

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 were 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 the Catawba Nuclear Station, Units 1 and 2 (Catawba). 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),

(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.

Fuel Cycle

1 Table S-4, "Environmental Impact of Transportation of Fuel and Waste to and from One
2 Light-Water-Cooled Nuclear Power Reactor." The GEIS also addresses the impacts from
3 radon-222 and technetium-99.
4

5 **6.1 The Uranium Fuel Cycle**

6
7 Category 1 issues in 10 CFR Part 51, Subpart A, Appendix B, Table B-1, that are applicable to
8 Catawba from the uranium fuel cycle and solid waste management are listed in Table 6-1.
9

10 **Table 6-1.** Category 1 Issues Applicable to the Uranium Fuel Cycle and Solid Waste
11 Management During the Renewal Term
12

13 ISSUE—10 CFR Part 51, Subpart A, Appendix B, Table B-1 GEIS Sections	
14 Uranium Fuel Cycle and Waste Management	
15 Offsite radiological impacts (individual effects from 16 other than the 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
17 Offsite radiological impacts (collective effects)	6.1; 6.2.2.1; 6.2.3; 6.2.4, 6.6
18 Offsite radiological impacts (spent fuel and HLW 19 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 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

26

1 Duke Energy Corporation (Duke) stated in its Environmental Report (ER; Duke 2001) that it is
2 not aware of any new and significant information associated with the renewal of the Catawba
3 operating licenses (OLs). The staff has not identified significant new information during its
4 independent review of the Catawba ER (Duke 2001), the staff's site visit, the scoping process,
5 or its evaluation of other available information. Therefore, the staff concludes that there are no
6 impacts related to these issues beyond those discussed in the GEIS. For all of those issues,
7 the staff concluded in the GEIS that the impacts are SMALL except for collective offsite
8 radiological impacts from the fuel cycle and from HLW and spent fuel disposal, as discussed
9 below, and additional plant-specific mitigation measures are not likely to be sufficiently
10 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 51 for each of these issues, follows:

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

16
17
18 Off-site 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 significant new information during its independent review of
24 the Catawba ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of
25 other available information. Therefore, the staff concludes that there are no offsite
26 radiological impacts of the uranium fuel cycle (with regard to individual effects from other
27 than the disposal of spent fuel and HLW) during the renewal term beyond those discussed
28 in the GEIS.

- 29
30 • Offsite radiological impacts (collective effects). In the GEIS, the staff concluded that

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

Fuel Cycle

1 these doses projected over thousands of years are meaningful. However, these
2 assumptions are questionable. In particular, science cannot rule out the
3 possibility that there will be no cancer fatalities from these tiny doses. For
4 perspective, the doses are very small fractions of regulatory limits, and even
5 smaller fractions of natural background exposure to the same populations.
6

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

17 The staff has not identified any significant new information during its independent review of
18 the Catawba ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of
19 other available information. Therefore, the staff concludes that there are no offsite
20 radiological impacts (collective effects) from the uranium fuel cycle during the renewal term
21 beyond those discussed in the GEIS.
22

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

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

1 international bodies that the limits should be a fraction of the 100 millirem
2 [1 mSv] per year. The lifetime individual risk from 100 millirem [1 mSv] annual
3 dose limit is about is about 3×10^{-3} .

4
5 Estimating cumulative doses to populations over thousands of years is more
6 problematic. The likelihood and consequences of events that could seriously
7 compromise the integrity of a deep geologic repository were evaluated by the
8 Department of Energy in the "Final Environmental Impact Statement:
9 Management of Commercially Generated Radioactive Waste," October 1980
10 [DOE 1980]. The evaluation estimated the 70-year whole-body dose commit-
11 ment to the maximum individual and to the regional population resulting from
12 several modes of breaching a reference repository in the year of closure, after
13 1000 years, after 100,000 years, and after 100,000,000 years. Subsequently,
14 the NRC and other federal agencies have expended considerable effort to
15 develop models for the design and for the licensing of a high level waste
16 repository, especially for the candidate repository at Yucca Mountain. More
17 meaningful estimates of doses to population may be possible in the future as
18 more is understood about the performance of the proposed Yucca Mountain
19 repository. Such estimates would involve very great uncertainty, especially with
20 respect to cumulative population doses over thousands of years. The standard
21 proposed by the NAS is a limit on maximum individual dose. The relationship of
22 the potential new regulatory requirements, based on the NAS report, and
23 cumulative population impacts has not been determined, although the report
24 articulates the view that protection of individuals will adequately protect the
25 population for a repository at Yucca Mountain. However, EPA's [Environmental
26 Protection Agency's] generic repository standards in 40 CFR part 191 generally
27 provide an indication of the order of magnitude of cumulative risk to population
28 that could result from the licensing of a Yucca Mountain repository, assuming the
29 ultimate standards will be within the range of standards now under consideration.
30 The standards in 40 CFR part 191 protect the population by imposing "contain-
31 ment requirements" that limit the cumulative amount of radioactive material
32 released over 10,000 years. Reporting performance standards that will be
33 required by EPA are expected to result in releases and associated health
34 consequences in the range between 10 and 100 premature cancer deaths with
35 an upper limit of 1000 premature cancer deaths worldwide for a 100,000 metric
36 tonne (MTHM) repository.

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

Fuel Cycle

1 any plant, that the option of extended operation under 10 CFR Part 54 should be
2 eliminated. Accordingly, while the Commission has not assigned a single level of
3 significance for the impacts of spent fuel and high level waste disposal, this issue
4 is considered Category 1.
5

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

25 On February 15, 2002, subsequent to the receipt of a recommendation by the Secretary,
26 Department of Energy, the President recommended the Yucca Mountain site for the
27 development of a repository for the geologic disposal of spent nuclear fuel and high-level
28 nuclear waste.
29

30 This change in regulatory status does not cause the staff to change its position with respect
31 to the impact of spent fuel and HLW disposal. The staff still considers the Category 1
32 classification in the GEIS appropriate.
33

34 The staff has not identified any significant new information during its independent review of
35 the Catawba ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of
36 other available information. Therefore, the staff concludes that there are no offsite
37 radiological impacts of the uranium fuel cycle with regard to spent fuel and HLW disposal
38 during the renewal term beyond those discussed in the GEIS.
39

- 1 • Nonradiological impacts of the uranium fuel cycle. Based on information in the GEIS,
2 the 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 significant new information during its independent review of
8 the Catawba ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of
9 other available information. Therefore, the staff concludes that there are no nonradiological
10 impacts of the uranium fuel cycle during the renewal term beyond those discussed in the
11 GEIS.
12

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

15
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 significant new information during its independent review of
30 the Catawba ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of
31 other available information. Therefore, the staff concludes that there are no impacts of
32 low-level waste storage and disposal associated with the renewal term beyond those
33 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
42 the environment posed by mixed waste at all plants. The radiological and

Fuel Cycle

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

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

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

14
15 The expected increase in the volume of spent fuel from an additional 20 years of
16 operation can be safely accommodated on site with small environmental effects
17 through dry or pool storage at all plants if a permanent repository or monitored
18 retrievable storage is not available.
19

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

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

26
27 No changes to generating systems are anticipated for license renewal. Facilities
28 and procedures are in place to ensure continued proper handling and disposal at
29 all plants.
30

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

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

38
39 The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with
40 average burnup for the peak rod to current levels approved by NRC up to

1 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to
2 a single repository, such as Yucca Mountain, Nevada are found to be consistent
3 with the impact values contained in 10 CFR 51.52(c), Summary Table
4 S-4–Environmental Impact of Transportation of Fuel and Waste to and from One
5 Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or burnup
6 conditions are not met, the applicant must submit an assessment of the
7 implications for the environmental impact values reported in § 51.52.
8

9 Catawba meets the fuel-enrichment and burnup conditions set forth in Addendum 1 to the
10 GEIS. The staff has not identified any significant new information during its independent
11 review of the Catawba ER (Duke 2001), the staff's site visit, the scoping process, or its
12 evaluation of other available information. Therefore, the staff concludes that there are no
13 transportation impacts associated with license renewal beyond those discussed in the GEIS.
14

15 There are no Category 2 issues for the uranium fuel cycle and solid waste management.
16

17 6.2 References

18
19 10 CFR 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection
20 Regulations for Domestic Licensing and Related Regulatory Functions."

21
22 10 CFR 54. Code of Federal Regulations, Title 10, *Energy*, Part 54, "Requirements for
23 Renewal of Operating Licenses for Nuclear Power Plants."

24
25 10 CFR 63. Code of Federal Regulations, Title 63, *Energy* Part 63, "Disposal of High-Level
26 Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada."
27

28 40 CFR 191. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 191,
29 "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear
30 Fuel, High-Level and Transuranic Radioactive Waste."
31

32 40 CFR 197. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 197,
33 "Public Health and Radiation Protection Standards for Yucca Mountain, Nevada."
34

35 Duke Energy Corporation (Duke). 2001. *Applicant's Environmental Report – Operating
36 License Renewal Stage Catawba Nuclear Station Units 1 and 2*. Charlotte, North Carolina.
37

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

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

Fuel Cycle

- 1 National Environmental Policy Act (NEPA) of 1969, as amended, 42 USC 4321, et seq.
2
3 U.S. Department of Energy (DOE). 1980. *Final Environmental Impact Statement:
4 Management of Commercially Generated Radioactive Waste*. DOE/EIS 00046-G,
5 Volumes 1-3, Washington, D.C.
6
7 U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement
8 for License Renewal of Nuclear Plants*. NUREG-1437, Volumes 1 and 2, Washington, D.C.
9
10 U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement
11 for License Renewal of Nuclear Plants, Main Report*, “Section 6.3 - Transportation, Table 9.1,
12 Summary of findings on NEPA issues for license renewal of nuclear power plants, Final
13 Report.” NUREG-1437, Volume 1, Addendum 1, Washington, D.C.