

6.0 Environmental Impacts of the Uranium Fuel Cycle and Solid Waste Management

Environmental issues associated with the uranium fuel cycle and solid waste management are discussed in the *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS), NUREG-1437 (NRC 1996; 1999).^(a) The GEIS includes a determination of whether the analysis of the environmental issue could be applied to all plants and whether additional mitigation measures would be warranted. Issues are then assigned a Category 1 or a Category 2 designation. As set forth in the GEIS, Category 1 issues are those that meet all of the following criteria:

- (1) The environmental impacts associated with the issue have been determined to apply either to all plants or, for some issues, to plants having a specific type of cooling system or other specified plant or site characteristic.
- (2) 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 [HLW] and spent fuel disposal).
- (3) Mitigation of adverse impacts associated with the issue has been 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 issues that meet the three Category 1 criteria, no additional plant-specific analysis is required unless new and significant information is identified.

Category 2 issues are those that do not meet one or more of the criteria of Category 1, and therefore, additional plant-specific review for these issues is required.

This chapter addresses the issues that are related to the uranium fuel cycle and solid waste management during the license renewal term that are listed in Table B-1 of 10 CFR Part 51, Subpart A, Appendix B, that are applicable to North Anna Power Station, Units 1 and 2. The generic potential impacts of the radiological and nonradiological environmental impacts of the uranium fuel cycle and transportation of nuclear fuel and wastes are described in detail in the GEIS based, in part, on the generic impacts provided in 10 CFR 51.51(b), Table S-3, "Table of Uranium Fuel Cycle Environmental Data," and in 10 CFR 51.52(c), Table S-4, "Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear

(a) The GEIS was originally issued in 1996. Addendum 1 to the GEIS was issued in 1999. Hereafter, all references to the "GEIS" include the GEIS and its Addendum 1.

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Power Reactor." The GEIS also addresses the impacts from radon-222 and technetium-99. There are no Category 2 issues for the uranium fuel cycle and solid waste management.

6.1 The Uranium Fuel Cycle

Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to North Anna Power Station, Units 1 and 2 from the uranium fuel cycle and solid waste management are listed in Table 6-1.

Table 6-1. Category 1 Issues Applicable to the Uranium Fuel Cycle and Solid Waste Management During the Renewal Term

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Sections
Uranium Fuel Cycle and Waste Management	
Offsite radiological impacts (individual effects from other than the disposal of spent fuel and high-level waste [HLW])	6.1; 6.2.1; 6.2.2.1; 6.2.2.3; 6.2.3; 6.2.4; 6.6
Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4, 6.6
Offsite radiological impacts (spent fuel and HLW disposal)	6.1; 6.2.2.1; 6.2.3; 6.2.4, 6.6
Nonradiological impacts of the uranium fuel cycle	6.1; 6.2.2.6; 6.2.2.7; 6.2.2.8; 6.2.2.9; 6.2.3; 6.2.4; 6.6
Low-level waste storage and disposal	6.1; 6.2.2.2; 6.4.2; 6.4.3; 6.4.3.1; 6.4.3.2; 6.4.3.3; 6.4.4; 6.4.4.1; 6.4.4.2; 6.4.4.3; 6.4.4.4; 6.4.4.5; 6.4.4.5.1; 6.4.4.5.2; 6.4.4.5.3; 6.4.4.5.4; 6.4.4.6, 6.6
Mixed waste storage and disposal	6.4.5.1; 6.4.5.2; 6.4.5.3; 6.4.5.4; 6.4.5.5; 6.4.5.6; 6.4.5.6.1; 6.4.5.6.2; 6.4.5.6.3; 6.4.5.6.4, 6.6
Onsite spent fuel	6.1; 6.4.6; 6.4.6.1; 6.4.6.2; 6.4.6.3; 6.4.6.4; 6.4.6.5; 6.4.6.6; 6.4.6.7; 6.6
Nonradiological waste	6.1; 6.5; 6.5.1; 6.5.2; 6.5.3; 6.6
Transportation	6.1; 6.3.1; 6.3.2.3; 6.3.3; 6.3.4; 6.6, Addendum 1

The Virginia Electric and Power Company (VEPCo) stated in its Environmental Report (ER) (VEPCo 2001) that it is not aware of any new and significant information associated with the

1 renewal of the North Anna Power Station, Units 1 and 2, operating licenses. No significant new
2 information on these issues has been identified by the staff in the review process and in the
3 staff's independent review. Therefore, the staff concludes that there are no impacts related to
4 these issues beyond those discussed in the GEIS. For all of those issues, the staff concludes
5 in the GEIS that the impacts are SMALL except for collective offsite radiological impacts from
6 the fuel cycle and from HLW and spent fuel disposal, as discussed below, and plant-specific
7 mitigation measures are not likely to be sufficiently beneficial to be warranted.

8
9 A brief description of the staff review and the GEIS conclusions, as codified in Table B-1,
10 10 CFR Part 51 for each of these issues follows:

- 11
12 • Offsite radiological impacts (individual effects from other than the disposal of spent fuel and
13 HLW). Based on information in the GEIS, the Commission found that

14
15 Off-site impacts of the uranium fuel cycle have been considered by the
16 Commission in Table S-3 of this part [10 CFR 51.51(b)]. Based on information in
17 the GEIS, impacts on individuals from radioactive gaseous and liquid releases
18 including radon-222 and technetium-99 are SMALL.

19
20 The staff has not identified any new and significant information on this issue during its
21 independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping
22 process, or its evaluation of other available information. Therefore, the staff concludes that
23 there are no offsite radiological impacts (individual effects from other than the disposal of
24 spent fuel and HLW) of the uranium fuel cycle during the renewal term beyond those
25 discussed in the GEIS.

- 26
27 • Offsite radiological impacts (collective effects). Based on information in the GEIS, the
28 Commission found that

29
30 The 100 year environmental dose commitment to the U.S. population from the
31 fuel cycle, high level waste and spent fuel disposal excepted, is calculated to be
32 about 14,800 person rem [148 person Sv], or 12 cancer fatalities, for each
33 additional 20-year power reactor operating term. Much of this, especially the
34 contribution of radon releases from mines and tailing piles, consists of tiny doses
35 summed over large populations. This same dose calculation can theoretically be
36 extended to include many tiny doses over additional thousands of years as well
37 as doses outside the U.S. The result of such a calculation would be thousands
38 of cancer fatalities from the fuel cycle, but this result assumes that even tiny
39 doses have some statistical adverse health effect which will not ever be
40 mitigated (for example no cancer cure in the next one thousand years), and that
41 these doses projected over thousands of years are meaningful. However, these

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1 assumptions are questionable. In particular, science cannot rule out the possi-
2 bility that there will be no cancer fatalities from these tiny doses. For perspec-
3 tive, the doses are very small fractions of regulatory limits, and even smaller
4 fractions of natural background exposure to the same populations.
5

6 Nevertheless, despite all the uncertainty, some judgement as to the regulatory
7 NEPA [National Environmental Policy Act] implications of these matters should
8 be made and it makes no sense to repeat the same judgement in every case.
9 Even taking the uncertainties into account, the Commission concludes that these
10 impacts are acceptable in that these impacts would not be sufficiently large to
11 require the NEPA conclusion, for any plant, that the option of extended operation
12 under 10 CFR Part 54 should be eliminated. Accordingly, while the Commission
13 has not assigned a single level of significance for the collective effects of the fuel
14 cycle, this issue is considered Category 1.
15

16 The staff has not identified any new and significant information on this issue during its
17 independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping
18 process, or its evaluation of other available information. Therefore, the staff concludes that
19 there are no offsite radiological impacts (collective effects) from the uranium fuel cycle
20 during the renewal term beyond those discussed in the GEIS.
21

- 22 • Offsite radiological impacts (spent fuel and HLW disposal). Based on information in the
23 GEIS, the Commission found that
24

25 For the high level waste and spent fuel disposal component of the fuel cycle,
26 there are no current regulatory limits for offsite releases of radioactive nuclides
27 for the current candidate repository site. However, if we assume that limits are
28 developed along the lines of the 1995 National Academy of Sciences (NAS)
29 report, Technical Bases for Yucca Mountain Standards," and that in accordance
30 with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository
31 can and likely will be developed at some site which will comply with such limits,
32 peak doses to virtually all individuals will be 100 millirem [1 mSv] per year or
33 less. However, while the Commission has reasonable confidence that these
34 assumptions will prove correct, there is considerable uncertainty since the limits
35 are yet to be developed, no repository application has been completed or
36 reviewed, and uncertainty is inherent in the models used to evaluate possible
37 pathways to the human environment. The NAS report indicated that 100 millirem
38 [1 mSv] per year should be considered as a starting point for limits for individual
39 doses, but notes that some measure of consensus exists among national and
40 international bodies that the limits should be a fraction of the 100 millirem

1 [1 mSv] per year. The lifetime individual risk from 100 millirem [1 mSv] annual
2 dose limit is about is about 3×10^{-3} .

3
4 Estimating cumulative doses to populations over thousands of years is more
5 problematic. The likelihood and consequences of events that could seriously
6 compromise the integrity of a deep geologic repository were evaluated by the
7 DOE in the "Final Environmental Impact Statement: Management of
8 Commercially Generated Radioactive Waste," October 1980 [DOE 1980]. The
9 evaluation estimated the 70-year whole-body dose commitment to the maximum
10 individual and to the regional population resulting from several modes of
11 breaching a reference repository in the year of closure, after 1,000 years, after
12 100,000 years, and after 100,000,000 years. Subsequently, the NRC and other
13 federal agencies have expended considerable effort to develop models for the
14 design and for the licensing of a high level waste repository, especially for the
15 candidate repository at Yucca Mountain. More meaningful estimates of doses to
16 population may be possible in the future as more is understood about the
17 performance of the proposed Yucca Mountain repository. Such estimates would
18 involve very great uncertainty, especially with respect to cumulative population
19 doses over thousands of years. The standard proposed by the NAS is a limit on
20 maximum individual dose. The relationship of the potential new regulatory
21 requirements, based on the NAS report, and cumulative population impacts has
22 not been determined, although the report articulates the view that protection of
23 individuals will adequately protect the population for a repository at Yucca
24 Mountain. However, EPA's generic repository standards in 40 CFR part 191
25 generally provide an indication of the order of magnitude of cumulative risk to
26 population that could result from the licensing of a Yucca Mountain repository,
27 assuming the ultimate standards will be within the range of standards now under
28 consideration. The standards in 40 CFR part 191 protect the population by
29 imposing "containment requirements" that limit the cumulative amount of
30 radioactive material released over 10,000 years. Reporting performance
31 standards that will be required by EPA are expected to result in releases and
32 associated health consequences in the range between 10 and 100 premature
33 cancer deaths with an upper limit of 1,000 premature cancer deaths worldwide
34 for a 100,000 metric tonne (MTHM) repository.

35
36 Nevertheless, despite all the uncertainty, some judgement as to the regulatory
37 NEPA implications of these matters should be made and it makes no sense to
38 repeat the same judgement in every case. Even taking the uncertainties into
39 account, the Commission concludes that these impacts are acceptable in that
40 these impacts would not be sufficiently large to require the NEPA conclusion, for
41 any plant, that the option of extended operation under 10 CFR part 54 should be

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1 eliminated. Accordingly, while the Commission has not assigned a single level of
2 significance for the impacts of spent fuel and high level waste disposal, this issue
3 is considered Category 1.
4

5 Since the GEIS was originally issued in 1996, EPA published radiation protection standards
6 for Yucca Mountain, Nevada, at 40 CFR Part 197, "Public Health and Environmental
7 Radiation Protection Standards for Yucca Mountain, Nevada," on June 13, 2001 (66 FR
8 32132). The Energy Policy Act of 1992 directs the NRC to adopt these standards into its
9 regulations for reviewing and licensing the repository. NRC published its regulations at 10
10 CFR Part 63, "Disposal of High-Level Radioactive Wastes in Geologic Repository at Yucca
11 Mountain, Nevada," on November 2, 2001 (66 FR 55792). These standards include the
12 following: (1) a 0.15 mSv/yr (15 mrem/yr) dose limit for members of the public during the
13 storage period prior to repository closure, (2) a 0.15 mSv/yr (15 mrem/yr) dose limit for the
14 reasonably maximally exposed individual from the undisturbed repository for 10,000 years
15 following disposal, (3) a 0.15 mSv/yr (15 mrem/yr) dose limit for the reasonably maximally
16 exposed individual as a result of a human intrusion at or before 10,000 years after disposal,
17 and (4) a ground-water protection standard that states that for 10,000 years of undisturbed
18 performance after disposal, radioactivity in a representative volume of groundwater will not
19 exceed (a) 0.2 Bq/L (5 pCi/L) for radium-226 and radium-228, (b) 0.56 Bq/L (15 pCi/L) for
20 gross alpha activity, and (c) 0.04 mSv/yr (4 mrem/yr) to the whole body or any organ (from
21 combined beta- and photon-emitting radionuclides, assuming consumption of 2 Lpd of the
22 affected water).
23

24 On February 15, 2002, subsequent to the receipt of a recommendation by the Secretary,
25 Department of Energy, the President recommended the Yucca Mountain site for the
26 development of a repository for the geologic disposal of spent nuclear fuel and HLW.
27

28 This change in regulatory status does not cause the staff to change its position with respect
29 to the impact of spent fuel and HLW disposal. The staff still considers the Category 1
30 classification in the GEIS (NRC 1996, 1999) appropriate.
31

32 The staff has not identified any new and significant information on this issue during its
33 independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping
34 process, or its evaluation of other available information. Therefore, the staff concludes that
35 there are no offsite radiological impacts related to spent fuel and HLW disposal during the
36 renewal term beyond those discussed in the GEIS.
37

- 1 • Nonradiological impacts of the uranium fuel cycle. Based on information in the GEIS, the
2 Commission found that

3
4 The nonradiological impacts of the uranium fuel cycle resulting from the renewal
5 of an operating license for any plant are found to be small.

6
7 The staff has not identified any new and significant information on this issue during its
8 independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping
9 process, or its evaluation of other available information. Therefore, the staff concludes that
10 there are no nonradiological impacts of the uranium fuel cycle during the renewal term
11 beyond those discussed in the GEIS.

- 12
13 • Low-level waste storage and disposal. Based on information in the GEIS, the Commission
14 found that

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16 The comprehensive regulatory controls that are in place and the low public
17 doses being achieved at reactors ensure that the radiological impacts to the
18 environment will remain small during the term of a renewed license. The
19 maximum additional on-site land that may be required for low-level waste
20 storage during the term of a renewed license and associated impacts will be
21 small. Nonradiological impacts on air and water will be negligible. The
22 radiological and nonradiological environmental impacts of long-term disposal of
23 low-level waste from any individual plant at licensed sites are small. In addition,
24 the Commission concludes that there is reasonable assurance that sufficient
25 low-level waste disposal capacity will be made available when needed for
26 facilities to be decommissioned consistent with NRC decommissioning
27 requirements.

28
29 The staff has not identified any new and significant information on this issue during its
30 independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping
31 process, or its evaluation of other available information. Therefore, the staff concludes that
32 there are no impacts of low-level waste storage and disposal associated with the renewal
33 term beyond those discussed in the GEIS.

- 34
35 • Mixed waste storage and disposal. Based on information in the GEIS, the Commission
36 found that

37
38 The comprehensive regulatory controls and the facilities and procedures that are
39 in place ensure proper handling and storage, as well as negligible doses and
40 exposure to toxic materials for the public and the environment at all plants.
41 License renewal will not increase the small, continuing risk to human health and

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1 the environment posed by mixed waste at all plants. The radiological and
2 nonradiological environmental impacts of long-term disposal of mixed waste from
3 any individual plant at licensed sites are small. In addition, the Commission
4 concludes that there is reasonable assurance that sufficient mixed waste
5 disposal capacity will be made available when needed for facilities to be
6 decommissioned consistent with NRC decommissioning requirements.

7
8 The staff has not identified any new and significant information on this issue during its
9 independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping
10 process, or its evaluation of other available information. Therefore, the staff concludes that
11 there are no impacts of mixed waste storage and disposal associated with the renewal term
12 beyond those discussed in the GEIS.

- 13
14 • Onsite spent fuel. Based on information in the GEIS, the Commission found that

15
16 The expected increase in the volume of spent fuel from an additional 20 years of
17 operation can be safely accommodated on site with small environmental effects
18 through dry or pool storage at all plants if a permanent repository or monitored
19 retrievable storage is not available.

20
21 The staff has not identified any new and significant information on this issue during its
22 independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping
23 process, or its evaluation of other available information. Therefore, the staff concludes that
24 there are no impacts of onsite spent fuel associated with license renewal beyond those
25 discussed in the GEIS.

- 26
27 • Nonradiological waste. Based on information in the GEIS, the Commission found that

28
29 No changes to generating systems are anticipated for license renewal. Facilities
30 and procedures are in place to ensure continued proper handling and disposal at
31 all plants.

32
33 The staff has not identified any new and significant information on this issue during its
34 independent review of the VEPCo ER (VEPCo 2001), the staff's site visit, the scoping
35 process, or its evaluation of other available information. Therefore, the staff concludes that
36 there are no nonradiological waste impacts during the renewal term beyond those
37 discussed in the GEIS.

- 1 • Transportation. Based on information contained in the GEIS, the Commission found that

2
3 The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with
4 average burnup for the peak rod to current levels approved by NRC up to
5 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to
6 a single repository, such as Yucca Mountain, Nevada are found to be consistent
7 with the impact values contained in 10 CFR 51.52(c), Summary Table S-4—
8 Environmental Impact of Transportation of Fuel and Waste to and from One
9 Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or burnup
10 conditions are not met, the applicant must submit an assessment of the
11 implications for the environmental impact values reported in § 51.52.

12
13 North Anna Power Station, Units 1 and 2, meet the fuel-enrichment and burnup conditions
14 set forth in Addendum 1 to the GEIS. The staff has not identified any new and significant
15 information on this issue during its independent review of the VEPCo ER (VEPCo 2001), the
16 staff's site visit, the scoping process, or its evaluation of other available information.
17 Therefore, the staff concludes that there are no impacts of transportation associated with
18 license renewal beyond those discussed in the GEIS.

19 20 **6.2 References**

21
22 10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental
23 Protection Regulations for Domestic Licensing and Related Regulatory Functions."

24
25 10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy*, Part 54, "Requirements for
26 Renewal of Operating Licenses for Nuclear Power Plants."

27
28 10 CFR Part 63. Code of Federal Regulations, Title 10, *Energy*, Part 63, "Disposal of High-
29 Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada."

30
31 40 CFR Part 191. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 191,
32 "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear
33 Fuel, High-Level and Transuranic Radioactive Waste."

34
35 40 CFR Part 197. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 197,
36 "Public Health and Environmental Radiation Protection Standards for Yucca Mountain,
37 Nevada."

38
39 Energy Policy Act of 1992. 42 USC 10101 et seq.
40

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- 1 National Academy of Sciences (NAS). 1995. *Technical Bases for Yucca Mountain Standards*.
2 Washington, D.C.
- 3
- 4 National Environmental Policy Act (NEPA) of 1969, as amended, 42 USC 4321, et seq.
- 5
- 6 U.S. Department of Energy (DOE). 1980. *Final Environmental Impact Statement:*
7 *Management of Commercially Generated Radioactive Waste*. DOE/EIS 00046-G, Vols. 1-3,
8 Washington, D.C.
- 9
- 10 U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement*
11 *for License Renewal of Nuclear Plants*. NUREG-1437, Washington, D.C.
- 12
- 13 U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement*
14 *for License Renewal of Nuclear Plants, Main Report, Section 6.3 - Transportation, Table 9.1,*
15 *Summary of findings on NEPA issues for license renewal of nuclear power plants.*
16 NUREG-1437, Vol. 1, Addendum 1, Washington, D.C.
- 17
- 18 Virginia Electric and Power Company (VEPCo). 2001. *Application for License Renewal for*
19 *North Anna Power Station, Units 1 and 2, "Appendix E, Environmental Report - Operating*
20 *License Renewal Stage."* Richmond, Virginia.