

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, 1999a).^(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 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 McGuire Nuclear Station, Units 1 and 2 (McGuire). 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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1 Power Reactor." The GEIS also addresses the impacts from radon-222 and technetium-99.
2 There are no Category 2 issues for the uranium fuel cycle and solid waste management.
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4 **6.1 The Uranium Fuel Cycle**

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

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26 In its environmental report (ER) (Duke 2001), Duke stated that "no new information existed for
27 the issues that would invalidate the GEIS conclusions." No significant new information has
28 been identified by the staff in the review process and in the staff's independent review.

1 Therefore, the staff concludes that there are no impacts related to these issues beyond those
2 discussed in the GEIS. For all of those GEIS issues, the staff concluded that the impacts are
3 SMALL except for collective offsite radiological impacts from the fuel cycle and from HLW and
4 spent fuel disposal, as discussed below, and plant-specific mitigation measures are not likely to
5 be sufficiently beneficial to be warranted.

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

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

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

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

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24 • Offsite radiological impacts (collective effects). Based on information in the GEIS, the
25 Commission found that

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

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

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

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17 • Offsite radiological impacts (spent fuel and HLW disposal). Based on information in the
18 GEIS, the Commission found that

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20 For the high level waste and spent fuel disposal component of the fuel cycle,
21 there are no current regulatory limits for offsite releases of radionuclides for the
22 current candidate repository site. However, if we assume that limits are
23 developed along the lines of the 1995 National Academy of Sciences (NAS)
24 report, "Technical Bases for Yucca Mountain Standards," and that in accordance
25 with the Commission's Waste Confidence Decision, 10 CFR 51.23, a repository
26 can and likely will be developed at some site which will comply with such limits,
27 peak doses to virtually all individuals will be 100 millirem [1 mSv] per year or
28 less. However, while the Commission has reasonable confidence that these
29 assumptions will prove correct, there is considerable uncertainty since the limits
30 are yet to be developed, no repository application has been completed or
31 reviewed, and uncertainty is inherent in the models used to evaluate possible
32 pathways to the human environment. The NAS report indicated that 100 millirem
33 [1 mSv] per year should be considered as a starting point for limits for individual
34 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 [1
2 mSv] per year. The lifetime individual risk from 100 millirem [1 mSv] annual dose
3 limit is about 3×10^{-3} .

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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 possible
17 in the future as more is understood about the performance of the proposed Yucca
18 Mountain repository. Such estimates would involve very great uncertainty, especially
19 with respect to cumulative population doses over thousands of years. The standard
20 proposed by the NAS is a limit on maximum individual dose. The relationship of
21 potential new regulatory requirements, based on the NAS report, and cumulative
22 population impacts has not been determined, although the report articulates the view
23 that protection of individuals will adequately protect the population for a repository at
24 Yucca Mountain. However, EPA's [Environmental Protection Agency] generic
25 repository standards in 40 CFR part 191 generally provide an indication of the order
26 of magnitude of cumulative risk to population that could result from the licensing of a
27 Yucca Mountain repository, assuming the ultimate standards will be within the range
28 of standards now under consideration. The standards in 40 CFR part 191 protect the
29 population by imposing "containment requirements" that limit the cumulative amount
30 of 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 world-wide for a
34 100,000 metric tonne (MTHM) repository.

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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 these
40 impacts would not be sufficiently large to require the NEPA conclusion, for any plant,
41 that the option of extended operation under 10 CFR part 54 should be eliminated.
42 Accordingly, while the Commission has not assigned a single level of significance for

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1 the impacts of spent fuel and high level waste disposal, this issue is considered
2 Category 1.

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

21
22 On February 15, 2002, subsequent to receipt of a recommendation by Secretary Abraham,
23 U.S. Department of Energy, the President recommended the Yucca Mountain site for the
24 development of a repository for the geologic disposal of spent nuclear fuel and high-level
25 nuclear waste.

26
27 This change in regulatory status does not cause the staff to change its position with respect
28 to the impact of spent fuel and HLW disposal. The staff still considers the Category 1
29 classification in the GEIS appropriate.

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31 The staff has not identified any significant new information during its independent review of
32 the McGuire 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 offsite radio-
34 logical impacts related to spent fuel and HLW disposal during the renewal term beyond
35 those discussed in the GEIS.

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37 • Nonradiological impacts of the uranium fuel cycle. Based on information in the GEIS,
38 the Commission found that
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1 The nonradiological impacts of the uranium fuel cycle resulting from the renewal
2 of an operating license for any plant are found to be SMALL.

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

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

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

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

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

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35 The comprehensive regulatory controls and the facilities and procedures that are
36 in place ensure proper handling and storage, as well as negligible doses and
37 exposure to toxic materials for the public and the environment at all plants.
38 License renewal will not increase the small, continuing risk to human health and
39 the environment posed by mixed waste at all plants. The radiological and non-
40 radiological environmental impacts of long-term disposal of mixed waste from
41 any individual plant at licensed sites are small. In addition, the Commission
42 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.

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

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

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

16
17 The staff has not identified any significant new information during its independent review of
18 the McGuire 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 impacts of
20 onsite spent fuel associated with license renewal beyond those discussed in the GEIS.

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

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

27
28 The staff has not identified any significant new information during its independent review of
29 the McGuire ER (Duke 2001), the staff's site visit, the scoping process, or its evaluation of
30 other available information. Therefore, the staff concludes that there are no nonradiological
31 waste impacts during the renewal term beyond those discussed in the GEIS.

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33 • Transportation. Based on information contained in the GEIS, the Commission found
34 that

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36 The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with
37 average burnup for the peak rod to current levels approved by NRC up to
38 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to
39 a single repository, such as Yucca Mountain, Nevada are found to be consistent
40 with the impact values contained in 10 CFR 51.52(c), Summary

1 Table S-4--Environmental Impact of Transportation of Fuel and Waste to and
2 from One Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or
3 burnup conditions are not met, the applicant must submit an assessment of the
4 implications for the environmental impact values reported in Sec. 51.52.
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6 McGuire meets the fuel-enrichment and burnup conditions set forth in Addendum 1 to the
7 GEIS. In recent years, licensees have requested authorization to increase fuel enrichment
8 and fuel burnup. In its letter dated September 22, 1999 (NRC 1999b), the staff approved a
9 maximum burnup rate of 60,000 MWd/MTU. Based on a reassessment of the impacts
10 resulting from the transportation of spent fuel (NRC 2001), the staff's preliminary
11 determination is that the environmental impacts at a burnup rate of 62,000 MWd/MTU are
12 unchanged from those summarized in Table S-4. The staff has not identified any significant
13 new information during its independent review of the McGuire ER (Duke 2001), the staff's
14 site visit, the scoping process, or its evaluation of other available information. Therefore, the
15 staff concludes that there are no impacts of transportation associated with license renewal
16 beyond those discussed in the GEIS.
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18 6.2 References

19
20 10 CFR 51. Code of Federal Regulations, Title 10, *Energy*, Part 51, "Environmental Protection
21 Regulations for Domestic Licensing and Related Regulatory Functions."
22

23 10 CFR 54. Code of Federal Regulations, Title 10, *Energy*, Part 54, "Requirements for
24 Renewal of Operating Licenses for Nuclear Power Plants."
25

26 10 CFR 63. Code of Federal Regulations. Title 10, *Energy*, Part 63, "Disposal of High-Level
27 Radioactive Wastes in a Geologic Repository at Yucca Mountain, Nevada."
28

29 40 CFR 191. Code of Federal Regulations, Title 40, *Protection of Environment*, Part 191,
30 "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear
31 Fuel, High-Level and Transuranic Radioactive Waste."
32

33 40 CFR 197. Code of Federal Regulations. Title 40, *Protection of Environment*, Part 197,
34 "Public Health and Environmental Radiation Protection Standards for Yucca Mountain,
35 Nevada."
36

37 Duke Energy Corporation (Duke). 2001. *Applicant's Environmental Report - Operating*
38 *License Renewal Stage - McGuire Nuclear Station*. Charlotte, North Carolina.
39

40 Energy Policy Act of 1992. 42 USC 10101 et seq.
41

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- 1 U.S. Department of Energy (DOE). 1980. *Final Environmental Impact Statement:*
2 *Management of Commercially Generated Radioactive Waste*. DOE/EIS 00046-G, Vols. 1-3,
3 Washington, D.C.
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- 5 U.S. Nuclear Regulatory Commission (NRC). 1996. *Generic Environmental Impact Statement*
6 *for License Renewal of Nuclear Plants*. NUREG-1437, Volumes 1 and 2, Washington, D.C.
7
- 8 U.S. Nuclear Regulatory Commission (NRC). 1999a. *Generic Environmental Impact*
9 *Statement for License Renewal of Nuclear Plants, Main Report*, "Section 6.3 - Transportation,
10 Table 9.1 Summary of findings on NEPA issues for license renewal of nuclear power plants,
11 Final Report." NUREG-1437, Volume 1, Addendum 1, Washington, D.C.
12
- 13 U.S. Nuclear Regulatory Commission (NRC). 1999b. Letter from F. Rinaldi, NRC, to
14 H.B. Barron, Vice President, McGuire Site, Duke Energy Corporation. Subject: McGuire
15 Nuclear Station, Units 1 and 2 Re: ISSUANCE OF AMENDMENTS.
16
- 17 U.S. Nuclear Regulatory Commission (NRC). 2001. *Environmental Effects of Extending Fuel*
18 *Burnup Above 60 GWd/MTU*, NUREG/CR-6703, Washington D.C.