

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, Volumes 1 and 2 (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 characteristics.
- (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 not likely 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 for Category 1, and therefore, additional plant-specific review of 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, and are applicable to the Virgil C. Summer Nuclear Station (V.C. Summer). 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

(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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1 10 CFR 51.52(c), Table S-4, “Environmental Impact of Transportation of Fuel and Waste to and
2 from One Light-Water-Cooled Nuclear Power Reactor.” The GEIS also addresses the impacts
3 from radon-222 and technetium-99. There are no Category 2 issues for the uranium fuel cycle
4 and solid waste management.
5

6.1 The Uranium Fuel Cycle

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8 Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1 that are applicable to
9 V.C. Summer from the uranium fuel cycle and solid waste management are listed in Table 6-1.
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11 **Table 6-1.** Category 1 Issues Applicable to the Uranium Fuel Cycle and Solid Waste
12 Management During the Renewal Term
13

ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1	GEIS Section
URANIUM FUEL CYCLE AND WASTE MANAGEMENT	
16 Offsite radiological impacts (individual effects from other than the 17 disposal of spent fuel and HLW)	6.1; 6.2.1; 6.2.2.1; 6.2.2.3; 6.2.3; 6.2.4; 6.6
18 Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
19 Offsite radiological impacts (spent fuel and HLW disposal)	6.1; 6.2.2.1; 6.2.3; 6.2.4; 6.6
20 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
21 Low-level waste (LLW) 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
22 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
23 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
24 Nonradiological waste	6.1; 6.5; 6.5.1; 6.5.2; 6.5.3; 6.6
25 Transportation	6.1; 6.3.1; 6.3.2.3; 6.3.3; 6.3.4; 6.6, Addendum 1

1 South Carolina Electric and Gas Company (SCE&G) stated in its Environmental Report (ER)
2 (SCE&G 2002) that it is not aware of any new and significant information associated with the
3 renewal of the V.C. Summer operating license (OL). The staff has not identified any significant
4 new information on these issues during its independent review of the V.C. Summer ER
5 (SCE&G 2002), its site visit, the scoping process, or staff evaluation of other available
6 information. Therefore, the staff concludes that there are no impacts related to these issues
7 beyond those discussed in the GEIS. For these issues, the staff concluded in the GEIS that the
8 impacts are SMALL except for the collective offsite radiological impacts from the fuel cycle and
9 from HLW and spent fuel disposal, as discussed below, and that additional plant-specific
10 mitigation measures are not likely to be sufficiently beneficial to be warranted.

11
12 A brief description of the staff review and the GEIS conclusions, as codified in Table B-1,
13 10 CFR Part 51, for each of these issues follows:

- 14
15 • Offsite radiological impacts (individual effects from other than the disposal of spent fuel
16 and HLW). Based on information in the GEIS, the Commission found that

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

22
23 The staff has not identified any new and significant information on this issue during its
24 independent review of the V.C. Summer ER (SCE&G 2002), its site visit, the scoping
25 process, or its evaluation of other available information. Therefore, the staff concludes that
26 there are no offsite radiological impacts (individual effects from other than the disposal of
27 spent fuel and HLW) of the uranium fuel cycle during the renewal term beyond those
28 discussed in the GEIS.

- 29
30 • Offsite radiological impacts (collective effects). Based on information in the GEIS, the
31 Commission found that

32
33 The 100 year environmental dose commitment to the U.S. population from the
34 fuel cycle, high level waste and spent fuel disposal excepted, is calculated to be
35 about 14,800 person rem [148 person Sv], or 12 cancer fatalities, for each
36 additional 20-year power reactor operating term. Much of this, especially the
37 contribution of radon releases from mines and tailing piles, consists of tiny doses
38 summed over large populations. This same dose calculation can theoretically be
39 extended to include many tiny doses over additional thousands of years as well
40 as doses outside the U.S. The result of such a calculation would be thousands of

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1 cancer fatalities from the fuel cycle, but this result assumes that even tiny doses
2 have some statistical adverse health effect which will not ever be mitigated (for
3 example no cancer cure in the next thousand years), and that these doses
4 projected over thousands of years are meaningful. However, these assumptions
5 are questionable. In particular, science cannot rule out the possibility that there
6 will be no cancer fatalities from these tiny doses. For perspective, the doses are
7 very small fractions of regulatory limits and even smaller fractions of natural
8 background exposure to the same populations.

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

19
20 The staff has not identified any new and significant information on this issue during its
21 independent review of the V.C. Summer ER (SCE&G 2002), its 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 (collective effects) from the uranium fuel cycle
24 during the renewal term beyond those discussed in the GEIS.

- 25
26 • Offsite radiological impacts (spent fuel and HLW disposal). Based on information in the
27 GEIS, the Commission found that

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

1 pathways to the human environment. The NAS report indicated that 100 millirem
2 [1 mSv] per year should be considered as a starting point for limits for individual
3 doses, but notes that some measure of consensus exists among national and
4 international bodies that the limits should be a fraction of the 100 millirem [1
5 mSv] per year. The lifetime individual risk from 100 millirem [1 mSv] annual dose
6 limit is about 3×10^{-3} .

7
8 Estimating cumulative doses to populations over thousands of years is more
9 problematic. The likelihood and consequences of events that could seriously
10 compromise the integrity of a deep geologic repository were evaluated by the
11 U.S. Department of Energy in the *Final Environmental Impact Statement:
12 Management of Commercially Generated Radioactive Waste*, October 1980
13 [DOE 1980]. The evaluation estimated the 70-year whole-body dose
14 commitment to the maximum individual and to the regional population resulting
15 from several modes of breaching a reference repository in the year of closure,
16 after 1000 years, after 100,000 years, and after 100,000,000 years.
17 Subsequently, the NRC and other federal agencies have expended considerable
18 effort to develop models for the design and for the licensing of a high level waste
19 repository, especially for the candidate repository at Yucca Mountain. More
20 meaningful estimates of doses to population may be possible in the future as
21 more is understood about the performance of the proposed Yucca Mountain
22 repository. Such estimates would involve very great uncertainty, especially with
23 respect to cumulative population doses over thousands of years. The standard
24 proposed by the NAS is a limit on maximum individual dose. The relationship of
25 potential new regulatory requirements, based on the NAS report, and cumulative
26 population impacts has not been determined, although the report articulates the
27 view that protection of individuals will adequately protect the population for a
28 repository at Yucca Mountain. However, the EPA's [U.S. Environmental
29 Protection Agency] generic repository standards in 40 CFR Part 191 generally
30 provide an indication of the order of magnitude of cumulative risk to population
31 that could result from the licensing of a Yucca Mountain repository, assuming the
32 ultimate standards will be within the range of standards now under consideration.
33 The standards in 40 CFR Part 191 protect the population by imposing
34 "containment requirements" that limit the cumulative amount of radioactive
35 material released over 10,000 years. Reporting performance standards that will
36 be required by EPA are expected to result in releases and associated health
37 consequences in the range between 10 and 100 premature cancer deaths with
38 an upper limit of 1000 premature cancer deaths worldwide for a 100,000 metric
39 tonne (MTHM) repository.
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1 Nevertheless, despite all the uncertainty, some judgement as to the regulatory
2 NEPA implications of these matters should be made and it makes no sense to
3 repeat the same judgement in every case. Even taking the uncertainties into
4 account, the Commission concludes that these impacts are acceptable in that
5 these impacts would not be sufficiently large to require the NEPA conclusion, for
6 any plant, that the option of extended operation under 10 CFR Part 54 should be
7 eliminated. Accordingly, while the Commission has not assigned a single level of
8 significance for the impacts of spent fuel and high level waste disposal, this issue
9 is considered Category 1.

10
11 Since the GEIS was originally issued in 1996, the EPA has published radiation protection
12 standards for Yucca Mountain, Nevada, at 40 CFR Part 197, "Public Health and
13 Environmental Radiation Protection Standards for Yucca Mountain, Nevada," on June 13,
14 2001 (66 FR 32132). The Energy Policy Act of 1992 (42 USC 10101 et seq.) directs that
15 the U.S. Nuclear Regulatory Commission (NRC) adopt these standards into its regulations
16 for reviewing and licensing the repository. NRC published its regulations at 10 CFR Part 63,
17 "Disposal of High-Level Radioactive Wastes in Geologic Repository at Yucca Mountain,
18 Nevada" on November 2, 2001 (66 FR 55792). These standards include the following:
19 (1) 0.15 mSv/year (15 mrem/year) dose limit for members of the public during the storage
20 period prior to repository closure, (2) 0.15 mSv/year (15 mrem/year) dose limit for the
21 reasonably maximally exposed individual for 10,000 years following disposal,
22 (3) 0.15 mSv/year (15 mrem/year) dose limit for the reasonably maximally exposed
23 individual as a result of a human intrusion at or before 10,000 years after disposal, and
24 (4) a groundwater protection standard that states for 10,000 years of undisturbed
25 performance after disposal, radioactivity in a representative volume of groundwater will not
26 exceed (a) 0.19 Bq/L (5 pCi/L) for radium-226 and radium-228, (b) 0.56 Bq/L (15 pCi/L) for
27 gross alpha activity, and (c) 0.04 mSv/year (4 mrem/year) to the whole body or any organ
28 (from combined beta and photon-emitting radionuclides, assuming consumption of 2 L/d of
29 the affected water).

30
31 On February 15, 2002, subsequent to receipt of a recommendation by the Secretary,
32 U.S. Department of Energy, the President recommended the Yucca Mountain site for the
33 development of a repository for the geologic disposal of spent nuclear fuel and HLW. The
34 U.S. Congress approved this recommendation on July 9, 2002, in House Joint
35 Resolution 87. On July 23, 2002, the President signed into law House Joint Resolution 87.
36 This development does not represent new and significant information with respect to the
37 offsite radiological impacts related to spent fuel and HLW disposal during the renewal term.

38
39 The staff has not identified any new and significant information on this issue during its
40 independent review of the V.C. Summer ER (SCE&G 2002), its site visit, the scoping

1 process, or staff evaluation of other available information. Therefore, the staff concludes
2 that there are no offsite radiological impacts related to spent fuel and HLW disposal during
3 the renewal term beyond those discussed in the GEIS.

- 4
5 • Nonradiological impacts of the uranium fuel cycle. Based on information in the GEIS,
6 the Commission found that

7
8 The nonradiological impacts of the uranium fuel cycle resulting from the renewal
9 of an operating license for any plant are found to be small.

10
11 The staff has not identified any new and significant information on this issue during its
12 independent review of the V.C. Summer ER (SCE&G 2002), its site visit, the scoping
13 process, or its evaluation of other available information. Therefore, the staff concludes that
14 there are no nonradiological impacts of the uranium fuel cycle during the renewal term
15 beyond those discussed in the GEIS.

- 16
17 • Low-level waste storage and disposal. Based on information in the GEIS, the
18 Commission found that

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

31
32 The staff has not identified any new and significant information on this issue during its
33 independent review of the V.C. Summer ER (SCE&G 2002), its site visit, the scoping
34 process, or its evaluation of other available information. Therefore, the staff concludes that
35 there are no impacts of LLW storage and disposal associated with the renewal term beyond
36 those discussed in the GEIS.

- 37
38 • Mixed waste storage and disposal. Based on information in the GEIS, the Commission
39 found that

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1 The comprehensive regulatory controls and the facilities and procedures that are
2 in place ensure proper handling and storage, as well as negligible doses and
3 exposure to toxic materials for the public and the environment at all plants.
4 License renewal will not increase the small, continuing risk to human health and
5 the environment posed by mixed waste at all plants. The radiological and
6 nonradiological environmental impacts of long-term disposal of mixed waste from
7 any individual plant at licensed sites are small. In addition, the Commission
8 concludes that there is reasonable assurance that sufficient mixed waste
9 disposal capacity will be made available when needed for facilities to be
10 decommissioned consistent with NRC decommissioning requirements.

11
12 The staff has not identified any new and significant information on this issue during its
13 independent review of the V.C. Summer ER (SCE&G 2002), its site visit, the scoping
14 process, or its evaluation of other available information. Therefore, the staff concludes that
15 there are no impacts of mixed waste storage and disposal associated with the renewal term
16 beyond those discussed in the GEIS.

- 17
18 • Onsite spent fuel. Based on information in the GEIS, the Commission found that

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

24
25 The staff has not identified any new and significant information on this issue during its
26 independent review of the V.C. Summer ER (SCE&G 2002), its site visit, the scoping
27 process, or its evaluation of other available information. Therefore, the staff concludes that
28 there are no impacts of onsite spent fuel associated with license renewal beyond those
29 discussed in the GEIS.

- 30
31 • Nonradiological waste. Based on information in the GEIS, the Commission found that

32
33 No changes to generating systems are anticipated for license renewal. Facilities
34 and procedures are in place to ensure continued proper handling and disposal at
35 all plants.

36
37 The staff has not identified any new and significant information on this issue during its
38 independent review of the V.C. Summer ER (SCE&G 2002), its site visit, the scoping
39 process, or its evaluation of other available information. Therefore, the staff concludes that

1 there are no nonradiological waste impacts during the renewal term beyond those
2 discussed in the GEIS.

- 3
4 • Transportation. Based on information contained in the GEIS, the Commission found
5 that

6
7 The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with
8 average burnup for the peak rod to current levels approved by NRC up to
9 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to
10 a single repository, such as Yucca Mountain, Nevada, are found to be consistent
11 with the impact values contained in 10 CFR 51.52(c), Summary Table S-
12 4—Environmental Impact of Transportation of Fuel and Waste to and from One
13 Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or burnup
14 conditions are not met, the applicant must submit an assessment of the
15 implications for the environmental impact values reported in § 51.52.

16
17 V.C. Summer meets the fuel-enrichment and burnup conditions set forth in Addendum 1 to
18 the GEIS. The staff has not identified any new and significant information on this issue
19 during its independent review of the V.C. Summer ER (SCE&G 2002), its site visit, the
20 scoping process, or its evaluation of other available information. Therefore, the staff
21 concludes that there are no impacts of transportation associated with license renewal
22 beyond those discussed in the GEIS.
23

24 6.2 References

25
26 10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, “Environmental
27 Protection Regulations for Domestic Licensing and Related Regulatory Functions.”

28
29 10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy*, Part 54, “Requirements for
30 Renewal of Operating Licenses for Nuclear Power Plants.”

31
32 10 CFR Part 63. Code of Federal Regulations, Title 10, *Energy*, Part 63, “Disposal of High-
33 Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada.”

34
35 40 CFR Part 191. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 191,
36 “Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear
37 Fuel, High-Level and Transuranic Radioactive Waste.”
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1 40 CFR Part 197. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 197,
2 “Public Health and Environmental Radiation Protection Standards for Management and
3 Disposal for Yucca Mountain, Nevada.”

4
5 66 FR 32132, “Public Health and Environmental Radiation Protection Standards for Yucca
6 Mountain, Nevada. *Federal Register* Vol. 66, No. 114. June 13, 2001.

7
8 66 FR 55792, “Disposal of High-Level Radioactive Wastes in a Proposed Geological Repository
9 at Yucca Mountain, Nevada.” *Federal Register* Vol. 66, No. 213. November 2, 2001.

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11 Energy Policy Act of 1992. 42 USC 10101, et seq.

12
13 South Carolina Electric and Gas Company (SCE&G). 2002. *Virgil C. Summer Nuclear Station*
14 *License Renewal Application*. “Appendix E, Environmental Report.” Docket Number 50/395;
15 License Number NPF-12. Jenkinsville, South Carolina.

16
17 National Academy of Sciences (NAS). 1995. *Technical Bases for Yucca Mountain Standards*.
18 Washington, D.C.

19
20 National Environmental Policy Act (NEPA) of 1969, as amended. 42 USC 4321, et seq.

21
22 U.S. Department of Energy (DOE). 1980. *Final Environmental Impact Statement:*
23 *Management of Commercially Generated Radioactive Waste*. DOE/EIS-0046F.
24 Washington, D.C.

25
26 U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement*
27 *for License Renewal of Nuclear Plants*. NUREG-1437, Volumes 1 and 2. Washington, D.C.

28
29 U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement*
30 *for License Renewal of Nuclear Plants, Main Report*. “Section 6.3 – Transportation, Table 9.1,
31 Summary of findings on NEPA issues for license renewal of nuclear power plants, Final
32 Report.” NUREG-1437, Volume 1, Addendum 1, Washington, D.C.