

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, 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 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 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 10 CFR Part 51, Subpart A, Appendix B, and are applicable to the R.E. Ginna Nuclear Power Plant (Ginna). 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

(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 Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear
2 Power Reactor." The GEIS also addresses the impacts from radon-222 and technetium-99.
3 There are no Category 2 issues for the uranium fuel cycle and solid waste management.
4

5 **6.1 The Uranium Fuel Cycle**

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

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)	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 high-level waste)	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

1 In the Ginna Environmental Report (ER) (RG&E 2002), Rochester Gas and Electric Corporation
2 (RG&E) stated that “no new information existed for the issues that would invalidate the GEIS
3 conclusions.” The staff has not identified any new and significant information on this issue
4 during its independent review of the Ginna ER, the staff’s site visit, the scoping process,
5 discussions with other agencies, or its evaluation of other information. Therefore, the staff
6 concludes that there are no impacts related to these issues beyond those discussed in the
7 GEIS. For all of those GEIS issues, the staff concluded that the impacts are SMALL except for
8 collective offsite radiological impacts from the fuel cycle and from high-level waste and spent
9 fuel disposal, as discussed below, and plant-specific mitigation measures are not likely to be
10 sufficiently beneficial to be warranted.

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

- 14 • Offsite radiological impacts (individual effects from other than the disposal of spent fuel
15 and high-level waste). 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 new and significant information. Therefore, the staff
24 concludes that there are no offsite radiological impacts of the uranium fuel cycle during the
25 renewal term beyond those 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 thousand years), and that
41 these doses projected over thousands of years are meaningful. However, these
42 assumptions are questionable. In particular, science cannot rule out the

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1 possibility that there will be no cancer fatalities from these tiny doses. For
2 perspective, the doses are very small fractions of regulatory limits, and even
3 smaller fractions of natural background exposure to the same populations.
4

5 Nevertheless, despite all the uncertainty, some judgement as to the regulatory
6 NEPA [National Environmental Policy Act] implications of these matters should
7 be made and it makes no sense to repeat the same judgement in every case
8 [NEPA 1969]. Even taking the uncertainties into account, the Commission
9 concludes that these impacts are acceptable in that these impacts would not be
10 sufficiently large to require the NEPA conclusion, for any plant, that the option of
11 extended operation under 10 CFR Part 54 should be eliminated. Accordingly,
12 while the Commission has not assigned a single level of significance for the
13 collective effects of the fuel cycle, this issue is considered Category 1.
14

15 The staff has not identified any new and significant information. Therefore, the staff
16 concludes that there are no offsite radiological impacts (collective effects) from the uranium
17 fuel cycle during the renewal term beyond those discussed in the GEIS.
18

- 19 • Offsite radiological impacts (spent fuel and high-level waste disposal). Based on
20 information in the GEIS, the Commission found that

21
22 For the high level waste and spent fuel disposal component of the fuel cycle,
23 there are no current regulatory limits for offsite releases of radionuclides for the
24 current candidate repository site. However, if we assume that limits are
25 developed along the lines of the 1995 National Academy of Sciences (NAS)
26 report, "Technical Bases for Yucca Mountain Standards," and that in accordance
27 with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository
28 can and likely will be developed at some site which will comply with such limits,
29 peak doses to virtually all individuals will be 100 millirem [1 mSv] per year or
30 less. However, while the Commission has reasonable confidence that these
31 assumptions will prove correct, there is considerable uncertainty since the limits
32 are yet to be developed, no repository application has been completed or
33 reviewed, and uncertainty is inherent in the models used to evaluate possible
34 pathways to the human environment. The NAS report indicated that 100 millirem
35 [1 mSv] per year should be considered as a starting point for limits for individual
36 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 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: Management
9 of Commercially Generated Radioactive Waste," October 1980 [DOE 1980]. The
10 evaluation estimated the 70-year whole-body dose commitment to the maximum
11 individual and to the regional population resulting from several modes of breaching a
12 reference repository in the year of closure, after 1,000 years, after 100,000 years,
13 and after 100,000,000 years. Subsequently, the NRC and other federal agencies
14 have expended considerable effort to develop models for the design and for the
15 licensing of a high level waste repository, especially for the candidate repository at
16 Yucca Mountain. More meaningful estimates of doses to population may be
17 possible in the future as more is understood about the performance of the proposed
18 Yucca Mountain repository. Such estimates would involve very great uncertainty,
19 especially with respect to cumulative population doses over thousands of years. The
20 standard proposed by the NAS is a limit on maximum individual dose. The
21 relationship of potential new regulatory requirements, based on the NAS report, and
22 cumulative population impacts has not been determined, although the report
23 articulates the view that protection of individuals will adequately protect the
24 population for a repository at Yucca Mountain. However, EPA's [Environmental
25 Protection Agency] generic repository standards in 40 CFR Part 191 generally
26 provide an indication of the order of magnitude of cumulative risk to population that
27 could result from the licensing of a Yucca Mountain repository, assuming the
28 ultimate standards will be within the range of standards now under consideration.
29 The standards in 40 CFR Part 191 protect the population by imposing "containment
30 requirements" that limit the cumulative amount of radioactive material released over
31 10,000 years. Reporting performance standards that will be required by EPA are
32 expected to result in releases and associated health consequences in the range
33 between 10 and 100 premature cancer deaths with an upper limit of
34 1,000 premature cancer deaths world-wide for a 100,000 metric tonne (MTHM)
35 repository.

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

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

5 Since the GEIS was originally issued in 1996, the EPA has published radiation protection
6 standards for Yucca Mountain, Nevada, at 40 CFR Part 197, "Public Health and
7 Environmental Radiation Protection Standards for Yucca Mountain, Nevada," on June 13,
8 2001 (66 FR 32132). The Energy Policy Act of 1992 (42 USC 10101) directed that the NRC
9 adopt these standards into its regulations for reviewing and licensing the repository. The
10 NRC published its regulations at 10 CFR Part 63, "Disposal of High-Level Radioactive
11 Wastes in a Geologic Repository at Yucca Mountain, Nevada," on November 2, 2001
12 (66 FR 55792). These regulations include the following requirements: (1) 0.15 mSv/year
13 (15.00 mrem/year) dose limit for members of the public during the storage period prior to
14 repository closure; (2) 0.15 mSv/year (15.00 mrem/year) dose limit for the reasonably
15 maximally exposed individual for 10,000 years following disposal; (3) 0.15.00 mSv/year
16 (15.00 mrem/year) dose limit for the reasonably maximally exposed individual as a result of
17 a human intrusion at or before 10,000 years after disposal; and (4) a groundwater protection
18 standard that states for 10,000 years of undisturbed performance after disposal,
19 radioactivity in a representative volume of groundwater will not exceed (a) 0.19 Bq/L (5.00
20 pCi/L) (radium-226 and radium-228), (b) 0.56 Bq/L (15 pCi/L) (gross alpha activity), and (c)
21 0.04 mSv/year (4.00 mrem/year) to the whole body or any organ (from combined beta- and
22 photon-emitting radionuclides).
23

24 On February 15, 2002, subsequent to receipt of a recommendation by Secretary Abraham,
25 U.S. 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 high-level
27 nuclear waste.
28

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

33 The staff has not identified any new and significant information. Therefore, the staff
34 concludes that there are no offsite radiological impacts related to spent fuel and high-level
35 waste disposal during the renewal term beyond those discussed in the GEIS.
36

- 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 new and significant information. Therefore, the staff
8 concludes that there are no nonradiological impacts of the uranium fuel cycle during the
9 renewal term beyond those discussed in the GEIS.

- 10
11 • Low-level waste storage and disposal. Based on information in the GEIS, the
12 Commission found that

13
14 The comprehensive regulatory controls that are in place and the low public
15 doses being achieved at reactors ensure that the radiological impacts to the
16 environment will remain small during the term of a renewed license. The
17 maximum additional on-site land that may be required for low-level waste
18 storage during the term of a renewed license and associated impacts will be
19 small. Nonradiological impacts on air and water will be negligible. The
20 radiological and nonradiological environmental impacts of long-term disposal of
21 low-level waste from any individual plant at licensed sites are small. In addition,
22 the Commission concludes that there is reasonable assurance that sufficient
23 low-level waste disposal capacity will be made available when needed for
24 facilities to be decommissioned consistent with NRC decommissioning
25 requirements.

26
27 The staff has not identified any new and significant information. Therefore, the staff
28 concludes that there are no impacts of low-level waste storage and disposal associated with
29 the renewal term beyond those discussed in the GEIS.

- 30
31 • Mixed waste storage and disposal. Based on information in the GEIS, the Commission
32 found that

33
34 The comprehensive regulatory controls and the facilities and procedures that are
35 in place ensure proper handling and storage, as well as negligible doses and
36 exposure to toxic materials for the public and the environment at all plants.
37 License renewal will not increase the small, continuing risk to human health and
38 the environment posed by mixed waste at all plants. The radiological and non-
39 radiological environmental impacts of long-term disposal of mixed waste from
40 any individual plant at licensed sites are small. In addition, the Commission
41 concludes that there is reasonable assurance that sufficient mixed waste

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1 disposal capacity will be made available when needed for facilities to be
2 decommissioned consistent with NRC decommissioning requirements.

3
4 The staff has not identified any new and significant information. Therefore, the staff
5 concludes that there are no impacts of mixed waste storage and disposal associated with
6 the renewal term beyond those discussed in the GEIS.

- 7
8 • Onsite spent fuel. Based on information in the GEIS, the Commission found that

9
10 The expected increase in the volume of spent fuel from an additional 20 years of
11 operation can be safely accommodated on site with small environmental effects
12 through dry or pool storage at all plants if a permanent repository or monitored
13 retrievable storage is not available.

14
15 The staff has not identified any new and significant information. Therefore, the staff
16 concludes that there are no impacts of onsite spent fuel associated with license renewal
17 beyond those discussed in the GEIS.

- 18
19 • Nonradiological waste. Based on information in the GEIS, the Commission found that

20
21 No changes to generating systems are anticipated for license renewal. Facilities
22 and procedures are in place to ensure continued proper handling and disposal at
23 all plants.

24
25 The staff has not identified any new and significant information. Therefore, the staff
26 concludes that there are no nonradiological waste impacts during the renewal term beyond
27 those discussed in the GEIS.

- 28
29 • Transportation. Based on information contained in the GEIS, the Commission found
30 that

31
32 The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with
33 average burnup for the peak rod to current levels approved by NRC up to
34 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to
35 a single repository, such as Yucca Mountain, Nevada are found to be consistent
36 with the impact values contained in 10 CFR 51.52(c), Summary
37 Table S-4 – Environmental Impact of Transportation of Fuel and Waste to and
38 from One Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or
39 burnup conditions are not met, the applicant must submit an assessment of the
40 implications for the environmental impact values reported in 51.52.

1 Ginna meets the fuel-enrichment and burnup conditions set forth in Addendum 1 to the
2 GEIS. The staff has not identified any new and significant information. Therefore, the staff
3 concludes that there are no impacts of transportation associated with license renewal
4 beyond those discussed in the GEIS.
5

6 **6.2 References**

7
8 10 CFR Part 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, “Environmental
9 Protection Regulations for Domestic Licensing and Related Regulatory Functions.”

10
11 10 CFR Part 54. Code of Federal Regulations, Title 10, *Energy*, Part 54, “Requirements for
12 Renewal of Operating Licenses for Nuclear Power Plants.”

13
14 10 CFR Part 63. Code of Federal Regulations. Title 10, *Energy*, Part 63, “Disposal of High-
15 Level Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada.”

16
17 40 CFR Part 191. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 191,
18 “Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear
19 Fuel, High-Level and Transuranic Radioactive Waste.”

20
21 40 CFR Part 197. Code of Federal Regulations. Title 40, *Protection of Environment*, Part 197,
22 “Public Health and Environmental Radiation Protection Standards for Yucca Mountain,
23 Nevada.”

24
25 Energy Policy Act of 1992. 42 USC 10101, et seq.

26
27 National Environmental Policy Act of 1969 (NEPA). 42 USC 4321, et seq.

28
29 Rochester Gas and Electric Corporation (RG&E). 2002. *R.E. Ginna Nuclear Power Plant*
30 *Application for Renewed Operating License, Appendix E – Environmental Report*. Rochester,
31 New York.

32
33 U.S. Department of Energy (DOE). 1980. *Final Environmental Impact Statement:*
34 *Management of Commercially Generated Radioactive Waste*. DOE/EIS 00046-G, Vols. 1-3,
35 Washington, D.C.

36
37 U.S. Environmental Protection Agency (EPA). 2001. “Part 197 – Public Health and
38 Environmental Radiation Protection Standards for Yucca Mountain, Nevada.” 66 FR 32132.

39
40 U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement*
41 *for License Renewal of Nuclear Plants*. NUREG-1437, Volumes 1 and 2, Washington, D.C.

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- 1 U.S. Nuclear Regulatory Commission (NRC). 1999. *Generic Environmental Impact Statement*
- 2 *for License Renewal of Nuclear Plants, Main Report*, “Section 6.3 – Transportation, Table 9.1
- 3 Summary of findings on NEPA issues for license renewal of nuclear power plants, Final
- 4 Report.” NUREG-1437, Volume 1, Addendum 1, Washington, D.C.
- 5
- 6 U.S. Nuclear Regulatory Commission (NRC). 2001. “Part 63 – Disposal of High-Level
- 7 Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada.” 66 FR 55792.
- 8 November 2, 2001.