7.1-17, 7.1-19, 7.1-20, 7.1-22, 7.1-24, 7.1-26, & 7.1-28; Figures 1.1-1 & 2.1-2.
Low Population Zone (LPZ)	10 CFR 100.21(a) Meets requirement [Both units/groups]	• The LPZ is a 6-mile-radius circle centered at the Unit 1 containment building. • Refer to Sections 2.7.5, 2.7.6, 5.8.3.1, 7.1.2, 7.1.4; Tables 2.7-12, 7.1-1, 7.1-2, 7.1-4, 7.1-6, 7.1-8, 7.1-10, 7.1-11, 7.1-13, 7.1-15, 7.1-17, 7.1-19, 7.1-20, 7.1-22, 7.1-24, 7.1-26, & 7.1-28.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters	
Structure Height	≤234 ft [Same for 2nd unit/group]	• The height from finished grade to the top of the tallest power block structure, excluding cooling towers • Refer to Sections 2.7.5, 3.1.2.2, & 6.4.1.1.
Structure Foundation Embedment	≤140 ft [Same for 2nd unit/group]	• The depth from finished grade to the bottom of the basemat for the most deeply embedded power block structure • Refer to Section 4.2.1.2.
Normal Plant Heat Sink		
• Condenser/Heat Exchanger Duty	≤1.03 E10 Btu/hr [Additional 1.03 E10 Btu/hr for 2nd unit/group]	• Waste heat rejected from the main condenser and the auxiliary heat exchangers during normal plant operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3, 3.4.2.3, 5.3.2.1, & 5.3.2.1.2.
• Maximum Inlet Temperature Condenser/ Heat Exchanger	100°F [Same for 2nd unit/group]	• Maximum water temperature at condenser and heat exchanger inlet • Refer to Section 3.4.1.3.2.
• Unit 3 Closed-Cycle, Dry and Wet Tower		
Height	≤180 ft	• The height above finished grade of the cooling towers • Refer to Sections 3.1.2.2, 5.3.3.2.4, & 5.8.1.5.
Make-Up Flow Rate	15,384 gpm, maximum (MWC mode) 22,268 gpm, maximum (EC mode)	• The expected rate of removal of water from Lake Anna to replace water losses from the closed-cycle cooling water system • Refer to Sections 3.4.1.1, 3.4.2.1, 3.4.2.2, 5.2.1.1, 5.2.2.1.2, 5.3.1, 5.3.1.1, 5.3.1.1.2, 5.3.2.1.2, & 5.3.2.1.3; Table 3.3-1; Figure 3.3-1.
Evaporation Rate	8707 gpm, average (96% plant capacity factor with wet tower cooling) 11,532 gpm, maximum (MWC mode) 16,695 gpm, maximum (EC mode)	• Expected rates at which water is lost by evaporation resulting from operation of the plant cooling towers. • Refer to Section 5.2.1.1; Tables 3.3-1 & 5.2-1; Figure 3.3-1.
Drift Rate	8 gpm, maximum (MWC mode) 8 gpm, maximum (EC mode)	• Expected rates at which water is lost by drift resulting from operation of the plant cooling towers based on 0.001% of cooling water flow. • Refer to Table 3.3-1; Figure 3.3-1.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Normal Plant Heat Sink (continued)		
• Unit 3 Closed-Cycle, Dry and Wet Tower (continued)		
Blowdown Flow Rate	3844 gpm, maximum (MWC mode) 5565 gpm, maximum (EC mode)	• Flow rate of the blowdown stream from the closed-cycle cooling water system to the WHTF • Refer to Sections 3.4.1.1, 3.4.2.1, 3.4.2.2, 5.2.1.1, 5.2.2.1.2, 5.3.1, 5.3.1.1, 5.3.1.1.2, 5.3.2.1.2, & 5.3.2.1.3; Table 3.3-1; Figure 3.3-1.
Blowdown Temperature	100°F	• The maximum expected temperature of the cooling tower blowdown stream to the WHTF • Refer to Sections 3.4.1.1 & 5.3.2.2.2
Blowdown Constituents and Concentrations		• The maximum expected concentrations for anticipated constituents in the cooling water system blowdown to the WHTF • Refer to Section 5.5.1.1.
• Free Available Chlorine	<0.3 ppm	
• Copper	<1 ppm	
• Iron	<1 ppm	
• Sulfate	<300 ppm	
• Total Dissolved Solids	<3000 ppm	
Heat Rejection Rate	≤1.03 E10 Btu/hr	• The expected maximum heat rejection rate to the atmosphere during normal operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3.1, 3.4.2.3, 5.3.2.1 & 5.3.2.1.2.
Noise	<65 dbA at EAB	• Maximum expected sound level produced by operation of the cooling towers • Refer to Sections 3.1.5, 5.3.3.2.3, 5.3.4.2, & 5.8.1.2.
• Unit 4 Dry Cooling Towers		
Evaporation Rate	None or negligible (on the order of 1 gpm, average)	• The expected rate at which water is lost by evaporation from the cooling water system • Refer to Sections 1.1.4, 2.3.1.1, 3.1.5, 3.3.1, 3.4.1.1, 5.2.1, 5.2.2.1.2, 5.3.3.1, & 5.3.3.2.1; Table 3.3-2; Figure 3.3-2.
Height	≤150 ft	• The vertical height above finished grade of the cooling towers • Refer to Sections 3.1.2.2, 5.3.3.2.4, & 5.8.1.5.
Make-Up Flow Rate	None or negligible (on the order of 1 gpm, average)	• The expected rate of removal of water from Lake Anna to replace evaporative water losses from the cooling water system • Refer to Sections 2.3.1.1, 2.3.3.1, 3.3.1, 3.4.1.1, 3.4.2.1, 5.2.1, 5.2.1.1, 5.2.1.4, 5.3.1, 5.3.1.1, 5.3.1.2.2 & 5.3.3.1; Table 3.3-2; Figure 3.3-2.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Normal Plant Heat Sink (continued)		
• Unit 4 Dry Cooling Towers (continued)		
Noise	<60 dbA at EAB	• Maximum expected sound level produced by operation of the cooling towers • Refer to Sections 3.1.5, 5.3.3.2.3, 5.3.4.2 & 5.8.1.2.
Heat Rejection Rate	≤1.03 E10 Btu/hr	• Waste heat rejected to the atmosphere from the cooling water system, during normal plant operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3.1, & 3.4.2.3.
Ultimate Heat Sink Mechanical Draft Cooling Towers		
• Blowdown Constituents and Concentrations • Free Available Chlorine • Copper • Iron • Sulfate • Total Dissolved Solids	[Values same for both units/group] <0.3 ppm <1 ppm <1 ppm <300 ppm <3000 ppm	• The maximum expected concentrations for anticipated constituents in the UHS blowdown to the WHTF • Refer to Section 5.5.1.1.
• Blowdown Flow Rate	144 gpm expected, 850 gpm maximum [288 gpm expected, 1700 gpm maximum]	• The normal expected and maximum flow rate of the blowdown stream from the UHS system to the WHTF • Refer to Sections 3.4.1.2, 3.4.2.2, & 5.3.2.1; Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Evaporation Rate	411 gpm normal, 850 gpm shutdown [822 gpm normal, 1700 gpm shutdown]	• The expected (and maximum) rate at which water is lost by evaporation from the UHS system • Refer to Section 3.4.1.2; Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Height	≤60 ft [Same for 2nd unit/group]	• The vertical height above finished grade of mechanical draft cooling towers associated with the UHS system. • Refer to Section 3.1.5.
• Maximum Consumption of Raw Water	850 gpm, nominal [1700 gpm]	• The expected maximum short-term consumptive use of water from Lake Anna by the UHS system (evaporation and drift losses) • Refer to Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Monthly Average Consumption of Raw Water	411 gpm [822 gpm]	• The expected normal operating consumption of water from Lake Anna by the UHS system (evaporation and drift losses) • Refer to Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Release Point		
▪ Elevation	Ground Level	• The elevation above finished grade of the release point for routine operational and accident sequence releases
Source Term		
• Gaseous (Normal)	Values in Table 5.4-7 (maximum values) [Double values in Table 5.4-7]	• The annual activity, by isotope, contained in routine plant airborne effluent streams • Refer to Section 5.4.2.2; Table 5.4-7.
• Gaseous (Post-Accident)	Values in Section 7.1 tables (maximum values) [Same for 2nd unit/group]	• The activity, by isotope, contained in post-accident airborne effluents • Refer to Section 7.1.4; Tables 7.1-3, 7.1-5, 7.1-7, 7.1-9, 7.1-12, 7.1-14, 7.1-16, 7.1-18, 7.1-21, 7.1-23, 7.1-25, & 7.1-27.
▪ Tritium	3500 Ci/y [7000 Ci/yr] (maximum values)	• The annual activity of tritium contained in routine plant airborne effluent streams • Refer to Section 5.4.2.2; Table 5.4-7.
Liquid Radwaste System		
• Release Point Dilution Factor	1000 (minimum) [Same for 2nd unit/group]	• The ratio of liquid potentially radioactive effluent streams discharged at 100 gpm to liquid non-radioactive effluent streams from plant systems to the WHTF through the discharge canal used for NAPS Units 1 and 2 • Refer to Section 5.4.1.1; Table 5.4-1.
• Liquid	Values in Table 5.4-6 (maximum values) [Double the values in Table 5.4-6]	• The annual activity, by isotope, contained in routine plant liquid effluent streams • Refer to Section 5.4.2.1; Table 5.4-6.
• Tritium	≤850 Ci/yr [≤1700 Ci/yr]	• The annual activity of tritium contained in routine plant liquid effluent streams • Refer to Section 5.4.2.1; Table 5.4-6.
Solid Radwaste System		
• Activity	≤2700 Ci/yr [≤5400 Ci/yr]	• The annual activity contained in solid radioactive wastes generated during routine plant operations • Refer to Section 3.5.3.
• Volume	≤9041 cu ft/yr [≤18,646 cu ft/yr]	• The expected volume of solid radioactive wastes generated during routine plant operations • Refer to Section 3.5.3.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
Part 2 - Design Parameters (continued)		
Plant Characteristics		
• Acreage	Approximately 128.5 acres [Both units/groups]	• Approximate area on the NAPS site that would be affected on a long-term basis as a result of additional permanent facilities • Refer to Section 4.1.1.4.
• Megawatts Thermal	≤4500 MWt [≤9000 MWt]	• The thermal power generated by one unit (may be the total of several modules) • Refer to Sections 1.1.3, 3.1.2.2, 3.1.5, 3.2.1, 3.8.1, 5.7.1, 7.1.3 & 7.1.4; Tables 3.8-1, 5.4-6, & 5.4-7.
• Plant Population – Operation	Approximately 720 permanent employees [Both units/groups]	• Anticipated number of new employees that would be required for operation of the new units • Refer to Sections 2.5.2, 5.8.2, & 5.8.2.2.
• Plant Population – Refueling / Major Maintenance	Approximately 700–1,000 temporary workers during planned outages [Same for 2nd unit/group]	• Anticipated number of additional workers onsite during planned outages of the new units • Refer to Sections 2.5.2 & 5.8.2.1.2.
• Plant Population – Construction	5,000 people maximum [simultaneous construction]	• Peak workforce of 5,000 for construction of both new units/groups • Refer to Sections 2.5.2, 4.4.2, 4.4.2.2.1, 4.5.4, 5.8.2.2, & 5.8.2.2.2.
• Maximum Fuel Enrichment for Light-Water-Cooled Reactors	5% [Same for 2nd unit/group]	• Concentration of U-235 in fuel • Refer to Sections 3.2.1 & 3.8; Table 3.8-1.
• Maximum Fuel Burn-up for Light-Water-Cooled Reactors	62,000 MWd/MTU [Same for 2nd unit/group]	• The value derived by calculating the reactor thermal power multiplied by the time of irradiation divided by fuel mass (expressed as megawatt-days per metric ton of irradiated fuel) • Refer to Sections 3.2.1 & 3.8; Table 3.8-1.
• Maximum Fuel Enrichment for Gas-Cooled Reactors	19.8% [Same for 2nd unit/group]	• Concentration of U-235 in fuel • Refer to Sections 3.2.1 & 3.8; Table 3.8-2.
• Maximum Fuel Burn-up for Gas-Cooled Reactors	133,000 MWd/MTU [Same for 2nd unit/group]	• The value derived by calculating the reactor thermal power multiplied by the time of irradiation divided by fuel mass (expressed as megawatt-days per metric ton of irradiated fuel) • Refer to Sections 3.2.1 & 3.8; Table 3.8-2.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 1 - Site Characteristics	
Atmospheric Dispersion (χ/Q) (Accident)		• Atmospheric dispersion coefficients used to estimate dose consequences of accident airborne releases. • Refer to Section 2.7.5; Tables 2.7-11 & 2.7-12.
• EAB	3.34E-5 sec/m^3 [Same for 2nd unit/group]	
• LPZ	2.17E-6 sec/m^3 [Same for 2nd unit/group]	
Gaseous Effluents Dispersion, Deposition (Annual Average)		
• Atmospheric Dispersion (χ/Q)	χ/Q values in Table 2.7-14 [Same for 2nd unit/group]	• The atmospheric dispersion coefficients used to estimate dose consequences of normal airborne releases. • Refer to Section 2.7.6; Table 2.7-14.
• Ground Deposition (D/Q)	D/Q values in Table 2.7-14 [Same for 2nd unit/group]	• The ground deposition coefficients used to estimate dose consequences of normal airborne releases. • Refer to Section 2.7.6; Table 2.7-14.
Dose Consequences		
• Normal	10 CFR 20, 10 CFR 50 Appendix I, and 40 CFR 190 dose limits [Same for 2nd unit/group]	• Radiological dose consequences due to gaseous releases from normal operation of the plant. • Refer to Section 5.4.3; Tables 5.4-7, 5.4-10 & 5.4-11.
• Post-Accident	10 CFR 50.34(a)(1) and 10 CFR 100 dose limits [Same for 2nd unit/group]	• Radiological dose consequences due to gaseous releases from postulated plant accidents. • Refer to Sections 7.1.2 & 7.1.4.
• Minimum Distance to Site Boundary	2854.9 ft [Same for 2nd unit/group]	• Minimum lateral distance from the ESP Plant Parameter Envelope boundaries to the Exclusion Area Boundary • Refer to Figure 3.1-3.
Liquid Radwaste System		
• Normal Dose Consequences	10 CFR 50 Appendix I, 10 CFR 20, and 40 CFR 190 dose limits [Same for 2nd unit/group]	• The radiological dose consequences due to liquid effluent releases from normal operation of the plant. • Refer to Section 5.4.3; Tables 5.4-6, 5.4-10 & 5.4-11.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 1 - Site Characteristics (continued)	
Population Density		
• Population density at the time of initial site approval and within about 5 years thereafter	Population density meets the guidance of RS-002, Section 2.1.3 for RG 4.7, Regulatory Position C.4 [Both units/groups]	• At the time of initial site approval and within about 5 years hereafter, the population densities, including weighted transient population, averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the circular area at that distance), would not exceed 500 persons per square mile. • Refer to Section 2.5.1.5; Figure 2.5-13.
• Population density at the time of initial operation	Population density meets the guidance of RS-002, Section 2.1.3 [Both units/groups]	• The population densities, including weighted transient population, averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), would not exceed 500 persons per square mile at the time of initial operation. • Refer to Section 2.5.1.5; Figure 2.5-13.
• Population density over the lifetime of the new units until 2065	Population density meets the guidance of RS-002, Section 2.1.3 [Both units/groups]	• The population densities, including weighted transient population, averaged over any radial distance out to 30 miles (cumulative population at a distance divided by the area at that distance), would not exceed 1000 persons per square mile over the lifetime of new units. • Refer to Section 2.5.1.5; Figure 2.5-13.
Population Center Distance	10 CFR 100.21(b) Meets requirement [Both units/groups]	• The distance from the ESP plant parameter envelope to the nearest boundary of a densely populated center containing more than about 25,000 residents is not less than one and one-third times the distance from the ESP plant parameter envelope to the outer boundary of the LPZ. • Refer to Section 2.5.1.2.
Exclusion Area Boundary (EAB)	10 CFR 100.21(a) Meets requirement [Both units/groups]	• The exclusion area boundary is the perimeter of a 5000-ft-radius circle from the center of the abandoned Unit 3 containment. • Refer to Sections 2.7.5, 2.7.6, 3.1.5, 4.1.1, 4.4.1.3, 5.1.1, 5.3.3.2.3, 5.3.4, 5.3.4.2, 5.4.1.3, 5.4.2.2, 5.5.1.3, 5.8.1.1, 5.8.1.2, 5.8.1.4, 5.8.3.1, 7.1.2, 7.1.4; Tables 2.7-10, 2.7-11, 2.7-14, 4.4-2, 7.1-1, 7.1-2, 7.1-4, 7.1-6, 7.1-8, 7.1-10, 7.1-11, 7.1-13, 7.1-15, 7.1-17, 7.1-19, 7.1-20, 7.1-22, 7.1-24, 7.1-26, & 7.1-28; Figures 1.1-1 & 2.1-2.
Low Population Zone (LPZ)	10 CFR 100.21(a) Meets requirement [Both units/groups]	• The LPZ is a 6-mile-radius circle centered at the Unit 1 containment building. • Refer to Sections 2.7.5, 2.7.6, 5.8.3.1, 7.1.2, 7.1.4; Tables 2.7-12, 7.1-1, 7.1-2, 7.1-4, 7.1-6, 7.1-8, 7.1-10, 7.1-11, 7.1-13, 7.1-15, 7.1-17, 7.1-19, 7.1-20, 7.1-22, 7.1-24, 7.1-26, & 7.1-28.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters	
Structure Height	≤234 ft [Same for 2nd unit/group]	• The height from finished grade to the top of the tallest power block structure, excluding cooling towers • Refer to Sections 2.7.5, 3.1.2.2, & 6.4.1.1.
Structure Foundation Embedment	≤140 ft [Same for 2nd unit/group]	• The depth from finished grade to the bottom of the basemat for the most deeply embedded power block structure • Refer to Section 4.2.1.2.
Normal Plant Heat Sink		
• Condenser/Heat Exchanger Duty	≤1.03 E10 Btu/hr [Additional 1.03 E10 Btu/hr for 2nd unit/group]	• Waste heat rejected from the main condenser and the auxiliary heat exchangers during normal plant operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3, 3.4.2.3, 5.3.2.1, & 5.3.2.1.2.
• Maximum Inlet Temperature Condenser/ Heat Exchanger	100°F [Same for 2nd unit/group]	• Maximum water temperature at condenser and heat exchanger inlet • Refer to Section 3.4.1.3.2.
• Unit 3 Closed-Cycle, Dry and Wet Tower		
Height	≤180 ft	• The height above finished grade of the cooling towers • Refer to Sections 3.1.2.2, 5.3.3.2.4, & 5.8.1.5.
Make-Up Flow Rate	15,384 gpm, maximum (MWC mode) 22,268 gpm, maximum (EC mode)	• The expected rate of removal of water from Lake Anna to replace water losses from the closed-cycle cooling water system • Refer to Sections 3.4.1.1, 3.4.2.1, 3.4.2.2, 5.2.1.1, 5.2.2.1.2, 5.3.1, 5.3.1.1, 5.3.1.1.2, 5.3.2.1.2, & 5.3.2.1.3; Table 3.3-1; Figure 3.3-1.
Evaporation Rate	8707 gpm, average (96% plant capacity factor with wet tower cooling) 11,532 gpm, maximum (MWC mode) 16,695 gpm, maximum (EC mode)	• Expected rates at which water is lost by evaporation resulting from operation of the plant cooling towers. • Refer to Section 5.2.1.1; Tables 3.3-1 & 5.2-1; Figure 3.3-1.
Drift Rate	8 gpm, maximum (MWC mode) 8 gpm, maximum (EC mode)	• Expected rates at which water is lost by drift resulting from operation of the plant cooling towers based on 0.001% of cooling water flow. • Refer to Table 3.3-1; Figure 3.3-1.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Normal Plant Heat Sink (continued)		
• Unit 3 Closed-Cycle, Dry and Wet Tower (continued)		
Blowdown Flow Rate	3844 gpm, maximum (MWC mode) 5565 gpm, maximum (EC mode)	• Flow rate of the blowdown stream from the closed-cycle cooling water system to the WHTF • Refer to Sections 3.4.1.1, 3.4.2.1, 3.4.2.2, 5.2.1.1, 5.2.2.1.2, 5.3.1, 5.3.1.1, 5.3.1.1.2, 5.3.2.1.2, & 5.3.2.1.3; Table 3.3-1; Figure 3.3-1.
Blowdown Temperature	100°F	• The maximum expected temperature of the cooling tower blowdown stream to the WHTF • Refer to Sections 3.4.1.1 & 5.3.2.2.2
Blowdown Constituents and Concentrations		• The maximum expected concentrations for anticipated constituents in the cooling water system blowdown to the WHTF • Refer to Section 5.5.1.1.
• Free Available Chlorine	<0.3 ppm	
• Copper	<1 ppm	
• Iron	<1 ppm	
• Sulfate	<300 ppm	
• Total Dissolved Solids	<3000 ppm	
Heat Rejection Rate	≤1.03 E10 Btu/hr	• The expected maximum heat rejection rate to the atmosphere during normal operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3.1, 3.4.2.3, 5.3.2.1 & 5.3.2.1.2.
Noise	<65 dbA at EAB	• Maximum expected sound level produced by operation of the cooling towers • Refer to Sections 3.1.5, 5.3.3.2.3, 5.3.4.2, & 5.8.1.2.
• Unit 4 Dry Cooling Towers		
Evaporation Rate	None or negligible (on the order of 1 gpm, average)	• The expected rate at which water is lost by evaporation from the cooling water system • Refer to Sections 1.1.4, 2.3.1.1, 3.1.5, 3.3.1, 3.4.1.1, 5.2.1, 5.2.2.1.2, 5.3.3.1, & 5.3.3.2.1; Table 3.3-2; Figure 3.3-2.
Height	≤150 ft	• The vertical height above finished grade of the cooling towers • Refer to Sections 3.1.2.2, 5.3.3.2.4, & 5.8.1.5.
Make-Up Flow Rate	None or negligible (on the order of 1 gpm, average)	• The expected rate of removal of water from Lake Anna to replace evaporative water losses from the cooling water system • Refer to Sections 2.3.1.1, 2.3.3.1, 3.3.1, 3.4.1.1, 3.4.2.1, 5.2.1, 5.2.1.1, 5.2.1.4, 5.3.1, 5.3.1.1, 5.3.1.2.2 & 5.3.3.1; Table 3.3-2; Figure 3.3-2.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
Part 2 - Design Parameters (continued)		
Normal Plant Heat Sink (continued)		
• Unit 4 Dry Cooling Towers (continued)		
Noise	<60 dbA at EAB	• Maximum expected sound level produced by operation of the cooling towers • Refer to Sections 3.1.5, 5.3.3.2.3, 5.3.4.2 & 5.8.1.2.
Heat Rejection Rate	≤1.03 E10 Btu/hr	• Waste heat rejected to the atmosphere from the cooling water system, during normal plant operation at full station load • Refer to Sections 3.4.1.1, 3.4.1.3.1, & 3.4.2.3.
Ultimate Heat Sink Mechanical Draft Cooling Towers		
• Blowdown Constituents and Concentrations	[Values same for both units/group]	• The maximum expected concentrations for anticipated constituents in the UHS blowdown to the WHTF • Refer to Section 5.5.1.1.
• Free Available Chlorine	<0.3 ppm	
• Copper	<1 ppm	
• Iron	<1 ppm	
• Sulfate	<300 ppm	
• Total Dissolved Solids	<3000 ppm	
• Blowdown Flow Rate	144 gpm expected, 850 gpm maximum [288 gpm expected, 1700 gpm maximum]	• The normal expected and maximum flow rate of the blowdown stream from the UHS system to the WHTF • Refer to Sections 3.4.1.2, 3.4.2.2, & 5.3.2.1; Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Evaporation Rate	411 gpm normal, 850 gpm shutdown [822 gpm normal, 1700 gpm shutdown]	• The expected (and maximum) rate at which water is lost by evaporation from the UHS system • Refer to Section 3.4.1.2; Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Height	≤60 ft [Same for 2nd unit/group]	• The vertical height above finished grade of mechanical draft cooling towers associated with the UHS system. • Refer to Section 3.1.5.
• Maximum Consumption of Raw Water	850 gpm, nominal [1700 gpm]	• The expected maximum short-term consumptive use of water from Lake Anna by the UHS system (evaporation and drift losses) • Refer to Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.
• Monthly Average Consumption of Raw Water	411 gpm [822 gpm]	• The expected normal operating consumption of water from Lake Anna by the UHS system (evaporation and drift losses) • Refer to Tables 3.3-1 & 3.3-2; Figures 3.3-1 & 3.3-2.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Release Point		
▪ Elevation	Ground Level	• The elevation above finished grade of the release point for routine operational and accident sequence releases
Source Term		
• Gaseous (Normal)	Values in Table 5.4-7 (maximum values) [Double values in Table 5.4-7]	• The annual activity, by isotope, contained in routine plant airborne effluent streams • Refer to Section 5.4.2.2; Table 5.4-7.
• Gaseous (Post-Accident)	Values in Section 7.1 tables (maximum values) [Same for 2nd unit/group]	• The activity, by isotope, contained in post-accident airborne effluents • Refer to Section 7.1.4; Tables 7.1-3, 7.1-5, 7.1-7, 7.1-9, 7.1-12, 7.1-14, 7.1-16, 7.1-18, 7.1-21, 7.1-23, 7.1-25, & 7.1-27.
▪ Tritium	3500 Ci/y [7000 Ci/yr] (maximum values)	• The annual activity of tritium contained in routine plant airborne effluent streams • Refer to Section 5.4.2.2; Table 5.4-7.
Liquid Radwaste System		
• Release Point Dilution Factor	1000 (minimum) [Same for 2nd unit/group]	• The ratio of liquid potentially radioactive effluent streams discharged at 100 gpm to liquid non-radioactive effluent streams from plant systems to the WHTF through the discharge canal used for NAPS Units 1 and 2 • Refer to Section 5.4.1.1; Table 5.4-1.
• Liquid	Values in Table 5.4-6 (maximum values) [Double the values in Table 5.4-6]	• The annual activity, by isotope, contained in routine plant liquid effluent streams • Refer to Section 5.4.2.1; Table 5.4-6.
• Tritium	≤850 Ci/yr [≤1700 Ci/yr]	• The annual activity of tritium contained in routine plant liquid effluent streams • Refer to Section 5.4.2.1; Table 5.4-6.
Solid Radwaste System		
• Activity	≤2700 Ci/yr [≤5400 Ci/yr]	• The annual activity contained in solid radioactive wastes generated during routine plant operations • Refer to Section 3.5.3.
• Volume	≤9041 cu ft/yr [≤18,646 cu ft/yr]	• The expected volume of solid radioactive wastes generated during routine plant operations • Refer to Section 3.5.3.

Table 3.1-9 Bounding Site-Specific Plant Parameters Envelope

Item	Single Unit/Group Value [Second Unit/Group Value]	Description and References
	Part 2 - Design Parameters (continued)	
Plant Characteristics		
• Acreage	Approximately 128.5 acres [Both units/groups]	• Approximate area on the NAPS site that would be affected on a long-term basis as a result of additional permanent facilities • Refer to Section 4.1.1.4.
• Megawatts Thermal	≤4500 MWt [≤9000 MWt]	• The thermal power generated by one unit (may be the total of several modules) • Refer to Sections 1.1.3, 3.1.2.2, 3.1.5, 3.2.1, 3.8.1, 5.7.1, 7.1.3 & 7.1.4; Tables 3.8-1, 5.4-6, & 5.4-7.
• Plant Population – Operation	Approximately 720 permanent employees [Both units/groups]	• Anticipated number of new employees that would be required for operation of the new units • Refer to Sections 2.5.2, 5.8.2, & 5.8.2.2.
• Plant Population – Refueling / Major Maintenance	Approximately 700–1,000 temporary workers during planned outages [Same for 2nd unit/group]	• Anticipated number of additional workers onsite during planned outages of the new units • Refer to Sections 2.5.2 & 5.8.2.1.2.
• Plant Population – Construction	5,000 people maximum [simultaneous construction]	• Peak workforce of 5,000 for construction of both new units/groups • Refer to Sections 2.5.2, 4.4.2, 4.4.2.2.1, 4.5.4, 5.8.2.2, & 5.8.2.2.2.
• Maximum Fuel Enrichment for Light-Water-Cooled Reactors	5% [Same for 2nd unit/group]	• Concentration of U-235 in fuel • Refer to Sections 3.2.1 & 3.8; Table 3.8-1.
• Maximum Fuel Burn-up for Light-Water-Cooled Reactors	62,000 MWd/MTU [Same for 2nd unit/group]	• The value derived by calculating the reactor thermal power multiplied by the time of irradiation divided by fuel mass (expressed as megawatt-days per metric ton of irradiated fuel) • Refer to Sections 3.2.1 & 3.8; Table 3.8-1.
• Maximum Fuel Enrichment for Gas-Cooled Reactors	19.8% [Same for 2nd unit/group]	• Concentration of U-235 in fuel • Refer to Sections 3.2.1 & 3.8; Table 3.8-2.
• Maximum Fuel Burn-up for Gas-Cooled Reactors	133,000 MWd/MTU [Same for 2nd unit/group]	• The value derived by calculating the reactor thermal power multiplied by the time of irradiation divided by fuel mass (expressed as megawatt-days per metric ton of irradiated fuel) • Refer to Sections 3.2.1 & 3.8; Table 3.8-2.

Additional Staff Response to Board Questions 78 and 80

Board Questions 78 and 80 request a comparison of the 50% χ/Qs and DBA doses calculated for the environmental review with more protective χ/Qs and DBA doses that are appropriate for the safety review. The following tables provide those comparisons.

Atmospheric Dispersion Factors (χ/Q, s/m^3)

Time Period and Boundary	Environmental Analysis (Realistic, 50%)	Safety Analysis (Conservative, ~95%)
0 to 2 hr Exclusion Area Boundary	3.34×10^{-5}	2.26×10^{-4}
0 to 8 hr Low Population Zone	2.17×10^{-6}	2.05×10^{-5}
8 to 24 hr Low Population Zone	1.5×10^{-6}	1.36×10^{-5}
1 to 4 day Low Population Zone	1.2×10^{-6}	5.58×10^{-6}
4 to 30 day Low Population Zone	9.0×10^{-7}	1.55×10^{-6}

AP1000 Design Basis Accidents (TEDE, Sv)

	FEIS (50%)		Safety Analysis (Conservative, ~95%)	
Accident	EAB	LPZ	EAB	LPZ
Main Steam Line Break				
Pre-existing Iodine Spike	3.9×10^{-4}	7.9×10^{-5}	2.6×10^{-3}	6.1×10^{-4}
Accident-Initiated Spike	4.5×10^{-4}	3.1×10^{-4}	3.0×10^{-3}	2.2×10^{-3}
Steam Generator Tube Rupture				
Pre-existing Iodine Spike	1.7×10^{-3}	5.5×10^{-5}	1.1×10^{-2}	5.2×10^{-4}
Accident-Initiated Spike	8.4×10^{-4}	4.0×10^{-5}	5.7×10^{-3}	3.7×10^{-4}
Loss-of-Coolant	1.4×10^{-2}	1.7×10^{-3}	9.3×10^{-2}	1.5×10^{-2}
Feedwater System Pipe Break	4.5×10^{-4}	3.1×10^{-4}	3.0×10^{-3}	2.2×10^{-3}
Rod Ejection	1.7×10^{-3}	2.8×10^{-4}	1.1×10^{-2}	2.5×10^{-3}
Reactor Coolant Pump Rotor Seizure (Locked Rotor)	1.4×10^{-3}	9.6×10^{-5}	9.4×10^{-3}	9.1×10^{-4}
Reactor Coolant Pump Rotor Break	1.4×10^{-3}	9.6×10^{-5}	9.4×10^{-3}	9.1×10^{-4}
Failure of Small Lines Carrying Primary Coolant Outside Containment	7.2×10^{-4}	4.8×10^{-5}	4.9×10^{-3}	4.6×10^{-4}
Fuel Handling	1.3×10^{-3}	9.6×10^{-5}	9.0×10^{-3}	9.1×10^{-4}

ABWR Design Basis Accidents (TEDE, Sv)

	FEIS (50%)		Safety Analysis (Conservative, ~95%)	
Accident	EAB	LPZ	EAB	LPZ
Main Steam Line Break				
Pre-existing Iodine Spike	7.6×10^{-4}	4.9×10^{-5}	5.1×10^{-3}	4.6×10^{-4}
Accident-Initiated Spike	3.7×10^{-5}	2.4×10^{-6}	2.5×10^{-4}	2.3×10^{-5}
Loss-of-Coolant	2.6×10^{-3}	7.5×10^{-3}	1.8×10^{-2}	2.1×10^{-2}
Failure of Small Lines Carrying Primary Coolant Outside Containment	6.4×10^{-5}	4.1×10^{-6}	4.3×10^{-4}	3.9×10^{-5}
Fuel Handling	9.2×10^{-4}	6.0×10^{-5}	6.2×10^{-3}	5.7×10^{-4}
Cleanup Water Line Break	4.7×10^{-6}	3.0×10^{-7}	3.2×10^{-5}	2.9×10^{-6}

ESBWR Design Basis Accidents (TEDE, Sv)

	FEIS (50%)		Safety Analysis (Conservative, ~95%)	
Accident	EAB	LPZ	EAB	LPZ
Main Steam Line Break				
Pre-existing Iodine Spike	3.1×10^{-3}	2.0×10^{-4}	2.1×10^{-2}	1.9×10^{-3}
Accident-Initiated Spike	1.6×10^{-4}	1.0×10^{-5}	1.1×10^{-3}	9.6×10^{-5}
Loss-of-Coolant	2.1×10^{-3}	1.3×10^{-3}	1.4×10^{-2}	9.1×10^{-3}
Feedwater System Pipe Break	6.8×10^{-8}	4.4×10^{-9}	4.6×10^{-7}	4.2×10^{-8}
Failure of Small Lines Carrying Primary Coolant Outside Containment	4.5×10^{-5}	6.8×10^{-6}	3.0×10^{-4}	6.5×10^{-5}
Fuel Handling	1.8×10^{-3}	1.2×10^{-4}	1.2×10^{-2}	1.1×10^{-3}
Cleanup Water Line Break	2.6×10^{-4}	1.7×10^{-5}	1.8×10^{-3}	1.6×10^{-4}

Additional Staff Response to Board Question 110

<u>Non-radiological Accidents, Injuries, and Fatalities for North Anna ESP</u>

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February 27, 2007

This analysis supports a request for clarification from the Atomic Safety Licensing Board in support of the North Anna ESP request. The objective of this analysis is to develop estimates of the non-radiological accident impacts associated with transporting personnel and materials to and from the proposed North Anna and alternative ESP sites. Non-radiological impacts are the accident frequencies and human health impacts projected to result from traffic accidents involving shipments of workers and materials; they do not consider radiological or hazardous characteristics. Non-radiological impacts include the projected number of traffic accidents, injuries, and fatalities that could result from worker's commuting to/from their work locations and shipments of materials to/from the site during construction and operations phases.

Methodology and Assumptions

Non-radiological impacts are calculated using accident, injury, and fatality rates from published sources. The rates (i.e., impacts per vehicle-km traveled) are then multiplied by estimated travel distances for workers and materials. The general formula for calculating non-radiological impacts is:

*Impacts = Unit rate * Round-trip Shipping Distance * Annual number of shipments*

In the formula above, impacts are presented in units of the number of accidents, number of injuries, and number of fatalities per year. Corresponding unit rates are used in the calculations (i.e., accidents, injuries, and fatalities per unit distance, respectively).

In some cases, the data needed to calculate non-radiological impacts are not available. Assumptions were made to fill in reasonable estimates of the data needed to calculate non-radiological impacts. The key assumptions and data sources are described below:

- Construction material requirements are based on information taken from the Dominion Environmental Report (ER), Section 10.2.2 (Dominion 2006). It was stated that each 1,000 MWe unit requires up to 200,000 yd^3 of concrete and 15,000 tons of structural steel. These quantities were doubled to account for a 2-unit plant. In addition, the steel quantity was assumed to be doubled to account for shipments of other construction materials, such as pipe, cable, conduit, cable tray, and ductwork.

- It was assumed that shipment capacities are 10 m^3 (~13 yd^3) of concrete per shipment and 10 MT (11 tons) of structural steel and other construction materials per shipment.

- The number of construction workers was estimated at 5,000 in the Dominion ER (Table 3.1-9). This value represents the peak work force for construction of 2 units simultaneously. At an average of 1.8 persons/vehicle, there will be about 2,800 vehicles per day (see NRC 2006, Section 4.2.2). Each person was assumed to travel to and from the ESP site 250 days per year. A five-year construction period was assumed. This is not realistic but was selected because it produces bounding impact estimates.

- The number of workers during operations was given in the Dominion ER (Table 3.1-9) as 720 (both units). An additional 700 to 1,000 temporary workers per unit are estimated to be needed for refueling outages. It was assumed that outages for the 2 units would not occur simultaneously.

- Average shipping distances for construction materials were assumed to be 64 km (40 miles) one-way. This was based on the approximate one-way shipping distance from Richmond, VA, to the North Anna ESP site. The average commute distance for construction and operations workers was assumed to be 32 km (20 miles) one-way.

- Accident, injury, and fatality rates for construction materials were taken from Table 4 in ANL/ESD/TM-150 *State-level Accident Rates for Surface Freight Transportation: A Reexamination* (Saricks and Tompkins 1999). Rates for the State of Virginia were used for construction material shipments, typically conducted in heavy-combination trucks. Nation-wide median rates were used for shipments of fuel and waste to/from the site during operations. The data in Saricks and Tompkins are representative of heavy truck safety and do not specifically address the impacts associated with commuter traffic (i.e., workers traveling to and from the site). However, a single source that provided all three rates to model worker transportation to/from the site was unavailable. To develop more realistic commuter traffic impacts, a source was located that provided a Virginia-specific fatality rate for all traffic for the years 2001 to 2005 (*Traffic Safety Facts, Virginia, 2005*). This fatality rate was used as the base for estimating Virginia-specific injury and accident rates. Adjustment factors were developed using national-level traffic accident statistics in *National Transportation Statistics 2007*. The adjustment factors are the ratio of the national injury rate to the national fatality rate and the ratio of the national accident rate to the national fatality rate. These adjustment factors were multiplied by the Virginia-specific fatality rate to approximate the injury and accident rates for commuters in the State of Virginia.

- Shipping distances and projected numbers of fuel and waste shipments were taken from the North Anna EIS, Appendix G.

Results

Table 1 presents the projected annual non-radiological accidents, injuries, and fatalities associated with constructing and operating each potential reactor type at the North Anna ESP Site. The first component of the table is for an ABWR/ESBWR at North Anna and includes detailed breakdowns of the totals for the construction and operations phases. It also shows the non-radiological impacts associated with transporting personnel and materials to/from the North Anna Site. Only the totals are presented for the other reactor types. The table shows that the non-radiological impacts during construction are significantly larger than during operations. The table also shows that there are only small differences in impacts associated with construction and operations of the various reactor designs. The differences are small because the non-radiological impacts are dominated by traffic accidents involving workers commuting to and from the site. It is shown that the non-radiological impacts from construction workers commuting to and from them site are significantly larger than the impacts of shipping construction materials. Similarly, during reactor operations, non-radiological impacts associated with permanent and outage workers commuting to and from the site are significantly larger than the impacts associated with transporting fuel and waste to/from the site. Note that non-radiological impacts associated with outage workers commuting to/from the site are prorated over a two year period, the approximate length of time between refueling outages.

Figure 1, 2, and 3 illustrate the differences in accidents, injuries, and fatalities, respectively, for the different reactor types. Note that, due to lack of information, the construction impacts for all reactor types are assumed to be the same. No data was presented in the Dominion ER on the material requirements for the reactors, except for a high-level estimate of concrete and structural steel requirements. Operating personnel requirements were also assumed to be the same for each reactor type. Any differences in Figures 1 through 3 among the non-radiological impact estimates for the various reactor types are due to shipments of fuel and waste to and from the site during reactor operations. Note that the differences among the impacts by reactor are small because the impacts are dominated by transportation of workers to/from the reactor site.

Table 2 presents a comparison of non-radiological impacts among the alternative ESP sites: North Anna, Portsmouth, Savannah River, and Surry. As shown, the non-radiological impacts estimates are not significantly different among the alternative sites. This is primarily because the impacts are dominated by workers commuting to/from the site and the worker commute assumptions are the same for all site alternatives. As with the reactor type comparisons, none of these differences among the different ESP sites are significant with respect to uncertainty.

Table 3 presents a comparison of the non-radiological injury and fatality frequencies for the 4 alternative ESP sites relative to the non-radiological impact condition in 10 CFR 51.52, Table S-4 (i.e., less than one injury per ten years and less than one fatality per hundred years). The comparisons assume that an ABWR/ESBWR is constructed and operated at each of the alternative sites. As shown, all of the non-radiological injury and fatality frequencies are less than the Table S-4 conditions.

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Saricks, C.L., and M.M. Tompkins. 1999. *State-Level Accident Rates for Surface Freight Transportation: A Reexamination*. ANL/ESD/TM-150. Argonne National Laboratory, Argonne, Illinois.

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U.S. Department of Transportation. *Traffic Safety Facts, Virginia, 2005*, National Center for Statistics and Analysis, Washington, D.C., available at **http://www-nrd.nhtsa.dot.gov/departments/nrd-30/ncsa/STSI/51_VA/2005/51_VA_2005.htm**.

U.S. Department of Transportation. 2007. *National Transportation Statistics 2007*. Bureau of Transportation Statistics, Washington, D.C., available at
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Table 1. Non-radiological Impacts Associated with Construction and Operation of Seven Alternative Reactor Types at the North Anna ESP Site

ESP Site, Reactor Type	Annual Impacts		
	Accidents per Year	Injuries per Year	Fatalities per year
North Anna, ABWR/ESBWR			
Construction			
Workers	4.9E+01	2.2E+01	3.4E-01
Materials			
Concrete	1.3E-02	9.4E-03	6.3E-04
Structural Steel	2.2E-03	1.7E-03	1.1E-04
Total - Construction	**4.9E+01**	**2.2E+01**	**3.4E-01**
Operations			
Permanent Workers	7.0E+00	3.2E+00	4.8E-02
Outage Workers	2.3E+00	1.1E+00	1.6E-02
Unirradiated Fuel	7.4E-03	5.0E-03	2.4E-04
Spent Fuel	8.1E-02	5.5E-02	2.7E-03
Radioactive Waste	1.2E-02	8.2E-03	4.0E-04
Total - Operations	**9.4E+00**	**4.3E+00**	**6.7E-02**
North Anna, AP-1000			
Total - Construction	**4.9E+01**	**2.2E+01**	**3.4E-01**
Total - Operations	**9.4E+00**	**4.3E+00**	**6.6E-02**
North Anna, ACR-700			
Total - Construction	**4.9E+01**	**2.2E+01**	**3.4E-01**
Total - Operations	**9.4E+00**	**4.4E+00**	**6.8E-02**
North Anna, IRIS			
Total - Construction	**4.9E+01**	**2.2E+01**	**3.4E-01**
Total - Operations	**9.4E+00**	**4.3E+00**	**6.6E-02**
North Anna, GT-MHR			
Total - Construction	**4.9E+01**	**2.2E+01**	**3.4E-01**
Total - Operations	**9.5E+00**	**4.4E+00**	**6.8E-02**
North Anna, PBMR			
Total - Construction	**4.9E+01**	**2.2E+01**	**3.4E-01**
Total - Operations	**9.4E+00**	**4.3E+00**	**6.6E-02**

Table 2. Comparison of Non-radiological Impacts for the Alternative ESP Sites

	Annual Impacts		
	Accidents per Year	**Injuries per Year**	**Fatalities per year**
North Anna ABWR/ESBWR (See Table 1 for Details)			
Total - Construction	**4.9E+01**	**2.2E+01**	**3.4E-01**
Total - Operations	**9.4E+00**	**4.3E+00**	**6.7E-02**
Portsmouth, ABWR/ESBWR			
Total - Construction	**4.9E+01**	**2.2E+01**	**3.4E-01**
Operations			
Permanent Workers	7.0E+00	3.2E+00	4.8E-02
Outage Workers	2.3E+00	1.1E+00	1.6E-02
Unirradiated Fuel	7.4E-03	5.0E-03	2.4E-04
Spent Fuel	7.2E-02	4.9E-02	2.4E-03
Radioactive Waste	1.2E-02	8.2E-03	4.0E-04
Total - Operations	**9.4E+00**	**4.3E+00**	**6.7E-02**
Savannah River, ABWR/ESBWR			
Total - Construction	**4.9E+01**	**2.2E+01**	**3.4E-01**
Operations			
Permanent Workers	7.0E+00	3.2E+00	4.8E-02
Outage Workers	2.3E+00	1.1E+00	1.6E-02
Unirradiated Fuel	7.4E-03	5.0E-03	2.4E-04
Spent Fuel	7.9E-02	5.3E-02	2.6E-03
Radioactive Waste	1.2E-02	8.2E-03	4.0E-04
Total - Operations	**9.4E+00**	**4.3E+00**	**6.7E-02**
Surry, ABWR/ESBWR			
Total - Construction	**4.9E+01**	**2.2E+01**	**3.4E-01**
Operations			
Permanent Workers	7.0E+00	3.2E+00	4.8E-02
Outage Workers	2.3E+00	1.1E+00	1.6E-02
Unirradiated Fuel	7.4E-03	5.0E-03	2.4E-04
Spent Fuel	8.4E-02	5.7E-02	2.8E-03
Radioactive Waste	1.2E-02	8.2E-03	4.0E-04
Total - Operations	**9.4E+00**	**4.3E+00**	**6.7E-02**

Table 3. Comparison of Injury and Fatality Impacts to Table S-4 Conditions (ABWR/ESBWR Reactor Type)

ESP Site	Injuries/yr	Fatalities/yr
10 CFR 51.52, Table S-4 Condition	1E-01 (1 in 10 years)	1E-02 (1 in 100 years)
North Anna		
Unirradiated Fuel	5.0E-03	2.4E-04
Spent Fuel	5.5E-02	2.7E-03
Radioactive Waste	8.2E-03	4.0E-04
Total	**6.9E-02**	**3.3E-03**
Portsmouth		
Unirradiated Fuel	5.0E-03	2.4E-04
Spent Fuel	4.9E-02	2.4E-03
Radioactive Waste	8.2E-03	4.0E-04
Total	**6.2E-02**	**3.0E-03**
Savannah River		
Unirradiated Fuel	5.0E-03	2.4E-04
Spent Fuel	5.3E-02	2.6E-03
Radioactive Waste	8.2E-03	4.0E-04
Total	**6.7E-02**	**3.2E-03**
Surry		
Unirradiated Fuel	5.0E-03	2.4E-04
Spent Fuel	5.7E-02	2.8E-03
Radioactive Waste	8.2E-03	4.0E-04
Total	**7.0E-02**	**3.4E-03**

Figure 1. Non-radiological Impacts (Annual Accidents) by Reactor Type

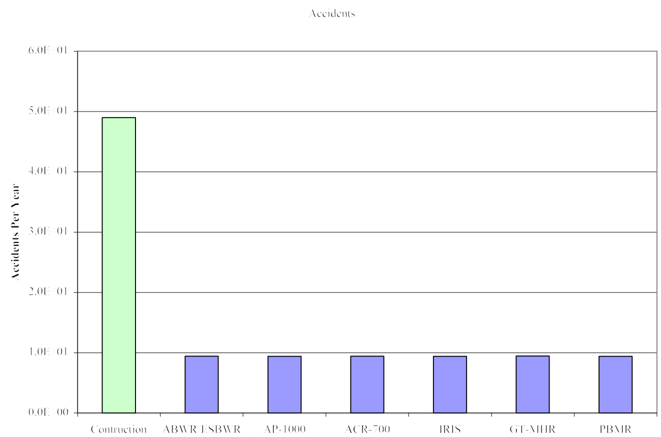

Figure 2. Nonradiological Impacts (Annual Injuries) by Reactor Type

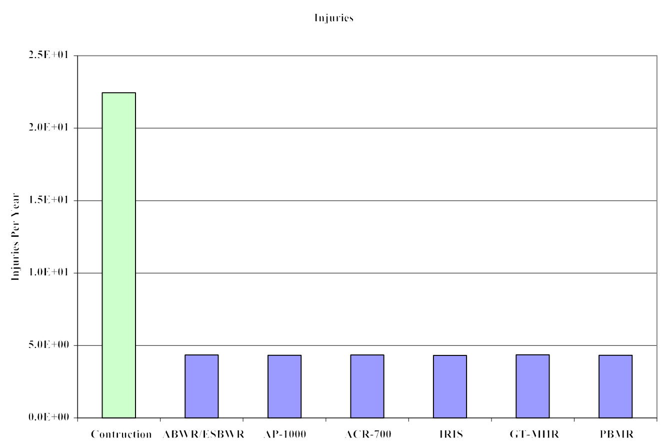

Figure 3. Nonradiological Impacts (Annual Fatalities) by Reactor Type