ATTACHMENT 1

TO

NRC STAFF ANSWER IN OPPOSITION TO
PETITION FOR LEAVE TO INTERVENE FILED BY
BEYOND NUCLEAR INC. AND SIERRA CLUB, INC.

PARTIAL COMPARISON OF (1) NRC STAFF'S DECEMBER 2023 SITE-SPECIFIC DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS) *TO* (2) NRC STAFF'S AUGUST 2021 DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT (DSEIS) FOR SUBSEQUENT LICENSE RENEWAL OF NORTH ANNA UNITS 1 AND 2

Attachment 1 contains the following:

- Cover Page
- Abstract
- Executive Summary
- Section 3.11.6.9 (Postulated Accidents)
- Section 3.14.3 (Greenhouse Gas Emissions and Climate Change)
- Section 3.15 (Cumulative Effects of the Proposed Action)
- Appendix F (Environmental Impacts of Postulated Accidents)
- Appendix G (Environmental Issues and Impact Findings Contained in the Proposed Rule, 10 CFR Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions")

Deletions from the August 2021 DSEIS are shown in strikeout; new text added by the December 2023 DEIS are underlined.

Note: Numbering of pages and lines may not correspond to page and line numbers in the DEIS and DSEIS.

Filed: May 6, 2024

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NUREG-1437
Supplement 7
Second Renewal

Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 7, Second Renewal

Regarding Subsequent License Renewal for North Anna Power Station Units 1 and 2

Draft Report

Office of Nuclear Material Safety and Safeguards

(1)

U.S.NRC

United States Nuclear Regulatory Commission

Protecting People and the Environment

~~Generic~~

Site-Specific Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement ~~7,~~

7a, Second Renewal

Regarding Subsequent License Renewal for North Anna Power Station Units 1 and 2

Draft Report for Comment

Office of Nuclear Material Safety and Safeguards

(2)

U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

NUREG-1437
Supplement 7a
Second Renewal

Site-Specific Environmental Impact Statement for License Renewal of Nuclear Plants

Supplement 7a, Second Renewal

Regarding Subsequent License Renewal for North Anna Power Station Units 1 and 2

Draft Report for Comment

Manuscript Completed: ~~August 2021~~December 2023
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~~Office of Nuclear Material Safety and Safeguards~~

Office of Nuclear Material Safety and Safeguards

(3)

Supplement 7 Second Renewal

COVER SHEET

Responsible Agency: U.S. Nuclear Regulatory Commission, Office of Nuclear ~~Reactor Regulation~~Material Safety and Safeguards.

Title: ~~Generic~~Site-Specific Environmental Impact Statement for ~~License Renewal of Nuclear Plants, Supplement 7, Second Renewal, Regarding~~ Subsequent License Renewal ~~for~~of North Anna Power Station, Units 1 and 2, NUREG-1437, Supplement 7a, Second Renewal, Draft Report for Comment ~~(NUREG-1437).~~

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ABSTRACT

The U.S. Nuclear Regulatory Commission ~~staff~~(NRC) has prepared this ~~supplemental~~site-specific environmental impact statement (~~SEIS~~EIS) as part of its environmental review of Dominion Energy Virginia's (Dominion) application ~~to renew~~for subsequent renewal of the operating licenses for North Anna Power Station, Units 1 and 2 (North Anna) for an additional 20 years. This ~~SEIS~~EIS includes the ~~NRC staff's~~ site-specific evaluation of the environmental impacts of the proposed action (North Anna subsequent license renewal (SLR)), and alternatives ~~to license renewal. Alternatives~~ to SLR. As alternatives, the NRC considered ~~include:~~ (1) new nuclear (small modular reactor ~~or SMR~~) generation ~~and~~, (2) a combination of solar photovoltaic, offshore wind, ~~new nuclear (SMR),~~small modular reactor, and demand-side management~~. The~~, and (3) no action.

This site-specific EIS considers information contained in Dominion's September 28, 2022, submittal (Agencywide Documents Access and Management System No. ML22272A041, VEPCO 2022-TN8270), which supplements its August 24, 2020, SLR application (VEPCO 2020-TN8383). Previously, in August 2021, the NRC issued *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, Supplement 7, Second Renewal, Regarding Subsequent License Renewal for North Anna Power Station Units 1 and 2, Draft Report for Comment (NUREG-1437, Supplement 7, Second Renewal) (DSEIS) (NRC 2021-TN7294). The 2021 DSEIS considered the impacts of license renewal according to the categories established in NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, Revision 1, Final Report (NUREG-1437) (LR GEIS) (NRC 2013-TN2654) and Table B–1 in Appendix B to Subpart A of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51 (TN250): Category 1 issues (generic to all or a distinct subset of nuclear power plants and Category 2 issues (specific to individual nuclear power plants). For the 54 Category 1 issues applicable to North Anna SLR, the 2021 DSEIS found no new and significant information concerning any of these issues that would change the conclusions of the 2013 LR GEIS. The LR GEIS's conclusions of SMALL impact was adopted for those issues in the 2021 DSEIS. For

12 Category 2 issues applicable to North Anna SLR, the 2021 DSEIS evaluated each of those issues on a site-specific basis and made site-specific findings of SMALL, MODERATE, or LARGE impact.

In February 2022, the Commission issued three memoranda and orders, Commission Legal Issuance (CLI)-22-02, CLI-22-03, and CLI-22-04 (NRC 2022-TN8182, NRC 2022-TN8272, NRC 2022-TN9553), concerning SLR environmental reviews. In CLI-22-02, the Commission found that the LR GEIS did not address SLR and that 10 CFR 51.53(c)(3)(TN250) does not apply to SLR applications and, therefore, the NRC may not rely on the 2013 GEIS and Table B–1 for the evaluation of Category 1 issues for SLR. In its decisions, the Commission determined that the NRC staff must address these Category 1 issues on a site-specific basis in site-specific EISs, unless the SLR applicant elects to await the issuance of a revised GEIS and rule.

On November 15, 2022, following Dominion's submittal of its site-specific environmental report supplement (VEPCO 2022-TN8270), the NRC staff issued a notice (87 FR 68522-TN8588) of the staff's intent to conduct a site-specific evaluation and to publish a site-specific EIS for North Anna SLR.

Consistent with the notice in 87 FR 68522, the NRC staff has prepared this site-specific EIS, which considers the impacts of all SLR issues applicable to North Anna SLR on a site-specific basis. In sum, this EIS (1) addresses, on a site-specific basis, the issues that were previously treated as generic "Category 1" issues in the 2021 DSEIS, and (2) updates and revises the evaluation of site-specific "Category 2" issues in the 2021 DSEIS.

Based on the NRC staff's site-specific evaluation of environmental impacts, the staff's preliminary recommendation is that the adverse environmental impacts of ~~license renewal for~~ North Anna SLR are not so great that preserving the option of ~~license renewal~~SLR for energy-planning ~~decisionmakers~~decision-makers would be unreasonable. The NRC staff based its preliminary recommendation on the following:

- ~~the analysis and findings in NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*~~
- ~~the~~Dominion's environmental report ~~submitted by Dominion Energy Virginia~~, as supplemented
- the NRC staff's ~~consultation~~consultations with Federal, State, Tribal, and local agencies
- the NRC staff's independent environmental review
- ~~the NRC staff's~~ consideration of public comments received during two scoping periods and comments received on the DSEIS

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This site-specific EIS supersedes NUREG-1437, Supplement 7, Second Renewal, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 7, Second Renewal, Regarding Subsequent License Renewal for North Anna Power Station Units 1 and 2, Draft Report for Comment," published in August 2021.

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EXECUTIVE SUMMARY

Background

By letter dated August 24, 2020, Virginia Electric and Power Company, doing business as Dominion Energy Virginia (Dominion), submitted to the U. S. Nuclear Regulatory Commission (NRC) an application requesting subsequent license renewal (SLR) for the North Anna Power Station, Units 1 and 2 (North Anna), renewed facility operating licenses (Agencywide Documents Access and Management System [ADAMS] No. ML20246G703, ~~is available electronically from the NRC's Public Electronic Reading Room at: <http://www.nrc.gov/reading-rm.html>. From this site, the public can gain access to~~ (VEPCO 2020-TN8383). Dominion's application included an environmental report (ER) (Agencywide Documents Access and Management System (ADAMS) No. ML20246G698) (TN8099). Dominion subsequently submitted additional information, and supplemented its application with a site-specific supplement to its ER (ML22272A041) (TN8270), as listed in this EIS, Appendix D~~, which provides the NRC's public documents, by using the ADAMS accession number)~~. The North Anna, Unit 1 ~~current~~ renewed facility operating license (NPF-4) expires at midnight on April 1, 2038; the North Anna, Unit 2 ~~current~~renewed facility operating license (NPF-7) expires at midnight on August 21, 2040. In its application, Dominion requested ~~license renewal~~ renewed facility operating licenses for a period of 20 years beyond ~~the~~these expiration dates ~~when the current operating licenses expire~~; that is, to April 1, 2058, for North Anna, Unit 1, and ~~to~~August 21, 2060, for North Anna, Unit 2.

~~Pursuant to Title~~ The NRC's environmental protection regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) ~~51.20(b)(2), the renewal of a power reactor operating license requires preparation of an environmental impact statement (EIS) or a supplement to an existing EIS. In addition, 10 CFR 51.95(c), "Operating License Renewal Stage," states that, in connection with the renewal of an operating license, the NRC staff shall prepare an EIS, which is a supplement to the Commission's NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*.~~

~~Once the NRC officially accepted Dominion's application, the NRC staff began the environmental review process as described in 10 CFR~~ Part 51, (TN250), "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions~~."~~," implement the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.; TN661). This Act is commonly referred to as NEPA. The ~~environmental review begins by~~regulations at 10 CFR Part 51 require the NRC ~~publishing in the *Federal Register* a notice of intent to~~ to prepare ~~a supplemental~~an environmental impact statement (~~SEIS) and to conduct scoping~~EIS) before deciding whether to issue an operating license or a renewed operating license for ~~the~~a nuclear power plant. ~~To prepare~~Pursuant to these regulations, the ~~North Anna draft SEIS, the NRC~~ staff performed ~~the following actions:~~

- ~~conducted a public scoping meeting on November 4, 2020 (webinar)~~
- ~~conducted a remote~~an environmental ~~site audit during the week~~review of ~~December 1, 2020, and a severe accident mitigation alternatives in-office audit on December 9, 2020~~
- ~~reviewed~~ Dominion's ~~environmental report (ER) and compared it~~SLR application and prepared a supplement to *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, Revision 1, Final Report (NUREG-1437)

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(LR GEIS) (NRC 2013-TN2654). In August 2021, the NRC issued the supplement as a draft for public comment, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* ~~(the GEIS)~~

- ~~consulted with Federal, State, Tribal, and local agencies~~

~~conducted a review of the issues following the guidance set forth in NUREG-1555~~, Supplement ~~1, Revision 1, *Standard Review Plans for Environmental Reviews*~~ 7, Second Renewal, Regarding Subsequent License Renewal for ~~*Nuclear*~~North Anna Power ~~*Plants:*~~ Station Units 1 and 2, Draft Report for Comment (NUREG-1437, Supplement ~~*1: Operating License Renewal, Final Report*~~ 7, Second Renewal) (DSEIS) (NRC 2021-TN7294). The DSEIS evaluated the impacts of license renewal issues determined to be site-specific (Category 2) in the LR GEIS on a site-specific basis. For license renewal issues determined to be generic (Category 1) issues in the LR GEIS, the DSEIS adopted the LR GEIS's findings.

The NRC received public comments on the DSEIS; these comments are addressed in Appendix A.2, "Comments Received on the North Anna Power Station, Units 1 and 2 DSEIS Environmental Review," in this EIS. The NRC staff was preparing to address those comments in a Final Supplemental Environmental Impact Statement (FSEIS). However, on February 24, 2022, before the NRC issued the FSEIS, the NRC Commission issued three memoranda and orders that addressed SLR proceedings for five nuclear power plant SLR applications. Two of these orders, Commission Legal Issuance (CLI)-22-02 (NRC 2022-TN8182) and CLI-22-03 (NRC 2022-TN8272), are relevant to the North Anna SLR environmental review. In those orders, the Commission concluded that the LR GEIS, which the NRC staff relies on in part to meet its obligations under 10 CFR Part 51 and NEPA, did not consider the impacts from operation during the SLR period of extended operations (PEO). Therefore, the Commission determined that the NEPA reviews for the affected nuclear power plants, including North Anna, were inadequate.

In CLI-22-03, the Commission directed the NRC staff to review and update the LR GEIS so that it covers nuclear power plant operation during the SLR PEO. The Commission stated that the most efficient way to proceed would be for the NRC staff to review and update the LR GEIS and then take appropriate action with respect to pending SLR applications to ensure that the environmental impacts of SLR are considered. However, the Commission afforded SLR applicants an opportunity to submit a revised ER, providing a site-specific evaluation of environmental impacts during the SLR PEO. In such a submittal, SLR applicants must evaluate, on a site-specific basis, the impacts of environmental issues that were dispositioned in the LR GEIS and Table B–1 in Appendix B to Subpart A of 10 CFR Part 51 as generic (Category 1) issues. The NRC staff would then address the impacts of these issues during the SLR PEO in site-specific EISs.

On September 28, 2022, Dominion submitted a supplement to its ER, in which it presented a site-specific environmental review of the impacts of continued operations of North Anna during the SLR period for those environmental issues for which Dominion had previously relied on the LR GEIS's generic findings in its ER (VEPCO 2022-TN8270). That review addressed on a site-specific basis each environmental issue that had been previously dispositioned as a Category 1 issue in the 2013 LR GEIS and Dominion's ER.

- This EIS considers the impacts of all subsequent license renewal issues applicable to North Anna SLR on a site-specific basis, including the site-specific issues considered in the August 2021 DSEIS as well as the issues that had been treated as generic Category 1 issues in the August 2021 DSEIS. This EIS

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considers information in Dominion's SLR application, as supplemented; Dominion's September 28, 2022, submittal; the staff's consultation with Federal, State, Tribal, and local government agencies; and other new information, as appropriate. In addition, Appendix A.2 ~~considered public comments received during the scoping comment period~~

of this EIS presents the comments that the NRC staff received on the DSEIS and the staff's responses thereto. The NRC staff considered those comments, as appropriate, in the discussions and analyses contained in this draft EIS. Thus, this EIS supersedes the August 2021 DSEIS.

Proposed Action

~~Dominion initiated the~~The proposed Federal action (~~issuance of subsequent renewed power reactor~~renewal of the North Anna operating licenses ~~for North Anna)~~) was initiated by Dominion upon submitting ~~an~~its SLR application. The ~~existing~~current North Anna operating licenses ~~were previously renewed for a period of 20 years, and~~are set to expire at midnight on April 1, 2038, for Unit 1 (NPF-4) and August 21, 2040, for Unit 2 (NPF-7). The NRC's Federal action is to ~~decide~~determine whether to ~~issue subsequent renewed~~renew the North Anna operating licenses ~~authorizing~~for an additional 20 years of reactor operation. If the NRC ~~issues~~renews the ~~subsequent renewed~~operating licenses, ~~North Anna Units 1 and 2~~Dominion would be authorized to operate until April 1, 2058 (Unit 1), and August 21, 2060~~, respectively.~~ (Unit 2).

Purpose and Need for ~~Actions~~the Proposed Federal Action

The purpose and need for the proposed action (~~i.e., issuance of subsequent renewed~~renewal of the North Anna operating licenses) is to provide an option that allows for power generation capability beyond the term of the current renewed nuclear power plant operating licenses to meet future system generating needs~~. Energy~~, as such needs may be determined by energy-planning ~~decisionmakers~~decision-makers such as ~~States~~State regulators, utility ~~operators~~owners, and, where authorized, Federal agencies (other than the NRC~~) may determine these future system generating needs. The Atomic Energy Act of 1954, as amended, and the National Environmental Policy Act of 1969, as amended, require the NRC to perform a safety review and an environmental review of the proposed action. The above~~). The definition of purpose and need reflects the NRC's recognition that, ~~unless there are~~absent findings in the ~~staff~~safety review required by the Atomic Energy Act of 1954, as amended, or in the NEPA environmental analysis that would lead the NRC to reject ~~a license renewal~~an SLR application, the NRC ~~does not have a~~has no role in the energy-planning decisions of utility officials and State regulators as to whether a particular nuclear power plant should continue to operate.

Environmental Impacts of Subsequent License Renewal

This ~~SEIS~~site-specific EIS evaluates the potential environmental impacts of the proposed action and reasonable alternatives to that action. The NRC designates the environmental impacts from the proposed action and reasonable alternatives as SMALL, MODERATE, or LARGE.~~The NRC designates the environmental impacts from the proposed action and reasonable alternatives as SMALL, MODERATE, or LARGE.~~ These designations are described below:

SMALL: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

MODERATE: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

LARGE: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

~~NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (the GEIS), evaluates 78 environmental issues related to plant operation and classifies each issue as either a Category 1 issue (generic to all or a distinct subset of nuclear power plants as described below) or a Category 2 issue (specific to individual power plants). Category 1 issues are those that meet all the following criteria:~~

- ~~The environmental impacts associated with the issue apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristics.~~
- ~~A single significance level (i.e., SMALL, MODERATE, or LARGE) has been assigned to the impacts except for collective offsite radiological impacts from the fuel cycle and from high-level waste and spent fuel disposal.~~
- ~~Mitigation of adverse impacts associated with the issue is considered in the analysis, and it has been determined that additional plant-specific mitigation measures are likely not to be sufficiently beneficial to warrant implementation.~~

~~For Category 1 issues, no additional site-specific analysis is required in this SEIS unless new and significant information is identified. Chapter 4 of this SEIS presents the process for identifying new and significant information.~~

~~Category 2 issues are site-specific issues that do not meet one or more of the criteria for Category 1 issues; therefore, an SEIS must include additional site-specific review for these non-generic issues.~~

~~Table 3-1 in Chapter 3 lists the Category 1 issues that are applicable to North Anna, and the significance levels of their impacts. Dominion and the NRC staff have identified no information that is both new and significant related to Category 1 issues that has the potential to affect the conclusions in the GEIS. This conclusion is supported by the NRC staff's review of Dominion's environmental report and other documentation relevant to the applicant's activities, the public scoping process, and the findings from the NRC staff's site audits. Therefore, the NRC staff relied upon the conclusions of the GEIS for all Category 1 issues applicable to North Anna.~~

~~In this SEIS, the NRC staff evaluated Category 2 issues applicable to North Anna, as well as cumulative impacts, and considered new information regarding severe accident mitigation alternatives (SAMAs). Table ES-1 summarizes the Category 2 issues relevant to North Anna and the NRC staff's findings related to those issues. If the NRC staff determined that there were no Category 2 issues applicable for a particular resource area, then the findings of the GEIS, as documented in Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," of 10 CFR Part 51, are incorporated for that resource area.~~

In this EIS, the NRC staff evaluates 66 environmental issues applicable to North Anna SLR. Table B–1 in Appendix B to Subpart A of 10 CFR Part 51 and the LR GEIS address 54 of these issues as "generic" or "Category 1" issues. In the 2021 DSEIS, the NRC relied upon the analysis

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and conclusions in the 2013 LR GEIS for each of those generic (category 1) issues. The NRC staff determined that there would be no impacts related to these issues beyond those already discussed in the GEIS. For each of those issues, the staff adopted the LR GEIS's conclusions of "SMALL." However, as explained under "Background," the Commission has determined that the staff cannot rely on the LR GEIS for SLR reviews. Therefore, in this EIS, the NRC staff addresses each of these 54 "generic" environmental issues on a site-specific basis.

In the 2021 DSEIS, additional environmental issues were evaluated on a site-specific basis. Table B–1 in Appendix B to Subpart A of 10 CFR Part 51 and the LR GEIS address these issues as "site-specific" or "Category 2" issues. In the 2021 DSEIS, the NRC staff performed site-specific analyses and made site-specific findings of SMALL, MODERATE, or LARGE for each of these issues. This site-specific EIS includes the NRC staff's original site-specific analyses from the DSEIS, with certain updates and revisions (based, in part, upon comments received on the DSEIS), as appropriate.

Table ES-1 lists 66 environmental issues applicable to North Anna SLR and the NRC staff's findings related to these issues. The issues that are denoted with a Footnote "(a)" identify those issues that were formerly addressed in the 2021 DSEIS as Category 1 issues.

Table ES-1 Summary of ~~NRC Conclusions Relating to Site-Specific Impacts of~~Conclusions Regarding North Anna Power Station Subsequent License Renewal ~~at North Anna~~

Resource Area	~~Relevant Category 2 Issues~~Environmental Issue	Impacts
~~Groundwater Resources~~Land Use	Onsite land use[(a)]~~Radionuclides released to groundwater~~	SMALL
~~Terrestrial Resources~~Land Use	~~Effects on terrestrial resources (noncooling system impacts)~~Offsite land use[(a)]	SMALL
Land Use	Offsite land use in transmission line right-of-ways (ROWs)[(a)]	SMALL
~~Aquatic~~Visual Resources	~~Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)~~	~~SMALL~~
	~~Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds)~~Aesthetic impacts[(a)]	SMALL
~~Special Status Species and Habitats~~	~~Threatened, endangered, and protected species and essential fish habitat~~	~~May affect, but is not likely to adversely affect, the northern long-eared bat. Unlikely to result in effects on the northern long-eared bat habitat.~~
~~Historic and Cultural Resources~~	~~Historic and cultural resources~~	~~Would not adversely affect known historic properties~~
~~Human Health~~	~~Microbiological hazards to the public (plants with cooling ponds or canals or cooling towers that discharge to a river)~~	~~SMALL~~
	~~Electric shock hazards~~	~~SMALL~~
	~~Chronic effects of electromagnetic fields~~	~~Uncertain impact~~

~~Special Status Species and Habitats~~	~~Threatened, endangered, and protected species and essential fish habitat~~	~~May affect, but is not likely to adversely affect, the northern long-eared bat. Unlikely to result in effects on the northern long-eared bat habitat.~~
~~Environmental Justice~~	~~Minority and low-income populations~~	~~No disproportionately high and adverse human health and environmental effects on minority and low-income populations~~
~~Cumulative Impacts~~	~~Cumulative impacts~~	~~See SEIS Section 3.16~~
~~Postulated Accidents~~	~~Severe accidents (SAMAs)~~	~~See SEIS Appendix F~~

Table ES-1 Summary of Site-Specific Conclusions Regarding North Anna Power Station Subsequent License Renewal (Continued)

Resource Area	Environmental Issue	Impacts
Air Quality	Air quality impacts (all plants)[a]	SMALL
Air Quality	Air quality effects of transmission lines[a]	SMALL
Noise	Noise impacts[a]	SMALL
Geologic Environment	Geology and soils[a]	SMALL
Surface Water Resources	Surface water use and quality (non-cooling system impacts)[a]	SMALL
Surface Water Resources	Altered current patterns at intake and discharge structures[a]	SMALL
Surface Water Resources	Altered thermal stratification of lakes[a]	SMALL
Surface Water Resources	Scouring caused by discharged cooling water[a]	SMALL
Surface Water Resources	Discharge of metals in cooling system effluent[a]	SMALL
Surface Water Resources	Discharge of biocides, sanitary wastes, and minor chemical spills[a]	SMALL
Surface Water Resources	Surface water use conflicts (plants with once-through cooling systems)[a]	SMALL
Surface Water Resources	Effects of dredging on surface water quality[a]	SMALL
Surface Water Resources	Temperature effects on sediment transport capacity[a]	SMALL
Groundwater Resources	Groundwater contamination and use (non-cooling system impacts)[a]	SMALL
Groundwater Resources	Groundwater use conflicts (plants that withdraw less than 100 gallons per minute [gpm])[a]	SMALL
Groundwater Resources	Radionuclides released to groundwater	SMALL
Terrestrial Resources	Effects on terrestrial resources (non-cooling system impacts)	SMALL
Terrestrial Resources	Exposure of terrestrial organisms to radionuclides[a]	SMALL

Table ES-1 Summary of Site-Specific Conclusions Regarding North Anna Power Station Subsequent License Renewal (Continued)

Resource Area	Environmental Issue	Impacts
Terrestrial Resources	Cooling system impacts on terrestrial resources (plants with once-through cooling systems or cooling ponds)[a]	SMALL
Terrestrial Resources	Bird collisions with plant structures and transmission lines[a]	SMALL
Terrestrial Resources	Transmission line right-of-way (ROW) management impacts on terrestrial resources[a]	SMALL
Terrestrial Resources	Electromagnetic fields on flora and fauna (plants, agricultural crops, honeybees, wildlife, livestock)[a]	SMALL
Aquatic Resources	Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	SMALL
Aquatic Resources	Entrainment of phytoplankton and zooplankton (all plants)[a]	SMALL
Aquatic Resources	Thermal impacts on aquatic organisms (plants with once-through cooling systems or cooling ponds)	SMALL
Aquatic Resources	Infrequently reported thermal impacts (all plants)[a]	SMALL
Aquatic Resources	Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication[a]	SMALL
Aquatic Resources	Effects of non-radiological contaminants on aquatic organisms[a]	SMALL
Aquatic Resources	Exposure of aquatic organisms to radionuclides[a]	SMALL
Aquatic Resources	Effects of dredging on aquatic resources[a]	SMALL
Aquatic Resources	Effects on aquatic resources (non-cooling system impacts)[a]	SMALL
Aquatic Resources	Impacts of transmission line right-of-way (ROW) management on aquatic resources[a]	SMALL
Aquatic Resources	Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses[a]	SMALL
Special Status Species and Habitats	Threatened, endangered, and protected species and essential fish habitat	May affect but is not likely to adversely affect the northern long-eared bat, tricolored bat, and monarch butterfly; no effect on essential fish habitat; no effect on sanctuary resources of National Marine Sanctuaries
Historic and Cultural Resources	Historic and cultural resources	Would not adversely affect known historic properties

Table ES-1 Summary of Site-Specific Conclusions Regarding North Anna Power Station Subsequent License Renewal (Continued)

Resource Area	Environmental Issue	Impacts
Socioeconomics	Employment and income, recreation, and tourism[a]	SMALL
Socioeconomics	Tax revenues[a]	SMALL
Socioeconomics	Community services and education[a]	SMALL
Socioeconomics	Population and housing[a]	SMALL
Socioeconomics	Transportation[a]	SMALL
Human Health	Radiation exposures to the public[a]	SMALL
Human Health	Radiation exposures to plant workers[a]	SMALL
Human Health	Human health impact from chemicals[a]	SMALL
Human Health	Microbiological hazards to the public (plants with cooling ponds or canals or cooling towers that discharge to a river)	SMALL
Human Health	Microbiological hazards to plant workers[a]	SMALL
Human Health	Chronic effects of electromagnetic fields (EMFs)	Uncertain impact
Human Health	Physical occupational hazards[a]	SMALL
Human Health	Electric shock hazards	SMALL
Postulated Accidents	Design-basis accidents[a]	SMALL
Postulated Accidents	Severe accidents	See EIS Appendix F
Environmental Justice	Minority and low-income populations	No disproportionate and adverse human health and environmental effects on minority and low-income populations
Waste Management	Low-level waste storage and disposal[a]	SMALL
Waste Management	Onsite storage of spent nuclear fuel[a]	SMALL
Waste Management	Offsite radiological impacts of spent nuclear fuel and high-level waste disposal[a]	[b]
Waste Management	Mixed-waste storage and disposal[a]	SMALL
Waste Management	Nonradioactive waste storage and disposal[a]	SMALL
Cumulative Impacts	Cumulative impacts	See EIS Section 3.15
Uranium Fuel Cycle	Offsite radiological impacts—individual impacts from other than the disposal of spent fuel and high-level waste[a]	SMALL
Uranium Fuel Cycle	Offsite radiological impacts—collective impacts from other than the disposal of spent fuel and high-level waste[a]	[c]
Uranium Fuel Cycle	Nonradiological impacts of the uranium fuel cycle[a]	SMALL
Uranium Fuel Cycle	Transportation[a]	SMALL
Termination of Plant Operations and Decommissioning	Termination of plant operations and decommissioning[a]	SMALL

Note: gpm = gallons per minute; ROW = right-of-way; SAMA = severe accidents.
(a) Dispositioned as generic (Category 1) for initial license renewal of nuclear power plants in Table B–1 in Appendix B to Subpart A of Title 10 CFR Part 51 (TN250).
(b) The ultimate disposal of spent fuel in a potential future geologic repository is a separate and independent licensing action that is outside the regulatory scope of this site-specific review. Per 10 CFR Part 51 (TN250) Subpart A the Commission concludes that the impacts presented in NUREG-2157 (NRC 2014-TN4117) would not be sufficiently large to require the NEPA conclusion, for any plant, that the option of extended operation under 10 CFR Part 54 (TN4878) should be eliminated. Accordingly, while the Commission has not assigned a single level of significance for the impacts of spent nuclear fuel and high-level waste disposal, this issue is considered generic to all nuclear power plants and does not warrant a site-specific analysis.
(c) There are no regulatory limits applicable to collective doses to the general public from fuel cycle facilities. The practice of estimating health effects on the basis of collective doses may not be meaningful. All fuel cycle facilities are designed and operated to meet the applicable regulatory limits and standards. As stated in the 2013 GEIS, "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 Part 54 should be eliminated." (10 CFR Part 54; TN4878) (Section 3.13.3.3 of this EIS).

Alternatives

As part of its environmental review of SLR applications, the NRC staff is required to consider alternatives to ~~license renewal~~SLR and evaluate the environmental impacts associated with each alternative. These alternatives can include other methods of power generation (replacement ~~power~~energy alternatives), as well as simply not renewing the North Anna operating licenses (~~the~~ no-action alternative~~).~~).

In total, the NRC staff ~~initially~~ considered 16 alternatives ~~but later dismissed~~ to the proposed action and eliminated 14 ~~of these because of~~from detailed study due to technical, resource availability, or commercial limitations that ~~currently exist and that the NRC staff believes~~ are likely to ~~still~~ exist when the ~~current~~ North Anna operating licenses expire. ~~This left two feasible and~~ Two replacement energy alternatives were determined to be commercially viable ~~replacement power alternatives which, in addition to the no-action alternative, the staff evaluates in depth in this report~~, and include:

1. new nuclear (small modular reactor ~~or~~ [SMR~~)~~]) alternative
2. combination alternative of solar photovoltaic, offshore wind, new nuclear (SMR), and demand-side management

These ~~are the 14 additional~~ alternatives ~~that~~, along with the no-action alternative, were evaluated in detail in this EIS. In addition, the NRC staff ~~considered but ultimately dismissed:~~

- ~~natural gas combined-cycle~~
  - ~~solar power~~
  - ~~wind power~~
- ~~biomass~~
  - ~~demand-side management~~
  - ~~hydroelectric power~~
  - ~~geothermal power~~
  - ~~wave and ocean energy~~
- ~~municipal solid waste power~~
  - ~~petroleum-fired power~~

- ~~coal-fired power~~
- ~~fuel cells~~
- ~~purchased power~~
- ~~delayed retirement of other power generating facilities~~

~~The NRC staff evaluated each of the remaining alternatives that was considered to be reasonable, using the same resource areas that it used in evaluating impacts from license renewal. The NRC staff~~ also evaluated ~~any~~ new and significant information that could alter the conclusions of the ~~SAMA~~severe accident mitigation alternatives (SAMA) analysis ~~that was performed~~ previously ~~in connection with~~performed for the North Anna initial license renewal ~~of North Anna~~ in 2003, which authorized ~~North Anna to be operated~~continued reactor operation for ~~a period of~~an additional 20 years beyond the original 40-year operating license ~~period~~term.

Preliminary Recommendation

The NRC staff's preliminary recommendation is that the adverse environmental impacts of ~~subsequent license renewal for~~ North Anna SLR are not so great that preserving the option of ~~subsequent license renewal~~SLR for energy -planning ~~decisionmakers~~decision-makers would be unreasonable. The NRC staff based its preliminary recommendation on the following:

- ~~the analysis and findings in NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*~~
- ~~the environmental report submitted by Dominion~~
- Dominion's ER, as supplemented
- the NRC staff's ~~consultation~~consultations with Federal, State, Tribal, and local agencies
- the NRC staff's independent environmental review
- ~~the NRC staff's~~ consideration of public comments received during ~~the~~two scoping ~~comment period~~

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- periods and comments received on the 2021 DSEIS

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As discussed in Section 3.11.5~~3.11.4, "Electromagnetic Fields~~, "Other Hazards," there are no offsite transmission ~~lines~~lines that are in scope for this ~~SEIS.~~ EIS. Therefore, there are no potential impacts on members of the public. There are four onsite overhead transmission lines with the potential for electric shock to workers through induced currents. To address this occupational hazard, Dominion adheres to NESC code and OSHA compliance requirements for shock hazard avoidance, as supported by a corresponding investigation of the before-mentioned overhead transmission lines. As discussed in Section 3.11.5~~3.11.5,~~ North Anna maintains an occupational safety program for its workers in accordance with OSHA regulations, which includes protection from acute electric shock. Therefore, the NRC staff concludes that the potential impacts from acute electric shock during the SLR term would be SMALL.

~~*3.12.6.3*~~*3.11.6.9~~*Environmental Consequences of Postulated Accidents*

This section considers two environmental issues identified in Table 3-1~~The GEIS (NRC 2013a) evaluates the following~~: design-basis accidents and SAMAs.

There are two classes of postulated ~~accidents~~accidents as they relate to ~~license renewal~~nuclear power plants:

- Design-Basis Accidents: Postulated accidents that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to ensure public health and safety.
- Severe Accidents: Postulated accidents that are more severe than design-basis ~~accidents~~accidents because they could result in substantial damage to the reactor core.

~~As shown in Table 3-1 of this report, the GEIS (NRC 2013a) addresses design-basis accidents as a Category 1 issue and concludes that the environmental impacts of design-basis accidents are of SMALL significance for all nuclear power plants.~~

~~As shown in Table 3-2 of this report, the GEIS (NRC 2013a) designates~~For design-basis accidents, site-specific analysis of design-basis accidents is in the North Anna Updated Final Safety Analysis Report (UFSAR). For plant changes during the North Anna PEO, the validity of the UFSAR is maintained in compliance with 10 CFR 50.59, "Changes, tests and experiment." The UFSAR design-basis accident analysis forms the technical bases for the North Anna Technical Specifications for operation. The UFSAR and Technical Specification are parts of the current licensing basis and are the subject of the NRC oversight program for operation during PEO. Therefore, NRC staff concludes that the impacts of design-basis accidents are of SMALL significance. Appendix F contains additional discussion on North Anna postulated accidents.

For severe accidents ~~as~~, staff performed a ~~Category 2 issue requiring~~ site-specific analysis. in Appendix F. Based on information in ~~the 2013 GEIS~~this analysis, the NRC staff ~~determined in 10 CFR Part 51, Subpart A, Appendix B,~~concludes that ~~for all nuclear power plants,~~ the environmental impacts of severe accidents associated with license renewal are SMALL, with a the following caveat:

> The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater, and societal and economic impacts from severe accidents are SMALL for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives. [NRC ~~2013a~~2013-TN2654]

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Dominion's 2001 ER, submitted as part of its initial license renewal application, included an assessment of SAMAs for North Anna (~~Dominion~~VEPCO 2001~~).~~ ~~–~~TN8297). The NRC staff at that time reviewed Dominion's 2001 analysis of SAMAs for North Anna and documented this review in its SEIS for the initial license renewal, which the NRC published in 2002, as Supplement 7 to NUREG~~–~~1437 (NRC ~~2002b).~~ 2002-TN665). Because the NRC staff has previously considered SAMAs for North Anna, Dominion is not required to perform another SAMA analysis for its ~~subsequent license renewal~~SLR application (10 CFR 51.53(c)(3)(ii)(L~~))~~)) (TN250).

However, the NRC's regulations at 10 CFR Part 51~~,~~ (TN250), which implement NEPA Section 102(2), require that (a1) all applicants for license renewal submit an ER to the NRC and (~~b~~2) in the ER, the applicant is to identify any "new and significant information regarding the environmental impacts of license renewal of which the applicant is aware" (10 CFR 51.53(c)(3)(iv~~)).~~)) (TN250). This includes new and significant information that could affect the environmental impacts related to postulated severe accidents or that could affect the results of a previous SAMA assessment. Accordingly, in its ~~subsequent license renewal~~2021 SLR application ER, Dominion evaluated areas of new and potentially significant information that could affect the environmental impact of postulated severe accidents during the SLR period. The NRC staff discusses new information pertaining to SAMAs in Appendix F~~Appendix F,~~ "Environmental Impacts of Postulated Accidents," in this ~~SEIS~~EIS.

Based on the NRC staff's review and evaluation of Dominion's analysis of new and potentially significant information regarding SAMAs and the staff's independent analyses as documented in Appendix F ~~to~~of this ~~SEIS~~EIS, the staff finds that there is no new and significant information for North Anna related to SAMAs.

3.11.7 No-Action Alternative

~~3.12.73.1.1No-Action Alternative~~

Under the no-action alternative~~,~~ the NRC would not issue subsequent renewed licenses, and North Anna would shut down on or before the expiration of the current renewed licenses. Human health risks would be smaller following nuclear power plant shutdown. The reactor units, which currently operate within regulatory limits, would emit less radioactive gaseous, liquid, and solid material to the environment. In addition, following shutdown, the variety of potential accidents at the nuclear power plant (radiological or industrial) would be reduced to a limited set associated with shutdown events and fuel handling and storage. In Section 3.11.6~~3.11.6,~~ "Proposed Action," the NRC staff concluded that the impacts of continued nuclear power plant operation on human health would be SMALL, except for "Chronic effects of electromagnetic fields (EMFs)," for which the impacts are UNCERTAIN. In Section 3.11.6.9~~3.11.6.4,~~ "Environmental Consequences of Postulated Accidents," the NRC staff concluded that the impacts of accidents during operation are SMALL. Therefore, as radioactive emissions to the environment decrease, and as the likelihood and types of accidents decrease following shutdown, the NRC staff concludes that the risk to human health following nuclear power plant shutdown would be SMALL.

~~3.12.83~~3.11.8Replacement Power Alternatives: Common Impacts

Impacts on human health from construction of a replacement power station would be similar to impacts associated with the construction of any major industrial facility. Compliance with worker

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nuclear power plant are evaluated NUREG-0586, "Generic Environmental Impact Statement on Decommissioning Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors" (NRC 2002-TN7254). The NRC staff determined that license renewal would have a negligible effect on these impacts of terminating operations and decommissioning on all resources.

The NRC staff identified no information or situations that would result in different environmental impacts for this issue for the SLR term at North Anna. Therefore, the NRC staff concludes that the incremental environmental impacts of termination of plant operations and decommissioning due to continued nuclear power plant operations at North Anna during the SLR term would be SMALL (NRC 2002-TN7254).

New Nuclear Alternatives

The environmental impacts from the termination of nuclear power plant operations and decommissioning of a power generating facility are dependent on the facility's decommissioning plan. ~~The decommissioning plan outlines~~Decommissioning plans generally outline the actions ~~necessary~~needed to restore the site to a condition equivalent in character and value to the site on which the facility was first constructed ~~(NRC 2013a).~~ . General elements and requirements for a thermoelectric power plant decommissioning plan ~~are discussed in Section 4.12.2.2 of the license renewal GEIS (NRC 2013a) and~~ can include the removal of structures ~~to at least 3 ft (1 m)~~ below grade, the removal of all accumulated waste materials, the removal of intake and discharge structures, and the cleanup and remediation of incidental spills and leaks at the facility. ~~The staff incorporates the information in NUREG-1437, Revision 1, Section 4.12.2.2 (NRC 2013a: 4-224, 4-225), here by reference.~~

Activities that are unique to the termination of operations and decommissioning of a nuclear power generating facility include the safe removal of the facility from service and the reduction of residual radioactivity to a level that permits release of the property under restricted conditions or unrestricted use and termination of the license.

Renewable Energy Alternatives

Termination of nuclear power plant operation and decommissioning for renewable energy facilities would generally be similar to the impacts discussed for new nuclear alternatives above. Decommissioning would involve the removal of facility components and operational wastes and residues to restore sites to a condition equivalent in character and value to the site on which the facility was first constructed ~~(NRC 2013a). The range of possible decommissioning impacts, depending on the renewal energy alternative considered, are discussed in Section 4.12.2.2 of the GEIS (see subsection, "Renewable Alternatives") (NRC 2013a).~~.

~~3.15.3~~3.14.3 Greenhouse Gas Emissions and Climate Change

The following sections discuss ~~greenhouse gas (GHG)~~ emissions and climate change impacts. Section 3.14.3.1~~3.15.3.1~~ evaluates GHG emissions associated with the operation of North Anna and replacement power alternatives. ~~.~~ Section 3.14.3.2~~3.15.3.2~~ discusses the observed changes in climate and potential future climate change during the ~~subsequent license renewal~~SLR term, based on climate model simulations under future global GHG emissions scenarios. ~~In Section 3.16, "Cumulative Impacts," of this SEIS, the NRC staff considers the potential cumulative, or overlapping, impacts from climate change on environmental resources where there are incremental impacts of the proposed action (subsequent license renewal).~~

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~~3.15.3.1~~3.14.3.1 *Greenhouse Gas Emissions from the Proposed Project and Alternatives*

Gases found in the Earth's atmosphere that trap heat and play a role in the Earth's climate are collectively termed ~~greenhouse gases (~~GHGs~~).~~. These GHGs include ~~carbon dioxide (~~CO_2~~),~~, methane (CH_4), nitrous oxide (N_2O), water vapor ~~(H_2O),~~ and fluorinated gases, such as hydrofluorocarbons ~~(HFCs),~~, perfluorocarbons ~~(PFCs),~~, and sulfur hexafluoride ~~(SF_6).~~. The Earth's climate responds to changes in concentrations of GHGs in the atmosphere because these gases affect the amount of energy absorbed and heat trapped by the atmosphere. Increasing concentrations of ~~these gases~~GHGs in the atmosphere generally increase the Earth's surface temperature. Atmospheric concentrations of ~~carbon dioxide, methane~~CO_2, CH_4, and ~~nitrous oxide~~N_2O have significantly increased since 1750 (IPCC ~~2007~~2013-TN7434, IPCC ~~2013). Carbon dioxide, methane, nitrous oxide~~2021-TN7435). In 2019, atmospheric concentrations of CO_2 (measured at 410 parts per million) were higher than any time in at least 2 million years (IPCC 2023-TN8557). Long-lived GHGs—CO_2, CH_4, N_2O, and fluorinated gases ~~(termed long-lived GHGs)~~ —are well mixed throughout the Earth's atmosphere, and their impact on climate is long-lasting and cumulative in nature as a result of their long atmospheric ~~lifetime~~lifetimes (EPA 2016~~).~~ TN7561). Therefore, the extent and nature of climate change is not specific to where GHGs are emitted. Carbon dioxide is of primary concern for global climate change because it is the primary gas emitted as a result of human activities. ~~Climate change research indicates that the cause of the Earth's warming over the last 50 years is due to the buildup of GHGs in the atmosphere resulting from human activities (IPCC 2013; USGCRP 2014, USGCRP 2017, USGCRP 2018). EPA has determined that GHGs "may reasonably be anticipated both to endanger public health and to endanger public welfare" (74 FR 66496).~~

~~3.15.4~~3.1.1 ~~Proposed Action~~

The sixth assessment synthesis report from the Intergovernmental Panel on Climate Change states that "it is unequivocal that human influence has warmed the atmosphere, ocean, and land" (IPCC 2023-TN8557). In 2019, global net GHG emissions were estimated to be 59±6.6 gigatons of CO_2 equivalents (CO_2eq), with the largest share in gross GHG emissions being CO_2 from fossil fuels combustion and industrial processes (IPCC 2023-TN8557). The EPA has determined that GHGs "may reasonably be anticipated both to endanger public health and to endanger public welfare" (74 FR 66496-TN245).

Proposed Action

The operation of North Anna results in both direct and indirect GHG emissions. Dominion has calculated direct (i.e., stationary and portable combustion sources) and indirect (i.e., workforce commuting~~) GHG emissions, which are reported in Table 3-32. Dominion does not maintain an inventory of GHG emissions resulting from visitor and delivery vehicles (Dominion 2020b).~~). Fluorinated gas emissions from refrigerant sources and from electrical transmission and distribution systems can result from leakage, servicing, repair, or disposal of sources. Dominion uses sulfur hexafluoride for electrical breaker cooling. In addition to being GHGs, chlorofluorocarbons and hydrochlorofluorocarbons are ozone-depleting substances that are regulated by the ~~Clean Air Act~~CAA (42 U.S.C. 7401 et seq.~~).~~; Clean Air Act-TN1141) under Title VI, "Stratospheric Ozone Protection." Dominion maintains a program to manage stationary refrigeration appliances at North Anna to recycle, recapture, and reduce emissions of ozone-depleting substances. North Anna's annual GHG emissions are reported in Table 3-32. Dominion does not maintain an inventory of GHG emissions resulting from visitor and delivery vehicles (VEPCO 2020-TN8099). Therefore, Table 3-32 ~~Therefore, Table 3-32 below does not account for any potential emissions from stationary refrigeration sources at North Anna~~

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~~(Dominion 2020b). In addition, Dominion uses mineral oil in electrical equipment (e.g., transformers) and does not purchase electrical equipment containing perfluorocarbon liquids (Dominion 2020b).~~ below does not account for GHG emissions from visitor and delivery vehicles.

Table 3-32 Annual Greenhouse Gas Emissions from Operation at North Anna, ~~Units 1 and 2~~

Year	Onsite ~~Combustion~~ Sources[a] (in tons)	Workforce Commuting[b] (in tons)	Total Carbon Dioxide Equivalents (CO_2eq) (in tons)
~~2013~~2017	~~620~~1,010	4,~~490~~485	5,~~110~~495
~~2014~~2018	~~430~~1,140	4,~~490~~485	4,~~920~~5,625
~~2015~~2019	~~560~~1,090	4,~~490~~485	5,~~050~~575
~~2016~~2020	~~690~~1,020	4,~~490~~485	5,~~180~~505
~~2017~~2021	~~480~~930	4,~~490~~485	4,~~970~~5,415
2022	700	4,485	5,185

~~Note: GHG emissions are reported in metric tons and converted to short tons. All reported values are rounded. To convert tons per year, multiply by 0.90718. Expressed in carbon dioxide equivalents (CO_2eq), a metric used to compare the emissions of greenhouse gases (GHG) based on their global warming potential (GWP). The GWP is a measure used to compare how much heat a GHG traps in the atmosphere. The GWP is the total energy that a gas absorbs over a period of time compared to carbon dioxide. CO_2eq is obtained by multiplying the amount of the GHG by the associated GWP. For example, the GWP of methane is 21; therefore, 1 ton of methane emission is equivalent to 21 tons of carbon dioxide emissions.~~

~~[a] Onsite combustion sources include the North Anna blackout diesel generator and four emergency generators.~~

~~[b] Emissions consider North Anna permanent full-time employees and contract workers (866 passenger vehicles per day based on a 4.1 percent carpool rate for 903 employees) and does not include additional contractor workers during refueling outages. Refueling outages occur on a staggered, 18-month schedule and last approximately 30 days per unit.~~

~~Source: Dominion 2020b~~

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Inserted Cells
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~~3.15.53.1.1~~No-Action Alternative

Note: GHG emissions are reported in metric tons and converted to short tons. All reported values are rounded. To convert tons per year, multiply by 0.90718. Expressed in carbon dioxide equivalents (CO_{2eq}), a metric used to compare the emissions of GHGs based on their GWP. The GWP is a measure used to compare how much heat a GHG traps in the atmosphere. The GWP is the total energy that a gas absorbs over a period of time compared to

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CO_2. CO_{2e} is obtained by multiplying the amount of the GHG by the associated GWP. For example, the GWP of methane is 21; therefore, 1 ton of methane emission is equivalent to 21 tons of CO_2 emissions.
(a) Onsite sources include the North Anna's combustion sources (blackout diesel generator and four emergency generators), CO_2 added to the fire suppression system, sulfur hexafluoride used for electrical breaker cooling, and hydrofluorocarbon refrigerant used for equipment onsite.
(b) Emissions consider North Anna permanent full-time workers (870 passenger vehicles per day based on a 3.6 percent carpool rate for 903 employees) and does not include additional contractor workers during refueling outages. Refueling outages occur on a staggered, 18-month schedule and last approximately 30 days per unit.
Source: VEPCO 2023-TN8534

No-Action Alternative

Under the no-action alternative~~,~~ the NRC would not issue subsequent renewed licenses, and North Anna would shut down on or before the expiration of the current renewed licenses. At some point, all nuclear power plants will terminate operations and undergo decommissioning. The ~~Decommissioning~~decommissioning GEIS (NUREG-0586, NRC ~~2002a~~2002-TN665) considers the environmental impacts from decommissioning. Therefore, the scope of impacts considered under the no-action alternative includes the immediate impacts resulting from activities at North Anna that would occur between nuclear power plant shutdown and the beginning of decommissioning (i.e., activities and actions necessary to cease operation of North Anna). Facility operations would terminate at or before the expiration of the current renewed licenses. When the facility stops operating, a reduction in GHG emissions from activities related to nuclear power plant operation, such as the use of diesel generators and employee vehicles, would occur. The NRC staff anticipates that GHG emissions for the no-action alternative would be less than those presented in Table 3-32~~Table 3-32.~~.

~~Since~~Because the no-action alternative would result in a loss of power-generating capacity due to nuclear power plant shutdown, the sections below discuss GHG emissions associated with replacement baseload power generation for each replacement power alternative analyzed.

New Nuclear Alternative (Small Modular Reactor)

The ~~license renewal~~LR GEIS (NUREG-1437) presents life-cycle GHG emissions associated with nuclear power generation. As presented in Tables 4.12-4 through 4.12-6 of the LR GEIS (NRC ~~2013a~~ 2013-TN2654), life-cycle GHG emissions from nuclear power generation can range from 1 to 288 grams of carbon equivalent per kilowatt-hour (g Ceq/kWh). Nuclear power plants do not burn fossil fuels to generate electricity. Sources of GHG emissions from the new nuclear alternative would include stationary combustion sources such as emergency diesel generators, boilers, and pumps similar to existing sources at North Anna (see Section 3.3.2~~3.3.2,~~ "Air Quality," of this ~~SEIS).~~ EIS). The NRC staff estimates that GHG emissions from a new nuclear alternative would be similar to those from North Anna.

Combination Alternative

For the combination alternative, GHGs would primarily be emitted from the new nuclear alternative component and offshore wind portion of this alternative. ~~GHG sources~~Sources of GHGs for the new nuclear portion are discussed above. ~~GHG sources~~Sources of GHGs for the offshore wind component would include diesel generators supporting meteorological data collection facilities. ~~GHG emissions~~Emissions of GHGs for the combination alternative would be similar and comparable to those from North Anna.

Summary of Greenhouse Gas Emissions from the Proposed Action and Alternatives

The proposed action, the no-action alternative~~,~~ new nuclear alternative, and combination alternative would have similar and comparable GHG emissions. If North Anna's generating

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capacity were to be replaced by either the new nuclear alternative or the combination alternative, there would be no significant increase or decrease in GHG emissions.

As discussed in Section 2.3.2 of this EIS, the Commonwealth of Virginia recently passed the VCEA (TN8532). This legislation mandates that electric generation in Virginia be 100 percent carbon-free by 2045; this would require the closure of all carbon-emitting power plants that generate electricity, including power plants that generate electricity using natural gas, unless a waiver has been sought by the utility and granted by the State, to allow the continued operation of such power plants. Further, the VCEA establishes yearly total electricity energy targets that must come from renewable sources. The NRC staff concludes that the proposed action, the new nuclear alternative, and the combination alternative appear to align with the goals of the VCEA.

~~3.15.5.1~~3.14.3.2 *Climate Change*

Climate change is the decades or longer change in climate measurements (e.g., temperature and precipitation) that has been observed on a global, national, and regional level (IPCC 2007; ~~EPA 2016; USGCRP 2014). Climate change can vary regionally, spatially, and seasonally, depending on local, regional, and global factors. Just as regional climate differs throughout the world, the impacts of climate change can vary among locations.~~ TN7421; EPA 2016-TN7561; USGCRP 2014-TN3472). Climate change research indicates that the cause of the Earth's warming over the last 50 to 100 years is due to the buildup of GHGs in the atmosphere resulting from human activities IPCC 2013-TN7434, IPCC 2021-TN7435; IPCC 2023-TN8557; USGCRP 2014-TN3472, USGCRP 2017-TN5848, USGCRP 2018-TN5847).

Observed Trends in Climate Change Indicators

Global surface temperature has increased faster since 1970 than in any other 50-year period over at least the last 2,000 years (IPCC 2023-TN8557). On a global level, from 1901 to 2016, the average temperature has increased by 1.8°F (~~1.0~~ °C) (USGCRP 2018~~).~~ TN5847). Since 1901, precipitation has increased at an average rate of 0.04 in. (0.0.1 cm) per decade on a global level (EPA 2021-TN8555). The ~~year 2018 was the second warmest year in a 140-year~~ U.S. Global Change Research Program (USGCRP) reports that from 1901 to 2016, average surface temperatures have increased by 1.8°F (1.0°C) across the contiguous United States (USGCRP 2018-TN5847). Since 1901, average annual precipitation has increased by 4 percent across the United States (USGCRP 2018-TN5847). Observed climate ~~record; the top five warmest years (in order) are~~ change indicators across the United States include increases in the frequency~~2016, 2019, 2015, 2017,~~ and ~~2018 (NOAA 2020a; NOAA 2020b).~~ intensity of heavy precipitation, earlier onset of spring snowmelt and runoff, rise of sea level and increased tidal flooding in coastal areas, an increased occurrence of heat waves, and a decrease in the occurrence of cold waves. Since the 1980s, data show an increase in the length of the frost-free season (i.e., the period between the last occurrence of 32°F (0°C) in the spring and first occurrence of 32°F (0°C) in the fall), across the contiguous United States. Over the period 1991 through 2011, the average frost-free season was 10 days longer (relative to the 1901 through 1960 time period) (USGCRP 2014-TN3472). Over just the past two decades, the number of high-temperature records observed in the United States has far exceeded the number of low-temperature records (USGCRP 2018-TN5847). Since the 1980s, the intensity, frequency, and duration of North Atlantic hurricanes have increased (USGCRP 2014-TN3472).

Climate change and its impacts can vary regionally, spatially, and seasonally, depending on local, regional, and global factors. Observed climate changes and impacts have not been uniform across the United States. Section 4.15.3.2, "Observed Trends in Climate Change

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Indicators," of NUREG-1437, Supplement 6, Second Renewal (NRC 2020b 2020-TN7324), the SEIS for subsequent license renewalSLR of Surry Power Station, Units 1 &and 2, describes in detail observed changes in average temperature and precipitation on a global level and across the United States and the Southeast region. Unlike Surry Power Station, North Anna is not located on a tidal river, and Lake Anna Reservoir is not directly affected by sea level changes along the Atlantic coast. See section 3.16.2"Climate Change Projections" below for a discussion of how climate change can impact surface water resources in the vicinity of North Anna. Therefore, with the exception of information related to sea level rise, the NRC staff incorporates the observed trends described in Section 4.15.3.2 of NUREG-1437, Supplement 6, Second Renewal by reference (NRC 2020b2020-TN7324: 4.15.3.2, 4127-4-127-4-129), with key information summarized below.

The Southeast is one of the few places in the world where there has not been an overall increase in daily maximum temperatures since 1900 (NOAA 2013a; USGCRP 20182013-TN7424); however, since the early 1960s, the Southeast has been warming at a similar rate as the rest of the United States and has been accompanied by an increase in the number of hot days with maximum temperatures above 95°F (35°C) in the daytime and above 75°F (23.9°C) in the nighttime (NOAA 2013a2013-TN7424; USGCRP 2009,-TN18, USGCRP 2014,-TN3472, USGCRP 2018-TN5847: Fig. 19.1). Average annual precipitation data for the Southeast region does not exhibit an increasing or decreasing trend overall for the long-term period (1895–2011) (NOAA 2013b). 2013-TN7433). Precipitation in the Southeast region varies considerably throughout the seasons, and average precipitation has generally increased in the fall and decreased in the summer (NOAA 2013b2013-TN7433; USGCRP 2009-TN18).

The NRC staff used the National Oceanic and Atmospheric Administration (NOAA) Climate at a Glance tool to analyze temperature and precipitation trends for the period of 1895–20202023 in the Eastern Piedmont Climate Division. A trend analysis shows that the average annual temperature has increased at a rate of 0.1°F (0.06°C) per decade, while average annual precipitation has increased at a rate of 0.2429 in. (0.67 cm) per decade (NOAA 2020c2023-TN8560).

Climate Change Projections

Future global GHG emission concentrations (emission scenarios) and climate models are commonly used to project possible climate change. Climate models indicate that, over the next few decades, temperature increases will continue due to current GHG emission concentrations in the atmosphere (USGCRP 2014). -TN3472). This is because it takes time for Earth's climate system to respond to changes in GHG concentrations; if GHG concentrations were to stabilize at current levels, this would still result in at least an additional 1.1°F (0.6°C) of warming (USGCRP 2018). -TN5847). Over the longer term, the magnitude of temperature increases and climate change effects will depend on future global GHG emissions (IPCC 2007-TN7421, IPCC 2013-TN7434; USGCRP 2009,-TN18, USGCRP 2014,-TN3472, USGCRP 2018). -TN5847). Climate model simulations often use GHG emission scenarios to represent possible future social, economic, technological, and demographic development that, in turn, drive future emissions. Consequently, the GHG emission scenarios, their supporting assumptions, and the projections of possible climate change effects entail substantial uncertainty.

Section 4.15.3.2 of NUREG-1437, Supplement 6, Second Renewal (NRC 2020b2020-TN7324), describes in detail annual mean temperature and precipitation projections for Virginia based on climate model simulations and future GHG scenarios. As discussed in NUREG-1437, Supplement 6, Second Renewal (NRC 2020b2020-TN7324), the SEIS for subsequent license

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renewalSLR of Surry Power Station, Units 1 &and 2, increases in temperature are projected to occur across the majority of the Southeast region under a low- and high-emissions scenario. With the exception of the information related to sea level rise, the NRC staff incorporates the discussion contained in Section 4.15.3.2, "Climate Change Projections," of NUREG-1437, Supplement 6, Second Renewal, into this SEISEIS by reference (NRC 2020b2020-TN7324: Section 4.15.3.2, 4-129–4-132), with key information summarized in this section. Climate model simulations suggest spatial differences in annual mean precipitation change across the Southeast, with some areas experiencing an increase and others a decrease in precipitation. For the period 2041–2070 (2055 midpoint), a 0 to 3-percent increase in annual mean precipitation is projected for both a low- and high-emission modeled scenario across the northern reaches of the Southeast region, encompassing Virginia. Increases are projected to occur in the winter, spring, and fall, with decreases during the summer (NOAA 2013a2013-TN7424).

The effects of climate change on North Anna structures, systems, and components are outside the scope of the NRC staff's subsequent license renewalSLR environmental review. The environmental review documents the potential effects from continued nuclear power plant operation on the environment. Site-specific environmental conditions are considered when siting nuclear power plants. This includes the consideration of meteorological and hydrologic siting criteria as set forth in 10 CFR Part 100, "Reactor Site Criteria.""." (TN282). NRC regulations require that nuclear power plant structures, systems, and components important to safety be designed to withstand the effects of natural phenomena, such as flooding, without loss of capability to perform safety functions. Further, nuclear power plants are required to operate within technical safety specifications in accordance with the nuclear power plants' NRC operating license, including coping with natural phenomena hazards. The NRC conducts safety reviews before allowing licensees to make operational changes due to changing environmental conditions. Additionally, the NRC evaluates nuclear power plant operating conditions and physical infrastructure to ensure safe operation under the nuclear power plant's initial and renewed facility operating licenses through the NRC's Reactor Oversight Program. If new information about changing environmental conditions that threaten safe operating conditions or challenge compliance with the nuclear power plant's technical specifications becomes available, the NRC will evaluate the new information to determine if any safety-related changes are needed at licensed nuclear power plants. This is a separate and distinct process from the NRC staff's subsequent license renewal environmental review conducted in accordance with NEPA. Nonetheless, as discussed below in Section 3.16, the NRC staff considers the impacts of climate change in combination with the effects of subsequent license renewal in assessing cumulative impacts.

Cumulative Impacts

Cumulative impacts may result when the environmental effects associated with the proposed action (subsequent license renewal) are added to the environmental effects from other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. As explained in the license renewal GEIS (NRC 2013a), the effects of the license renewal action, combined with the effects of other actions, could generate cumulative impacts on a given resource.

For the purposes of this analysis, past actions are those that occurred since the commencement of North Anna reactor operations and before the submittal of the subsequent license renewal application. Older actions are considered as part of the affected environment analyses

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~~presented in Sections 3.2 through 3.13 of this SEIS. Present actions are those that are occurring during current power plant operations. Reasonably foreseeable future actions are those that would occur through the end of power plant operation, including the period of extended operation. In response to Dominion's application for a COL for Unit 3, the NRC issued a final SEIS in support of its review in 2010 (NUREG-1917) and issued the COL to Dominion in 2017 (NRC 2010, NRC 2017b). Although Dominion stated in its ER for subsequent license renewal that it has not decided whether to proceed with Unit 3 project activities, it did include Unit 3 as a reasonably foreseeable action in its ER (Dominion 2020b, 2021a). Accordingly, the NRC staff considers Unit 3 to be a reasonably foreseeable future action in this SEIS. Therefore, the associated construction and operation impacts of Unit 3 have been factored into the cumulative impacts analysis below, where appropriate, for informational purposes. In this cumulative impacts analysis, the NRC staff considers potential effects through the end of the current license term, as well as through the end of the 20-year subsequent license renewal term.~~

~~The cumulative impacts analysis accounts for both geographic (spatial) and time (temporal) considerations of past, present, and reasonably foreseeable future actions to determine whether other potential actions are likely to contribute to the total environmental impact. In addition, because cumulative impacts accrue to resources and focus on overlapping impacts with the proposed action, no cumulative impacts analysis was performed for resource areas where the proposed action is unlikely to have any incremental impacts on that resource. Consequently, no cumulative impacts analysis was performed for the following resource areas: land use, noise, geology and soils, terrestrial resources, aquatic resources, and historic and cultural resources.~~

~~As noted in Section 3.15.3.2, "Climate Change," of this SEIS~~Nonetheless, changes in climate could have broad implications for certain resource areas. ~~Accordingly, a~~ As discussed below, the NRC staff considers the impacts of climate change ~~impact discussion is provided for those resource areas that could be~~on environmental resources that are incrementally affected by the proposed action ~~(subsequent license renewal). It is also important to note that the potential effects of climate change could occur irrespective of the proposed action.~~.

~~Information from Dominion's ER (Dominion 2020b); responses to requests for additional information; information from other Federal, State, and local agencies; scoping comments; and information gathered during the environmental site audit at North Anna were used to identify past, present, and reasonably foreseeable future actions in the cumulative impacts analysis. To evaluate cumulative impacts resulting from the continued operation of North Anna Units 1 and 2, the incremental impacts of the proposed action, as described in Sections 3.2 to 3.13 of this chapter, are combined with the impacts of other past, present, and reasonably foreseeable future actions, regardless of which agency (Federal or non-Federal) or person undertakes such actions. In general, the effects of past actions have already been described and accounted for in each resource specific description of the existing (i.e., affected) environment, which serves as the environmental baseline for the cumulative impacts analysis.~~

~~Appendix E, "Projects and Actions Considered in the Cumulative Impacts Analysis," describes other actions, including new and continuing activities and specific projects that the NRC staff identified during this environmental review and that were considered in the analysis of potential cumulative impacts.~~

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~~3.15.63.1.1Air Quality~~

~~The region of influence the NRC staff considered in the cumulative air quality analysis consists of Louisa and Spotsylvania counties, because air quality designations in Virginia are made at the county level. North Anna is located primarily in Louisa County, with a portion of the site extending into neighboring Spotsylvania County, VA. Dominion has not proposed any refurbishment-related activities during the subsequent license renewal term. As a result, the NRC staff expects that air emissions from the plant during the SLR term would be similar to those presented in Section 3.3, "Meteorology, Air Quality, and Noise." Appendix E identified present and reasonably foreseeable projects that could contribute to the cumulative impacts on air quality in Louisa and Spotsylvania counties. Current air emission sources operating in Louisa and Spotsylvania counties have not resulted in long-term NAAQS violations, given the designated in attainment status for all criteria pollutants. Consequently, cumulative changes to air quality in Louisa and Spotsylvania counties would be the result of future projects and actions that change present-day emissions within the counties.~~

~~Development and construction activities identified in Appendix E could increase air emissions during their respective construction periods, but these air emissions would be temporary and localized. Air emissions associated with the operation of future solar PV facilities would be negligible because no fossil fuels would be directly burned to generate electricity. However, future operation of facilities can result in an increase in vehicular traffic and in overall long-term air emissions that contribute to cumulative air quality impacts. Any entity establishing new stationary sources of emissions in the region of influence would be required to apply for an air permit from VDEQ and would also be required to operate in accordance with applicable Federal, State, and local regulatory requirements.~~

Air Quality: Climate change can impact air quality as a result of changes in meteorological conditions. The formation, transport, dispersion, and deposition of air pollutants depend, in part, on weather conditions (IPCC 2007~~).~~ TN7421). Ozone is particularly sensitive to climate change (IPCC 2007~~; EPA 2009a).~~ TN7421). Ozone is formed by the chemical reaction of ~~nitrogen oxides~~NO_x and ~~volatile organic compounds~~VOCs in the presence of heat and sunlight. ~~Sunshine~~Sunlight, high temperatures, and air stagnation are favorable meteorological conditions for higher levels of ozone (IPCC 2007~~; EPA 2009b).~~ TN7421; 74 FR 66496-TN245). The emission of ozone precursors also depends on temperature, wind, and solar radiation (IPCC 2007~~).~~ TN7421). According to the EPA, both nitrogen oxide and biogenic VOC emissions are expected to be higher in a warmer climate (~~EPA 2009a).~~ 74 FR 66496-TN245). Although surface temperatures are expected to increase in the Southeast region of the United States (where North Anna is located), this may not necessarily result in an increase in ozone. While some climate models project seasonal, short-term increases of ozone concentrations during summer months in the Southeast ~~United States~~ (e.g., Wu et al. ~~20082007~~-TN8566), others (e.g., Tao et al. 2007-TN8567; Nolte et al. 2018-TN8571; Meehl et al. 2018-TN8574) found differences in future changes in ozone for the Southeast with decreases in ozone concentrations under a low-emission ~~modelled~~modeled scenario, increases under a high-emission ~~modelled~~modeled scenario, or decreases in ozone on heat wave days. Among ~~modelled~~modeled studies of climate-related ozone changes, model simulations for the Southeast region have the least consensus. Therefore, the potential cumulative impact on air quality ozone levels in the vicinity of North Anna due to climate change is unknown.

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Water Resources

Surface Water Resources

The description of the affected environment in Section 3.5.1, "Surface Water Resources," of this SEIS serves as the baseline for the NRC staff's cumulative impacts assessment for surface water resources. North Anna withdraws cooling water directly from the North Anna Reservoir and discharges return flows and comingled effluents to the dedicated WHTF and ultimately to the reservoir. As such, this cumulative impact review focuses on those projects and activities that would withdraw water from, or discharge effluents to, the North Anna Reservoir and its tributaries (see Figure 3-4).

Water Use and Water Quality Considerations

The NRC staff previously considered the cumulative impacts on surface water resources at North Anna in Section 7.3, "Water Use and Quality," of the NRC's supplemental EIS for the combined license for proposed Unit 3 at North Anna (NUREG-1917) (NRC 2010). In that analysis, the staff considered the combined impacts on Lake Anna's hydrology and water quality associated with existing Units 1 and 2, along with the incremental impacts of construction and operations of proposed Unit 3. In NUREG-1917, the staff also independently reviewed Dominion's water budget model of Lake Anna and proposed Unit 3 operational parameters and their effect on consumptive water use. In summary, the staff concluded in NUREG-1917 that the cumulative impacts on water use, to include the construction and operation of the proposed Unit 3, would remain SMALL except during drought periods, when the impacts would be MODERATE. The NRC staff incorporates the cumulative impacts analysis in Section 7.3 of NUREG-1917 by reference (NRC 2010: Section 7.3, p. 7-2–7-4), to present an analysis of cumulative impacts if Dominion were to construct and operate Unit 3 during the SLR period of extended operation.

The North Anna Reservoir was created to provide a source of cooling water for the North Anna nuclear generating units. As discussed in Section 3.5.1.2, with the exception of a small fraction of water being lost to evaporation, surface water withdrawn by North Anna is returned to the North Anna Reservoir. Dominion has not proposed to increase North Anna Unit 1 and 2 surface water withdrawals or consumptive water use during the SLR term. In addition, as referenced in Section 3.5.1.1, Dominion has a Virginia water protection permit (number 10-2001) for operation of proposed Unit 3. This permit, in conjunction with the release schedule for the North Anna Dam included in Dominion's VPDES permit for Units 1 and 2 (VDEQ 2014), will help to ensure that minimum instream flows are maintained in the North Anna River to minimize water use conflicts and to safeguard designated uses. The staff has identified no new or proposed projects (see Appendix E, Table E-1) that have the potential to substantially impact surface water withdrawals or consumptive water use in the Lake Anna watershed. The NRC staff continues to recognize that resolution of any future conflicts over water availability would fall within the regulatory authority of the Commonwealth of Virginia.

In Section 7.3 of NUREG-1917 (NRC 2010), the staff also evaluated the potential cumulative impacts on water quality associated with the operation of proposed Unit 3 combined with existing Units 1 and 2. The staff considered the presence of two pollutants (copper and tributyltin) and the potential for the pollutants to be concentrated by the operation of proposed Unit 3's cooling system. Based on its analysis, the staff concluded that cumulative water quality impacts associated with the proposed Unit 3 would remain SMALL, as all effluent discharges would be regulated under the VPDES permit program. The NRC staff incorporates the analysis in Section 7.3 of NUREG-1917 by reference (NRC 2010: Section 7.3, p. 7-2–7-4), to address

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~~the cumulative impacts on water resources if Dominion were to decide to construct and operate North Anna Unit 3 during the Units 1 and 2 SLR period of extended operation.~~

~~In Appendix E, Table E-1 of this SEIS, the staff has identified a number of ongoing and reasonably foreseeable future actions that could impact surface water quality in affected watersheds. Specific to the Lake Anna region, the primary impact driver is likely to be continued residential and mixed-use development.~~

~~Future development can result in water quality degradation if those projects increase sediment loading and the discharge of other pollutants to nearby surface water bodies. On an individual facility basis, State-issued permits (i.e., the VPDES in Virginia) under CWA Section 402 set limits on wastewater, stormwater associated with construction and industrial activity, and other point source discharges. As previously discussed, Section 303(d) of the Federal CWA requires states to identify all "impaired" waters for which effluent limitations and pollution control activities are not sufficient to attain water quality standards and to establish total maximum daily loads to ensure future compliance with water quality standards. Consequently, a substantial regulatory framework exists to address current and potential future sources of water quality degradation within the watershed of Lake Anna Reservoir with respect to potential cumulative impacts on surface water quality.~~

~~**Climate Change and Related Considerations**~~

~~Climate change can impact surface water resources as a result of changes in temperature, precipitation, and other parameters, as discussed in Section 3.15.3.2, "Greenhouse Gas Emissions and Climate Change."~~

~~The U.S. Global Change Research Program (USGCRP) projects that water demand across Virginia will increase by 10 to 25 percent by 2060, relative to 2005, based on combined changes in population, socioeconomic conditions, and climate (USGCRP 2014, Figure 3.11).~~

: Elevated surface water temperatures can decrease the cooling efficiency of thermoelectric power generating facilities and nuclear power plant capacity. Therefore, as intake water temperatures warm, the volume of surface water needed for nuclear power plant cooling can increase (USGCRP 2014~~). Power~~ TN3472). Nuclear power plants would have to account for any changes in water temperature in operational practices and procedures.

Since 1958, heavy precipitation (i.e., the amount of annual precipitation falling in the heaviest 1 percent of events) has increased by an average of 27 percent across the Southeast ~~region~~ (USGCRP 2018-TN5847: Fig. 2.6). Observed increases in heavy precipitation events are projected to continue across the Southeast, including Virginia. Increases in annual precipitation and heavy precipitation events can result in greater runoff from the land while increasing the potential for riverine flooding. In turn, these changes can result in the transport of a higher sediment load and other contaminants to surface ~~waters~~waters with potential degradation of ambient water quality.

3.15 Cumulative Effects of the Proposed Action

Actions considered in the cumulative effects (impacts) analysis include the proposed SLR action when added to the environmental effects from past, present, and reasonably foreseeable future actions. The analysis considers all actions, however minor, because the effects of individually minor actions may be significant when considered collectively over time. The goal of the cumulative effects analysis is to identify potentially significant impacts. The environmental

effects of the proposed SLR action when combined with the effects of other actions could result in a cumulative impact.

The cumulative effects or impacts analysis only considers resources and environmental conditions that could be affected by the proposed license renewal action, including the effects of continued reactor operations during the SLR term and any refurbishment activities at a nuclear power plant. In order for there to be a cumulative effect, the proposed action (SLR) must have an incremental new, additive, or increased physical impact on the resource or environmental condition beyond what is already occurring.

For the purposes of this analysis, past and present actions include all actions that have occurred since the commencement of North Anna reactor operations up to the submittal of the SLR request. Older actions are accounted for in baseline assessments presented in the affected environment discussions in Sections 3.2 through 3.13. The time frame for the consideration of reasonably foreseeable future actions is the 20-year SLR term. Reasonably foreseeable future actions include current and ongoing planned activities through the end of the period of extended operation.

The incremental effects of the proposed action (SLR) when added to the effects from past, present, and reasonably foreseeable future actions and other actions result in the overall cumulative effect. A qualitative cumulative effects analysis is conducted in instances where the incremental effects of the proposed action (SLR) and past, present, and reasonably foreseeable future actions are uncertain or not well known.

Although Dominion stated in its ER that it has not decided whether to proceed with the construction and operation of North Anna Unit 3, it did consider Unit 3 to be a reasonably foreseeable action (VEPCO 2020-TN8099, VEPCO 2021-TN8179). Accordingly, the NRC considers North Anna Unit 3 to be a reasonably foreseeable future action in the cumulative effects analysis. Therefore, North Anna Unit 3 construction and operation impacts have been factored into the cumulative impacts analysis.

Chapter 7.0 of the North Anna Unit 3 combined license EIS (NUREG-1917) (NRC 2010-TN6) provides an analysis of cumulative impacts at the North Anna site resulting from the future effects of constructing and operating Unit 3 combined with the operational effects of North Anna Units 1 and 2. This information is incorporated here by reference (NRC 2010-TN6: p. 7-1 through 7-8).

The following sections discuss the cumulative effects on the environmental near North Anna—when the incremental environmental effects of the proposed SLR action are compounded by the effects of past, present, and reasonably foreseeable future actions. For the most part, environmental conditions near North Anna are not expected to change appreciably during the SLR term beyond what is already being experienced. Consequently, no cumulative impacts analysis was performed for the following resource areas: land use, noise, geology and soils, terrestrial resources, aquatic resources, and historic and cultural resources.

Appendix E, "Projects and Actions Considered in the Cumulative Impacts Analysis," describes other actions, including new and continuing activities and specific projects that were identified during this environmental review and considered in the analysis of potential cumulative impacts.

3.15.1 Air Quality

The ROI in the cumulative air quality analysis consists of Louisa and Spotsylvania counties, because air quality designations in Virginia are made at the county level. North Anna is located primarily in Louisa County, with a portion of the site extending into neighboring Spotsylvania County, Virginia. Dominion has not proposed any refurbishment-related activities during the SLR term. As a result, air emissions from the nuclear power plant during the SLR term would be similar to those presented in Section 3.3, "Meteorology, Air Quality, and Noise." Therefore, there would be no cumulative effect from the proposed action caused by continued operations at North Anna in the SLR term beyond what is already being experienced.

Appendix E identifies present and reasonably foreseeable projects that could contribute to future air quality in Louisa and Spotsylvania counties. Current air emission sources operating in Louisa and Spotsylvania counties have not resulted in long-term NAAQS violations, given the designated in attainment status for all criteria pollutants. Consequently, cumulative changes to air quality in Louisa and Spotsylvania counties would be the result of future projects and actions that change present-day emissions within the counties, unrelated to the proposed action (SLR).

Development and construction activities identified in Appendix E could increase air emissions during their respective construction periods, but those air emissions would be temporary and localized. Air emissions associated with the operation of future solar photovoltaic facilities would be negligible because no fossil fuels would be directly burned to generate electricity. However, future operation of facilities can result in an increase in vehicular traffic and in overall long-term air emissions that contribute to cumulative air quality impacts. Any entity establishing new stationary sources of emissions in the ROI would be required to apply for an air permit from VDEQ and would also be required to operate in accordance with applicable Federal, State, and local regulatory requirements.

3.15.2 Water Resources

3.15.2.1 Surface Water Resources

The description of the affected environment in Section 3.5.7.1, "Surface Water Resources," serves as the baseline for the cumulative impacts assessment for surface water resources. North Anna withdraws cooling water directly from Lake Anna and discharges return flows and comingled effluents to the dedicated WHTF and ultimately to the reservoir. As such, this cumulative impact review focuses on those projects and activities that would withdraw water from, or discharge effluents to Lake Anna and its tributaries (see Figure 2-1).

Water Use and Water Quality Considerations

The cumulative impacts on surface water resources at North Anna are discussed in Section 7.3, "Water Use and Quality," of the NRC's SEIS for the proposed Unit 3 COL at North Anna (NUREG-1917) (NRC 2010-TN6). In that analysis, the combined impacts on Lake Anna's hydrology and water quality associated with existing Units 1 and 2, along with the incremental impacts of constructing and operating North Anna Unit 3. The NRC reviewed Dominion's water budget model of Lake Anna and proposed Unit 3 operational parameters and their effect on consumptive water use in NUREG-1917, and concluded the cumulative impacts on water use, including the construction and operation of Unit 3, would remain SMALL except during drought periods, when the impacts could be MODERATE. The cumulative impacts analysis in Section 7.3 of NUREG-1917 is incorporated by reference (NRC 2010-TN6: Section 7.3, p. 7-2–

7-4), to present an analysis of cumulative impacts if Dominion were to construct and operate Unit 3 during the SLR period of extended operation.

Lake Anna was created to provide a source of cooling water for North Anna. As discussed in Section 3.5.1.2, with the exception of a small fraction of water lost to evaporation, surface water withdrawn by North Anna is returned to Lake Anna. Dominion has not proposed to increase North Anna Unit 1 and 2 surface water withdrawals or consumptive water use during the SLR term. In addition, as referenced in Section 3.5.1.1, Dominion has a Virginia water protection permit (number 10-2001) for operation of proposed Unit 3. This permit, in conjunction with the release schedule for the North Anna Dam included in Dominion's VPDES permit for Units 1 and 2 (VEPCO 2020-TN8383), will help to ensure that minimum instream flows are maintained in the North Anna River to minimize water use conflicts and to safeguard designated uses. No new or proposed projects were identified (see Appendix E, Table E-1) that have the potential to substantially impact surface water withdrawals or consumptive water use in the Lake Anna watershed. The resolution of any future conflicts over water availability would fall within the regulatory authority of the Commonwealth of Virginia.

Section 7.3 of NUREG-1917 (NRC 2010-TN6), evaluates the potential cumulative impacts on water quality associated with the operation of North Anna Unit 3 combined with existing Units 1 and 2. The presence of two pollutants (copper and tributyltin) and the potential for the pollutants to be concentrated by the operation of proposed Unit 3's cooling system were considered. Based on this analysis, the cumulative water-quality impacts associated with the North Anna Unit 3 would remain SMALL, as all effluent discharges would be regulated under the VPDES permit program. The analysis in Section 7.3 of NUREG-1917 is incorporated by reference (NRC 2010-TN6; Section 7.3, p. 7-2–7-4), to address the cumulative impacts on water resources if Dominion were to decide to construct and operate North Anna Unit 3 during the SLR period of extended operation.

Appendix E, Table E-1 lists a number of ongoing and reasonably foreseeable future actions that could impact surface water quality in affected watersheds. Specific to the Lake Anna region, the primary impact driver is likely to be continued residential and mixed-use development.

Future development could also result in water quality degradation if those projects increase sediment loading and the discharge of other pollutants to nearby surface water bodies. On an individual facility basis, State-issued permits (i.e., the VPDES in Virginia) under CWA Section 402 set limits on wastewater, stormwater associated with construction and industrial activity, and other point source discharges. As previously discussed, CWA Section 303(d) requires states to identify all "impaired" waters for which effluent limitations and pollution control activities are not sufficient to attain water quality standards and to establish total maximum daily loads to ensure future compliance with water quality standards. Consequently, a substantial regulatory framework exists to address current and potential future sources of water quality degradation within the watershed of Lake Anna with respect to potential cumulative impacts on surface water quality. Based on the hydrologic setting, compliance with applicable water use and water quality permitting and associated permit conditions, and adherence to BMPs, the proposed action would have no cumulative effect on surface water resources beyond what is already being experienced.

~~3.15.6.1~~3.15.2.2Groundwater Resources

Section 3.5.2~~3.5.2.~~, "Groundwater Resources," describes regional groundwater supply systems. In the North Anna region, over the period of license renewal, the groundwater within the aquifer

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should continue to be affected by human activities and natural processes. Surrounding aquifer resources may continue to be subject to depletion and water quality degradation; however, the hydraulically isolated nature of the North Anna site groundwater aquifer with respect to the surrounding area precludes impacts on the surrounding region and users. In addition, the North Anna site has approved waste management and spill prevention practices and stormwater BMPs in place to prevent or minimize surface source releases from migrating to the groundwater flow system. Therefore, continued pumping of groundwater at the North Anna site during the SLR term is anticipated to have a negligible impact on groundwater contamination, groundwater use conflicts, and groundwater degradation impacts.

~~**The NRC staff incorporates the information in NUREG-1811, Section 7.3 (NRC 2006: Section 7.3, p. 7-2, 7-3) on cumulative impacts, here by reference.**~~ If North Anna Unit 3 is constructed and operated, up to five additional domestic wells would be developed for Unit 3 construction and operation (~~**Dominion 2016b;**~~ NRC 2010-TN6) under the purview of VDEQ and VDH permitting requirements. Withdrawals related to construction dewatering for Unit 3 foundations and basemats would cause aquifer drawdowns; however, drawdown due to well water withdrawals during construction and operation would be mitigated by the hydraulic boundaries of Lake Anna and the discharge canal.

Based on the ~~**NRC staff's**~~ review of Dominion's annual radioactive effluent release report data (VEPCO ~~**2016, 2017**~~, 2018-TN8391, 2019-TN8392, 2020~~**), the staff determined that**~~ TN8393, 2021-TN8394, 2022-TN8476), the North Anna site monitoring program is consistent with the groundwater protection procedures as described in ER Section E3.6.2.4 (~~**Dominion 2020b).**~~ VEPCO 2020-TN8099). During the past 5 years, the monitoring well network has detected tritium in groundwater, while no nuclear power plant-related gamma isotopes or residual radionuclides have been detected. As described in Section 3.5.2.3 ~~**3.5.2.3 above,**~~, GWP-18 tritium concentrations were indicative of surface water leaking into the pipe tunnel and subsequent leaching of tritium from the concrete of the tunnel to the ground. After excess water was removed from the tunnel, GWP-18 concentrations returned to historical threshold values. Pipe tunnel surface water ingress points were sealed during 2020 and the tunnel remains dry to preclude leaching of residual tritium in tunnel concrete to groundwater (~~**Haley & Aldrich 2020).**~~VEPCO 2021-TN8268).

Groundwater well permitting and withdrawals are within the purview of VDEQ and VDH permitting requirements. Based on the hydrogeologic setting, compliance with groundwater permitting, adherence to the groundwater protection initiative (~~**NEI**~~NRC 2007~~**), and**~~-TN8483), the ~~**staff's 2006 review of Unit 3 groundwater use impacts (NUREG-1811, Section 7.3), the**~~proposed action would have no cumulative ~~**impact from Unit 1 and Unit 2 during the SLR period of operation would be**~~ effect beyond what is already being experienced~~**SMALL**~~.

~~3.15.7~~3.15.3 Socioeconomics

~~This section addresses socioeconomic factors that have the potential to be affected by changes in operations at North Anna, in addition to the aggregate effects of other past, present, and reasonably foreseeable future actions.~~ As discussed in Section 3.10.7~~3.10.7,~~ continued operation of North Anna during the SLR term would have no impact on socioeconomic conditions in the region beyond what is already being experienced. Dominion has no planned activities at North Anna beyond continued reactor operations and maintenance.

As summarized in Section 7.6 of NUREG-1917 (NRC 2010-TN6), the cumulative socioeconomic impacts from constructing and operating North Anna Unit 3 could range from MODERATE to

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LARGE. As discussed in Section 4.5 (NUREG-1917, NRC 2010-TN6), regional transportation and recreational use of Lake Anna, area housing, and school enrollment could experience MODERATE construction impacts. These impacts would be temporary and limited to peak construction periods. As discussed in NUREG-1917 (NRC 2010-TN6), Section 5.5, socioeconomic impacts during Unit 3 operations could also have MODERATE to LARGE impacts on the regional economy and tax revenue (NRC 2010-TN6: Sections 4.5, 5.5, 7.6, p. 4–13–4-20, p. 5-17–5-28, p. 7–6). The socioeconomic impact analyses in NUREG-1917 is incorporated into this EIS by reference (NRC 2010-TN6).

Because Dominion has no plans to hire additional workers during the SLR term, overall expenditures and employment levels at North Anna ~~Units 1 and 2~~ would remain ~~relatively~~ unchanged with no new or increased demand for housing and public services. ~~Based on this and other information presented in this chapter, there would be no contributory effect on socioeconomic conditions in the region during the SLR term from the continued operation of North Anna beyond what is currently being experienced.~~ Therefore, the only contributory effects would come from reasonably foreseeable future planned operational activities at North Anna ~~unrelated to the proposed action~~ and other planned offsite activities, unrelated to the proposed action (SLR). When combined with past, present, and reasonably foreseeable future activities, the proposed action would have no new or increased cumulative effect beyond what is already being experienced.

~~In the supplemental EIS for the Unit 3 combined license (NUREG-1917 (NRC 2010)), the NRC staff evaluated the potential socioeconomic impacts from construction and operation of proposed Unit 3, if built, at the North Anna site. As summarized in Section 7.6 of NUREG-1917, the NRC staff determined that construction and operation of proposed Unit 3 could make detectable adverse contributions to the cumulative effects associated with some socioeconomic issues, including aesthetics and recreation, with individual impacts ranging from MODERATE adverse to LARGE beneficial. Specifically, as presented in Section 4.5 of NUREG-1917, the staff found that adverse construction impacts could be MODERATE for regional transportation and recreational use of Lake Anna, area housing, and school enrollment. These impacts would be temporary. Construction could have MODERATE beneficial impacts on the regional economy and tax revenue. All other socioeconomic impacts would be SMALL. For operations, as presented in Section 5.5 of NUREG-1917, the staff projected that there could be MODERATE adverse impacts on visual aesthetics and on recreational use of Lake Anna on a periodic basis. Operations could have MODERATE to LARGE beneficial impacts on the regional economy and tax revenue (NRC 2010: Sections 4.5, 5.5, 7.6, p. 4-13–4-20, p. 5-17–5-28, p. 7-6). The NRC staff incorporates these impact analyses from NUREG-1917 into this SEIS by reference.~~

~~3.15.8~~3.15.4Human Health

The NRC and the EPA have established radiological dose limits to protect the public and workers from both acute and long-term exposure to radiation and radioactive materials. These dose limits are specified in 10 CFR Part 20-TN283 and 40 CFR Part 190-TN739, "Environmental Radiation Protection Standards for Nuclear Power Operations." As discussed in Section 3.11.6 et seq., "Human Health," ~~of this SEIS,~~ the impacts on human health from continued nuclear power plant operations during the SLR term would be SMALL.

For the purposes of this cumulative impacts analysis, the geographical area considered is the area within a 50-mi (80-km) radius of North Anna. There are no other nuclear power plants within this 50-mi (80-km) radius. However, that radius does overlap with the 50-mi (80-km)

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radius around the Surry Power Station and the Calvert Cliffs Nuclear Power Station, which are located approximately 86 mi (138 km) and 78 mi (125 km) from North Anna, respectively. Like North Anna, both nuclear power stations comply with all NRC and ~~EPA~~the EPA regulations on radiation and radioactive materials exposure. As discussed in Section 2.1.4.4, "Radioactive Waste Storage," of this ~~SEIS~~EIS, Dominion stores spent nuclear fuel from Units 1 and 2 in a storage pool and in an onsite ~~independent spent fuel storage installation (~~ISFSI~~).~~. Currently, the ISFSI consists of three separate spent fuel storage pads. Dominion stated in the ER that it has no current plans to add additional storage pads (~~Dominion 2020b~~VEPCO 2020-TN8099).

~~As referenced in Section 3.16, the staff provides the following evaluation regarding the likely cumulative impacts on human health if~~If Dominion were to construct and operate North Anna Unit 3 during the SLR period of extended operation~~. In this regard, the NRC staff notes that~~, the operation of ~~North Anna~~ Unit 3~~, if built,~~ would result in additional radiological releases and dose impacts to workers and the public, in addition to the ~~impacts resulting~~human health effects from ~~operation of~~operating Units 1 and 2. ~~Also,~~Operation of Unit 3 would generate additional spent fuel ~~would accumulate~~to be stored onsite~~ as a result of the operation of Unit 3~~, in addition to the spent fuel ~~produced~~generated by ~~continued operations of~~ Units 1 and 2. Section 5.9.2.3, "External Radiation Pathway"; Section 5.9.3, ~~"~~"Impacts to Members of the Public"; Section 5.9.4, ~~"~~"Occupational Doses to Workers"; and Section 6.1, "Fuel Cycle Impacts and Solid Waste Management" ~~of~~in NUREG-1917 (NRC 2010-TN6) describe the projected operational impacts of ~~proposed~~ Unit 3~~ in detail.~~. As summarized in NUREG-1917, Section 7.8 ~~of the NRC staff's supplemental EIS for the Unit 3 combined license (NUREG-1917), the staff projected that~~(NRC 2010-TN6), cumulative public and occupational doses from the operation of Units 1 and 2 ~~and proposed~~ combined with Unit 3 would be well below regulatory limits and standards. ~~In NUREG-1917, the NRC staff determined that the~~The radiological health, fuel cycle, and waste management impacts of Unit 3 operation~~, alone or~~ combined with Units 1 and 2, would be SMALL (NRC 2010-TN6: Sections 5.9.2.3, 5.9.3, 5.9.4, 6.1, 7.8, p. 5-41–5-48, 6-1–6-3, 7-7). The ~~NRC staff incorporates those~~human health impact analyses ~~from~~in NUREG-1917 is incorporated into this ~~SEIS~~EIS by reference~~, to describe these cumulative impacts if Unit 3 were to be built.~~.

~~The EPA~~The EPA's regulations~~ at~~, 40 CFR Part 190 (TN739), limit ~~the dose~~doses to members of the public from all sources in the nuclear fuel cycle, including nuclear power plants, fuel fabrication facilities, waste disposal facilities, and transportation of fuel and waste. As discussed in Section 2.1.4.5~~2.1.4.5~~, "Radiological Environmental Monitoring Program," ~~in this SEIS~~, Dominion has a ~~radiological environmental monitoring program~~REMP that measures radiation and radioactive materials in the environment from North Anna, its ISFSI, and all other sources. ~~The NRC staff reviewed the~~The radiological environmental monitoring results for the 5-year period from 2015 through 2019~~ as part of this cumulative impacts assessment. The review of Dominion's data~~ showed no indication of an adverse trend in radioactivity levels in the environment from either North Anna or the ISFSI. The data showed that there was no measurable radiological impact on the environment from ~~operations at~~ North Anna.

~~In summary, the NRC staff concludes that~~Based on this information, there ~~is~~would be no significant cumulative radiological effect on human health resulting from the proposed action ~~of subsequent license renewal,~~(SLR), in combination with the cumulative ~~impacts~~effects from other sources. ~~The NRC staff bases this~~ This conclusion is based on ~~its~~the review of radiological environmental monitoring program data, radioactive effluent release data, and worker dose data; the expectation that North Anna would continue to comply with Federal radiation protection standards during the period of extended operation; and the continued regulation of

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any future development or actions in the vicinity of ~~the~~ North Anna ~~site~~ by the NRC and the Commonwealth of Virginia.

~~3.15.9~~3.15.5Environmental Justice

This cumulative impact analysis evaluates the potential for ~~disproportionately high~~disproportionate and adverse human health and environmental effects on minority and low-income populations that could result from past, present, and reasonably foreseeable future actions, including the continued operational effects of North Anna ~~Units 1 and 2~~ during the ~~renewal~~SLR term. ~~As discussed in Section 3.12.1, there would be no disproportionately high and adverse impacts on minority and low-income populations from the continued operation of North Anna Units 1 and 2 during the SLR term.~~

Everyone living near North Anna, including minority and low-income populations, currently experiences its operational effects. The NRC addresses environmental justice ~~matters for license renewal~~ by identifying the location of minority and low-income populations, determining whether there would be any potential human health or environmental effects, and whether any of the effects may be ~~disproportionately high~~disproportionate and adverse ~~on~~to these populations.

Adverse health effects are measured in terms of the risk and rate of fatal or ~~non-fatal~~nonfatal adverse impacts on human health. ~~Disproportionately high~~Disproportionate and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population ~~is significant and~~ exceeds the risk or exposure rate for the general population or for another appropriate comparison group. ~~Disproportionately high~~Disproportionate environmental effects refer to impacts or risks of impacts in the natural or physical environment in a minority or low-income community that ~~are significant and~~ appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts. Some of these potential effects have been identified in resource areas presented in preceding sections of this chapter ~~of the SEIS.~~. As previously discussed in this chapter, the ~~impact from license renewal~~SLR impacts for all resource areas (e.g., land, air, water, and human health) would be SMALL.

As discussed in Section 3.12~~3.12.1,~~ there would be no ~~disproportionately high~~disproportionate and adverse ~~impacts~~human health and environmental effects on minority and low-income populations from the continued operation of North Anna ~~Units 1 and 2~~ during the SLR term. Because Dominion has no plans to hire additional workers during the SLR term ~~to support continued operation of North Anna Unit 1 and 2 (Dominion 2020b~~(VEPCO 2020-TN8099), employment levels at North Anna would remain ~~relatively constant~~unchanged, and there would be no additional demand for housing or increase in traffic ~~due to subsequent license renewal of Units 1 and 2.~~. Based on this information and the analysis of human health and environmental ~~impacts presented in the preceding sections~~effects, it is not likely that there would be any ~~disproportionately high~~disproportionate and adverse contributory effects on minority and low-income populations from the continued operation of North Anna ~~Units 1 and 2~~ during the SLR term~~.~~ beyond what is already being experienced. Therefore, the only contributory effects would come from ~~the other~~ reasonably foreseeable future planned activities at North Anna, ~~unrelated to the proposed action (license renewal),~~ and other reasonably foreseeable ~~planned~~future offsite activities~~.~~, unrelated to the proposed action (SLR).

~~If Dominion were to proceed to construct and operate Unit 3, the staff would not expect any cumulative adverse impact on environmental justice populations. In the supplemental EIS for~~

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~~the Unit 3 combined license (NUREG-1917 (NRC 2010)), the NRC staff evaluated the potential for disproportionately high and adverse human health and environmental effects on minority and low-income populations from construction and operation of proposed Unit 3. As summarized in Section 7.6 of NUREG-1917, and detailed in Sections 4.7 and 5.7, the staff~~The human health and environmental effects of constructing and operating North Anna Unit 3 were evaluated NUREG-1917 (NRC 2010-TN6) including cumulative effects. The analysis determined that there would be no disproportionate and adverse ~~impacts~~human health and environmental effects on minority and low-income populations from the construction and operation of ~~proposed~~North Anna Unit 3~~, either~~ alone or in combination with ~~operation~~the operational effects of Units 1 and 2 (NRC 2010~~:~~-TN6): Sections 4.47, 5.7, 7.6, p. 4-22–4-23, 5-29–5-31, 7-5–7-6). ~~For informational purposes, the NRC staff incorporates these~~ The environmental justice impact analyses ~~from~~in NUREG-1917 is incorporated into this ~~SEIS~~EIS by reference~~, to address the likely environmental justice impacts if Dominion were to proceed to construct and operate North Anna Unit 3~~.

~~In sum, when~~When combined with ~~other~~ past, present, and reasonably foreseeable future activities, the ~~contributory effects of continuing reactor operations and maintenance at North Anna~~ proposed action (SLR) would not likely cause ~~disproportionately high~~disproportionate and adverse human health and environmental effects on minority and low-income populations ~~residing~~ near North Anna beyond effects already being experienced.

~~3.15.10~~3.15.6 Waste Management and Pollution Prevention

This section considers the incremental waste management impacts of the SLR term when added to the ~~aggregate~~contributory effects of ~~other~~ past, present, and reasonably foreseeable future actions. ~~In~~As discussed in Section 3.13.3~~3.13.3, the NRC staff concluded that~~, "Proposed Action," the potential waste management impacts from ~~North Anna Units 1 and 2~~ continued operations at North Anna during the SLR term would be SMALL.

~~The construction and operation of Unit 3 would generate additional radioactive and nonradioactive waste. In the supplemental EIS for the Unit 3 combined license (NUREG-1917 (NRC 2010)), the NRC staff evaluated the potential waste management impacts resulting from Unit 3 operations, either alone or in combination with Units 1 and 2. Cumulative waste impacts were addressed in Section 7.10, "Fuel Cycle, Transportation, and Decommissioning," and Unit 3 waste impacts were evaluated in Section 6.1,"Fuel Cycle Impacts and Solid Waste Management" of NUREG-1917. In sum, the NRC staff determined that uranium fuel cycle and solid waste management impacts of Unit 3 operation, either alone or in combination with Units 1 and 2, would be SMALL (NRC 2010: Sections 6.1, 7.10, p. 6-1–6-3, 7-8). For informational purposes, the NRC staff incorporates those impact analyses from NUREG-1917 into this SEIS by reference.~~

As discussed in Sections 2.1.4~~2.1.4~~ and 2.1.5~~2.1.5 of this draft SEIS~~, Dominion maintains waste management programs for radioactive and nonradioactive waste generated at North Anna and is required to comply with Federal and State permits and other regulatory waste management requirements. All industrial facilities, including nuclear power plants and other facilities within a 30-mi (48-km) radius of North Anna, are also required to comply with appropriate NRC, EPA~~,~~, and State requirements for the management of radioactive and nonradioactive waste. Current,~~ ongoing~~ waste management activities at North Anna would likely remain unchanged during the SLR term, and continued compliance with Federal and ~~State~~Commonwealth requirements for radioactive and nonradioactive waste is expected.

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In summary, the Cumulative waste impacts were addressed in NUREG-1917 (NRC staff concludes that there2010-TN6), Section 7.10, "Fuel Cycle, Transportation, and Decommissioning," and Unit 3 waste impacts were evaluated in Section 6.1, "Fuel Cycle Impacts and Solid Waste Management." During rector operations, uranium fuel cycle and solid waste management impacts of North Anna Unit 3, either alone or in combination with Units 1 and 2, would be SMALL (NRC 2010-TN6: Sections 6.1, 7.10, p. 6-1–6-3, 7-8). The waste management impact analyses in NUREG-1917 is no significant cumulative effect from the incorporated into this EIS by reference.

Therefore, the proposed action due to, including the continued radioactive and nonradioactive waste generation. during the SLR term, would have no cumulative effect beyond what is already being experienced. This is based on North Anna's expected continued compliance with Federal and Commonwealth of Virginia requirements for radioactive and nonradioactive waste management and the expected regulatory compliance of other waste producers in the area.

3.16 Resource Commitments Associated with the Proposed Action

This section describes the NRC staff's consideration of potentially unavoidable adverse environmental impacts that could result from implementation of the proposed action and alternatives; the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity; and the irreversible and irretrievable commitments of resources.

3.16.1 Unavoidable Adverse Environmental Impacts

Unavoidable adverse environmental impacts are impacts that would occur after implementation of all workable mitigation measures. Carrying out any of the replacement energy alternatives considered in this SEISEIS, including the proposed action, would result in some unavoidable adverse environmental impacts.

Minor unavoidable adverse impacts on air quality would occur due to the emission and release of various chemical and radiological constituents from nuclear power plant operations. Nonradiological emissions resulting from nuclear power plant operations are expected to comply with Federal EPA and State emissions standards. Chemical and radiological emissions would not exceed the national emission standards for hazardous air pollutants.

During nuclear power plant operations, workers and members of the public would face unavoidable exposure to low levels of radiation as well as hazardous and toxic chemicals. Workers would be exposed to radiation and chemicals associated with routine nuclear power plant operations and the handling of nuclear fuel and waste material. Workers would have higher levels of exposure than members of the public, but doses would be administratively controlled and are not expected to exceed regulatory standards or administrative control limits. In comparison, the alternatives involving the construction and operation of a non-nuclear power generating facility would also result in unavoidable exposure to hazardous and toxic chemicals, for workers and the public.

The generation of spent nuclear fuel and waste material, including low-level radioactive waste, hazardous waste, and nonhazardous waste, would be unavoidable. Hazardous and nonhazardous wastes would be generated at some non-nuclear power generating facilities. Wastes generated during nuclear power plant operations would be collected, stored, and shipped for suitable treatment, recycling, or disposal in accordance with applicable Federal and

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~~APPENDIX B~~APPENDIX F

ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS

Appendix F

~~9.3 ENVIRONMENTAL IMPACTS OF POSTULATED ACCIDENTS~~

This appendix describes the environmental impacts from postulated ~~accidents~~accidents that may occur at North Anna Power Station, Units 1 and 2 (North Anna) during the subsequent license renewal (SLR) period. The term "accident" refers to any unintentional event outside the normal nuclear power plant operational envelope that could result in either: ~~(a~~ (1) an unplanned release of radioactive materials into the environment~~;~~ or (~~b~~2) the potential for an unplanned release of radioactive materials into the environment.

NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (LR GEIS) (NRC 1996~~, 2013a~~-TN288, NRC 2013-TN2654), evaluates in detail the following two classes of postulated accidents as they relate to license renewal. The LR GEIS conclusions are codified in ~~10~~ Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions":

- Design-Basis Accidents: Postulated accidents that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to ensure public health and safety.

- Severe Accidents: Postulated accidents that are more severe than design-basis accident s because they could result in substantial damage to the reactor core, with or without serious offsite consequences.

On March 21, 2022, the Commission issued CLI-22-02 (NRC 2022-TN8182) when considering the appeals of Natural Resources Defense Council, Friends of the Earth, and Miami Waterkeeper (collectively, the Intervenors), and reconsidered the Commission's decision in CLI-20-3 (NRC 2022-TN8272, NRC 2020-TN9570). The Commission reversed CLI-20-3 (NRC 2022-TN8272), which addressed the referred ruling from the Atomic Safety and Licensing Board (ASLB). In CLI-20-3 (NRC 2022-TN8272), the Commission had held that, when considering the environmental impacts of an SLR, the U.S. Nuclear Regulatory Commission (NRC) staff may rely on the 2013 Generic Environmental Impact Statement for License Renewal of Nuclear Plants[1] (LR GEIS) and 10 CFR Part 51 (TN250) Subpart A, Appendix B, Table B-1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants," to evaluate environmental impacts of Category 1 issues. For the reasons described in CLI-22-02 (NRC 2022-TN8182), the Commission reversed that decision and held that the 2013 LR GEIS did not address SLR. The Commission stated, "that the Staff may not exclusively rely on the 2013 LR GEIS and Table B-1 for the evaluation of environmental impacts of Category 1 issues." (NRC 2022-TN8182). As a result, in this draft EIS, the staff has conducted a site-specific evaluation of the environmental impacts of North Anna's SLR application.

This appendix ~~first~~ describes (1) the NRC staff's evaluation of new and significant information related to design-basis ~~accidents~~accidents at North Anna, ~~followed by an~~(2) the staff's evaluation of new and significant information for postulated severe accidents at North Anna and (3) the staff's evaluation of new and significant information related to the North Anna severe accident mitigation alternative (SAMA) evaluation performed during initial license renewal. The

[1] "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (Final Report), NUREG-1437, Rev. 1, vols. 1–3 (June 2013), (ADAMS accession nos. ML13106A241, ML13106A242, ML13106A244) (NRC 2013-TN2654).

NRC staff conducted this site-specific new and significant evaluation to verify that the environmental impacts of design-basis accidents and the probability-weighted consequences of postulated severe accidents for North Anna continue to be SMALL.

~~A.1~~F.1 Background

Although this ~~supplemental~~draft environmental impact statement (~~SEIS~~EIS) documents the NRC staff's review of ~~a subsequent license renewal~~ an SLR application, it is helpful to keep in mind that long before any license renewal actions, an operating reactor has already completed the NRC licensing process for the original 40-year operating license. To receive a license to operate a nuclear power reactor, an applicant must submit to the NRC an operating license application that includes, among many other requirements, a safety analysis report. The applicant's safety analysis report presents the design criteria and design information for the proposed reactor and includes comprehensive data on the proposed site. The applicant's safety analysis report also describes various design-basis ~~accidents~~accidents and the safety features designed to prevent or mitigate their impacts. The NRC staff reviews the operating license application to determine if the nuclear power plant's design—including designs for preventing or mitigating accidents—meets the NRC's regulations and requirements. At the conclusion of that review, an operating license would be issued only if the NRC finds, in part, that there is reasonable assurance that the activities authorized by the license can be conducted without endangering the health and safety of the public and that the activities will be conducted in accordance with the NRC's regulations.

~~A.1.1~~F.1.1 Design-Basis Accidents

Design-basis accidents are postulated ~~accidents~~accidents that a nuclear facility must be designed and built to withstand without loss to the systems, structures, and components necessary to ensure public health and safety. Planning for design-basis ~~accidents~~accidents ensures that the proposed nuclear power plant can withstand normal transients (e.g., rapid changes in the reactor coolant system temperature or pressure, or rapid changes in reactor power), as well as a broad spectrum of postulated accidents without undue hazard to the health and safety of the public. Many of these design-basis accidents may occur, but are unlikely to occur, even once during the life of the nuclear power plant; nevertheless, carefully evaluating each design-basis accident is crucial to establishing the design basis for the ~~preventive~~preventative and mitigative safety systems of the proposed nuclear power plant. ~~Title 10 of the *Code of Federal Regulations* (10 CFR)~~ Part 50, (TN249), "Domestic Licensing of Production and Utilization Facilities," and 10 CFR Part 100, (TN282), "Reactor Site Criteria," describe the NRC's acceptance criteria for design-basis accidents.

Before the NRC will issue an operating license for a new nuclear power plant, the applicant must demonstrate the ability of its proposed reactor to withstand all design-basis ~~accidents.~~ accidents. The applicant and the NRC staff evaluate the environmental impacts of design-basis accidents for the hypothetical individual exposed to the maximum postulated amount of radiation (maximum exposed individual member of the public). The results of these evaluations of design-basis accidents are found in the reactor's original licensing documents, such as the applicant's final safety analysis report, the NRC staff's safety evaluation report, and the final environmental statement. Once the NRC issues the operating license for the new reactor, the licensee is required to maintain the acceptable design and performance criteria (which includes withstanding design-basis accidents) throughout the operating life of the nuclear power plant, including any license-renewal periods of extended operation. The consequences of design-basis accidents are evaluated for the hypothetical maximum exposed individual; as

such, changes in the nuclear power plant environment over time will not affect these evaluations.

~~The NRC regulation at 10 CFR 54.29(a), "Standards for Issuance of a Renewed License," requires license renewal applicants to demonstrate that identified actions have been or will be taken to manage the effects of aging and perform any required time-~~The NRC has reviewed North Anna's design basis on several occasions following the issuance of the initial operating licenses. For example, in a 2005 Issuance of Amendments Regarding Alternative Source Term, the NRC staff determined that the radiological consequences estimated by the licensee for the North Anna Units 1 and 2, with regard to various design-basis accidents will comply with the requirements of 10 CFR 50.67, "Accident source term" and the guidelines of Regulatory Guide (RG) 1.183, "Alternative Radiological Source Terms for Evaluating Design-Basis Accidents at Nuclear Reactors," and are therefore acceptable (NRC 2000-TN517). Another example is the NRC's review of updated external hazards information for all operating power reactors (as ordered by the Commission after the Fukushima Dai-Ichi accident). On June 9, 2020, the NRC completed its review of Fukushima-related information relevant to North Anna and concluded that no further regulatory actions were needed to ensure adequate protection or compliance with regulatory requirements, thereby reconfirming the acceptability of North Anna's design basis (NRC 2020-TN8336).

The site-specific analysis of design-basis accidents is presented in the North Anna Updated Final Safety Analysis Report (UFSAR) (NRC 2016-TN9560). For plant changes during the North Anna SLR period of extended operation, the continued validity of the UFSAR is maintained in compliance with 10 CFR 50.59 (TN249), "Changes, tests and experiment." The UFSAR design-basis accident analysis forms the technical bases for the North Anna Technical Specifications for operation. The UFSAR and Technical Specifications are parts of the current licensing basis and are the subject of the NRC reactor oversight program for operation during the period of extended operation. The environmental impacts of design-basis accidents are required to meet NRC onsite and offsite regulatory dose requirements.

Pursuant to 10 CFR 54.29(a)(TN4878), license renewal applicants are required to manage the effects of aging and perform any required time-limited aging analyses (as further described in the regulation), such that there is reasonable assurance that the activities authorized by the renewed license will continue to be conducted in accordance with the plant's current licensing basis (CLB) ~~(10 CFR 54.3(a), "Definitions"). Furthermore, the applicant must show that~~), and any changes made to the plant's CLB in order to comply with ~~paragraph (a) of 10 CFR~~ Section 54.29 ~~and~~ are in accordance with the Atomic Energy Act of 1954, as amended~~,~~ (AEA; 42 U.S.C. § 2011 et seq., TN663) and the ~~NRC's~~Commission's regulations. ~~Because of the requirements that the plant's existing design-basis and aging management programs be in effect~~Under the NRC's rules in 10 CFR Part 54, "Requirements for ~~license renewal, the environmental impacts of design-basis accidents as calculated~~Renewal of Operating Licenses for ~~the original operating license application should not differ significantly from the environmental impacts of design-basis accidents at any other time during plant operations, including during the~~ Nuclear Power Plans," applicants for initial license renewal and ~~subsequent renewal periods. Accordingly,~~ SLR must take adequate steps to account for aging during the period of extended operation either by updating time-limited aging analyses or implementing appropriate aging management plans. Based on these activities, the NRC expects that operation during an initial license renewal or SLR term would continue to provide a level of safety equivalent to that provided during the initial operating license period of operations. Further, as provided in the statement of considerations for Part 54, considerable experience has demonstrated that the NRC's regulatory process, including the performance-based requirements of the ~~design of~~ maintenance rule, provide

adequate assurance that degradation due to the ~~nuclear power plant, relative to design-basis accidents~~aging of structures, systems, and components that perform active safety functions will be appropriately managed to ensure their continued functionality during the period of extended operation~~, is considered to remain acceptable~~.

Because the requirements of the existing design basis and any necessary aging management programs will be in effect for SLR, the environmental impacts of design-basis accidents as calculated for the original operating license application should not differ significantly from the environmental impacts of design-basis accidents during other periods of plant operations, including during the initial license renewal and SLR periods.

In addition, the staff notes that in the 2013 LR GEIS, the NRC reexamined the information from the 1996 LR GEIS regarding design-basis accidents and concluded that this information is still valid. The NRC found that the environmental impacts of design-basis accidents are of SMALL significance for all nuclear plants. This conclusion was reached because the plants were designed to successfully withstand these accidents, and a licensee is required to maintain the plant within acceptable design and performance criteria, including during ~~the~~ license renewal term. It also stated that the environmental impacts during a LR term should not differ significantly from those calculated for the design-basis accident assessments conducted as part of the initial plant licensing process. Impacts from design-basis accidents would not be affected by changes in plant environment because such impacts (1) are based on calculated radioactive releases that are not expected to change, (2) are not affected by plant environment because they are evaluated for the hypothetical maximally exposed individual, and (3) have been previously determined to be acceptable (NRC 1996-TN288, NRC 2013-TN2654). For SLR of North Anna, the NRC staff finds that the same considerations apply.

In its environmental report (ER) for the North Anna SLR application, Dominion did not identify any new and significant information related to design-basis accidents at North Anna (VEPCO 2020-TN8099, VEPCO 2022-TN8270). In addition, the NRC staff did not identify any new and significant information related to design-basis accidents during its independent review of Dominion's ER and ER Supplement, through the scoping process, or in its evaluation of other available information. Therefore, the NRC staff concludes that the environmental impacts related to design-basis accidents at North Anna during the SLR period would be SMALL. In this regard, the staff notes that North Anna was designed to successfully withstand design-basis accidents. Due to the requirements for North Anna to maintain the licensing basis and implement appropriate aging management programs during the SLR term, the environmental impacts during the SLR term are not expected to differ significantly from those calculated for design-basis accidents as part of the initial plant licensing process. Based on the discussion above, the NRC staff concludes that the impacts of design-basis accidents during the SLR term for North Anna would be SMALL.

~~A.1.2~~F.1.2Design-Basis Accidents and License Renewal

Consistent with Regulatory Issue Summary RIS-2014-006, "Consideration of Current Operating Issues and Licensing Actions in License Renewal" (NRC ~~2014a~~2014-TN7851), the early and adequate identification of design-basis ~~accidents~~accidents (prior to ~~subsequent license renewal~~SLR) makes these design-basis accidents and associated structures, systems, and components a part of the CLB of the nuclear power plant as defined at 10 CFR 54.3(a~~).~~) (TN4878). The NRC requires licensees to maintain the CLB of the nuclear power plant under the current operating license, as well as during any license renewal period. Therefore, under the

provisions of 10 CFR 54.30~~,~~ (TN4878), "Matters not ~~Subject~~subject to a ~~Renewal Review~~renewal review," design-basis accidents are not subject to review under license renewal.

As stated in Section 5.3.2 of the 1996 LR GEIS~~,~~, the NRC staff assessed the environmental impacts from design-basis ~~accidents~~accidents in individual nuclear power plant-specific ~~environmental impact statements (~~EISs~~)~~ at the time of the initial license application review~~.~~ (NRC 1996-TN288). Consistent with the NRC Reactor Oversight Program/Process, a licensee is required to maintain the nuclear power plant within acceptable design and performance criteria, including during any license renewal term. As such, the NRC staff would not expect environmental impacts of continued nuclear power plant operation to change significantly, and accordingly, an additional assessment of the environmental impacts from design-basis accidents is not necessary (10 CFR Part 51-TN250, Appendix B to Subpart A, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant"). The 1996 LR GEIS concluded that the environmental impacts of design-basis accidents are of SMALL significance for all nuclear power plants, because the nuclear power plants were designed to withstand these accidents. ~~For the purposes of initial or subsequent~~For license renewal, the NRC ~~designates~~designated design-basis accidents as a Category 1 generic issue—applicable to all nuclear power plants (see 10 CFR Part 51, Appendix B to Subpart A~~). During~~) (TN250). In accordance with the ~~license renewal review process~~Commission's decisions in CLI-22-02 and CLI-22-03, the NRC staff ~~adopts~~has evaluated the applicable Category 1 issue conclusions from the LR GEIS ~~(unless new and significant information about~~on a site-specific basis for North Anna SLR, and determined that the ~~issue has been identified). Hence, the NRC staff need not address Category 1 issues (like~~impacts of design-basis accidents~~) in the site-specific SEIS for license renewal, unless new and significant information has been identified~~ for ~~those issues~~.North Anna during the SLR period of extended operations are SMALL.

~~In its environmental report for the North Anna subsequent license renewal application, Dominion did not identify any new and significant information related to design-basis accidents at North Anna (Dominion 2020). The NRC staff also did not identify any new and significant information related to design-basis accidents during its independent review of Dominion's environmental report, through the scoping process, or in its evaluation of other available information. Therefore, the NRC staff concludes that there are no environmental impacts related to design-basis accidents at North Anna during the subsequent license renewal period beyond those already discussed generically for all nuclear power plants in the GEIS.~~

~~A.1.3~~F.1.3Severe Accidents

Severe accidents are postulated ~~accidents~~accidents that are more severe than design-basis accident s because severe accidents can result in substantial damage to the reactor core, with or without serious offsite consequences. Severe accidents can entail multiple failures of equipment or functions.

~~A.1.4~~F.1.4Severe Accidents and License Renewal

Chapter 5 of the 1996 LR GEIS (NRC 1996-TN288) conservatively ~~predicts~~predicted the environmental impacts of postulated severe accidents that may occur during the period of extended operations at ~~nuclear power plants.~~ North Anna. Since that time, the NRC staff's prediction has been confirmed by a plant specific SAMA evaluation at North Anna which is found in the North Anna initial license renewal application (VEPCO 2001-TN8297).

In the ~~2013 GEIS, the staff updated the NRC's~~ 1996 ~~plant-by-plant severe accident environmental impact assessments (NRC 2013a, Appendix E). In the~~LR GEIS, the NRC considered impacts of severe accidents including:

- dose and health effects of accidents
- economic impacts of accidents
- effect of uncertainties on the results

The NRC staff calculated these estimated impacts by studying the risk analysis of severe accidents as reported in the EISs and/or final environmental statements that the NRC staff had prepared in support of each nuclear power plant's original reactor operating license review. When the NRC staff prepared the 1996 LR GEIS~~,~~ 28 nuclear power plant sites (44 units) had EISs or final environmental statements that contained a severe accident analysis. Not all original operating reactor licenses contained a severe accident analysis because the NRC had not always required such analyses. The 1996 LR GEIS assessed the environmental impacts of severe accidents during the license renewal period for all nuclear power plants by using the results of existing analyses and site-specific information to make conservative predictions. With few exceptions, the severe accident analyses evaluated in the 1996 LR GEIS were limited to consideration of reactor accidents caused by internal events. The 1996 LR GEIS addressed the impacts from external events (e.g., earthquakes and flooding) qualitatively.

For its severe accident environmental impact analysis for each nuclear power plant, the 1996 LR GEIS used very conservative 95th -percentile upper-confidence bound estimates for environmental impact whenever available. This approach provides conservatism to cover uncertainties, as described in Section 5.3.3.2.2 of the 1996 LR GEIS. The 1996 LR GEIS concluded that the probability-weighted consequences of severe accidents as related to license renewal are SMALL compared to other risks to which the populations surrounding nuclear power plants are routinely exposed. Since issuing the 1996 LR GEIS, the NRC's understanding of severe accident risk has continued to evolve.

The updated 2013 LR GEIS assesses more recent information and developments in severe accident analyses and how they might affect the conclusions in Chapter 5 of the 1996 LR GEIS. The 2013 LR GEIS also provides comparative data where appropriate. Based on information in the 2013 LR GEIS, the NRC staff determined that for all nuclear power plants, the probability-weighted consequences of severe accidents are SMALL. However, the LR GEIS determined that alternatives to mitigate severe accidents must be considered for all nuclear power plants that have not considered such alternatives, as a Category 2 issue. See Table B-1, "Summary of Findings on NEPA [National Environmental Policy Act] Issues for License Renewal of Nuclear Power Plants," of Appendix B to Subpart A of 10 CFR Part 51-TN250, which states:

> The probability-weighted consequences of atmospheric releases, fallout onto open bodies of water, releases to groundwater~~,~~ and societal and economic impacts from severe accidents are SMALL for all plants. However, alternatives to mitigate severe accidents must be considered for all plants that have not considered such alternatives.

~~An analysis of severe accident mitigation alternatives (SAMAs) was performed for North Anna at the time of initial license renewal (Dominion 2001). The staff documented its SAMA review in NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 7, Regarding North Anna, Units 1 and 2* (NRC 2002a). For the North Anna subsequent license renewal SAMA analysis, the NRC staff considered any new and significant information that might alter the conclusions of that analysis, as discussed below.~~

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The NRC's regulations in 10 CFR Part 51-TN250, which implement Section 102(2) of NEPA~~,~~ require that all applicants for license renewal must submit an ER to the NRC, in which they identify any "new and significant information regarding the environmental impacts of license renewal of which the applicant is aware" (10 CFR 51.53(c)(3)(iv~~)~~.-), This includes new and significant information that could affect the environmental impacts related to postulated severe accidents or that could affect the results of a previous SAMA analysis. ~~Accordingly, in its subsequent~~Therefore, the licensee performed an analysis of SAMAs for North Anna at the time of initial license renewal (VEPCO 2001-TN8297). The staff documented its SAMA review in NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 7, Regarding North Anna, Units 1 and 2* (NRC 2002-TN8296). For the SLR application ER, Dominion ~~evaluates~~evaluated areas of new and significant information that could affect the environmental impact of postulated severe accidents during the ~~subsequent license renewal~~SLR period of extended operation and possible new and significant information as it relates to SAMAs.

For the North Anna SLR SAMA analysis, the NRC staff considered any new and significant information applicable to SLR that might alter the conclusions presented in the LR GEIS or the staff's SAMA evaluation conducted for initial license renewal of North Anna Units 1 and 2, as discussed below.

~~A.2~~F.2Severe Accident Mitigation Alternatives (SAMAs)

In a SAMA analysis, the NRC requires license renewal applicants to consider the environmental impacts of severe accidents~~,~~ their probability of occurrence, and potential means to mitigate those accidents. As quoted above, 10 CFR Part 51-TN250, Table B-1 states, "Alternatives to mitigate severe accidents must be considered for all nuclear power plants that have not considered such alternatives.~~"~~." This NRC requirement to consider alternatives to mitigate severe accidents can be fulfilled by a SAMA analysis. The purpose of the SAMA analysis is to identify design alternatives, procedural modifications, or training activities that may further reduce the risks of severe accidents at nuclear power plants and that are also potentially cost-beneficial to implement. The SAMA analysis includes the identification and evaluation of SAMAs that may reduce the radiological risk from a severe accident by preventing substantial core damage (i.e., preventing a severe accident) or by limiting releases from containment if substantial core damage occurs (i.e., mitigating the impacts of a severe accident) (NRC ~~2013a)~~ 2013-TN2654). The regulation at 10 CFR 51.53(c)(3)(ii)(L) (TN250), states that each license renewal applicant must submit an environmental report that considers alternatives to mitigate severe accidents "[i]f the staff has not previously considered severe accident mitigation alternatives for the ~~applicant's~~applicant's nuclear power plant in an environmental impact statement or related supplement or in an environmental assessment.~~"~~."

~~A.2.1~~F.2.1North Anna Initial License Renewal Application and SAMA Analysis in 2001

As part of its initial license renewal application submitted in 2001, Dominion's environmental report included an analysis of SAMAs for North Anna (~~Dominion~~ VEPCO 2001~~).~~ -TN8297). Dominion based this SAMA analysis on: (1) the North Anna probabilistic risk assessment (PRA) for total accident frequency, core damage frequency (CDF~~),~~), and containment large early release frequency (LERF); and (2) a supplemental analysis of offsite consequences and economic impacts for risk determination. The North Anna PRA included a Level 1 analysis to determine the CDF from internally initiated events and a Level 2 analysis to determine containment performance during severe accidents~~.~~. The offsite consequences and economic impacts analyses (Level 3 PRA) used the MELCOR Accident Consequence Code System 2

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~~(MACCS2)~~ code, Version 1.12, to determine the offsite risk impacts on the surrounding environment and the public. Inputs for the latter analysis included nuclear power plant- and site-specific values for core radionuclide inventory, source term and release fractions, meteorological data, projected population distribution (based on 1990 census data, projected out to 2030),[2] emergency response evacuation modeling, and economic data. To help identify and evaluate potential SAMAs, Dominion considered insights and recommendations from SAMA analyses for other nuclear power plants, potential nuclear power plant improvements discussed in NRC and industry documents, and documented insights that the North Anna staff provided.

In its 2001 environmental report, Dominion considered 158 SAMA candidates. Dominion then performed a qualitative screening of those SAMAs, eliminating SAMAs that were not applicable to North Anna or had already been implemented at North Anna. Based on this qualitative screening, 107 SAMAs were eliminated, leaving 51 SAMAs subject to the final screening and evaluation process. The 51 remaining SAMAs are listed in Table G.2-2 of Appendix G of the 2001 ~~environmental report~~ (ER) ~~(Dominion~~ (VEPCO 2001~~).~~ TN8297). The final screening process involved identifying and eliminating those SAMAs whose cost exceeded twice their benefit. Ultimately, Dominion concluded that there were no potentially cost-beneficial SAMAs associated with the initial North Anna license renewal (~~Dominion~~VEPCO 2001-TN8297).

As part of its review of the initial North Anna license renewal application, the NRC staff reviewed Dominion's 2001 analysis of SAMAs for North Anna, as documented in Supplement 7 to NUREG-1437 (NRC ~~2002b).~~ 2002-TN8296). Chapter 5 of Supplement 7 to NUREG-1437 contains the NRC staff's evaluation of the potential environmental impacts of nuclear power plant accidents and examines each SAMA (individually and, in some cases, in combination) to determine the SAMA's individual risk reduction potential. The NRC staff then compared this potential risk reduction against the cost of implementing the SAMA to quantify the SAMA's cost-benefit value.

In Section 5.2 of NUREG-1437, Supplement 7, the NRC staff found that Dominion used a systematic and comprehensive process for identifying potential nuclear power plant improvements for North Anna, and that its bases for calculating the risk reductions afforded by these nuclear power plant improvements were reasonable and generally conservative~~.~~ (NRC 2002-TN8296). Further, the NRC staff found that Dominion's estimates of the costs of implementing each SAMA were reasonable and consistent with estimates developed for other operating reactors. In addition, the NRC staff concluded that Dominion's cost-benefit comparisons were performed appropriately. The NRC staff concluded that Dominion's SAMA methods and implementation of those methods were sound. The NRC staff agreed with Dominion's conclusion that none of the candidate SAMAs were potentially cost-beneficial based on conservative treatment of costs and benefits. The staff found that Dominion's conclusion was: (a) consistent with the low residual level of risk indicated in the North Anna PRA and (b) consistent with the fact that North Anna had already implemented many nuclear power nuclear power plant improvements identified during two risk analysis processes. These two risk analysis process were (1) the individual plant examination (IPE), a risk analysis that considers the unique aspects of a particular nuclear power plant, identifying the specific vulnerabilities to severe accidents of that nuclear power plant and, (2) the individual plant examination of external events (IPEEE), a risk analysis that considers external events such as earthquakes and high winds ~~(NRC 2002b).~~.

[2] In contrast, as discussed in Section F.3.9~~F.3.9~~ below, Dominion's ER for ~~subsequent license renewal~~SLR utilized projected population values for the year 2060 (~~Dominion~~VEPCO 2020-TN8099).

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~~A.2.2~~F.2.2 Subsequent License Renewal Application and New and Significant Information as It Relates to ~~the Probability-Weighted Consequences of Severe Accidents~~SAMA

As mentioned above, a license renewal application must include an ER that describes SAMAs if the NRC staff has not previously evaluated SAMAs for that nuclear power plant in an EIS, in a related supplement to an EIS, or in an environmental assessment. As also discussed above, the NRC staff performed a site-specific analysis of North Anna SAMAs in NUREG-1437, Supplement 7 (NRC ~~2002b).~~ 2002-TN8296). Therefore, in accordance with 10 CFR 51.53(c)(3)(ii)(L) and Table B-1 of Appendix B to Subpart A of 10 CFR Part 51-TN250, Dominion is not required to provide another SAMA analysis in its ER for the North Anna ~~subsequent license renewal~~SLR application.

In Dominion's assessment of new and significant information related to SAMAs in its ~~subsequent license renewal~~SLR application, Dominion used the Nuclear Energy Institute (NEI) guidance document, NEI 17-04, Revision 1, "Model SLR [Subsequent License Renewal] New and Significant Assessment Approach for SAMA" (NEI 2019-TN6815), which the NRC staff has endorsed (NRC ~~2019a).~~ 2019-TN7805). As discussed in Section F.5 below, NEI developed a model approach for license renewal applicants to use in assessing the significance of new information, of which the applicant is aware, that relates to a prior SAMA analysis that was performed in support of the issuance of an initial license, renewed license, or combined license.

NEI 17-04 provides a tiered approach that entails a three-stage screening process for the evaluation of new information. In this screening process, new information is deemed to be "potentially significant" to the extent that it results in the identification in Stage 1 (involving the use of PRA risk insights and/or risk model quantifications) of an unimplemented SAMA that reduces the maximum benefit ~~(MB)~~ by 50 percent or more. Maximum benefit is defined in Section 4.5 of NEI 05-01, Revision A, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document" (NEI ~~2005b~~2005-TN1978), as the benefit a SAMA could achieve if it eliminated all risk. The total offsite dose and total economic impact are the baseline risk measures from which the maximum benefit is calculated.

If a SAMA is found to result in a 50-percent reduction in maximum benefit in Stage 1, a Stage 2 assessment would then be performed (involving an updated averted cost-risk estimate for implementing that SAMA). A Stage 3 assessment (involving a cost-benefit analysis) would be required only for "potentially significant" SAMAs (i.e., those that are shown by the Stage 2 assessment to reduce the maximum benefit by 50 percent or more). Finally, if the Stage 3 assessment shows that a "potentially significant" SAMA is "potentially cost-beneficial," thus indicating the existence of "new and significant" information, then the applicant must supplement the previous SAMA analysis. The NRC staff endorsed NEI 17-04, Revision 1, for use by license renewal applicants on December 11, 2019 (NRC ~~2019a).~~ 2019-TN7805). Dominion's assessment of new and significant information related to its SAMA cost-benefit analysis is discussed in Section F.~~5~~F.5 of this appendix.

Below, the NRC staff summarizes possible areas of new and significant information and assesses Dominion's conclusions.

A.3F.3Evaluation of New Information Concerning Severe Accident Probability Weighted Consequences for North Anna as It Relates to the GEIS

The 2013 GEISLR GEIS considers developments in nuclear power plant operation and accident analysis that could have changed the assumptions made in the 1996 LR GEIS concerning severe accident consequences. The 2013 LR GEIS confirmed the determination in the 1996 LR GEIS that the probability-weighted consequences of severe accidents are SMALL for all nuclear power plants. In the 2013 LR GEIS, Appendix EAppendix E provides the NRC staff's evaluation of the environmental impacts of postulated accidents. accidents. Table E-19, "Summary of Conclusions," of the 2013 LR GEIS shows the developments that the NRC staff considered, as well as the staff's conclusions. Consideration of the items listed in Table E-19 was the basis for the NRC staff's overall determination in the 2013 LR GEIS that the probability-weighted consequences of severe accidents remain SMALL for all nuclear power plants.

For subsequent license renewal SLR for North Anna, the staff confirmed that there is no new and significant information that would change the 2013 GEIS1996 LR GEIS conclusions onregarding the probability-weighted consequences of severe accidents. The Similarly, the NRC staff evaluated Dominion's plant specific information related to the 2013 GEIS, Table E-19, "Summary of Conclusions,"to determine if there was any new and significant information that would warrant changes to the staff's conclusions in the 2002 Supplemental Environmental Impact Statement (SEIS) for initial license renewal of North Anna's operating licenses. The staff did not identify any new and significant information during the North Anna audit (NRC 2020a 2020-TN8100), during the scoping process, and through the evaluation of other available information. site-specific information that would warrant a different conclusion for the probability weighted consequences of severe accidents during the North Anna SLR term. The results of thatthe staff's review follow.

A.3.1F.3.1New Internal Events Information (Section E.3.1 of the 2013 GEIS)LR GEIS)

After Dominion submitted the North Anna initial license renewal application ER in 2001 and the NRC staff issued its corresponding SAMA review in its 2002 SEIS, there have been many improvements to North Anna's risk profile. (NRC 2002-TN8296). The North Anna internal events CDF in the initial license renewal SAMA was approximately 3.50× × 10^{-5}/year (Dominion VEPCO 2001). TN8297). The current North Anna internal events PRA model of record has a CDF of approximately 1.36× × 10^{-6}/year (Dominion VEPCO 2020). TN8099). This change represents a 96-percent reduction or a factor of 25 reduction in CDF for each unit. This substantial improvement in CDF makes any proposedTherefore, no new SAMA or previously evaluated SAMA less likely to be cost-beneficialand significant information exists for North Anna concerning offsite consequences of severe accidents initiated by internal events during the SLR term.

In addition, in the 2013 GEIS, the NRC staff reviewed the updated boiling water reactor (BWR) and pressurized water reactor (PWR) internal event CDFs. The CDF is an expression of the likelihood that, given the way a reactor is designed and operated, an accident could cause the fuel in the reactor to be damaged. The 2013 GEIS addresses new information on the risk and environmental impacts of severe accidents caused by internal events that had emerged following issuance of the 1996 GEIS and includes consideration of North Anna's plant specific PRA analysis. The new information addressed in the 2013 GEIS indicates that PWR and BWR CDFs evaluated for the 2013 GEIS are generally comparable to or less than the CDFs that formed the basis for the 1996 GEIS (NRC 2013a).

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Using North Anna internal events information, the 1996 LR GEIS indicated that the non-normalized predicted total population dose risk (person-rem/RY) (95 percent upper confidence bound) for North Anna Units 1 and 2 was 1,496 person-rem RY. The population dose risk is equivalent to the probability weighted consequences of a severe accident to the public and environment. The North Anna Units 1 and 2 initial license renewal SAMA total population dose risk was calculated to be 50 person-rem/RY. This provides a ratio of the North Anna 1996 LR GEIS 95 percent upper confidence bound predicted population dose, to North Anna initial license renewal total population dose risk (i.e., 1,496/50), of 30.

Therefore, considering the CDF reduction in North Anna's risk profile ~~and the new information evaluated in the 2013 GEIS~~, the NRC staff concludes that the offsite consequences of severe accidents initiated by internal events during the ~~subsequent license renewal~~ SLR term at North Anna would not ~~exceed~~change the ~~impacts predicted in~~conclusions of the ~~2013~~1996 LR GEIS. For these issues, the 1996 LR GEIS predicted that the probability-weighted consequences of severe accidents would be SMALL for all nuclear power plants. The NRC staff identified no new and significant information regarding internal events during its review of Dominion's ER and ER supplement, during the SAMA audit, through the scoping process, or through the evaluation of other available information. Thus, the NRC staff ~~finds Dominion's conclusion acceptable~~concludes that no new and significant information exists for North Anna during the SLR term concerning the offsite consequences of severe accidents initiated by internal events that would alter the ~~conclusions~~ conclusion that the probability-weighted consequences of severe accidents would be SMALL reached in the ~~2013 GEIS~~1996 LR GEIS, the 2013 LR GEIS, and the North Anna initial LR SEIS.

~~A.3.2~~F.3.2External Events (Section E.3.2 of the 2013 ~~GEIS~~)LR GEIS)

The 1996 LR GEIS concluded that severe accidents initiated by external events (such as earthquakes) could have potentially high consequences, but also found that the risks from these external events are adequately addressed through a consideration of severe accidents initiated by internal events (such as a loss of cooling water). ~~Therefore, the 1996 GEIS concluded that an applicant for license renewal need only analyze the environmental impacts from an internal event to characterize the environmental impacts from either internal or external events.~~ As summarized in the 2013 LR GEIS, the mean pressurized-water reactor (PWR) internal event CDF in the original EISs that were used in the 1996 LR GEIS to estimate probability-weighted, offsite consequences from airborne, surface water, and groundwater pathways, as well as the resulting economic impacts from such pathways, was 8.4×10^{-5} per reactor-year (NRC 2013-TN2654).

The 2013 LR GEIS expanded the scope of the evaluation in the 1996 LR GEIS and used more recent technical information that included both internally and externally initiated event core-damage frequencies. Section E.3.2.3 of the 2013 LR GEIS concludes that the CDFs from severe accidents initiated by external events, as quantified in NUREG-~~-~~1150, *Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants* (NRC ~~1990b~~ 1990-TN525), and other sources documented in the LR GEIS, are comparable to CDFs from accidents initiated by internal events, but lower than the CDFs that formed the basis for the 1996 ~~GEIS.~~ LR GEIS. This is evident, for example, in the CDFs from severe accidents at North Anna. The fire and seismic CDFs (3.9×10^{-6} per reactor-year [NRC 2002-TN8296] and 6×10^{-5} per reactor-year [VEPCO 2020-TN8099], respectively) for North Anna, as well as the sum of the two, were less than the mean PWR internal event CDF (8.4×10^{-5} per reactor-year) (NRC 2013-TN2654) that had been considered in the original EISs used in the 1996 LR GEIS to estimate probability-

weighted weighted, offsite consequences from airborne, surface water, and groundwater pathways, as well as the resulting economic impacts from such pathways.

~~The fire and seismic CDFs (3.9×10^{-5} per reactor year and 6×10^{-6} per reactor year, respectively) for North Anna as well as the sum of the two, were less than 5.9×10^{-5} per reactor year. This value (5.9×10^{-5}) was the internal events mean value CDF for PWRs that the 2013 GEIS used to estimate probability weighted, offsite consequences from airborne, surface water, and groundwater pathways, as well as the resulting economic impacts from such pathways.~~

Dominion indicated that the "~~NAPS~~North Anna-R07i" model was used to determine the level of significance of new information. This model includes internal events (including internal floods) and a Seismic PRA, which takes into account the 2011 Mineral, Virginia, earthquake (~~Dominion~~ VEPCO 2020-TN8099). Dominion indicated this PRA model reflected the most up-to-date understanding of nuclear power plant risk at the time of analysis. The staff determined that this approach is sufficient to evaluate new and significant information related to SAMAs because use of the model was consistent with the NEI 17-04 methodology.

On March 12, 2012, the NRC issued a request under 10 CFR 50.54(f) (TN249), as part of implementing lessons learned from the accident at Fukushima, that, among other things, requested licensees to reevaluate the seismic hazards at their sites using present-day methodologies and guidance to develop a ground motion response spectrum (~~GMRS~~) (~~NRC 2012~~). TN7762). Since the reevaluated seismic hazard for North Anna, as characterized by the ~~GMRS~~ground motion response spectrum, was not bounded by the current nuclear power plant design-basis SSE ~~9safe~~(safe-shutdown earthquake), the NRC requested that Dominion complete a ~~seismic probabilistic risk assessment~~ (Seismic PRA) to determine if nuclear power plant enhancements were warranted. Dominion submitted its Seismic PRA on March 28, 2018 (~~Dominion~~ VEPCO 2018). TN8330). The NRC staff reviewed Dominion's Seismic PRA and concluded that the results and risk insights provided by the Seismic PRA support the NRC's determination that no further response or regulatory action is required at North Anna (NRC ~~2019b~~). 2019-TN8333). The staff indicated that a backfit was not warranted because the staff did not identify any potential modifications that (1) would result in substantial reductions in the seismic core damage frequency and mean-seismic large-early -release frequency, (2) would be a substantial safety improvement, or (3) would be necessary for adequate protection or compliance. The staff also noted that the actions taken by Dominion and experience gained after the 2011 Mineral earthquake "provide additional assurance regarding North Anna's ability to handle a beyond-design-basis seismic event" (NRC ~~2019b~~). 2019-TN8333). In its June 9, 2020, letter completing its post-Fukushima assessment for North Anna, the staff noted that North Anna had implemented the safety enhancements mandated by the NRC based on the lessons learned from the Fukushima accident, and stated that the NRC will continue to provide oversight of North Anna's seismic safety enhancements through the Reactor Oversight Process (NRC ~~2020a, 2020b~~ 2020-TN8100, NRC 2020-TN8336).

The 1996 LR GEIS indicated that the non-normalized predicted total population dose risk (person-rem/RY) (95 percent upper confidence bound) for North Anna Units 1 and 2 was 1,496 person-rem RY. The population dose risk is equivalent to the probability weighted consequences of a severe accident to the public and environment. The North Anna Units 1 and 2 initial license renewal SAMA total population dose risk was calculated to be 50 person-rem/RY. This provides a ratio of the North Anna 1996 LR GEIS 95 percent upper confidence bound predicted population dose to North Anna initial license renewal total population dose risk of 30. This considerable margin offsets any increases in external events since the previous SAMA analysis.

In conclusion, there was ~~a~~ greater than a factor of 25 decrease in the North Anna internal events CDF~~.~~. North Anna also performed a Seismic PRA (external events) to determine if nuclear power plant enhancements were warranted~~,~~; and the staff determined that North Anna had implemented the safety enhancements mandated by the NRC based on the lessons learned from the Fukushima accident. ~~As predicted in~~Additionally, the 2013 ~~GEIS,~~LR GEIS evaluated the sum of the North Anna external events CDFs which was lower than the CDFs that formed the basis for the 1996 LR GEIS. Therefore, the NRC staff concludes that the probability-weighted offsite consequences of severe accidents initiated by external events during the ~~subsequent license renewal~~ SLR term would not exceed the ~~consequences predicted in the 2013 GEIS. For these issues, the GEIS predicts that the probability-weighted~~estimated consequences reported in both the 1996 LR GEIS and 2013 LR GEIS. The 1996 LR GEIS predicted that the probability weighted offsite consequences of severe accidents would be SMALL for all nuclear power plants. The SEIS for North Anna's initial license renewal reached the same conclusion for the initial LR period of extended operation. The NRC staff has identified no new and significant information regarding external events during the SLR term at North Anna, in its review of Dominion's ER and ER supplement, through the SAMA audit, during the scoping process, or through the evaluation of other available information~~.~~ that would alter this conclusion for North Anna SLR. Thus, the NRC staff concludes that no new and significant information exists for North Anna concerning the offsite consequences of severe accidents initiated by external events that would alter the ~~conclusions reached in the 2013 GEIS~~conclusion that the probability-weighted consequences of severe accidents would be SMALL for North Anna during the SLR term.

~~A.3.3~~F.3.3New Source Term Information (Section E.3.3 of the 2013 ~~GEIS~~)LR GEIS)

The source term refers to the magnitude and mix of the radionuclides released from the fuel (expressed as fractions of the fission product inventory in the fuel), as well as their physical and chemical form, and the timing of their release following an accident. The 2013 LR GEIS concludes that, in most cases, more recent estimates give significantly lower release frequencies and release fractions than was assumed in the 1996 LR GEIS. Thus, the environmental impacts of radioactive materials released during severe accidents~~,~~ used as the basis for the 1996 LR GEIS (i.e., the frequency-weighted release consequences), are higher than the environmental impacts that would be estimated today using more recent source term information. The NRC staff also notes that results from the NRC's State-of-the-Art Reactor Consequence Analysis (SOARCA) project (which represents a significant ongoing effort to re-~~-~~quantify realistic severe accident source terms) confirm that source term timing and magnitude values calculated in the SOARCA reports are significantly lower than those quantified in previous studies. The NRC staff expects to incorporate the information gleaned from the SOARCA project in future revisions of the LR GEIS (NRC ~~2013a~~ 2013-TN2654).

The 1996 LR GEIS indicated that the non-normalized predicted total population dose risk (person-rem/RY) (95 percent upper confidence bound) for North Anna Units 1 and 2 was 1,496 person-rem RY. The population dose risk is equivalent to the probability weighted consequences of a severe accident to the public and environment. The North Anna Units 1 and 2 initial license renewal SAMA total population dose risk was calculated to be 50 person-rem/RY. This provides a ratio of the North Anna 1996 LR GEIS 95 percent upper confidence bound predicted population dose, to the North Anna initial license renewal total population dose risk, (i.e., 1,496/50) of 30. This considerable margin accounts for any increases in external events since the previous SAMA analysis.

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For the reasons described above, current source term (timing and magnitude) at North Anna ~~are~~is likely to have significantly smaller effects than had been quantified in previous studies and the initial license renewal North Anna SAMA analysis in 2001. Therefore, the offsite consequences of severe accidents initiated by the new source term during the ~~subsequent license renewal~~ SLR term would not exceed the impacts predicted in the ~~GEIS.~~ North Anna initial LR SEIS or the 2013 LR GEIS. For these issues, the LR GEIS predicts that the probability-weighted consequences of severe accidents would be SMALL for all nuclear power plants. The NRC staff identified no new and significant information regarding the source term for North Anna SLR during its review of Dominion's ER and ER supplement, through the SAMA audit, during the scoping process, or through the evaluation of other available information~~.~~ that would alter that conclusion for North Anna during the SLR period of extended operation. Thus, the NRC staff concludes that no new and significant information exists for North Anna during the SLR term concerning the offsite consequences of severe accidents initiated by new source term ~~that would alter the conclusions reached in the 2013 GEIS~~information that would alter the conclusion that the probability-weighted consequences of severe accidents would be SMALL for North Anna during the SLR period of extended operations.

~~A.3.4~~F.3.4Power Uprate Information (Section E.3.4 of the 2013 GEIS)]

Operating at a higher reactor power level results in a larger fission product radionuclide inventory in the core than if the reactor were operating at a lower power level. In the event of an accident, the larger radionuclide inventory in the core would result in a larger source term. If the accident is severe, the release of radioactive materials from this larger source term could result in higher doses to offsite populations.

~~Large early release frequency (~~LERF~~)~~ represents the frequency of event sequences that could result in early fatalities. The impact of a power uprate on early fatalities can be measured by considering the impact of the uprate on the LERF calculated value. To this end, Table E-14 of the 2013 LR GEIS presents the change in LERF calculated by each licensee that has been granted a power uprate of greater than 10 percent. Table E-14 shows that the increase in LERF ranges from a minimal impact to an increase of about 30 percent (with a mean of 10.5 percent). The 2013 LR GEIS, Section E.3.4.3, "Conclusion," determines that a power uprate will result in a small ~~to~~ (in some cases) to moderate increase in the environmental impacts from a postulated accident~~.~~. However, taken in combination with the other information presented in the LR GEIS, the increases would be bounded by the 95-percent upper-confidence bound values in Table 5.10 and Table 5.11 of the 1996 LR GEIS.

In 2009, the NRC approved a 1.6-percent measurement uncertainty recapture (MUR) at North Anna, from 2,893 megawatts thermal (MWt) to 2,940 MWt (NRC ~~2009a).~~ 2009-TN8337). The MUR uprate is included in the current North Anna CDF and LERF. In the staff's safety evaluation for the MUR uprate, the change in nuclear power plant risk due to the uprate was determined to be insignificant since the power level increase is only 1.6-percent. The NRC ~~staff's~~staff's safety evaluation for the MUR power uprate concluded that the CLB (10 CFR 54.3- TN4878, "Definitions") dose~~-~~consequence analyses for design-basis ~~accidents~~accidents will remain bounding at the proposed MUR uprated power level (NRC~~-2009a).~~ 2009-TN8337).

Therefore, the NRC staff finds that the offsite consequences from the power uprate would not exceed the consequences predicted in the 2013 LR GEIS~~.~~. The NRC staff has identified no new and significant information regarding power uprates during its review of Dominion's ER and ER supplement, through the SAMA audit, during the scoping process, or through the evaluation of other available information~~.~~ that would alter this conclusion. Thus, the NRC staff concludes

that no new and significant information exists for North Anna concerning the offsite consequences ~~due to~~of severe accidents influenced by power uprates ~~that would alter the conclusions reached in~~during the ~~2013 GEIS~~SLR term that would alter the conclusion that the probability-weighted consequences of severe accidents would be SMALL for North Anna during the SLR period of extended operations.

~~A.3.5~~F.3.5Higher Fuel Burnup Information (Section E.3.5 of the 2013 ~~GEIS~~)LR GEIS)

According to the 2013 ~~GEIS~~,LR GEIS, increased peak fuel burnup from 42 to 75 gigawatt days per metric ton uranium (GWd/MTU) for PWRs, and 60 to 75 GWd/MTU for ~~BWRs~~boiling-water reactors, results in small to moderate increases (up to 38 percent) in population dose in the event of a severe accident. However, taken in combination with the other information presented in the 2013 LR GEIS, the increases would be bounded by the 95-percent upper-confidence bound values in Table 5.10 and Table 5.11 of the 1996 LR GEIS.

In ~~ER~~ Section 4.13.4.4 of the ER, Dominion indicated that the average burnup level of the peak rod is not planned to exceed 60,000 MWd/MTU during the proposed SLR operating term. Therefore, the offsite consequences from higher fuel burnup would not exceed the consequences predicted in the 2013 ~~GEIS.~~ LR GEIS. For these issues, the LR GEIS predicted that the probability-weighted consequences would be small for all nuclear power plants. The NRC staff identified no new and significant information regarding higher fuel burnup during its review of Dominion's ER and ER supplement, through the SAMA audit, during the scoping process, or through the evaluation of other available information. Thus, the staff concludes that no new and significant information exists for North Anna SLR concerning offsite consequences due to higher fuel burnup that would alter the conclusions reached in the ~~2013 GEIS.~~ 1996 LR GEIS and 2013 LR GEIS or the North Anna initial LR SEIS. Thus, the NRC staff concludes that no new and significant information exists for North Anna during the SLR term concerning the offsite consequences of severe accidents influenced by higher fuel burnup information that would alter the conclusion that the probability-weighted consequences of severe accidents would be SMALL for North Anna during the SLR period of extended operations.

~~A.3.6~~F.3.6Low Power and Reactor Shutdown Event Information (Section E.3.6 of the 2013 ~~GEIS~~)LR GEIS)

~~The 2013 GEIS concludes that the environmental impacts from accidents~~The 1996 LR GEIS estimates of the environmental impact of severe accidents bound potential impacts from accidents at low power and shut down, with margin. The NRC evaluated the Surry nuclear power plant in NUREG-1150 and NUREG/CR-6144; North Anna is a similarly designed nuclear power plant (i.e., both Surry and North Anna are Westinghouse PWRs with large containments), and there are no nuclear power plant configurations in low power and shutdown conditions that are likely to distinguish North Anna from the evaluated Surry nuclear power plants such that the assumptions in the 1996 LR GEIS and 2013 LR GEIS would not apply. Additionally, the 2013 LR GEIS concludes that the environmental impacts from accidents at low power and shutdown conditions are generally comparable to those from accidents at full power, based on a comparison of the values in NUREG/CR-6143, *Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Grand Gulf, Unit 1* (~~NRC 1995a~~SNL 1995-TN7783), and NUREG/CR-6144, *Evaluation of Potential Severe Accidents During Low Power and Shutdown Operations at Surry, Unit 1* (~~NRC 1995b~~BNL 1995-TN7776), with the values in NUREG-1150, *Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants* (NRC ~~1990b). The 1996 GEIS estimates of the environmental impact of severe accidents bound the potential impacts from accidents at low power and shut down, with margin. Surry~~

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~~was evaluated in NUREG-1150 and NUREG/CR-6144, and North Anna is a similarly designed plant (i.e., they are Westinghouse PWRs with large containments); thus, the NRC staff concludes that there are no plant configurations in low power and shutdown conditions likely to distinguish North Anna from the evaluated plants such that the assumptions in the 2013 and 1996 GEISs would not apply.~~1990-TN525).

Finally, as discussed in SECY-97-168, "Issuance for Public Comment of Proposed Rulemaking Package for Shutdown and Fuel Storage Pool Operation~~",~~" (NRC 1997~~),~~ TN7621) industry initiatives taken during the early 1990s have also contributed to the improved safety of low power and shutdown operations for all nuclear power plants. Therefore, the offsite consequences of severe accidents~~,~~ considering low power and reactor shutdown events, during the North Anna SLR term would not exceed the impacts predicted in either the 1996 LR GEIS or 2013 ~~GEIS.~~ LR GEIS. For these issues, the LR GEIS predicts that the probability-weighted consequences of severe accidents would be small for all nuclear power plants. ~~The~~Further, the NRC staff identified no new and significant information for North Anna SLR regarding low power and reactor shutdown events during its review of Dominion's ER and ER Supplement, through the NRC staff's SAMA audit, during the scoping process, or through the evaluation of other available information. Thus, the staff concludes that no new and significant information exists for North Anna during the SLR term, concerning low power and reactor shutdown events that would alter the ~~conclusions reached in the 2013 GEIS~~conclusion that the probability-weighted consequences of severe accidents would be SMALL for North Anna during the SLR term.

~~A.3.7~~F.3.7 Spent Fuel Pool Accident Information (Section E.3.7 of the 2013 ~~GEIS~~)LR GEIS)

The 2013 ~~GEIS~~LR GEIS concludes that the environmental impacts from accidents involving spent fuel pools (as quantified in NUREG-1738, *Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants* ([NRC 2001~~)),~~ TN5235]), can be comparable to those from reactor accidents at full power (as estimated in NUREG-1150 ([NRC ~~1990b)).~~ 1990-TN525]). The 2013 LR GEIS further indicates that subsequent analyses performed, and mitigative measures employed since 2001, have further lowered the risk of accidents involving spent fuel pools. In addition, the LR GEIS notes that even the conservative estimates from NUREG-1738 ~~(published in 2001)~~ are much lower than the impacts from full-power reactor accidents estimated in the 1996 LR GEIS. Therefore, the LR GEIS concludes, the environmental impacts stated in the 1996 LR GEIS bound the impact from spent fuel pool accidents for all nuclear power plants. For these issues, the LR GEIS predicts that the impacts would be SMALL for all nuclear power plants. There are no spent fuel configurations that would distinguish North Anna from the evaluated nuclear power plants such that the assumptions in the 1996 LR GEIS and 2013 ~~and 1996 GEISs~~LR GEIS would not apply. ~~The~~Further, the NRC staff identified no new and significant information regarding spent fuel pool accidents for North Anna during SLR term during its review of Dominion's ER and ER Supplement, through the SAMA audit, during the scoping process, or through the evaluation of other available information. Thus, the NRC staff concludes that no new and significant information exists for North Anna during the SLR term concerning spent fuel pool accidents that would alter the ~~conclusions reached in the 2013 GEIS~~conclusion that the probability-weighted consequences of severe accidents would be SMALL for North Anna during the SLR term.

~~A.3.8~~F.3.8 Use of Biological Effects of Ionizing Radiation ~~(BEIR)~~ VII Risk Coefficients (Section E.3.8 of the 2013 LR GEIS)

In 2005, the NRC staff completed a review of the National Academy of Sciences report, "Health Risks from Exposure to Low Levels of Ionizing Radiation: Biological Effects of Ionizing Radiation

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(BEIR) VII, Phase 2." The staff documented its findings in SECY-05-0202, "Staff Review of the National Academies Study of the Health Risks from Exposure to Low Levels of Ionizing Radiation (BEIR VII)" (NRC 2005~~).~~ TN4513). The SECY paper states that the NRC staff agrees with the BEIR VII report's major conclusion—namely, the current scientific evidence is consistent with the hypothesis that there is a linear, no-threshold, dose-response relationship between exposure to ionizing radiation and the development of cancer in humans. The BEIR VII conclusion is consistent with the hypothesis on radiation exposure and human cancer that the NRC uses to develop its standards of radiological protection. Therefore, the NRC staff has determined that the conclusions of the BEIR VII report do not warrant any change in the NRC's radiation protection standards and regulations because the NRC's standards are adequately protective of public health and safety and will continue to apply during the North ~~Anna's subsequent license renewal~~Anna SLR term. This general topic is discussed further in the NRC's 2007 denial of Petition for Rulemaking (PRM)-51-11 (72 FR 71083 2007-TN7789), in which the NRC stated that it finds no need to modify the 1996 ~~GEIS~~LR GEIS considering the BEIR VII report. For these issues, the LR GEIS predicts that the impacts of using the BEIR VII risk coefficients would be SMALL for all nuclear power plants.

The NRC staff identified no new and significant information regarding the risk coefficient used in the BEIR VII report during its review of Dominion's ER and ER supplement, through the SAMA audit, during the scoping process, or through the evaluation of other available information. Thus, the staff concludes that no new and significant information exists for North Anna during the SLR term concerning the biological effects of ionizing radiation that would alter the ~~conclusions reached in the 2013 GEIS.~~conclusion that the probability-weighted consequences of severe accidents would be SMALL for North Anna during the SLR term.

~~A.3.9~~F.3.9Uncertainties (Section E.3.9 of the 2013 LR GEIS))

Section 5.3.3 in the 1996 ~~GEIS~~LR GEIS provides a discussion of the uncertainties associated with the analysis in the LR GEIS and in the individual nuclear power plant EISs used to estimate the environmental impacts of severe accidents~~.~~. The 1996 LR GEIS used 95th percentile upper-confidence bound estimates whenever available for its estimates of the environmental impacts of severe accidents. This approach provides conservatism to cover uncertainties, as described in Section 5.3.3.2.2 of the 1996 LR GEIS. Many of these same uncertainties also apply to the analysis used in the 2013 LR GEIS update. As discussed in Sections E.3.1 through E.3.8 of the 2013 LR GEIS, the LR GEIS update used more recent information to supplement the estimate of environmental impacts contained in the 1996 LR GEIS. In effect, the assessments contained in Sections E.3.1 through E.3.8 of the 2013 LR GEIS provided additional information and insights into certain areas of uncertainty associated with the 1996 LR GEIS. However, as provided in the 2013 LR GEIS, the impact and magnitude of uncertainties, as estimated in the 1996 LR GEIS, bound the uncertainties introduced by the new information and considerations addressed in the 2013 LR GEIS. Accordingly, in the 2013 LR GEIS, the NRC staff concluded that the reduction in environmental impacts resulting from the use of new information (since the 1996 LR GEIS analysis) outweighs any increases in impact resulting from the new information. As a result, the findings in the 1996 LR GEIS remain valid. The NRC staff identified no new and significant information regarding uncertainties during its review of Dominion's ER and ER supplement, the SAMA audit, the scoping process, or the evaluation of other available information. Accordingly, the NRC staff concludes that no new and significant information exists for North Anna during the SLR term concerning uncertainties that would alter the conclusions reached in the ~~2013~~1996 LR GEIS and 2013 LR GEIS or the North Anna initial LR SEIS.

Section E.3.9.2 of Appendix E to the 2013 LR GEIS discusses the impact of population increases on offsite dose and economic consequences. The 2013 LR GEIS, in Section E.3.9.2, states the following:

> The 1996 GEIS estimated impacts at the mid-year of each ~~plant's~~plant's license renewal period (i.e., 2030 to 2050). To adjust the impacts estimated in the NUREGs and NUREG/CRs to the mid-year of the assessed ~~plant's~~plant's license renewal period, the information (i.e., exposure indexes [EIs]) in the 1996 GEIS can be used. The EIs adjust a ~~plant's~~plant's airborne and economic impacts from the year 2001 to its mid-year license renewal period based on population increases. These adjustments result in anywhere from a 5 to a 30 percent increase in impacts, depending upon the plant being assessed. Given the range of uncertainty in these types of analyses, a 5 to 30 percent change is not considered significant. Therefore, the effect of increased population around the plant does not generally result in significant increases in impacts.

~~The~~For initial license renewal, the population used in the North Anna initial license renewal ER (~~Dominion~~VEPCO 2001-TN8297, Section 4.20) was extrapolated to the year 2030 and found to be 2,468,629. In the SLR ER, ~~Dominion extrapolated the~~As provided in the North Anna ER, the area within a 50-mile (mi) (80 kilometer [km]) radius of the North Anna site totally or partially includes 32 counties and four independent cities within the states of Maryland and Virginia (ER Table E3.11-2). According to the 2010 census, the permanent population ~~to the year~~ (not including transient populations) of the 32 counties and four independent cities was approximately 3,268,359 (ER Table E3.11-2). By 2060. ~~Dominion projected the total~~, at the end of the proposed SLR term, the permanent population ~~for the year 2060~~ (not including transient populations) of the 32 counties and four independent cities is projected to be approximately 5,069,774. Based on the 2010–2060 population projections, an annual growth rate of approximately 0.96 percent is anticipated for the permanent population within the 50 mi (80 km) radius. Thus, a 20 year growth in population from 2040 to 2060 results in less than a 25 percent increase and is not considered to be a significant increase over a 20-year period. Similarly, the 2013 LR GEIS indicated that a 5 to 30 percent change is not considered significant. Therefore, the effect of increased population around North Anna does not result in a significant impact.

As can be seen from the data in Tables 5.10 and 5.11 of the 1996 ~~GEIS~~,LR GEIS, the estimated risk of early and latent fatalities from individual postulated nuclear power plant accidents is SMALL using very conservative 95th-percentile, upper-confidence bound estimates for environmental impact. The early and latent fatalities represent only a small fraction of the risk to which the public is exposed from other sources. As provided in ~~Regulatory Guide~~ (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," (NRC 2018-TN6335) the CDF risk metric is used as a surrogate for the individual latent cancer fatality risk, and the LERF risk metric is used as a surrogate for the individual early fatality risk. Given the substantial reduction in the North Anna CDF by a factor of 25, as explained in the PRA internal events section above, and the currently small North Anna LERF value of ~~2.49x10^{-6}/year~~1.72×10^{-7}/yr demonstrates that the risk of early and latent fatalities from individual postulated nuclear power plant accidents has decreased since the issuance of the 1996 LR GEIS (NRC 2015). TN8298). Furthermore, as discussed in Section E.3.3 of the 2013 LR GEIS and in this ~~SEIS~~SEIS, more recent estimates give significantly lower release frequencies and release fractions for the source term than was assumed in the 1996 LR GEIS. Specifically, the 2013 LR GEIS states that "a comparison of population dose from newer assessments illustrates a reduction in impact by a factor of 5 to 100 when compared to older assessments, and an additional factor of 2 to 4 due to the conservatism built into the

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1996 LR GEIS values." The effect of this reduction in total dose impact far exceeds the effect of a population increase. The staff concludes that the overall effect of increased population around the North Anna nuclear power plant during the SLR period of extended operation does not result in significant increases in impacts. Thus, the staff concludes that no new and significant information exists for North Anna during the SLR term concerning population increases that would alter the conclusions reached in the 1996 LR GEIS 2013 ~~GEIS~~LR GEIS or the North Anna initial LR SEIS.

~~A.3.10~~F.3.10Summary and Conclusion (Section E.5 of the 2013 LR GEIS~~)~~)

The 2013 LR GEIS categorizes "sources of new information" by their potential effect on the best-estimate environmental impacts associated with postulated severe accidents~~.~~. These effects can: (1) decrease the environmental impact associated with severe accidents; (2) not affect the environmental impact associated with severe accidents; or (3) increase the environmental impact associated with severe accidents.

Areas of new and significant information that can result in the first effect (decrease the environmental impacts associated with severe accidents~~)~~) at North Anna include:

- new internal events information (significant decrease)
- new source term information (significant decrease)
  - ~~population (population dose decreases when using more recent studies)~~

Areas of new and significant information that can result in the second effect (no effect on the environmental impact associated with severe accidents~~)~~) or the third effect (increase the environmental impact associated with severe accidents) include:

- use of BEIR VII risk coefficients
- consideration of external events ~~(comparable to internal event impacts)~~
- spent fuel pool accidents (could be comparable to full-power event impacts)
- higher fuel burnup (small ~~to moderate~~ increases)
- low power and reactor shutdown events (could be comparable to full-power event impacts)

The 2013 LR GEIS states, "[g]iven the difficulty in conducting a rigorous aggregation of these results with the differences in the information sources utilized, a fairly simple approach is taken." The LR GEIS estimated the net increase from the five areas listed above would be (in a simplistic sense) approximately an increase by a factor of 4.7. At the same time, however, for North Anna, the reduction in risk due to newer internal event information alone is a decrease in risk by a factor of 25. The net effect of an increase by a factor of 4.7 and a decrease by a factor of 25 would be an overall lower estimated impact (as compared to the 1996 LR GEIS assessment) by a factor of 20.3 (25 minus 4.7). ~~Thus~~Additionally, as described above using North Anna site specific information, the 1996 LR GEIS indicated that the non-normalized predicted total population dose risk (person-rem/RY) (95 percent upper confidence bound) for North Anna 1 and 2 was 1496 person-rem/RY. The population dose risk is equivalent to the probability weighted consequences of a severe accident to the public and environment. The North Anna Units 1 and 2 initial license renewal SAMA total population dose risk was calculated to be 50 person-rem/RY. This provides a ratio of the North Anna 1996 LR GEIS 95 percent upper confidence bound predicted population dose to North Anna initial license renewal total population dose risk of 30. This considerable margin accounts for any increases since the

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previous North Anna SAMA analysis was conducted. The NRC staff ~~finds that there is~~has identified no new and significant information related to severe accidents at North Anna during the SLR term that would alter the conclusions reached in the 1996 LR GEIS, the 2013 ~~GEIS~~LR GEIS, or the North Anna final supplemental environmental impact statement for initial license renewal, that the probability-weighted consequences of severe accidents are SMALL for all ~~plants~~nuclear power plants; this applies, as well, for North Anna during the SLR term.

Other areas of new information relating to the North Anna severe accident risk, severe accident environmental impact assessment, and cost-beneficial SAMAs are described below. These areas of new information demonstrate additional conservatism in the evaluations in the ~~GEIS~~LR GEIS and Dominion's ER, because they result in further reductions in the impact of a severe accident.

~~A.4~~F.4 Other New Information Related to NRC Efforts to Reduce Severe Accident Risk Following Publication of the 1996 ~~GEIS~~LR GEIS

The Commission considers ways to mitigate severe accidents at a given site more than just in the one-time SAMA analysis associated with a license renewal application. The Commission has considered and adopted various regulatory requirements for mitigating severe accident risks at reactor sites through a variety of NRC programs. For example, in 1996, when it promulgated Table B-1, "Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants," in Appendix B to Subpart A of 10 CFR Part 51-TN250, "Environmental Effect of Renewing the Operating License of a Nuclear Power Plant," the Commission explained in a *Federal Register* notice:

> The Commission has considered containment improvements for all plants pursuant to its Containment Performance Improvement program…and the Commission has additional ongoing regulatory programs whereby licensees search for individual plant vulnerabilities to severe accidents and consider cost-beneficial improvements (Final rule, "Environmental Review for Renewal of Nuclear Power Plant Operating Licenses," 61 FR 28467-TN4491 (June 5, 1996)).

These "additional ongoing regulatory programs" that the Commission mentioned include the IPE and the IPEEE program, which consider "potential improvements to reduce the frequency or consequences of severe accidents on a nuclear power plant-specific basis and essentially constitute a broad search for severe accident mitigation alternatives.~~"~~." Further, in the same rule, the Commission observed that the IPEs "resulted in a number of plant procedural or programmatic improvements and some plant modifications that will further reduce the risk of severe accidents" (61 FR 28481-TN8474) [*Federal Register* notices are accessible and searchable at https://www.federalregister.gov~~https://www.federalregister.gov]~~.]. Based on these and other considerations, the Commission stated its belief that it is "unlikely that any site-specific consideration of SAMAs for license renewal will identify major plant design changes or modifications that will prove to be cost-beneficial for reducing severe accident frequency or consequences." The Commission noted that it may review and possibly reclassify the issue of severe accident mitigation as a Category 1 issue upon the conclusion of its IPE/IPEEE program, but deemed it appropriate to consider SAMAs for nuclear power plants for which it had not done so previously, pending further rulemaking on this issue.

The Commission reaffirmed its SAMA-related conclusions in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 and 10 CFR 51.53(c)(3)(ii)(L), "Postconstruction environmental reports," in *Exelon Generation Co., LLC* (Limerick Generating Station, Units 1 and 2), CLI-13-07,

(October 31, 2013). In addition, the Commission observed that it had promulgated those regulations because it had "determined that one SAMA analysis would uncover most cost-beneficial measures to mitigate both the risk and the effects of severe accidents, thus satisfying our obligations under NEPA" (NRC 2013b 2013-TN7766).

The NRC has continued to address severe accident-related issues since the agency published the GEISLR GEIS in 1996. Combined NRC and licensee efforts have reduced risks from accidents beyond those accidents that were considered in the 1996 LR GEIS. The 2013 LR GEIS describes many of those efforts (NRC 2013a). 2013-TN2654).

These improvements and the Commission's conclusions apply to reactor operations at any time during a plant's life, whether under an initial operating license, initial license renewal, or SLR. In the remainder of Section F.4F.4 of this SEISsite-specific EIS, the NRC staff describes several efforts to reduce severe accident risk (i.e., CDF and LERF) following publication of the 1996 LR GEIS. Each of these initiatives applies to all reactors at any time during reactor operations, including North Anna. during the SLR term. Section F.4.1F.4.1 describes requirements adopted following the terrorist attacks of September 11, 2001, to address the loss of large areas of a nuclear power plant caused by fire or explosions. Section F.4.2F.4.2 describes the SOARCA project, which indicates that source -term timing and magnitude values may be significantly lower than source -term values quantified in previous studies using other analysis methods. Section F.4.3F.4.3 describes measures adopted following the Fukushima earthquake and tsunami events of 2013. Section F.4.4F.4.4 discusses efforts that have been made to use nuclear power plant operating experience to improve nuclear power plant performance and design features. These are areas of new information that reinforce the conclusion that the probability-weighted consequences of severe accidents are SMALL for all nuclear power plants as stated in the 2013 GEISLR GEIS and the North Anna final supplemental environmental impact statement for initial license renewal, and further reduce the likelihood of finding a cost-beneficial SAMA that would substantially reduce the severe accident risk at North Anna during the SLR term.

A.4.1F.4.1 10 CFR 50.54(hh)(2) Requirements Regarding Loss of Large Areas of the Nuclear Power Plant Caused by Fire or Explosions

As discussed on page E-7 of the 2013 GEIS,LR GEIS, following the terrorist attacks of September 11, 2001, the NRC conducted a comprehensive review of the agency's security program and made further enhancements to security at a wide range of NRC-regulated facilities. These enhancements included significant reinforcement of the defense capabilities for nuclear facilities, better control of sensitive information, enhancements in emergency preparedness, and implementation of mitigating strategies to deal with postulated events potentially causing loss of large areas of the nuclear power plant due to explosions or fires, including those that an aircraft impact might create. For example, the Commission issued Order EA-02-026, "Order for interim safeguards and security compensatory measures" (NRC 2002c2002-TN7825) to provide interim safeguards and security compensatory measures, which ultimately led to the promulgation of a new regulation in 10 CFR 50.54(hh).) (TN249). This regulation requires commercial power reactor licensees to prepare for a loss of large areas of the facility due to large fires and explosions from any cause, including beyond-design-basis aircraft impacts. In accordance with 10 CFR 50.54(hh)(2), licensees must adopt guidance and strategies to maintain or restore core cooling, containment, and spent-fuel pool cooling capabilities under circumstances associated with the loss of large areas of the nuclear power plant due to explosion or fire (NRC 2013a 2013-TN2654; 10 CFR Part 50-TN249).

NRC requirements pertaining to nuclear power plant security are subject to NRC oversight on an ongoing basis under a nuclear power plant's current operating license and are beyond the scope of license renewal. As discussed in Section 5.3.3.1 of the 1996 LR GEIS~~,~~ the NRC addresses security-related events using deterministic criteria in 10 CFR Part 73~~,~~ (TN423), "Physical Protection of Plants and Materials," rather than by risk assessments or SAMAs. However, the implementation of measures that reduce the risk of severe accidents~~,~~ including measures adopted to comply with 10 CFR 50.54(hh), "Conditions of licenses," also have a beneficial impact on the level of risk evaluated in a SAMA analysis, the purpose of which is to identify potentially cost-beneficial design alternatives~~,~~ procedural modifications, or training activities that may further reduce the risks of severe accidents. Dominion has updated North Anna's guidelines, strategies, and procedures to meet the requirements of 10 CFR 50.54(hh); therefore, those efforts have contributed to mitigation of the risk of a beyond-design-basis event. Accordingly, actions taken by Dominion to comply with those regulatory requirements have further contributed to the reduction of risk at North Anna.

In sum, the new information regarding actions that Dominion has taken to prepare for potential loss of large areas of the nuclear power plant due to fire or explosions has further contributed to the reduction of severe accident risk at North Anna~~.~~, including during SLR operations. Thus, this information does not alter the conclusions reached in the 2013 ~~GEIS~~LR GEIS regarding the probability-weighted consequences of severe accidents for North Anna SLR.

~~A.4.2~~F.4.2State-of-the-Art Reactor Consequence Analysis

The 2013 LR GEIS notes that a significant NRC effort is ongoing to re-quantify realistic, severe-accident source terms under the ~~State-of-the-Art Reactor Consequence Analysis~~ (SOARCA) project. Results indicate that source-term timing and magnitude values quantified using SOARCA are significantly lower than source-term values quantified in previous studies using other analysis methods (NRC 2008~~).~~ TN8380). The NRC staff plans to incorporate this new information regarding source term timing and magnitude using SOARCA in future revisions of the LR GEIS (NRC ~~2013a~~ 2013-TN2654).

The NRC has completed a SOARCA study for Surry~~;~~, which like North Anna~~,~~ ~~Surry~~ is a Westinghouse PWR with a large containment, located in close proximity to North Anna (NRC ~~2013c).~~ 2013-TN4593). The Surry SOARCA analyses indicate that successful implementation of existing mitigation measures can prevent reactor core damage or delay or reduce offsite releases of radioactive material. All SOARCA scenarios, even when unmitigated, progress more slowly and release much less radioactive material than the potential releases cited in the 1982 Siting Study, NUREG/CR-2239, *Technical Guidance for Siting Criteria Development* (~~NRC 2012b).~~ Aldrich et al. 1982-TN7749). As a result, the calculated risks of public health consequences of severe accidents modeled in SOARCA are very small.

This new information regarding the SOARCA project's findings has further contributed to the likelihood of a reduction of the calculated severe accident risk at North Anna, as compared to the 1996 LR GEIS and the North Anna SAMA evaluation for the initial license renewal application in 2001. ~~Thus,~~ the NRC staff finds there is no new and significant information related to the SOARCA project that would alter the conclusions reached in the 2013 LR GEIS or North Anna's previous SAMA analysis for North Anna operations during the SLR term.

~~A.4.3~~F.4.3 Fukushima-Related Activities

As discussed in Section E.2.1 of the 2013 LR GEIS~~,~~ on March 11, 2011, a massive earthquake off the east coast of the main island of Honshu, Japan, produced a tsunami that struck the coastal town of Okuma in Fukushima Prefecture. The resulting flooding damaged the six-unit Fukushima Dai-ichi nuclear power plant, causing the failure of safety systems needed to maintain cooling water flow to the reactors. Due to the loss of cooling, the fuel overheated, and there was a partial meltdown of fuel in three of the reactors. Damage to the systems and structures containing reactor fuel resulted in the release of radioactive material to the surrounding environment (NRC ~~2013a~~2013-TN2654).

As further discussed in Section E.2.1 of the 2013 LR GEIS~~,~~ in response to the earthquake, tsunami, and resulting reactor accidents at Fukushima Dai-ichi (hereafter referred to as the Fukushima events), the Commission directed the NRC staff to convene an agency task force of senior leaders and experts to conduct a methodical and systematic review of NRC regulatory requirements, programs, and processes (and their implementation) relevant to the Fukushima events. After thorough evaluation, the NRC required significant enhancements to U.S. commercial nuclear power plants. The enhancements included: adding capabilities to maintain key nuclear power plant safety functions following a large-scale natural disaster; updating evaluations on the potential impact from seismic and flooding events; adding new equipment to better handle potential reactor core damage events; and strengthening emergency coping capabilities. Additional discussion specific to the North Anna response to earthquakes, including Dominion's performance of a Seismic PRA, is available above in Section F.3.2~~F.3.2~~ and Section 3.4.4~~3.4.4~~ of this ~~SEIS~~EIS.

In summary, the Commission has imposed additional safety requirements on operating reactors, including North Anna, following the Fukushima accident (as described in the preceding paragraphs). The new regulatory requirements have further contributed to the reduction of severe accident risk at North Anna. ~~Therefore, the~~Further, these additional requirements apply to reactor operations at any time during a plant's life, whether under an initial operating license, initial license renewal, or SLR The NRC staff concludes that there is no new and significant information related to the Fukushima events that would alter the conclusions reached in n the 2013 LR GEIS or North Anna's previous SAMA analysis, as applicable to North Anna operations during the SLR term.

~~A.4.4~~F.4.4 Operating Experience

Section E.2 of the 2013 LR GEIS mentions the considerable operating experience that supports the safety of U.S. nuclear power plants. As with the use of any technology, greater user experience generally leads to improved performance and improved safety. Additional operating experience at nuclear power plants has contributed to improved nuclear power plant performance (e.g., as measured by trends in nuclear power plant-specific performance indicators), a reduction in adverse operating events, and new lessons learned that improve the safety of all operating nuclear power plants (NRC ~~2013a~~2013-TN2654).

~~A.4.5~~F.4.5 Conclusion

In sum, the new information related to NRC efforts to reduce severe accident risk described above contribute to improved safety, as do safety improvements not related to license renewal, including the NRC and industry response to generic safety issues ~~(~~(NRC 2011~~). Thus, the~~ TN7816). The performance and safety record of nuclear power plants operating in the United

States, including North Anna, continue to improve. This improvement is also confirmed by analysis, which indicates that, in many cases, improved nuclear power plant performance and design features have resulted in reductions in initiating event frequency, $CDF_{\bar{1}}$, and containment failure frequency (NRC ~~2013a~~2013-TN2654).

As discussed above, the NRC and the nuclear industry have addressed and continue to address numerous severe accident-related issues since the publication of the 1996 LR GEIS and the 2001 North Anna SAMA analysis~~.~~ performed at the time of initial license renewal. These actions reinforce the conclusion that the probability-weighted consequences of severe accidents are SMALL for all nuclear power plants, as stated in the 2013 LR GEIS, and further reduce the likelihood of finding a cost-beneficial SAMA that would substantially reduce the severe accident risk at North Anna during the SLR term.

~~A.5~~F.5Evaluation of New and Significant Information Pertaining to SAMAs Using NEI 17-04, "Model SLR New and Significant Assessment Approach for SAMA""

In its evaluation of the significance of new information, the NRC staff considers that new information is significant if it provides a seriously different picture of the impacts of the Federal action under consideration. Thus, for mitigation alternatives such as SAMAs, new information is significant if it indicates that a mitigation alternative would substantially reduce an impact of the Federal action on the environment. Consequently, with respect to SAMAs, new information may be significant if it indicates a given potentially cost-beneficial SAMA would substantially reduce the impacts of a severe accident or the probability or risk of a severe accident occurring (NRC ~~2013a~~ 2013-TN2654).

As discussed earlier in Section F.2.2~~F.2.2~~, Dominion stated in its ER (submitted as part of its ~~subsequent license renewal~~ SLR application), that it used the methodology in NEI 17-04 Revision 1, "Model SLR New and Significant Assessment Approach for SAMA"" (NEI 2019-TN6815) to evaluate new and significant information as it relates to the North Anna ~~subsequent license renewal~~SLR SAMAs. By letter dated December 11, 2019, the staff reviewed NEI 17-04 and found it acceptable for interim use, pending formal NRC endorsement of NEI 17-04 by incorporation in RG 4.2, Supplement 1, "Preparation of Environmental Reports for Nuclear Power Plant License Renewal Applications" (NRC 2019). In general, as discussed earlier, the NEI 17-04 methodology (NEI 2017-TN8338) does not consider a potential SAMA to be significant unless it reduces by at least 50 percent the maximum benefit as defined in Section 4.5, "Total Cost of Severe Accident Risk/Maximum Benefit," of NEI 05-01, Revision A, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document." NEI 05-01 is endorsed in NRC RG 4.2, Supplement 1 (NRC ~~2013a~~ 2013-TN2654).

NEI 17-04, "Model SLR New and Significant Assessment Approach for SAMA~~,~~"," describes a three-stage process for determining whether there is any new and significant information relevant to a previous SAMA analysis.

> **Stage 1**: The ~~subsequent license renewal~~SLR applicant uses PRA risk insights and/or risk model quantifications to estimate the percent reduction in the maximum benefit associated with: (1) all unimplemented "Phase 2" SAMAs for the analyzed nuclear power plant; and (2) those SAMAs identified as potentially cost-beneficial for other U.S. nuclear power plants and which are applicable to the analyzed nuclear power plant. If one or more of those SAMAs are shown to reduce the maximum benefit by 50 percent or more, then the applicant must complete Stage 2.

(Applicants that demonstrate through the Stage 1 screening process that there is no potentially significant new information are not required to perform the Stage 2 or Stage 3 assessments.)

Stage 2: The ~~subsequent license renewal~~SLR applicant develops updated averted cost-risk estimates for implementing those SAMAs. If the Stage 2 assessment confirms that one or more SAMAs reduce the maximum benefit by 50 percent or more, then the applicant must complete Stage 3.

Stage 3: The ~~subsequent license renewal~~SLR applicant performs a cost-benefit analysis for the "potentially significant" SAMAs identified in Stage 2.

Upon completion of the Stage 1 screening process, Dominion determined that there is no potentially significant new information affecting its North Anna SAMA analysis; thus, Dominion did not perform the Stage 2 or Stage 3 assessments. The following sections summarize Dominion's application of the NEI 17-04 methodology to North Anna SAMAs.

~~A.5.1~~F.5.1Data Collection

NEI 17-04 Section 3.1, "Data Collection," explains that the initial step of the assessment process is to identify the "new information" relevant to the SAMA analysis and to collect and develop those elements of information that will be used to support the assessment. The guidance document states that each applicant should collect, develop, and document the information elements corresponding to the stage or stages of the SAMA analysis performed for the site. For North Anna ~~subsequent license renewal~~SLR, the NRC staff reviewed the onsite information during an audit at NRC headquarters and determined that Dominion had considered the appropriate information (NRC ~~2020a~~ 2020-TN8100).

~~A.5.2~~F.5.2Stage 1 Assessment

Section E4.15.3, "Methodology for Evaluation of New and Significant SAMAs," of Dominion's ER describes the process it used to identify any potentially new and significant SAMAs from the 2001 SAMA analysis (~~Dominion~~VEPCO 2020~~).~~ -TN8099). In Stage 1 of the process, Dominion used PRA risk insights and/or risk model quantifications to estimate the percent reduction in the maximum benefit associated with the following two types of SAMAs:

- all unimplemented "Phase 2" SAMAs for North Anna~~.~~
- those SAMAs identified as potentially cost-beneficial for other U.S. nuclear power plants and that are applicable to North Anna (~~Dominion~~VEPCO 2020~~).~~ -TN8099)

~~A.5.3~~F.5.3Dominion's Evaluation of Unimplemented North Anna "Phase 2" SAMAs

In 2001, Dominion submitted an application for initial operating license renewal (~~Dominion~~ VEPCO 2001-TN8297), which the NRC approved in 2002 as described above in Section F.2.1. As part of the ~~subsequent license renewal application~~SLR, Dominion examined its initial license renewal SAMA analysis and the North Anna PRA again, for insights. The purpose was to determine if there was any new and significant information regarding the SAMA analyses that were performed ~~to support issuance of the~~ for initial ~~renewed~~renewal of the North Anna operating licenses ~~for North Anna.~~. Dominion reevaluated the 51 SAMAs that were

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considered to be "Phase 2" in connection with initial license renewal, using the NEI 17-04 process.

The list of SAMAs collected was evaluated qualitatively to screen any that are not applicable to North Anna or already exist at North Anna. The remaining SAMAs were then grouped (if similar) based on similarities in mitigation equipment or risk reduction benefits, and all were evaluated for the impact they have on the North Anna CDF and source term category frequencies if implemented. In addition, two other screening criteria were applied to eliminate SAMAs that have excessive cost. First, SAMAs were screened out if they were found to reduce the North Anna maximum benefit by greater than 50 percent in the initial North Anna license renewal~~,~~ but ~~also if they~~ were found not to be cost-effective due to high cost in the ~~first~~initial license renewal~~.~~ analysis. Second, SAMAs related to creating a containment vent were screened out because this nuclear power plant modification has been evaluated industrywide and explicitly found to not be cost-effective in Westinghouse large/dry containments. If any of the SAMAs were found to reduce the total CDF or at least one consequential source term category frequency by at least 50 percent, then the SAMA was retained for a Stage 2 assessment (Level 3 PRA evaluation of the reduction in maximum benefit). As discussed below, all SAMAs were screened out as not significant without the need to go to the Stage 2 assessment or PRA Level 3 evaluation.

~~A.5.4~~F.5.4Dominion's Evaluation of SAMAs Identified as Potentially Cost-Beneficial at Other U.S. Nuclear Power Plants ~~and Which~~that Are Applicable to North Anna

~~The 2013 GEIS (NRC 2013a) considered the plant-specific supplemental EISs that document potential environmental impacts and mitigation measures for severe accidents relevant to license renewal for each plant. Some of these plant-specific supplements had identified potentially cost-beneficial SAMAs.~~ Dominion reviewed the SEISs of nuclear power plants with a similar design to North Anna (PWR Large/Dry Containments), ~~to identify~~resulting in the identification of 283 potentially cost-beneficial SAMAs from other nuclear power plants. This large list of industry SAMAs was qualitatively screened using the criteria that a potential SAMA ~~is either~~ is not applicable to the North Anna design or the SAMA has already been implemented at North Anna. Dominion grouped the remaining SAMAs based on similarities in mitigation equipment or risk reduction benefits. Thus, Dominion evaluated 51 North Anna-specific SAMAs and 283 potentially cost-beneficial SAMAs identified at similarly designed nuclear power plants (industry SAMAs) for a total of 334 SAMAs.

Section E4.15.4 of Dominion's ~~subsequent license renewal~~SLR ER provides ~~the North Anna~~an evaluation using the methodology in NEI 17-04, "Model SLR New and Significant Assessment Approach for SAMA~~."~~." The industry SAMAs that were not qualitatively screened out were then merged with the North Anna-specific SAMAs collected from initial license renewal, with similar SAMAs grouped together for further analysis. The combined SAMA list was then quantitatively screened to determine if the CDF or any source term category frequency would be reduced at least 50 percent if the SAMA was implemented. Table E4.15-1 of the ER presents the 39 industry SAMAs that were not qualitatively screened out, combined with the 51 North Anna-specific SAMAs selected for further evaluation. Table E4.15-2 presents the quantitative screening results from the bounding SAMA evaluations. As seen in Table E4.15-2, none of the bounding quantitative screening evaluations resulted in a reduction of total CDF, total LERF, or total large release frequency (LRF) greater than 50 percent. Of the results presented in Table E4.15-2, one case (~~case name~~ labeled as "emergency diesel generator ("EDG~~"~~)") yielded an internal events ~~LERF~~, LLRF (Large Late Release Frequency) reduction of 57 percent. However, Dominion explained that the total change in the Maximum Benefit for the EDG case is

well below 50 percent. Since Dominion's Stage 1 analysis demonstrated that none of the SAMAs considered for quantitative evaluation would reduce the North Anna maximum benefit by 50 percent or greater, Dominion concluded that no new and significant information relevant to the original SAMA analysis for North Anna exists, and no further analysis is needed.

The NRC staff reviewed North Anna's onsite information and its SAMA Stage 1 process during an in-office audit at NRC headquarters (NRC 2020-TN8100 see Appendix D~~2020e).~~). The staff found that Dominion had used a methodical and reasonable approach to identify any SAMAs that might reduce the maximum benefit by at least 50 percent and therefore could be considered potentially significant. ~~Therefore, the~~The NRC staff finds that Dominion properly concluded, in accordance with the NEI 17-04 guidance, that it did not need to conduct a Stage 2 assessment.

~~A.5.5~~F.5.5Other New Information

As discussed in Dominion's ~~subsequent license renewal~~SLR application ER and in NEI 17-04, there are some inputs to the SAMA analysis that are expected to change or to potentially change for all nuclear power plants. Examples of these inputs include the following:

- Updated Level 3 PRA model consequence results, which may be impacted bymultiple inputs, including, but not limited to, the following:
  - population, as projected within a 50-~~mile~~ mi (80 -km) radius of the nuclear power plant
  - value of farm and nonfarm wealth
  - core inventory (e.g., due to power uprate)
  - evacuation timing and speed
  - Level 3 PRA methodology updates
  - cost-benefit methodology updates

In addition, other changes that could be considered new information may be dependent on nuclear power plant activities or site-specific changes. These types of changes (listed in NEI 17-04) include the following:

- Identification of a new hazard (e.g., a fault that was not previously analyzed in the seismic analysis).
  - Updated nuclear power plant risk model (e.g., a fire PRA that replaces the IPEEE analysis).
- Impacts of nuclear power plant changes that are included in the nuclear power plant risk models will be reflected in the model results and do not need to be assessed separately.
- Nonmodeled modifications to the nuclear power plant.
  - Modifications determined to have no risk impact need not be included (e.g., replacement of the condenser vacuum pumps), unless they impacta specific input to SAMA (e.g., new low-pressure turbine in the power conversion system that results in a greater net electrical output).

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The NEI methodology described in NEI 17-04 uses "maximum benefit" to determine if SAMA-related information is new and significant. Maximum benefit is defined in Section 4.5 of NEI 05-01, Revision A, "Severe Accident Mitigation Alternatives (SAMA) Analysis Guidance Document" (NEI ~~2005b~~2005-TN1978), as the benefit a SAMA could achieve if it eliminated all risk. The total offsite dose and total economic impact are the baseline risk measures from which the maximum benefit is calculated. The methodology in NEI 17-04 considers a cost-beneficial SAMA to be potentially significant if it reduces the maximum benefit by at least 50 percent. The NRC staff finds the criterion of exceeding a 50-percent reduction in the maximum benefit a reasonable significance value because it correlates with significance determinations in the American Society of Mechanical Engineers and American Nuclear Society PRA standard (cited in ~~Regulatory Guide (RG)~~ 1.200) (ASME/ANS 2009-TN6220; NRC ~~2009b~~2009-TN6211), NUMARC 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants" (NRC endorsed in RG 1.160) (NEI 2018-TN7758; NRC 2018-TN7799) and NEI 00-04, "10 CFR 50.69 SSC Categorization Guideline" (endorsed in RG 1.201) (NEI ~~2005a~~2005-TN8340; NRC 2006-TN6279), which the NRC has cited or endorsed. It is also a reasonable quantification of the qualitative criteria that new information is significant if it presents a seriously different picture of the impacts of the Federal action under consideration, requiring a supplement (NUREG-0386, *United States Nuclear Regulatory Commission Staff Practice and Procedure Digest: Commission, Appeal Board, and Licensing Board Decisions* ~~([~~NRC ~~2009c))~~. 2009-TN8377]). Furthermore, it is consistent with the criteria that the NRC staff accepted in the Limerick Generating Station license renewal final SEIS (NRC 2014~~).~~ TN7328). The NRC staff finds the approach in NEI 17-04 to be reasonable because, with respect to SAMAs, new information may be significant if it indicates a potentially cost-beneficial SAMA could substantially reduce the probability or consequences (risk) of a severe accident occurring. The implication of this statement is that "significance" is not solely related to whether a SAMA is cost-beneficial (which may be affected by economic factors, increases in population, etc.), but it also depends on a SAMA's potential to significantly reduce risk to the public.

~~A.5.6~~F.5.6Conclusion

The NRC staff reviewed Dominion's new and significant information analysis for severe accidents and SAMAs at North Anna during the ~~subsequent license renewal~~SLR period and finds Dominion's analysis and methods to be reasonable. As described above, Dominion evaluated a total of 334 SAMAs for North Anna ~~subsequent license renewal~~SLR and did not find any SAMAs that would reduce the maximum benefit by 50 percent or more. The NRC staff reviewed Dominion's evaluation and concludes that Dominion's methods and results were reasonable. Based on North Anna's Stage 1 qualitative and quantitative screening results, Dominion demonstrated that none of the nuclear power plant-specific and industry SAMAs that it considered constitute new and significant information in that none changed the conclusion of North Anna's previous SAMA analysis. Further, the NRC staff did not otherwise identify any new and significant information that would alter the conclusions reached in the previous SAMA analysis for North Anna. Therefore, the NRC staff concludes that there is no new and significant information that would alter the conclusions of the SAMA analysis performed for North Anna's initial license renewal.

In addition, given the low residual risk at North Anna, the substantial decrease in internal event CDF at North Anna from the previous SAMA analysis, and the fact that no potentially cost-beneficial SAMAs were identified during North Anna's initial license renewal review, the staff considers it unlikely that Dominion would have found any potentially cost-beneficial SAMAs for ~~subsequent license renewal.~~ North Anna SLR. Further, Dominion's implementation of actions to satisfy the NRC's orders and regulatory requirements regarding beyond-design-basis events

after the September 2001 terrorist attacks and the March 2011 Fukushima events, including Dominion's performance of a seismic PRA, as well as the conservative assumptions used in earlier severe accident studies and SAMA analyses, also make it unlikely that Dominion would have found any potentially significant cost-beneficial SAMAs during its ~~subsequent license renewal~~SLR review. For all the reasons stated above, the NRC staff concludes that Dominion reached reasonable SAMA conclusions in its ~~subsequent license renewal~~SLR ER and that there is no new and significant information regarding any potentially cost-beneficial SAMA that would substantially reduce the risks of a severe accident at North Anna during the SLR term.

~~A.~~F.6References

~~All NRC NUREG reports listed in Appendix F are available electronically from the NRC's public Web site found at: https://www.nrc.gov/reading-rm/doc-collections/nuregs/index.html. From this site, the public can gain access to NRC's collection of technical reports by using the technical report numbers (e.g., NUREG-xxxx or NUREG/CR-xxxx).~~

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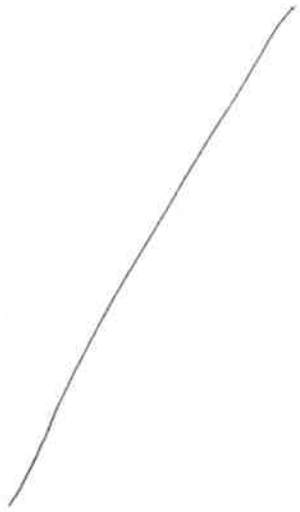

APPENDIX G

ENVIRONMENTAL ISSUES AND IMPACT FINDINGS CONTAINED IN THE PROPOSED RULE, 10 CFR PART 51, "ENVIRONMENTAL PROTECTION REGULATIONS FOR DOMESTIC LICENSING AND RELATED REGULATORY FUNCTIONS"

The U.S. Nuclear Regulatory Commission (NRC, the Commission) staff prepared this site-specific environmental impact statement (EIS) to evaluate the environmental impacts of subsequent license renewal (SLR) for North Anna Power Station, Units 1 and 2 (North Anna), operated by Dominion Electric and Power Company, doing business as Dominion Energy Virginia (Dominion).

This EIS includes the NRC staff's site-specific evaluation of the environmental impacts of SLR for North Anna for each of the environmental issues that were dispositioned as Category 1 issues (i.e., generic to all or a distinct subset of nuclear power plants) in the staff's draft supplemental environmental impact statement (DSEIS).[1] The DSEIS had been issued as a supplement to NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants," Revision 1, Final Report (the 2013 License Renewal Generic Environmental Impact Statement [LR GEIS]; NRC 2013). The 2013 LR GEIS and the associated revised rule (78 *Federal Register* [FR] 37282) had identified 78 environmental impact issues, 61 of which were deemed to be generic Category 1 issues and 17 of which were deemed to be Category 2 issues that required a plant-specific analysis. The DSEIS followed that approach, consistent with Table B–1 in Appendix B to Subpart A of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51, "Environmental protection regulations for domestic licensing and related regulatory functions."

In accordance with the Commission's decisions in Commission Legal Issuance (CLI)-22-02 and CLI-22-03, this EIS provides a site-specific evaluation of the issues that were treated as Category 1 issues in the DSEIS. This EIS also updates and considers new information concerning Category 2 issues (specific to individual nuclear power plants) in the DSEIS. This EIS evaluates, on a site-specific basis, all of the environmental impacts of continued operation for North Anna Units 1 and 2 during the SLR term. Thus, this EIS supersedes in its entirety the August 2021 DSEIS. On March 3, 2023, the NRC published a draft rule (88 FR 13329-TN8601) proposing to amend its environmental protection regulations in 10 CFR Part 51 (TN250). Specifically, the proposed rule would update the NRC's 2013 findings concerning the environmental impacts of renewing the operating license of a nuclear power plant and specifically addresses SLR. The technical basis for the proposed rule would be provided by Revision 2 to NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (the 2023 LR GEIS; NRC 2023-TN7802), which would update NUREG-1437, Revision 1 (the 2013 LR GEIS NRC 2013-TN2654), which, in turn, was an update of NUREG-1437, Revision 0 (the 1996 LR GEIS; NRC 1996-TN288). The 2023 LR GEIS would specifically support the proposed revised list of National Environmental Policy Act of 1969, as amended, issues and associated environmental impact findings for license renewal (including SLR) to be contained in Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250). The 2023 LR

[1] "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 7, Second Renewal, Regarding Subsequent License Renewal for North Anna Power Station Units 1 and 2, Draft Report for Comment" (NUREG-1437, Supplement 7, Second Renewal) (DSEIS) (NRC 2021-TN7294) issued in August 2021.

GEIS and proposed rule reflect lessons learned and knowledge gained from the NRC's conducting of environmental reviews for initial license renewal and SLR since 2013.

The proposed rule would redefine the number and scope of the environmental issues that must be addressed by the NRC during initial license renewal and SLR environmental reviews. The proposed rule identifies 80 environmental impact issues, 20 of which would require plant-specific analyses. The proposed rule would reclassify some previously site-specific (Category 2) issues as generic (Category 1) issues and would consolidate other issues. It would also add new Category 1 and Category 2 issues to Table B-1. In Section 1.10 of the 2023 proposed LR GEIS, these proposed changes are summarized as follows.

- One Category 2 issue, "Groundwater quality degradation (cooling ponds at inland sites)," and a related Category 1 issue, "Groundwater quality degradation (cooling ponds in salt marshes)," would be consolidated into a single Category 2 issue, "Groundwater quality degradation (plants with cooling ponds)."
- Two related Category 1 issues, "Infrequently reported thermal impacts (all plants)" and "Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication," and the thermal effluent component of the Category 1 issue, "Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses," would be consolidated into a single Category 1 issue, "Infrequently reported effects of thermal effluents."
- One Category 2 issue, "Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)," and the impingement component of the Category 1 issue, "Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses," would be consolidated into a single Category 2 issue, "Impingement mortality and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)."
- One Category 1 issue, "Impingement and entrainment of aquatic organisms (plants with cooling towers)," and the impingement component of the Category 1 issue, "Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses," would be consolidated into a single Category 1 issue, "Impingement mortality and entrainment of aquatic organisms (plants with cooling towers)."
- One Category 2 issue, "Threatened, endangered, and protected species and essential fish habitat," would be divided into three Category 2 issues: (1) "Endangered Species Act: federally listed species and critical habitats under U.S. Fish and Wildlife jurisdiction," (2)"Endangered Species Act: federally listed species and critical habitats under National Marine Fisheries Service jurisdiction," and (3) "Magnuson-Stevens Act: essential fish habitat."
- Two new Category 2 issues, "National Marine Sanctuaries Act: sanctuary resources" and "Climate change impacts on environmental resources," would be added.
- One Category 2 issue, "Severe accidents," would be changed to a Category 1 issue.
- One new Category 1 issue, "Greenhouse gas impacts on climate change," would be added.

Several issue titles and findings would be revised to clarify their intended meanings. The final versions of the 2023 LR GEIS and the proposed rule are expected to be published in August 2024 and, upon being finalized, the NRC's environmental protection regulations would be revised. Thereafter, the NRC would have to consider and analyze in its initial license renewal and SLR environmental reviews, any potential significant impacts associated with the Category

2 issues and, to the extent that there is any new and significant information, the potential significant impacts associated with the Category 1 issues. In order to account for the proposed rule and 2023 LR GEIS and the possibility that the proposed rule and revised LR GEIS may be finalized in 2024, before a final determination is reached on the North Anna SLR application, the NRC staff analyzes in this appendix the new and revised environmental issues as they may apply to SLR for North Anna. Table G-1 lists the new and revised environmental issues that would apply to North Anna SLR. The sections that follow discuss how the NRC staff addressed each of these new and revised issues in this site-specific EIS and explains the NRC staff's conclusion that this EIS covers all the issues in the proposed rule and 2023 LR GEIS.

Table G-1 New and Revised 10 CFR Part 51 License Renewal Environmental Issues

Issue	2023 LR GEIS Section	Category
Infrequently reported effects of thermal effluents	4.6.1.2	1
Impingement mortality and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)	4.6.1.2	2
Endangered Species Act: federally listed species and critical habitats under U.S. Fish and Wildlife jurisdiction	4.6.1.3.1	2
Endangered Species Act: federally listed species and critical habitats under National Marine Fisheries Service jurisdiction	4.6.1.3.2	2
Magnuson-Stevens Act: essential fish habitat	4.6.1.3.3	2
National Marine Sanctuaries Act: sanctuary resources	4.6.1.3.4	2
Severe accidents	4.9.1.2.1	1
Greenhouse gas impacts on climate change	4.12.1	1
Climate change impacts on environmental resources	4.12.3	2

G.1 Infrequently Reported Effects of Thermal Effluents

The draft rule proposes to combine two Category 1 issues, "Infrequently reported thermal impacts (all plants)" and "Effects of cooling water discharge on dissolved oxygen, gas supersaturation, and eutrophication," and the thermal effluent component of the Category 1 issue, "Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses," into one Category 1 issue, "Infrequently reported effects of thermal effluents." This issue pertains to interrelated and infrequently reported effects of thermal effluents, including cold shock, thermal migration barriers, accelerated maturation of aquatic insects, and proliferated growth of aquatic nuisance species, as well as the effects of thermal effluents on dissolved oxygen, gas supersaturation, and eutrophication. This issue also considers sublethal stresses associated with thermal effluents that can increase the susceptibility of exposed organisms to predation, parasitism, or disease. These changes do not introduce any new environmental issues; rather, the proposed rule would reorganize existing issues. The changes are fully summarized and explained in Section 4.6.1.2 of the 2023 LR GEIS and in the proposed rule.

Sections 3.7.3.4, 3.7.3.5, and 3.7.3.11 of this EIS analyze infrequently reported effects of thermal effluents for North Anna SLR and conclude that the impacts would be SMALL. Therefore, the environmental issue of infrequently reported effects of thermal effluents is addressed in this EIS.

G.2 Impingement Mortality and Entrainment of Aquatic Organisms (Plants with Once-Through Cooling Systems or Cooling Ponds)

The draft rule proposes to combine the Category 2 issue, "Impingement and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)," and the impingement component of the Category 1 issue, "Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses," into one Category 2 issue, "Impingement mortality and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds)." This issue pertains to impingement mortality and entrainment of finfish and shellfish at nuclear power plants with once-through cooling systems and cooling ponds during the license renewal term (either initial license renewal or SLR). This includes plants with helper cooling towers that are seasonally operated to reduce thermal load to the receiving water body, reduce entrainment during peak spawning periods, or reduce consumptive water use during periods of low river flow.

In the 2023 LR GEIS, the NRC renamed this issue to specify impingement mortality, rather than simply impingement. This change is consistent with the U.S. Environmental Protection Agency (EPA) 2014 Clean Water Act Section 316(b) regulations and the EPA's assessment that impingement reduction technology is available, feasible, and has been demonstrated to be effective. Additionally, the EPA 2014 Clean Water Act Section 316(b) regulations establish best technology available standards for impingement mortality based on the fact that survival is a more appropriate metric for determining environmental impact rather than simply looking at total impingement. Therefore, the 2023 LR GEIS also consolidates the impingement component of the "Losses from predation, parasitism, and disease among organisms exposed to sublethal stresses" issue for plants with once-through cooling systems or cooling ponds into this issue.

Section 3.7.3.1 of this EIS analyzes the impacts of impingement and entrainment for North Anna SLR. The analysis considers the components of the proposed revision to this issue, impingement mortality, and the impingement component of losses from predation, parasitism, and disease among organisms exposed to sublethal stresses. In this section, the NRC staff concludes that impingement and entrainment during the SLR term would be of SMALL significance on the aquatic organisms in Lake Anna. Therefore, the environmental issue of impingement mortality and entrainment of aquatic organisms (plants with once-through cooling systems or cooling ponds) is addressed in this EIS.

G.3 Endangered Species Act: Federally Listed Species and Critical Habitats Under U.S. Fish and Wildlife Jurisdiction

The draft rule proposes to divide the Category 2 issue, "Threatened, endangered, and protected species and essential fish habitat," into three separate Category 2 issues for clarity and consistency with the separate Federal statues and interagency consultation requirements that the NRC must consider with respect to federally protected ecological resources. When combined, however, the scope of the three issues is the same as the scope of the former "Threatened, endangered, and protected species and essential fish habitat" issue discussed in the 2013 LR GEIS. As discussed in this section, as well as Sections G.4 and G.5 below, such impacts were considered in this EIS.

The first of the three issues, "Endangered Species Act: federally listed species and critical habitats under U.S. Fish and Wildlife jurisdiction," concerns the potential effects of continued nuclear power plant operation and any refurbishment during the license renewal term on

federally listed species and critical habitats protected under the Endangered Species Act (ESA) and under the jurisdiction of the U.S. Fish and Wildlife Service (FWS).

Sections 3.8.1 and 3.8.4 of this EIS addresses the impacts of North Anna SLR on federally listed species and critical habitats under FWS jurisdiction. The NRC staff determined that North Anna SLR may affect but is not likely to adversely affect the northern long-eared bat, tricolored bat, and monarch butterfly. Appendix C.1 describes the staff's ESA consultation with the FWS. Therefore, the environmental issue of Endangered Species Act: federally listed species and critical habitats under FWS jurisdiction is addressed in this EIS.

G.4 Endangered Species Act: Federally Listed Species and Critical Habitats Under National Marine Fisheries Service Jurisdiction

As explained in the previous section, the draft rule proposes to divide the Category 2 issue, "Threatened, endangered, and protected species and essential fish habitat," into three separate Category 2 issues. The second of the three issues, "Endangered Species Act: federally listed species and critical habitats under National Marine Fisheries Service jurisdiction," concerns the potential effects of continued nuclear power plant operation and any refurbishment during the license renewal term on federally listed species and critical habitats protected under the ESA and under the jurisdiction of the National Marine Fisheries Service.

Section 3.8.1 and 3.8.4 of this EIS find that no federally listed species or critical habitats under National Marine Fisheries Service jurisdiction occur within the action area. Accordingly, the NRC staff concluded that the proposed action would have no effect on federally listed species or habitats under National Marine Fisheries Service jurisdiction. Therefore, the environmental issue of Endangered Species Act: federally listed species and critical habitats under National Marine Fisheries Service jurisdiction is addressed in this EIS.

G.5 Magnuson-Stevens Act: Essential Fish Habitat

As explained above, the draft rule proposes to divide the Category 2 issue, "Threatened, endangered, and protected species and essential fish habitat," into three separate Category 2 issues. The third of the three issues, "Magnuson-Stevens Act: essential fish habitat," concerns the potential effects of continued nuclear power plant operation and any refurbishment during the license renewal term on essential fish habitat protected under the Magnuson-Stevens Act.

Sections 3.8.2 and 3.8.5 of this EIS find that no essential fish habitat occurs within the affected area. Accordingly, the NRC staff concluded that the proposed action would have no effect on essential fish habitats. Therefore, the environmental issue of Magnuson-Stevens Act: essential fish habitat is addressed in this EIS.

G.6 National Marine Sanctuaries Act: Sanctuary Resources

The draft rule proposes to add a new Category 2 issue, "National Marine Sanctuaries Act: sanctuary resources," to evaluate the potential effects of continued nuclear power plant operation and any refurbishment during the license renewal term on sanctuary resources protected under the National Marine Sanctuaries Act.

Under the National Marine Sanctuaries Act, the National Oceanic and Atmospheric Administration Office of National Marine Sanctuaries designates and manages the National

Marine Sanctuary System. Marine sanctuaries may occur near nuclear power plants located on or near marine waters as well as the Great Lakes.

Section 3.8.3 and 3.8.6 of this EIS find that no National Marine Sanctuaries occur within the affected area. Accordingly, the NRC staff concluded that the proposed action would have no effect on sanctuary resources. Therefore, the environmental issue of National Marine Sanctuaries Act: sanctuary resources is addressed in this EIS.

G.7 Severe Accidents

With respect to postulated accidents, the draft rule proposes to amend Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250) by reclassifying the Category 2 "Severe accidents" issue as a Category 1 issue. In the 2013 LR GEIS, the issue of severe accidents was classified as a Category 2 issue only to the extent that alternatives to mitigate severe accidents must be considered for nuclear power plants where the licensee had not previously performed a severe accident mitigation alternatives (SAMA) analysis for the plant. In the 2023 LR GEIS, the NRC notes that this issue will be resolved generically for the vast majority, if not all, expected license renewal applicants because the applicants who will likely reference the LR GEIS have previously completed a SAMA analysis.

As discussed in Appendix F of this EIS, an analysis of SAMAs was performed for North Anna and evaluated by the NRC staff at the time of initial license renewal (NRC 2002-TN8296). In Section 3.11.6.9 and Appendix F of this EIS, the NRC staff evaluated the significance of new information related to the plant-specific SAMA analysis. Therefore, the environmental issue of severe accidents is addressed in this EIS.

G.8 Greenhouse Gas Impacts on Climate Change

With respect to greenhouse gas (GHG) emissions and climate change, the draft rule proposes to amend Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250) by adding a new Category 1 issue "Greenhouse gas impacts on climate change." This new issue has an impact level of SMALL. This new issue considers GHG impacts on climate change from routine operations of nuclear power plants and construction vehicles and other motorized equipment for refurbishment activities. GHG emissions from routine operations of nuclear power plants are typically very minor, because such plants, by their very nature, do not normally combust fossil fuels to generate electricity. However, nuclear power plant operations do have some GHG emission sources, including diesel generators, pumps, diesel engines, boilers, refrigeration systems, and electrical transmission and distribution systems, as well as mobile sources (e.g., worker vehicles and delivery vehicles). GHG emissions from construction vehicles and other motorized equipment for refurbishment activities would be intermittent and temporary, restricted to the refurbishment period. GHG emissions from continued operations and refurbishment activities are minor.

The issue of GHG impacts on climate change associated with nuclear power plant operations was not identified as either a generic or plant-specific issue in the 1996 LR GEIS or the 2013 LR GEIS. In the 2013 LR GEIS, however, the NRC staff presented GHG emission factors associated with the nuclear power life cycle. Following the issuance of CLI-09-21 (NRC 2009-TN6406), the NRC began to evaluate the effects of GHG emissions in plant-specific environmental reviews for license renewal applications. Accordingly, Section 3.13 of this EIS) evaluates GHG emissions associated with the operation of North Anna during the SLR term. Table 3-1 of this EIS presents quantified annual GHG emissions from sources at North Anna

for the 2017–2022 time period when GHGs were emitted from North Anna operations directly and indirectly. North Anna's direct GHG emissions result from stationary portable combustion sources, fire suppression system, electrical breakers, and refrigerant used for equipment onsite refrigeration appliances.

Dominion has no plans to conduct major refurbishment during the North Anna SLR term; therefore, no GHG emissions from refurbishment or increases in GHG emissions from routine operations at North Anna are anticipated. The NRC staff concludes that there would be no impacts on climate change beyond the impacts discussed in the 2023 LR GEIS and in Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 of the proposed rule (88 FR 13329-TN8601). Based on this information, the NRC staff concludes that GHG impacts on climate change for North Anna during the SLR term are SMALL. Therefore, the environmental issue of GHG impacts on climate change is addressed in this EIS.

G.9 Climate Change Impacts on Environmental Resources

With respect to climate change, the draft rule proposes to amend Table B-1 in Appendix B to Subpart A of 10 CFR Part 51 (TN250) by adding the new Category 2 issue "Climate change impacts on environmental resources." This new issue considers the additive effects of climate change on environmental resources that may also be directly affected by continued operations and refurbishment during the license renewal term. The effects of climate change can vary regionally and climate change information at the regional and local scale is necessary to assess trends and the impacts on the human environment for a specific location. The impacts of climate change on environmental resources during the license renewal term are location-specific and cannot be evaluated generically.

The issue of climate change impacts was not identified as either a generic or plant-specific issue in the 1996 LR GEIS or the 2013 LR GEIS. However, the 2013 LR GEIS described the environmental impacts that could occur on resources areas (e.g., land use, air quality, water resources, etc.) that may also be affected by license renewal. In plant-specific initial license renewal and SLR environmental reviews prepared since the development of the 2013 LR GEIS, the NRC staff has considered projected differences in climate changes in the United States and climate change impacts on the resource areas that could be incrementally affected by the proposed action as part of its cumulative impacts analysis. Accordingly, Section 3.14.3.2 of this EIS discusses the observed changes in climate and the potential future climate change across the Southeast region of the United States during the North Anna SLR term based on climate model simulations under future global GHG emissions scenarios. The NRC staff considered regional projected climate changes from numerous climate assessment reports, including the U.S. Global Change Research Program, the Intergovernmental Panel on Climate Change (IPCC), the EPA, and the National Oceanic and Atmospheric Administration (NOAA 2013-TN7424). Furthermore, in Section 3.14.3 of this EIS, the NRC staff evaluated the overlapping impacts from climate change on environmental resources (e.g., Air Quality, Water Resources) where there are incremental impacts due to North Anna SLR. Therefore, this issue, "Climate change impacts on environmental resources," has been addressed in this EIS.

G.10 References

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