[7590-01-P]

NUCLEAR REGULATORY COMMISSION

10 CFR Part 51

RIN 3150-AG05

Changes to Requirements for Environmental Review for Renewal of Nuclear Power Plant Operating Licenses

AGENCY: Nuclear Regulatory Commission.

ACTION: Final Rule.

SUMMARY: The Nuclear Regulatory Commission (NRC) is amending its regulations on the environmental information required in applications to renew the operating licenses of nuclear power plants. This amendment expands the generic findings about the environmental impacts due to transportation of fuel and waste to and from a single nuclear power plant. Specifically, this amendment adds to findings concerning the cumulative environmental impacts of convergence of spent fuel shipments on a single destination, rather than multiple destinations, and the environmental impact of transportation of higher enriched and higher burnup spent fuel during the renewal term. The effect of this amendment is to permit the NRC to make a generic finding regarding the impacts so that an analysis of these impacts will not have to be repeated for each individual license renewal application. This action reduces the regulatory burden on applicants for license renewal by replacing individual plant operating license renewal reviews with a generic review of these topics. Also, this amendment incorporates rule language to be

consistent with the findings in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (May 1996), which addresses local traffic impacts attributable to continued operation of the nuclear power plant during the license renewal term.

In analyzing the environmental impact of transporting spent fuel and waste in the vicinity of a single repository, the NRC evaluated the impact in the vicinity of Yucca Mountain and specifically the impacts in the vicinity of Las Vegas, NV. The NRC elected to evaluate the impacts in the vicinity of Yucca Mountain because Yucca Mountain is the only location currently being evaluated for a repository under the Nuclear Waste Policy Act. The NRC's analysis of the impacts in the vicinity of Yucca Mountain in this instance does not prejudge the eventual licensing of Yucca Mountain as a repository. Rather, it reflects NRC's existing license renewal process by reflecting current repository activities and policies. If an application is filed by the Department of Energy (DOE), the licensing process for a repository in the vicinity of Yucca Mountain will constitute an entirely separate regulatory action from the proposed final rule. Furthermore, if, based on technical or national policy considerations, some site other than Yucca Mountain is selected in the future for study as a repository, the NRC will evaluate the applicability of the generic environmental impact statement for the license renewal process to other proposed repository sites.

EFFECTIVE DATE: ( 30 days after NRC publication of the final rule in the Federal Register).

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SUPPLEMENTARY INFORMATION:

## Background

On June 5, 1996 (61 FR 28467), the Commission published in the *Federal Register* a final rule amending its environmental protection regulations in 10 CFR Part 51 to improve the efficiency of the process of environmental review for applicants seeking to renew a nuclear power plant operating license for up to an additional 20 years. The rulemaking was based on the analyses reported in the final report of NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS) (May 1996). The rulemaking drew on the considerable experience of operating nuclear power plants in order to generically assess many of the environmental impacts, so that repetitive reviews of issues whose impacts are well understood could be minimized. In the statement of considerations accompanying the final rule, the Commission stated that before the final rule became effective, the Commission was seeking comments on the treatment of low-level waste (LLW) storage and disposal impacts, the cumulative radiological effects from the uranium fuel cycle, and the effects from the disposal of high-level waste (HLW) and spent fuel. In response to the June 5, 1996, final rule, a number of commentors stated that the requirements for the review of transportation of HLW in the rule were unclear with respect to (1) the use and legal status of 10 CFR 51.52, 'Table S-4--Environmental Impact of Transportation of Fuel and Waste To and From One Light-Water-

Cooled Nuclear Power Reactor,' in plant-specific license renewal reviews; (2) the conditions that must be met before an applicant may adopt Table S-4; and (3) the extent to which the generic effects of transporting spent fuel to a HLW repository should be considered in a plant-specific license renewal review.

After considering the comments received on the rule, the Commission republished the rule in the *Federal Register* on December 18, 1996 (61 FR 66537). The rule at 10 CFR 51.53(c)(3)(ii)(M) continued to require, "The environmental effects of transportation of fuel and waste shall be reviewed in accordance with 10 CFR 51.52." However, in response to comments received, the following requirement was added:

> The review of impacts shall also discuss the generic and cumulative impacts associated with transportation operation in the vicinity of a high-level waste repository site. The candidate site at Yucca Mountain should be used as a representative site for the purpose of impact analysis as long as that site is under consideration for licensing.

Also in response to the comments, the Commission stated that:

> As part of its effort to develop regulatory guidance for this rule, the Commission will consider whether further changes to the rule are desirable to generically address: (1) the issue of cumulative transportation impacts and (2) the implications that the use of higher burnup fuel have for the conclusions in Table S-4. After consideration of these issues, the Commission will determine whether the issue of transportation impacts should be changed to Category 1.[1]

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[1] In NUREG-1437 and in the rule, Category 1 issues are those environmental issues for which the analysis and findings have been determined to be applicable to all nuclear power plants or to plants with specific types of cooling systems or other common plant or site characteristics. Absent new information that significantly changes the finding, these generic findings may be adopted in plant license renewal reviews. Category 2 issues are those that analysis has shown that one or more of the criteria of Category 1 cannot be met and, therefore, additional plant-specific review is required.

In SECY-97-279, titled "Generic and Cumulative Environmental Impacts of Transportation of High-Level Waste (HLW) in the Vicinity of a HLW Repository," dated December 3, 1997, the NRC staff informed the Commission that it was the staff's preliminary view that its supplemental analyses of the generic and cumulative impacts of the transportation of HLW and of the implications of higher burnup fuel for transportation impacts support a reasonable technical and legal determination that transportation of HLW is a Category 1 issue and may be generically adopted in a license renewal application. In a Staff Requirements Memorandum (SRM) dated January 13, 1998, the Commission directed the NRC staff to proceed with rulemaking to amend 10 CFR 51.53(c)(3)(ii)(M) to categorize the impacts of transportation of HLW as a Category 1 issue. In a memorandum dated July 1, 1998, the NRC staff informed the Commission of its plans for amending 10 CFR Part 51.

In that memorandum the NRC staff also proposed, as an administrative amendment, to address local traffic impacts attributable to continued operation of the plant during the license renewal term. This issue was identified as a Category 2 issue in NUREG-1437, Section 4.7.3.2 and the overall issue of transportation was designated as Category 2 in the rule (see 10 CFR Part 51, Subpart A, Appendix B, Table B-1, "Public Services, Transportation"). However, the specific issue of local transportation impacts during the renewal term was inadvertently omitted from 10 CFR 51.53(c)(3)(ii)(J) and its inclusion in Table B-1 is not explicitly stated. The basic transportation concern identified in NUREG-1437 is the potential adverse contribution of a larger plant work force to traffic flow in the vicinity of the power plant.

To address the above issues, the Commission issued proposed amendments to 10 CFR Part 51 on February 26, 1999 (64 FR 9884), and provided a public comment period of 60 days. The supplemental analysis, which supports this rule, is reported in NUREG-1437, Vol. 1, Addendum 1, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants:

Main Report Section 6.3—'Transportation,' Table 9.1 'Summary of findings on NEPA issues for license renewal of nuclear power plants,' Final Report." The draft for comment was published in February 1999 and the final report is expected to be published in August 1999.

The public comment period closed on April 27, 1999. Extensive public comments were received, including concerns by some commentors about the length of the comment period. Although the NRC did not extend the public comment period, the NRC staff did consider comments dated as late as June 25, 1999, and received as late as early July 1999. The NRC staff's responses to the comments are provided below. As explained in more detail below, the comments have led to both the use of more conservative assumptions in the analysis reported in Addendum 1 and a fuller explanation of the analysis. The regulatory text has been edited for clarification but there is no material change from the proposed rule.

## Discussion

### Relationship of this Rulemaking to Repository Licensing

The NRC is promulgating this rule in order to meet its National Environmental Policy Act (NEPA) responsibilities to consider the environmental impact of its license renewal decisions. In 1996 (61 FR 28467 and 61 FR 66537), the NRC published a rule that codified conclusions regarding the environmental impacts of license renewal (see 10 CFR Part 51, Appendix B to Subpart A). The amendment issued in the present Notice constitutes a relatively small addition to those previously published conclusions. In particular, as discussed above, this amendment ensures among other things that the NRC has considered the likely impacts of transporting spent fuel generated during the license renewal period over a single transportation corridor in the vicinity of a waste repository.

Because the Yucca Mountain site in Nevada currently represents the most likely candidate for a repository, the NRC has used that site as a representative site for its analysis in lieu of considering transportation to an unspecified, hypothetical site. The decision to use Yucca Mountain for the purposes of the current analysis, however, in no way increases or decreases the likelihood that Yucca Mountain will in fact be licensed as a repository for the nation's high level waste. Instead, it simply provides the NRC with the information it needs to gauge the potential impacts from licensing nuclear power plants for an additional 20 year period. If an application is filed by the Department of Energy (DOE), the licensing process for a repository in the vicinity of Yucca Mountain will constitute an entirely separate regulatory action from this final rule. Any NRC decision on a repository license will be accompanied by separate safety and environmental analyses that will include a thorough examination of the environmental impacts stemming from the construction and operation of the repository. If the analyses prepared for the repository licensing decision yield results that are inconsistent with those reached in the present notice, it is likely that the NRC will have to amend the conclusions in Table B-1 of Part 51 to conform with the new findings.

Amendments to the Rule

The current regulations require each applicant for license renewal to review the environmental effects of transportation of fuel and waste in accordance with 10 CFR 51.52, and to discuss the generic and cumulative impacts associated with transportation in the vicinity of the candidate HLW repository site at Yucca Mountain (see 10 CFR 51.53(c)(3)(ii)(M)). The NRC staff has performed a generic assessment of these cumulative impacts, which is reported in NUREG-1437, Vol. 1, Addendum 1. The analysis focused on Clark County, Nevada

because it represents the area with the largest population in the vicinity of the potential repository. The final rule codifies the conclusions of this analysis in 10 CFR Part 51. In addition, the NRC staff has generically considered the potential impacts of transporting higher enriched and higher burnup fuel than is currently covered in 10 CFR 51.52 and is codifying these findings with this final rule. That assessment concludes that the impacts of transporting fuel and waste generated during the license renewal period are small and are consistent with the impacts of the values in Table S-4 of the Commission's regulations (§ 51.52). Under the Commission's regulations for the environmental review of license renewal decisions (see 10 CFR Part 51, Subpart A, Appendix B), the Commission may reach a conclusion of "small" impact for a particular issue if the:

> ... environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small as the term is used in this table.

The final rule amends the issue of transportation of fuel and waste from Category 2 to Category 1. In order to reach this Category 1 conclusion on an issue and thus not require site specific analysis of the issue pursuant to §51.53(c)(3)(i), the Commission has made the following findings in accordance with the definitions set out in 10 CFR Part 51, Subpart A, Appendix B:

(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, in this case "small" has been assigned to the impacts (except for collective off site radiological impacts from the fuel cycle and from high level waste and spent fuel disposal[2]); and

(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.

As a result of this Category 1 finding, neither applicants nor the NRC staff will need to prepare a separate analysis of the issue for individual license renewal applications as long as no new and significant information exists. The analysis in NUREG-1437, Vol. 1, Addendum 1 which forms the technical basis for the rulemaking, relies on a series of conservative assumptions. As such, the results of the analysis overestimate the environmental impacts of spent fuel shipments converging on one location, such as Yucca Mountain. Although the NRC staff has assessed these impacts as if Yucca Mountain would be the only HLW repository, the NRC staff believes that the impacts calculated for Yucca Mountain bound the impacts that would be experienced for a site other than Yucca Mountain. It is unlikely that any other repository site would have an exposed population greater than that assumed for Las Vegas and it is unlikely that spent-fuel shipments from all points of origin converge on and are transported through one metropolitan area. If an alternative to a high level waste repository at Yucca Mountain is considered in the future, the NRC may need to determine whether such an alternative includes new and significant information that may change the regulatory outcome.

In addition to considering the cumulative impacts of transportation in the vicinity of a repository, the NRC also considered whether use of higher burnup or higher enriched fuel that

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[2]This exception only applies to the two entries in Table B-1 labeled "Offsite radiological impacts (collective effects)" and "Offsite radiological impacts (spent fuel and high level waste disposal).

is shipped to a repository results in impacts consistent with the NRC regulations (§51.52,'Table S-4--Environmental Impact of Transportation of Fuel and Waste To and From One Light-Water-Cooled Nuclear Power Reactor' ). The environmental consequences of incremental increases in the burnup of fuel and the associated use of higher enrichment fuel are discussed in Section 6.2.3 of NUREG-1437. Section 6.2.3 addresses the sensitivity of the data presented in Table S-3 and Table S-4 to the growing use of higher enriched fuel and higher fuel burnup. Table S-3 summarizes natural resource use and effluents to the environment for the uranium fuel cycle, from mining to ultimate disposal of spent fuel. The discussion of the implications for the environmental impact data reported in Table S-4 was not repeated or referenced in Section 6.3, which addresses the incremental impacts of license renewal on the transportation of fuel and waste to and from nuclear power plants. Addendum 1 and this final rule clarify the NRC findings on the sensitivity of values in Table S-4 to the use of higher enrichment fuel and higher burnup fuel presently in use. The analysis concludes that shipment of higher enriched or higher burnup fuel results in impacts consistent with the impacts in Table S-4, 10 CFR 51.52. It should be noted that cask designs used to transport or store higher enriched fuel and higher burnup fuel require specific NRC review and approval.

In the course of preparing the final rule, several non-substantive changes to the wording and organization of the regulatory text were made in order to maintain the rule's internal consistency. First, the content of the proposed language in §51.53(c)(3)(ii)(J) regarding local transportation impacts in the vicinity of the licensed plant was also placed into Table B-1 under "Public Services, Transportation" under the Socioeconomics section of the Table. Similarly, the proposed language in §51.53(c)(3)(ii)(M) has not been included in the final rule because the matters covered by §51.53(c)(3)(ii) only apply to Category 2 issues and, as such, the inclusion of matters related to a Category 1 issue in that section would not have been appropriate.

Instead, the content of the language that had been proposed for §51.53(c)(3)(ii)(M) is adequately covered by the amended entry in Table B-1 itself under the issue of "Transportation" in the Uranium Fuel Cycle and Waste Management section.

Response to Comments

Thirty-one comment letters were received on the proposed rule from power reactor licensees, State and local Government agencies, the nuclear power industry and its legal affiliations, a public interest group, and an individual. Most of the comments were from the State of Nevada, Clark and Nye Counties, Nevada, and local government entities in Nevada. These comments focused on the NRC not involving Nevada in scoping and designing the study in Addendum 1 and on perceived deficiencies in the scope and thoroughness of the analysis in the Addendum. The State of Utah also submitted extensive comments that focused on concerns with the scope and thoroughness of the supporting analysis in Addendum 1, including the lack of consideration of the proposed Private Fuel Storage Facility at Skull Valley, Utah. Industry comments focused on clarifications in the rule language.

The written comments have been summarized and grouped into issue categories. As a result of the NRC staff's review of all written comments, some modifications and clarifications have been incorporated into Addendum 1—notably, the use of more conservative assumptions in the analyses and a fuller explanation of those analyses. In addition, the rule language has been edited for clarification. The NRC staff has also prepared responses, given below, to the issues raised by the commentors.

Issue 1—Public Notice

Comment: The titles of the notices published in the *Federal Register* were inaccurate and misleading because they do not clearly indicate the subject matter of the proposed rule and Addendum 1 that addresses transportation of spent nuclear fuel.

Response: The NRC believes that the titles properly reflect the regulatory action being taken. As required by NRC regulations,[3] a notice of the proposed rule and a Notice of Availability of Addendum 1 were published in the *Federal Register* (64 FR 9884 and 64 FR 9889, February 26, 1999). While the notice's title did not include the specific term "transportation," the titles define the subject matter of the regulation to be affected; the title of the proposed rule is "Changes to Requirements for Environmental Review for Renewal of Nuclear Power Plant Operating Licenses." The title of the Notice of Availability is "Changes to Requirements for Environmental Review for Renewal of Nuclear Power Plant Operating Licenses, Availability of Supplemental Environmental Impact Statement." Addendum 1 supplements specific sections of NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (May 1996). This limited function is indicated by the title of Addendum 1, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Main Report Section 6.3—`Transportation,' Table 9.1 `Summary of findings on NEPA issues for license renewal of nuclear power plants,' Draft Report for Comment.*

The rule change and the supporting Addendum 1 affect only the plant-specific environmental analysis required to be submitted in the Environmental Report of an applicant for the renewal of a nuclear power plant operating license and the plant-specific supplemental

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[3]10 CFR 2.804, "Notice of proposed rulemaking" and 10 CFR 51.117, "Draft environmental impact statement–notice of availability."

environmental impact statement prepared by the NRC. Even though the analysis in Addendum 1 focuses on spent-fuel shipments converging on the proposed repository at Yucca Mountain, Nevada, that analysis and the resulting rule affect only the review requirements for renewal of an individual nuclear power plant operating license. It is not intended that Addendum 1 or the revised rule support any other regulatory decision by the NRC.

Issue 2—Communications

Comment: NRC failed to consult with Nevada State agencies, Nevada local governments, and with Nevada Indian Tribes.

Response: As discussed above, a variety of organizations and government agencies submitted substantive comments in response to the proposed rule. The NRC has considered these comments and, in many cases, altered its analysis as a result of this input. Prior to issuance of the proposed rule for comment, however, the NRC did not seek any pre-publication input from Nevada state agencies, Nevada local Governments, and Nevada Indian Tribes for the following reasons. First, the rule involves a narrow aspect of the environmental review of individual nuclear power plant license renewal decisions, which is a regulatory decision completely separate from the regulatory requirements that will guide the NRC licensing review of a HLW repository and from the decision process leading to a DOE site recommendation on Yucca Mountain, Nevada, the site DOE currently has under study. This rule amends the December 18, 1996, rule with respect to two questions not adequately answered:

1. Are the current environmental impact values in Table S-4, based on several destinations, still reasonable to incorporate in a license renewal review that assumes a single destination for spent fuel at Yucca Mountain, Nevada?
2. Are the current environmental impact values in Table S-4 (which are based on fuel enriched to no greater than 4 percent, the average level of irradiation of spent fuel not exceeding 33,000 MWd/MTU, and shipment no less than 90 days after discharge from the reactor) still reasonable to incorporate in a license renewal review of plants that may use fuel enriched up to 5 percent and potentially ship spent fuel with a burnup of up to 62,000 MWd/MTU?

The amendment has no direct regulatory impact on any entity within Nevada. The selection of Yucca Mountain for the generic evaluation of transportation impacts was made because that site is currently the only one under consideration for a high-level-waste (HLW) repository. Before HLW is actually transported to Yucca Mountain, Nevada, the State, local Governments, Indian Tribes, and the public have the opportunity to provide input on site-specific transportation impacts by commenting on DOE's draft EIS for the proposed repository at the Yucca Mountain site, which was made available for a 180-day comment period beginning on August 13, 1999 (http://www.ynp.gov).

Also, the need for and scope of the current rule amendment were identified within the context of a preceding rulemaking that specified the plant-specific content of the environmental review of applications for the renewal of individual nuclear power plant operating licenses. The previous final rule was published in the *Federal Register* first on June 5, 1996 (61 FR 28467), and again with minor modifications on December 18, 1996 (61 FR 66537). The Commission stated in the December *Federal Register* notice, "as part of its efforts to develop regulatory guidance for this rule, the Commission will consider whether further changes to the rule are

desirable to generically address: (1) The issue of cumulative transportation impacts and (2) the implications that the use of higher burn-up fuel have for the conclusions in Table S-4. After consideration of these issues, the Commission will determine whether the issue of transportation impacts should be changed to Category 1."

Issue 3—Transportation Analysis

Comment: NRC failed to consult relevant Yucca Mountain transportation risk and impact studies.

Response: The publications cited by commentors have been reviewed for information that may be of direct use within the limited focus and purpose of the current rule. Most of the information in these documents was found to be potentially more relevant to a detailed site-specific review of Yucca Mountain than to the generic analysis for this rule. That information has been brought to the attention of those organizational units within the NRC responsible for activities relating to DOE's study on the Yucca Mountain site so they can appropriately consider the information in any future prelicensing activities involving Yucca Mountain. Specific to the current rule, the demographic data used as inputs to the RADTRAN computer code, which was used to generate the impact analysis in Addendum 1 were more current than data used in many of the studies cited by the commentors.

Comment: NRC failed to consult the full spectrum of transportation mode and route scenarios.

Response: The purpose of this rule and associated analysis is to reach conclusions regarding the likely environmental impact of license renewal. As noted above, this amendment is an addition to generic assessments of license renewal environmental impacts already codified in the Commission's regulations at 10 CFR Part 51, Subpart A, Appendix B. It is not an environmental impact statement for a repository at Yucca Mountain for which DOE is responsible and, as such, does not delve into the expansive range of different transportation modes and route scenarios that would be considered in the context of a decision on Yucca Mountain as the possible site for the facility itself. Instead, the NRC has sought to determine a conservative estimate of the likely impacts from transporting fuel and waste generated, during the license renewal term, in the vicinity of a potential repository. In doing so, the NRC considered only those transportation modes and route scenarios that would likely result in the greatest impacts. For the proposed rule, the NRC staff—in consultation with the DOE staff—determined that truck shipments through densely populated areas of Clark County, Nevada, would have the highest potential impacts among the alternative transportation scenarios and modes that would receive serious consideration in decisions relating to the suitability of the site undergoing study for a repository at Yucca Mountain. The NRC continues to believe that using these route scenarios and modes to generate conservative estimates is reasonable for the purpose of this rulemaking.

Comment: There was insufficient consideration of routine transportation radiological risks due to use of an average dose rate lower than the regulatory limit.

Response: The RADTRAN analysis reported in the final Addendum 1 has been modified to use the most conservative assumption that the radiation levels for all shipments are at the

regulatory limit of 0.1 mSv/hour [10 mrem/hour] at 2 m [6.6 ft] from the shipment vehicle surface. As noted in Section 2.2.3 of Addendum 1, this assumption is sufficiently conservative to bound the analysis of routine transportation radiological risk and allow a reasonable assessment of that risk. Actual average radiation levels and associated doses would be much lower because shipments must be designed so that the regulatory limits are not exceeded. The use of the regulatory limits in the revised analysis results in higher dose estimates for incident-free transportation. However, these revised estimates are still small as defined in 10 CFR Part 51, Subpart A, Appendix B. Consequently, the conclusion regarding the radiological risks of routine transportation remains valid.

Comment: There was insufficient consideration of routine transportation radiological risks to members of the public residing, working, or institutionally confined at locations near shipping routes.

Response: The analysis encompasses members of the public residing, working, or institutionally confined at locations near shipping routes by assuming that the resident population along the transportation routes is exposed to every shipment. The text of Sect. 2.3 of Addendum 1, has been revised to state this assumption and its effects on the revised analysis more clearly. In addition, more conservative assumptions of truck speed have been used in the revised RADTRAN analysis thus extending the exposure time to individuals along the transportation route. These assumptions further ensure that members of the public cited by the commentors would be encompassed by the dose and risk assessments. As expected, the use of these more conservative assumptions leads to higher estimates of radiation dose to the

public. However, these revised dose estimates remain well below regulatory limits for members of the public and small compared to natural background and other sources of radiation exposure.

Several commentors indicated that Addendum 1 should focus on unique and location-specific circumstances of the transportation routes and population centers. However, the analysis in Addendum 1 is generic and was designed to support only the limited scope of the decision regarding this rule change. The NRC believes that the routes chosen represent a conservative analysis due to the higher number of people who live along these routes. Because the purpose of this rule is to provide a generic analysis for the limited purpose of determining the likely impact of transportation during the license renewal term, the large analytical effort required for the identification of specific population locations and traffic circumstances is not warranted within the context of the current rule. Although the comments raise valid issues, those concerns should be resolved within the context of studying, and making decisions concerning, the suitability of the candidate repository site at Yucca Mountain and regulatory requirements governing transportation of spent fuel.

Comment: There was insufficient consideration of radiological risks resulting from traffic gridlock incidents.

Response: Traffic gridlock incidents are not specifically analyzed in NUREG-1437 because of the limited scope and generic nature of the analysis (see response to comment on consideration of risks to members of the public, above). However, the revised RADTRAN analysis conservatively includes approximately two hours of stationary time in Clark County

(during a 100 to 140 mile trip depending upon the route) for each truck shipment; and traffic gridlock could be one of the reasons for the truck being stationary.

To a limited extent, the incorporation of more conservative assumptions of truck speed into the revised RADTRAN analysis compensates for an analysis of traffic gridlock by allowing for increased exposure time at any given point during transport. As noted earlier, these revised assumptions lead to higher but still small dose estimates. In addition, the routes used in the analysis in Addendum 1 were deliberately chosen to maximize estimated dose. Actual routes would be less likely to have significant areas where traffic gridlock occurs. The selection of the actual routes, for example, would comply with the U.S. Department of Transportation's Federal Highway Administration regulations (49 CFR Part 397, Subpart D) that require minimizing the time in transit (i.e., avoiding periods of great traffic congestion) for routing radioactive shipments.

Comment: There was insufficient consideration of routine transportation radiological risks to vehicle inspectors and escorts.

Response: The RADTRAN analysis in the revised Addendum 1 uses the regulatory dose rate limit of .02 mSv/hour (2 mrem/hour) for the vehicle crew. In addition, a discussion of potential doses to escorts has been included in Addendum 1, Section 2.2.3. In the analysis, both the escorts and drivers are assumed to be exposed to the regulatory limit, although the dose to the escorts would realistically be less than that to the drivers. Even with these more conservative assumptions, the estimated dose and risk to the crew are small and below regulatory limits.

The risk to vehicle inspectors would be encompassed by the addition of stationary time for the transport truck in Clark County (see response to comment about traffic gridlock, above). Again, the estimated dose and risk are increased by the use of more conservative assumptions; but they remain small and below regulatory limits.

Comment: There was insufficient consideration of severe transportation accident risks.

Response: The Commission has evaluated the potential radiological hazards of severe transportation accidents involving truck and rail spent nuclear fuel (SNF) shipments (NUREG/CR-4829, " Shipping Container Response to Severe Highway and Railway Accident Conditions" February 1987, commonly referred to as the modal study). The modal study evaluated SNF shipping casks certified to NRC standards against thermal and mechanical forces generated in actual truck and rail accidents. This evaluation included an assessment of cask performance for a number of severe transportation accidents, including the Caldecott Tunnel fire. The modal study concluded that there would be no release in 994 of 1,000 real accidents, and that a substantially lower fraction of accidents could result in any significant release. These results when combined with the probability of a severe accident involving a shipment of SNF, demonstrate that the overall risk associated with severe accidents of SNF shipping casks is very low. The results of the modal study were factored into the analysis for this rulemaking, as an input to the RADTRAN computer code. Additional analyses were performed to address the possible impacts of accidents involving higher burnup fuel.

The consequences associated with an individual SNF shipment have an upper bound, based on the amount of material in the package, the availability of mechanisms to disperse the radioactive contents, the locations and number of receptors, and post-event intervention than

would occur. Further, this upper bound in transit might reasonably be expected to be less than that at the origin or destination points (where more SNF would be stored), and some events themselves might be expected to have greater consequences than the damage they cause to the SNF cask. The NRC recognizes that there are some conceivable events (not necessarily traditional 'transportation accidents'), that might be hypothesized to occur to a SNF cask while in transport. Even though these events have an extremely low probability of occurring, they might result in high consequences if they were to occur. The NRC considers these events to be remote and speculative and thus, does not call for detailed consideration. Because the NRC traditionally considers risk to be the product of the probability of an event and its resultant consequences, events with such low probability of occurring have a negligible contribution to the overall risk. In addition, as the probabilities of the events become very low, the value of insights to be gained, for use in regulatory decisions, is not apparent.

Comment: The study underestimates Clark County's residential population and growth rate. In addition, the study does not account for the large nonresident population, resulting in underestimates of risk and impacts.

Response: In keeping with the generic nature and limited intent of the analysis, the original analysis used best available data and best estimates of existing population and population growth rates. In response to commentors' concerns and to reflect the potentially large population growth rate of Clark County, the NRC staff has incorporated higher population estimates into the analysis to provide conservative (higher than best estimate) assessments of potential impacts. However, as indicated by the comment, the task of estimating the impacts on the area population is more complex than assuming a population growth rate. Both the rate

of growth of the population and changes in location of the population within the county are important. As stated in Addendum 1, populations within a half mile of the transportation route are the most affected by the transportation activities. Therefore, in order to ensure that the size of the affected population is conservative, the NRC staff's analysis not only increases over time the existing population densities along the assumed transportation routes, but also forecasts increased residential, business, and transient/tourist populations in the areas of likely development.

Issue 4—Cumulative Impacts

Comment: NRC failed to consider cumulative impacts of all spent fuel, HLW, and low-level-waste shipments.

Response: Table S-4 shows the environmental impacts of transportation of fuel and waste directly attributable to one nuclear power plant. The current rulemaking was narrowly focused on the question of whether the impact values given in Table S-4 would be different with spent fuel shipments converging on one destination, Yucca Mountain -- the candidate site under study by DOE for a repository, rather than several destinations. Table S-4 does not consider non-commercial power reactor shipments of fuel and waste. Nevertheless, a discussion of the cumulative impacts of transporting spent fuel, HLW, and low-level waste through southern Nevada has been added to Addendum 1 (Section 2.4). To estimate the potential cumulative effects of DOE shipments of LLW to the Nevada Test Site as well as shipments of HLW to a possible repository, the NRC staff used information published in DOE's Waste Management Programmatic EIS (DOE/EIS-0200-F) May 1997. To ensure that

cumulative impacts are not underestimated, the NRC staff selected alternatives in the EIS that led to the highest numbers of shipments to the Nevada Test Site and Yucca Mountain. The results of the analysis indicate that the cumulative doses and expected cancer fatalities resulting from the civilian SNF and the DOE shipments are small compared to the risk of cancer from other causes.

Comment: Commentors stated that cumulative impacts along the Wasatch Front must be considered.

Response: The State of Utah maintains that a study similar to the one conducted for Las Vegas and Clark County must be conducted for the cumulative impacts along the Wasatch Front that would originate from the proposed Private Fuel Storage Facility to be located at Skull Valley, Utah. Such an analysis is beyond the scope of this generic rulemaking because the Commission directed that cumulative impacts attributed to transportation be analyzed only in the vicinity of Yucca Mountain. However, the NRC is currently reviewing a site-specific application for construction and operation of the proposed Private Fuel Storage Facility at Skull Valley in a separate regulatory action. A site-specific study of the cumulative impacts of transportation is part of that review. The study will be reported in a draft Environmental Impact Statement to be published for public comment. Its availability will be noticed in the *Federal Register.*

Issue 5—Legal Requirements

Comment: NRC failed to conduct a legally sufficient risk assessment. Use of a model such as RADTRAN is not in and of itself sufficient to meet the requirements of the National Environmental Policy Act. The NRC must consider consequences of low-probability, high-consequence accidents not included in RADTRAN, including unique local conditions, unforeseen events, sabotage, and human error in cask design. The NRC should adopt the comprehensive risk assessment approach for SNF and HLW transportation described in Golding and White, *Guidelines on the Scope, Content, and Use of Comprehensive Risk Assessment in the Management of High-Level Nuclear Waste Transportation* (1990).

Response: See the response above regarding consideration of severe accident risk (low probability, high consequence accidents) during transportation.

The NRC's regulatory program will continue to ensure that the risk of severe transportation accidents are minimized. Physical security for spent fuel transportation is regulated under 10 CFR 73.37. The regulatory philosophy is designed to reduce the threat potential to shipments and to facilitate response to incidents and recovery of packages that might be diverted in transit. Although the analysis supporting the current rule does not account for the potential for human error, activities related to the design, fabrication, maintenance, and use of transportation packages are conducted under an NRC-approved Quality Assurance Program. This helps to provide consistency in performance and helps reduce the incidence of human error. While a location-specific transportation risk assessment is included in the DOE EIS for the decisions relating to a possible Yucca Mountain repository, the NRC staff believes that the analysis conducted for this rulemaking provides an adequate consideration of the impacts from license renewal. Further, through its regulatory, licensing, and certification functions, the NRC has tried to ensure that transportation of SNF is performed safely with

minimum risk to the public, and that vehicle crashes while transporting SNF do not result in severe accidents. Similarly, DOE is expected to ensure that the routes and procedures chosen for SNF transport to the repository provide ample protection of the public health and safety and the NRC reviews and approves the selected routes.

The analysis in Addendum 1 shows that even with conservative assumptions, the cumulative radiological and non-radiological accident risks of SNF transport in Clark County are small. However, there are a number of opportunities to further reduce human health impacts. These include transporting SNF by rail rather than by truck. This would reduce human health effects by reducing the number of shipments and the likelihood of accidents. In addition, shipping SNF via the proposed beltway would reduce health impacts compared to shipping via the current interstate highway system. The implementation of such mitigative measures must await future decisions that fall well outside of the scope of this rulemaking. In addition, for the purposes of individual license renewal rule decisions, no plant specific mitigation measures were found appropriate for addressing the impacts identified in the Addendum. The NRC staff notes that DOE addresses transportation impacts, mitigation measures, and alternative transportation modes in its EIS for the proposed repository at Yucca Mountain.

Issue 6—Socioeconomics

Comment: NRC failed to consider socioeconomic impacts.

Response: Several commentors raised an issue of public perception of risk of waste shipments and its effect on tourism and property values. Under the National Environmental Policy Act (NEPA), the NRC is obligated to consider the effects on the physical environment

that could result from the proposed action. Effects that are not directly related to the physical environment must have a reasonably close causal relationship to a change in the physical environment. The Supreme Court ruling in Metropolitan Edison Co. v. People Against Nuclear Energy, 460 U.S. 766 (1983) has narrowly circumscribed, if not entirely eliminated, an agency's NEPA obligation to consider impacts arising solely from the public's perception that an agency's action has created risks of accidents. Accordingly, it is not necessary to consider the impacts on tourism and property values from the public's perception of risk.

The socioeconomic impacts of plant refurbishment and continued operation during the renewal period are discussed in the plant-specific supplement to the GEIS for each individual license renewal applicant. The NRC recognizes that there will likely be increased costs in the unlikely event of an accident. However, for the majority of transportation accidents that may occur, the associated costs are small. For the most severe accidents analyzed by the RADTRAN computer code, the costs could be substantial. Given the low probability of such accidents, the socioeconomic impacts of transportation of SNF do not alter the Commission's conclusions regarding the impacts of this issue.

Issue 7—Higher Burnup Fuel

Comment: There was insufficient consideration of extended fuel burnup issues.

Response: Section 3 of Addendum 1 addresses the issues associated with extended fuel burnup in detail. The NRC staff's analysis of higher burnup fuel examined the issues of radiation doses due to higher dose rates during shipment, higher radiation doses in the event of

transportation accidents, and the potential for a criticality in the very unlikely event that high burnup fuel geometry is altered during a transportation accident.

The analysis done by the NRC staff concluded that higher burnup fuel would likely cause higher dose rates during transportation and that dose rates following transportation accidents with radiological releases would also increase, all other things being equal. However, despite the increased dose rates the potential impacts on the transport crews and the affected members of the public would still be acceptably small. The analysis of the potential for criticality following a change in fuel geometry as the result of a transportation accident determined that such an event was not a concern.

Issue 8—Environmental Justice

Comment: NRC failed to consider Environmental Justice.

Response: The analysis suggests that the routes through downtown Las Vegas, Nevada may run through areas containing a higher proportion of low-income and minority groups than the beltway routes. However, as discussed in Sections 2.3 and 2.4 Addendum, the radiological and nonradiological impacts of transportation of SNF are small. In addition, these small impacts are dispersed throughout the entire routes and do not appear to fall disproportionately in any one area. Based on the analysis performed the NRC staff concludes the overall impacts of transportation of SNF will not likely be disproportionately high or adverse for any minority or low-income population.

Issue 9—Regulatory Text

Comment: Several suggestions for clarifying the regulatory text were offered.

Response: The rule has been revised to make it clear that the environmental impact values in Table S-4 (10 CFR 51.52) may be used to account for the environmental effects of transportation of fuel and waste to and from a nuclear power plant at a repository such as Yucca Mountain, Nevada, which is under consideration as a HLW repository. If, in the future, Yucca Mountain is removed from consideration as a HLW repository, the Commission will evaluate whether the generic analysis performed for the current rule is applicable to other sites that are considered. If fuel enrichment greater than 5 percent Uranium-235 and fuel burnup of greater than 62,000 MWd/MTU are approved by the Commission, the Commission will consider a rulemaking to assess the continuing generic applicability of Table S-4 to environmental reviews for license renewal.

Comment: The addition to the rule of local transportation impacts associated with continued operation of a plant during the license renewal period needs further clarification in the rule language and in the Supplementary Information.

Response: The rule was revised to clarify that the issue of "Public services, Transportation" in Table B-1 of Appendix B to Subpart A of 10 CFR Part 51 involves the contribution of highway traffic directly attributable to refurbishment and continued operation of a plant during the license renewal period to changes in the service levels of highways in the vicinity of the plant. The majority of traffic directly attributable to a plant is commuting plant workers.

Comment: Paragraph (M) of 10 CFR 51.53(c)(3)(ii) should be deleted.

Response: The rule language has been amended and Paragraph (M) has been deleted. This change from the proposed rule was necessary in order to provide consistency with 51.53(c)(3)(ii), as this section only deals with Category 2 issues. Since the cumulative impacts of transportation of SNF in the vicinity of Yucca Mountain is no longer a Category 2 issue, inclusion in 51.53(c)(3)(ii) is no longer necessary.

Other Comments

This section addresses the comments that are not encompassed by the issue summaries and responses given above. In addition, some comments were received after the close of the comment period. These comments were reviewed, and most were found to be similar to comments already addressed by the issue summaries and responses. However, the comments that raised new ideas relevant to Addendum 1 are also presented in this section. For these late comments, revisions to Addendum 1 were necessarily minimal.

Comment: Addendum 1 assumes that truck transport would have the highest doses. This assumption is not necessarily valid. Also, a different route that avoids Las Vegas should be addressed. (A route through Nellis Air Force Base and down US-95 is being considered by DOE and it has been shown to have higher risks of accident fatalities and to increase the radiological risk.) Routes chosen in Addendum 1 do not bound the analysis properly.

Response: The transportation and route scenarios and their underlying assumptions were designed to reflect situations that most likely would result in highest doses in order to bound the analysis properly as the routes chosen for this analysis were the most populated routes in the state of Nevada. Also, as noted in an earlier response, the NRC staff consulted DOE in determining that truck shipments through densely populated areas of Clark County, Nevada, would have the highest potential impacts among the alternative transportation scenarios that would be given serious consideration in decisions relating to the suitability of the site undergoing study for a repository at Yucca Mountain.

The comment that a route from Nellis Air Force Base down US-95 is higher risk than those selected by the NRC staff provided no specific details concerning that assertion. In the NRC staff's view, any route that bypasses major centers of population will have significantly lower radiological impacts. With regard to traffic accident rates, while it may be true that certain routes will have accident rates that are higher than average, the average rates are low enough that modest increases from the average will not significantly change the staff's conclusions.

Comment: SNF from California would go through Las Vegas twice (in route to Skull Valley and subsequently to Yucca Mountain), resulting in increased risk.

Response: If the proposed SNF storage facility is licensed and built, some SNF may go through Clark County on the way to Skull Valley, Utah. The NRC staff has not analyzed this possible impact because it is not clear at this time that the proposed Skull Valley facility will be licensed or that the SNF would go through Las Vegas if the facility were built. In addition, SNF from California makes up only a small fraction of the SNF that would be shipped. The NRC

staff concludes that the conservative assumptions used in the analysis more than compensate for minor changes in transportation plans that may develop for that fraction of the total SNF.

Comment: The NRC should provide affected parties with some statement of the regulatory effect of the interrelationships between the numerous other similar analyses.

Response: As a general matter, the National Environmental Policy Act (NEPA) requires all Federal agencies to perform an environmental review for certain actions they propose to conduct. In the context of nuclear waste management, several agencies have regulatory and operational responsibilities which may involve various proposed actions that, in turn, require the preparation of environmental impact statements (EISs). Inevitably, there may be a degree of overlap in the types of impacts discussed in these various EISs. However, the analysis developed by the NRC for the purposes of license renewal is not binding on future actions and associated environmental impact analyses.

The NRC proposed action that has triggered the preparation of this rulemaking and the associated analysis of environmental impact is the agency's responsibility to review applications for the renewal of nuclear power plant licenses. In light of the discrete purpose of this rulemaking, the NRC has sought to gauge the impacts of license renewal given the information currently available on those impacts including the transportation of spent fuel. Even though these impacts do not occur at the plant site during license renewal, the NRC has considered them here pursuant to its NEPA responsibilities.

Future EISs prepared by other agencies on proposed actions in the waste management arena (e.g., any recommendation by DOE on approval of the Yucca Mountain site for development of a repository) will undoubtedly address some of the same impacts covered by

the analysis described in this notice. Some of these other impact statements are anticipated to be more detailed given their purpose and the availability of additional information in the future. This, however, does not diminish the adequacy of the NRC's action. This analysis is sufficient for the purpose it serves and it provides the Commission with the information needed to weigh the likely environmental impacts of SNF transportation for individual license renewals applications and reach informed decisions regarding the acceptability of these applications. The rule does not, however, dictate any particular result for future actions taken with regard to a waste repository or other waste management matters. Specifically, any generic conclusions by the Commission concerning the cumulative environmental impacts of transportation associated with nuclear power plants would in no way affect any DOE decision concerning the suitability of Yucca Mountain or any consideration that DOE may give to transportation impacts in making that decision.

Comment: Addendum 1 is not meaningful to the public. For example, it is impossible to determine if the spent fuel isotope inventory shown in the sample pages of the RADTRAN printout matches the fuel considered in the Addendum.

Response: In preparing Addendum 1, the NRC staff has attempted to write to a broad and diverse audience as much as possible. The NRC staff acknowledges that this rulemaking involves complicated, technical issues. However, the NRC staff has attempted to present these matters in the most clear manner possible. Addendum 1 has been revised and Table 2 provides the fuel isotope inventory that can be compared to the sample pages of the RADTRAN computer code printout.

Comment: The study area is inaccurately defined and the location of some cities is incorrectly stated.

Response: During the preparation of Addendum 1, the initial study area selected for analysis emphasized the urban areas in and near Las Vegas. Route selections were based in part on their proximity to those areas, not to county borders. However, in response to public comments, the study area was expanded to include the entire county. Consequently, the "entry" point for SNF shipments shifted to cities such as Mesquite.

Comment: Addendum 1 should discuss potential mitigation measures, not rely on the DOE Yucca Mountain EIS for that discussion.

Response: The analysis in Addendum 1 shows that, even with conservative assumptions, the cumulative radiological and non-radiological accident risks of SNF transport in Clark County are small. However, there are a number of opportunities to further reduce human health impacts. These include transporting SNF by rail rather than by truck. This would reduce human health effects by reducing the number of shipments and the likelihood of accidents. In addition, shipping SNF via the proposed beltway would reduce health impacts compared to shipping via the current interstate highway system. The implementation of such mitigative measures must await future decisions that fall well outside of the scope of this rulemaking. In addition, for the purposes of individual license renewal rule decisions, no plant specific mitigation measures were found appropriate for addressing the impacts identified in the Addendum. The NRC notes that DOE addresses transportation impacts, mitigation measures,

and alternative transportation modes in its EIS for the proposed action to develop a repository at Yucca Mountain.

Comment: Addendum 1 does not mention that the proposed repository which is the destination for shipments of spent nuclear fuel is in Nye County.

Response: A statement noting that the proposed Yucca Mountain repository is in Nye County has been added to Addendum 1.

Comment: No statements of baseline conditions are given in Addendum 1.

Response: Addendum 1 uses background and natural radiation levels as the baseline conditions against which dose estimates can be compared. Both are presented in Addendum 1 and are based in large part on information published by the National Council on Radiation Protection and Measurements.

Comment: The analysis in Addendum 1 is limited to human health effects. Other potential impacts should be considered.

Response: Addendum 1 was prepared to provide information regarding a proposed rule to determine whether the transportation of higher enriched, higher burnup fuel to a single destination is consistent with the values of Table S-4. Because the pertinent section of Table S-4 concerns impact values for human health effects, Addendum 1 concentrates on potential cumulative impacts to human health. However, Section 2.3 of Addendum 1 has been

revised to look at the potentially most significant non-human health effect which is the potential increase in traffic volume in Clark County as the result of the transportation of SNF. The NRC staff conclusion is that the impacts are small.

Comment: The analysis assumes the use of the large-capacity GA-4/9 truck cask, which has not been certified and must be used in combination with specially designed trucks that have not been tested. It also assumes that these cask and truck systems will be available in sufficient quantity for the shipments. The commentor seeks assurance that the assumed truck cask system is feasible and that DOE's proposed regional service contractor approach would feasiblely result in the use of such a system for all shipments in the potential truck shipment campaign.

Response: The analysis done by the NRC staff assumes that an adequate number of certified casks would be available. Addendum 1 used extremely conservative assumptions regarding SNF shipments and casks to ensure that the analysis would lead to maximum dose estimates. For example, the analysis of incident-free transportation impacts assumes the use of legal-weight trucks for shipment of the SNF, which results in more and smaller shipments. For the accident analysis, the use of the largest-capacity casks was assumed in order to maximize the amount of SNF that would be involved in the accident. These parameters were intended to bound the parts of the analysis, not to describe parts of the actual SNF shipment protocol such as the specific casks that will be used.

Comment: The analysis appears to assume that oldest spent nuclear fuel would be shipped first to the repository. If so, how will institutional measures achieve this sequencing? If

they do not, how will the maximum potential radioactive risk in shipment and storage or disposal be addressed?

Response: The spent fuel will be shipped in casks certified by the NRC. In fact, the current practice of NRC issuing certificates of compliance for casks used for shipment of power reactor fuel is to specify 5 years as the minimum cooling period in a certificate.

Comment: Addendum 1 uses national accident rate statistics. State and/or local rates would be more appropriate.

Response: For the analysis of radiological accidents, data specific to Nevada were used in the RADTRAN computer code runs. However, for the analysis of non-radiological accidents, the NRC staff required data regarding not only accident rates but also injury and fatality statistics. Those data were not available except from the U.S. Department of Transportation.

Comment: Water resource supplies within boundaries of the State of Nevada belong to the public. All waters are subject to appropriation for the beneficial use only under state law.

Response: The water resources of the state will be unaffected by the transport of SNF through Clark County.

Comment: Report failed to provide conditions for informed consent which requires disclosure to those affected, their understanding , and voluntary acceptance.

Response: NRC regulations already contain values that the NRC considers to be acceptable environmental impacts from the shipment of SNF and other radioactive waste. In Addendum 1 the NRC staff is, in part, ensuring that the overall impacts of the transportation of the additional SNF that will be generated as the result of nuclear power plant license renewal are bounded, given the best information the NRC staff has at this time, by those values previously found acceptable. The values specified in the regulations are supported by analysis and were adopted into the regulations only after providing opportunity for public comment as part of the NRC's rulemaking process. As such, the NRC has followed all applicable legal requirements and appropriately carried out its responsibility to consider the environmental impacts of its license renewal decision.

Comment: The NRC staff uses "flawed" science as evidenced by factors including a questionable definition of risk which fails to account for severe accidents, use of misleading if not false average radiation dose rates, manipulation of dose rate data to obtain acceptable results and lack of empirical data especially that applicable to transportation of SNF.

Response: The decision before the Commission is whether the impacts of license renewal are so severe that they should preclude the option of license renewal. As such, the Commission has considered a reasonable estimate of impacts and not included remote and speculative scenarios that do not add to our regulatory decision (see also response to comment on severe accidents, above).

In the analyses described in Addendum 1 the NRC staff uses dose rates that reflect the applicable regulatory limit rather than average dose rates. Even with these very conservative assumptions for dose rates, transportation modes, transportation routes, and a number of other

factors, radiation impacts on the transport crews and the general public were not only found to be within all regulatory limits but small as well and there was no need to adjust the assumptions.

Throughout Addendum 1 the NRC staff discusses the assumptions that were made and where applicable the empirical data used to support those assumptions is referenced. With respect to making judgements about the shipment of spent fuel the NRC staff has the benefit of data from over 40 years of experience in shipping SNF in this country as well as overseas.

Comment: High level waste management and transportation should not be a generic issue and Yucca Mountain should not be used for the study as DOE is behind schedule and it is not an approved site for SNF.

Response: Given that the potential environmental impacts of the transportation of SNF resulting from license renewal are similar for all nuclear power plants who seek to renew their operating licenses, and that the NRC staff's analysis contained in Addendum 1 concludes that the impacts are likely to be small, the Commission feels it is appropriate to reclassify the issue as a Category 1 issue. Use of Yucca Mountain, Nevada for purposes of the staff's analysis, as the destination of the SNF is appropriate as it is the only site presently under study. It must be emphasized that this generic environmental impact statement is required to make use of the best information available and at this time the assumption that Yucca Mountain is the destination is reasonable for purposes of the staff's analysis. If in the future, conditions change, the assumption made for this analysis may need to be reevaluated.

Comment: Need to consider the intermodal option being considered by Congress for Caliente, Nevada.

Response: The shipment of SNF by rail to Caliente and then transferring it to truck for shipment to Yucca Mountain is one of many options under consideration by DOE. Rather than speculate on which transportation option or options will ultimately be selected, the NRC staff has chosen a mode and routes to Yucca Mountain which in its judgement will have the greatest potential environmental impacts in order to do a bounding analysis for the purpose of this rulemaking.

Comment: The analysis needs to address the impacts of above ground nuclear weapons testing being done at the Nevada Test Site.

Response: For the purposes of considering the environmental impacts of license renewal, there does not appear to be a relevant connection between transportation impacts from civilian SNF and defense related weapons testing at the Nevada test site.

Comment: The analysis relies on assumptions that are 25-30 years old and that have a number of problems including omission of important radionuclides (Iodine-129, Chlorine-36 and Cobalt-60), unrealistic RADTRAN assumptions including inadequate consideration of severe accidents, outdated assumptions from NUREG-0170 and WASH-1238 including the failure to consider the degradation of cladding during extended dry storage, and failure to consider the rail-heavy haul truck option.

Response: With regard to the radionuclides, as indicated in Table 2 of Addendum 1, Cobalt-60 is considered. While both Iodine-129 and Chlorine-36 are long lived, neither is a significant contributor to overall dose. Iodine-129 has a very low specific activity and Chlorine-36 is a beta emitter.

The issue of the severity of accidents considered in the NRC staff's analysis was addressed in an earlier response to comment. The assumptions that are used in the NRC staff's analysis have been periodically reviewed and found adequate. The hypothetical accident conditions of 10 CFR 71.73 have been evaluated against actual conditions encountered in highway and railway accidents and were found to be bounding as documented in NUREG/CR-4829, February 1987, "Shipping Container Response to Severe Highway and Railway Accident Conditions." As noted in Table 3 of Addendum 1, the version of RADTRAN used is updated to March 1999.

Section 3 of Addendum 1 does consider the possible effect of cladding degradation on criticality in the context of increased burnup. That analysis would be equally applicable to any cladding degradation that might occur during prolonged dry storage of the SNF.

With regard to what is asserted to be inadequate consideration of the potential radiological impacts of the rail-heavy haul truck option, the NRC staff has analyzed the radiological impacts of the truck mode along various routes through and around Las Vegas and concludes that they are the limiting scenarios. The largest doses in the incident-free conditions are now to the public. If the rail-heavy haul transport scenario was adopted, a substantial portion of the public exposure would be avoided, since in this scenario, the slow moving heavy haul truck transport would not move through a major population center.

Comment: NRC must consider potential Indian Tribe claims of authority to regulate shipments across reservation lands.

Response: This analysis is a generic study that assumes certain routes for the purpose of evaluating environmental impacts. Because the purpose of this study is neither to propose nor approve routes, the NRC does not need to consider tribal claims of authority to regulate shipments in the context of this analysis.

Comment: The beltway is a county road, not part of the Federal highway system; it is not clear it can be used for shipments.

Response: The DOT regulations do not require that SNF shipments only use federal highways. Therefore, the NRC assumed that the beltway is a possible route around Las Vegas.

Comment: The NRC should address the implications of higher enrichment, higher burnup fuel for consequences of radiological sabotage, as NRC has done so far for the increase in burnup from 33,000 MWd/MTU to 40,000 MWd/MTU (see 49 FR 23867, Proposed Revisions to 10 CFR 73, Modification of Protection Requirements for Spent Fuel Shipments, 6/8/84).

Response: The NRC has not quantified the likelihood of the occurrence of sabotage in this analysis because the likelihood of an individual attack cannot be determined with any degree of certainty. Nonetheless, the NRC has considered, for the purposes of this environmental impact statement and rulemaking, the environmental consequences of such an

event. In the determination of the consequences of such an event, higher burnup is only one factor. Based on the staff's study of higher burnup fuel (NUREG-1437, Vol.1, Addendum 1, Table 2), the consequences of a sabotage event involving such fuel could be larger than those in the studies referenced by the commentor. However, given that the consequences of the studies referenced by the commentor were small, even modest increases due to the effects of higher burnup fuel would not result in unacceptably large consequences. Because burnup is not the only factor that could affect the consequences of a sabotage event, the staff continues to study this area. Should new and significant information result from the further study, actions addressing such information will be considered.

Nevertheless, the extensive security measures required by NRC regulations make sabotage events extremely unlikely. Moreover, the casks required to be used to transport spent fuel are designed to withstand very substantial impacts during transport without loss of containment integrity. The cask designs should serve to further reduce the likelihood of release of radioactive material in the extremely unlikely event of sabotage. In view of the fact that NRC safeguards regulations make sabotage events extremely unlikely, and the fact that the cask designs themselves should make a release of radioactive material unlikely even were sabotage to occur, and based on our judgement that, in the extremely unlikely event that sabotage and releases did occur, the consequences from higher burnup fuel would not be unacceptably large, we have concluded that a more extensive study of higher burnup fuel consequences is not warranted for this environmental impact statement and rulemaking.

On June 22, 1999, the Nevada Attorney General filed a petition with the Commission which requested the NRC to amend regulations governing safeguards for shipments of spent nuclear fuel against sabotage and terrorism and to initiate a comprehensive assessment. In particular, the petition indicated that NRC should factor into its regulations the changing nature

of threats posed by domestic terrorists, the increased availability of advanced weaponry and the greater vulnerability of larger shipping casks traveling across the country. If, as a result of reviewing this petition, the NRC reaches conclusions that are inconsistent with the results or assumptions in the present rulemaking, the Commission will need to revisit the analysis presented here.

## Finding of No Significant Environmental Impact: Availability

The NRC has determined that this final rule is the type of action described as a categorical exclusion in 10 CFR 51.22(c)(3). Therefore, neither an environmental impact statement nor an environmental assessment has been prepared for this regulation. This action is procedural in nature and pertains only to the type of environmental information to be reviewed.

## Paperwork Reduction Act Statement

This final rule decreases unnecessary regulatory burden on licensees by eliminating the requirement that license renewal applicants address the generic and cumulative environmental impacts associated with transportation operation in the vicinity of a HLW repository site (-400 hours, -2 responses), and adds a new requirement to address local traffic impacts attributable to continued operation of the plant during the license renewal term (+20 hours, +2 responses). The public burden for these information collections is estimated to average a reduction of 200 hours for each of 2 responses for the elimination of the above mentioned requirement, and an increase of 10 hours for each of 2 responses for the new requirement, for a net burden

reduction of 380 hours. Because the burden for this information collection is insignificant, Office of Management and Budget (OMB) clearance is not required. Existing requirements were approved by the OMB, approval number 3150-0021.

## Public Protection Notification

If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

## Regulatory Analysis

The regulatory analysis prepared for the final rule published on June 5, 1996 (61 FR 28467), and amended on December 18, 1996 (61 FR 66537), to make minor clarifying and conforming changes and add language unintentionally omitted from the June 5, 1996 final rule. The rule is unchanged except for an increase in benefits derived from a reduction in the applicant burden of 190 hours of effort in preparing an application for renewal of a nuclear power plant operating license.

This change increases the substantial cost saving of the final rule estimated in NUREG-1440, "Regulatory Analysis for Amendments to Regulations for the Environmental Review for Renewal of Nuclear Power Plant Operating Licences." NUREG-1440 is available for inspection in the NRC Public Document Room, 2120 L Street NW. (Lower Level), Washington, DC. In addition, copies of NRC final documents cited here may be purchased from the Superintendent of Documents, U.S. Government Printing Office, PO Box 37082, Washington, DC 20013-7082.

Copies are also available for purchase from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

## Regulatory Flexibility Act Certification

As required by the Regulatory Flexibility Act of 1980 (5 U.S.C. 605(b)), the Commission certifies that this final rule will not have a significant impact on a substantial number of small entities. The final rule will reduce the amount of information to be submitted by nuclear power plant licensees to facilitate NRC's obligations under the National Environmental Policy Act. Nuclear power plant licensees do not fall within the definition of small businesses as defined in Section 3 of the Small Business Act (15 U.S.C. 632) or the Commission's Size Standards, April 11, 1995 (60 FR 18344).

## Backfit Analysis

The Commission has determined that these amendments do not involve any provisions that would impose backfits as defined in 10 CFR 50.109(a)(1); therefore, a backfit analysis need not be prepared.

## Small Business Regulatory Enforcement Fairness Act

In accordance with the Small Business Regulatory Enforcement Fairness Act of 1996, the NRC has determined that this action is not a major rule and has verified this determination with the Office of Information and Regulatory Affairs of OMB.

## National Technology Transfer and Advancement Act

The National Technology Transfer and Advancement Act of 1995, Pub. L 104-113, requires that Federal agencies use technical standards developed by or adopted by voluntary consensus standards bodies unless the use of such a standard is inconsistent with applicable law or otherwise impractical. There are no consensus standards that apply to the analysis and findings process, nor to the requirements imposed by this rule. Thus the provisions of the Act do not apply to this rule.

## List of Subjects in 10 CFR Part 51

Administrative practice and procedure, Environmental impact statement, Nuclear materials, Nuclear power plants and reactors, Reporting and recordkeeping requirements.

For the reasons set out in the preamble to this notice and under the authority of the Atomic Energy Act of 1954, as amended; the Energy Reorganization Act of 1974, as amended; the National Environmental Policy Act of 1969, as amended; and 5 U.S.C. 552 and 553,' the NRC is adopting the following amendments to 10 CFR Part 51.

PART 51--ENVIRONMENTAL PROTECTION REGULATIONS FOR DOMESTIC LICENSING AND RELATED REGULATORY FUNCTIONS

1. The authority citation for Part 51 continues to read as follows:

AUTHORITY: Sec. 161, 68 Stat. 948, as amended, Sec. 1701, 106 Stat. 2951, 2952, 2953 (42 U.S.C. 2201, 2297f); secs. 201, as amended, 202, 88 Stat. 1242, as amended, 1244 (42 U.S.C. 5841, 5842).

Subpart A also issued under National Environmental Policy Act of 1969, secs. 102, 104, 105, 83 Stat. 853-854, as amended (42 U.S.C. 4332, 4334, 4335); and Pub. L. 95-604, Title II, 92 Stat. 3033-3041; and sec.193, Pub. L. 101-575, 104 Stat. 2835, (42 U.S.C. 2243). Sections 51.20, 51.30, 51.60, 51.61, 51.80, and 51.97 also issued under secs. 135, 141, Pub. L. 97-425, 96 Stat. 2232, 2241, and sec. 148, Pub. L. 100-203, 101 Stat. 1330-223 (42 U.S.C. 10155, 10161, 10168). Section 51.22 also issued under sec. 274, 73 Stat. 688, as amended by 92 Stat. 3036-3038 (42 U.S.C. 2021) and under Nuclear Waste Policy Act of 1982, sec. 121, 96 Stat. 2228 (42 U.S.C. 10141). Sections 51.43, 51.67, and 51.109 also issued under Nuclear Waste Policy Act of 1982, sec. 114(f), 96 Stat. 2216, as amended (42 U.S.C. 10134(f)).

2. In § 51.53, paragraph (c)(3)(ii)(M) is removed and reserved and paragraph (c)(3)(ii)(J) is revised to read as follows:

§ 51.53 Post-construction environmental reports.

* * * * *

(c) * * *

(3) * * *

(ii) * * *

(J) All applicants shall assess the impact of highway traffic generated by the proposed project on the level of service of local highways during periods of license renewal refurbishment activities and during the term of the renewed license.

* * * * *

(M) [Reserved].

* * * * *

3. The "Public services, Transportation" issue under the Socioeconomics Section and the "Transportation" issue under the Uranium Fuel Cycle and Waste Management Section of Table B-1, Appendix B to Subpart A to 10 CFR Part 51 are revised to read as follows:

Table B-1.—Summary of Findings on NEPA Issues for License Renewal of Nuclear Power Plants[1].

* * * * *

Socioeconomics

| Issue | Category | Findings |
|---|---|---|
| Public services, Transportation | 2 | SMALL, MODERATE, OR LARGE. Transportation impacts (level of service) of highway traffic generated during plant refurbishment and during the term of the renewed license are generally expected to be of small significance. However, the increase in traffic associated with additional workers and the local road and traffic control conditions may lead to impacts of moderate or large significance at some sites. See § 51.53(c)(3)(ii)(J). |

* * * * *

Uranium Fuel Cycle and Waste Management

| Issue | Category | Findings |
|---|---|---|
| Transportation | 1 | SMALL. The impacts of transporting spent fuel enriched up to 5 percent uranium-235 with average burnup for the peak rod to current levels approved by NRC up to 62,000 MWd/MTU and the cumulative impacts of transporting high-level waste to a single repository, such as Yucca Mountain, Nevada are found to be consistent with the impact values contained in 10 CFR 51.52(c), Summary Table S-4—Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-Cooled Nuclear Power Reactor. If fuel enrichment or burnup conditions are not met, the applicant must submit an assessment of the implications for the environmental impact values reported in §51.52. |

[1] Data supporting this table are contained in NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (May 1996) and NUREG-1437, Vol. 1, Addendum 1, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Main Report Section 6.3— 'Transportation,' Table 9.1 'Summary of findings on NEPA issues for license renewal of nuclear power plants,' Final Report" (August 1999).

Dated at Rockville, Maryland, this 24th day of August, 1999.

For the Nuclear Regulatory Commission.

Annette Vietti-Cook,
Secretary of the Commission.


Federal Recycling Program

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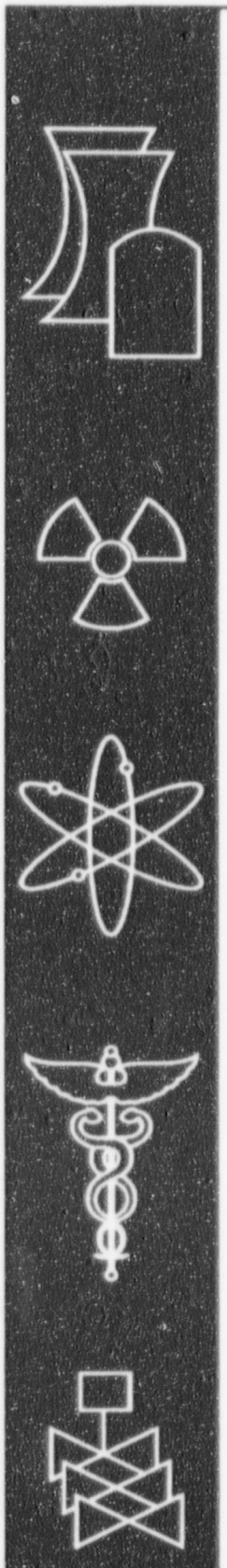


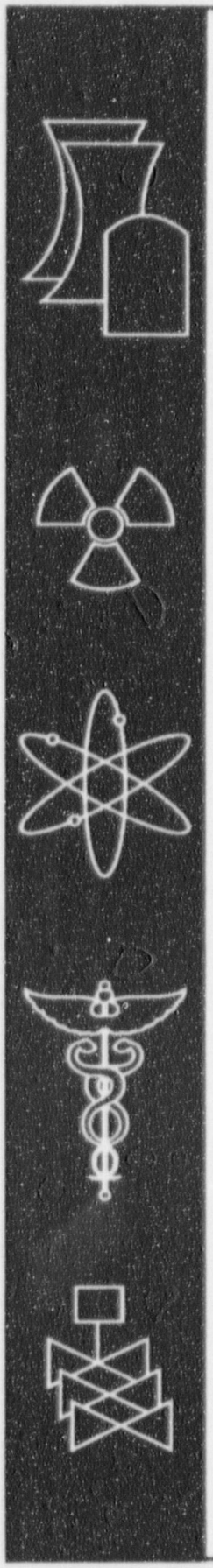
# Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Main Report
Section 6.3—Transportation
Table 9.1 Summary of findings on NEPA issues for license renewal of nuclear power plants

Draft Report for Comment

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, DC 20555-0001

NUREG-1437, Vol. 1
Addendum 1



# Generic Environmental Impact Statement for License Renewal of Nuclear Plants

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NUREG-1437, Vol. 1
Addendum 1

# Generic Environmental Impact Statement for License Renewal of Nuclear Plants

Main Report
Section 6.3—Transportation
Table 9.1 Summary of findings on NEPA issues for license renewal of nuclear power plants

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Manuscript Completed: February 1999
Date Published: February 1999

**Division of Reactor Program Management**
**Office of Nuclear Reactor Regulation**
**U.S. Nuclear Regulatory Commission**
**Washington, DC 20555-0001**

# ABSTRACT

This supplement to NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, documents the staff's analysis of the potential cumulative impacts to human health of transporting spent nuclear fuel in the vicinity of the proposed Yucca Mountain high-level waste repository.

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| CFR | *Code of Federal Regulations* |
| DOE | U.S. Department of Energy |
| DOT | U.S. Department of Transportation |
| EIS | environmental impact statement |
| *Fed. Regist.* | *Federal Register* |
| ft | foot |
| GEIS | *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* |
| GWd | gigawatt-days |
| km | kilometer |
| lb | pound |
| LRFC | lifetime risk of fatal cancer |
| m | meter |
| mrem | millirem |
| mSv | millisievert |
| MTHM | metric tons of heavy metal (a conventional unit for high-level nuclear waste) |
| MT | metric ton [i.e., 1000 kilograms (about 2200 pounds)] |
| MTU | metric tons uranium |
| MWd | megawatt-days |
| NRC | U.S. Nuclear Regulatory Commission |
| NWPA | Nuclear Waste Policy Act |
| SNF | spent nuclear fuel |
| Sv | sievert |

# 1. INTRODUCTION

## 1.1 PURPOSE OF THE SUPPLEMENT

This Supplement to NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants* (GEIS) addresses two aspects of high-level waste transportation that were not adequately addressed in the GEIS: (1) cumulative impacts of transportation of high-level radioactive waste in the vicinity of the proposed repository at Yucca Mountain, Nevada, and (2) the impacts of transporting higher-burnup fuel. These issues are currently designated as Category 2 in 10 CFR Part 51.53(c)(3)(ii)(M) and Table B-1 of Subpart A, Appendix B of Part 51. Designation of an issue as Category 2 requires that it be evaluated in each license renewal application. Currently, therefore, the environmental impacts of the transportation of fuel and waste must be reviewed in each renewal application, creating the potential for repetitive reviews among those applications. Designating an issue as Category 1 provides the basis for codification of the findings in 10 CFR Part 51 and adoption of the findings in individual license renewal reviews, with no further analysis required. This Supplement provides an assessment that supports changing the transportation impacts in 10 CFR 51 and Table B-1 from Category 2 to Category 1.

## 1.2 BACKGROUND

The purpose of the GEIS was to provide the technical basis for an amendment to the Nuclear Regulatory Commission's (NRC's) regulations at 10 CFR Pt. 51 (*Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions*), with regard to the renewal of nuclear power plant operating licenses. The final rule, *Environmental Review for Renewal of Nuclear Power Plant Operating Licenses*, which amends 10 CFR Pt. 51, was published in the *Federal Register* on Dec. 18, 1996 (61 *Fed. Regist.* 66537) and codified the findings reported in NUREG-1437. The rule amendment and the GEIS analysis were initiated with the objective of improving the efficiency of the license renewal process by documenting in the GEIS and codifying in the Commission's regulations those environmental impacts that are well understood so that repetitive reviews of those impacts could be avoided.

Chapter 6 of the GEIS addresses the environmental impacts associated with the management of radiological and nonradiological wastes resulting from license renewal. Section 6.3, "Transportation," addresses the environmental impacts resulting from the shipment of (1) low-level radioactive waste and mixed waste to off-site disposal facilities, (2) fresh fuel to the plant, and (3) spent nuclear fuel (SNF) from the plant to a monitored retrievable storage facility or permanent repository. Section 6.3 also provides an assessment of the applicability to license renewal of 10 CFR 51.52 "Environmental Effects of Transportation of Fuel and Waste—Table S-4." In Section 6.3.4, the NRC concluded that "The environmental impacts from the transport of fuel and waste attributable to license renewal are found to be small when they are within the range of impact parameters identified in Table S-4."

However, it was assumed in developing the data in Table S-4 that SNF would be shipped to a number of destinations rather than a single repository. Therefore, Table S-4 does not explicitly take into account the cumulative environmental impacts of the convergence of high-level waste shipments on a proposed repository at Yucca Mountain. This

Supplement provides that explicit consideration. Further, although the environmental implications of the use of more highly enriched fuel and of a higher burnup than is considered in 10 CFR 51.51 (Table S-3) and in 10 CFR 51.52 (Table S-4) is assessed in the GEIS in Section 6.2.3, that section focuses on Table S-3 and not on Table S-4. The analysis and conclusions relative to Table S-4 presented in Section 6.2.3 are not referenced in the assessment of transportation, Section 6.3. This Supplement corrects that omission and expands the GEIS discussion of the use of more highly enriched fuel and higher burnup.

This Supplement to NUREG-1437 and the rulemaking that it supports were anticipated at the time of the final rule published on Dec. 18, 1996. The Commission stated,

> "As part of its efforts to develop regulatory guidance for this rule, the Commission will consider whether further changes to the rule are desirable to generically address: (1) The issue of cumulative transportation impacts and (2) the implications that the use of higher burn-up fuel have for the conclusions in Table S-4. After consideration of these issues, the Commission will determine whether the issue of transportation impacts should be changed to Category 1" (64 *Fed. Regist.* 66538).

# 2. CUMULATIVE IMPACTS OF TRANSPORTATION

## 2.1 BACKGROUND

The generation of SNF at power reactors and its on-site and off-site storage is addressed in Section 6.4.6 "Spent Fuel" of the GEIS. The contribution of license renewal to the inventory of SNF is discussed in Section 6.4.6.2 "Effects of License Renewal." The environmental impacts of transporting the SNF to a monitored retrievable storage facility or to a permanent repository are addressed in Section 6.3, "Transportation," of the GEIS.

The Nuclear Waste Policy Act of 1982 (NWPA) gave the U.S. Department of Energy (DOE) the responsibility for finding a site for disposal of commercial SNF and other high-level waste, and for building and operating an underground disposal facility called a geologic repository. In 1987, Congress amended the NWPA and directed DOE to study only Yucca Mountain. Congress instructed DOE that if at any time Yucca Mountain was found to be unsuitable, studies would be stopped, the site would be restored, and DOE would seek new direction from Congress. DOE is in the process of preparing an environmental impact statement (EIS) for a repository at Yucca Mountain, Nevada. After the EIS process is completed and assuming the facility receives a license from NRC, it is anticipated that construction of the repository would begin. When construction is completed, SNF and high-level waste would be shipped to the site, beginning with the oldest materials.

Under the NWPA as amended, any NRC license for the repository must prohibit DOE from disposing of more than 70,000 metric tons of heavy metal (MTHM) in the repository until a second repository is in operation. Ninety percent (63,000 MTHM) of this

material is expected to be SNF from commercial nuclear power plants. The first repository will accommodate the SNF generated through about the year 2010. Unless larger capacity is authorized for the first repository, a second repository will be required for the SNF generated by plants that are operating under their initial operating licenses. Whether a second repository would have an authorized capacity large enough to accommodate the SNF generated by plants with renewed operating licenses cannot be known at this time. Although there is a potential for SNF generated as a result of license renewal to be placed in a second and third repository, this analysis of cumulative effects of transportation assumes that all the SNF resulting from the initial 40-year operating licenses and the 20-year renewal licenses will be transported to the first repository (i.e., a repository at Yucca Mountain currently under study). Further, it is assumed in this analysis that all shipments of SNF converge on and are moved through Clark County, Nevada.

## 2.2 APPROACH

The analysis estimates the potential cumulative health risk from radiation exposure and highway accidents associated with SNF transport in the vicinity of Las Vegas (Clark County), Nevada. Cumulative health risks are the total potential fatalities within the Clark County population over the period of shipment of SNF. Analyses of the radiation doses related to SNF transport in the Las Vegas vicinity were performed using the HIGHWAY routing computer code and the RADTRAN 4 risk assessment computer code (see Appendix). Radiation exposures are reported as collective dose to a population (person-Sv [person-rem]) and the dose to the maximally exposed individual (mSv [mrem]). Health risks from exposure to radiation are reported as estimated lifetime risk of fatal cancer (LRFC) resulting from accident free transportation of SNF and from highway accidents involving potential radiation releases. Expected fatalities from truck accidents not involving radiation releases are also reported.

The NAS report (1990, Table 4-2), commonly called the BEIR V report, gives estimates of the number of cancer deaths expected to occur from a continuous exposure of 10 mSv/year [1 rem/year] above background from age 18 until age 65. This value results in a risk factor of $4.0 \times 10^{-2}$ LRFC per person-Sv [$4.0 \times 10^{-4}$ LRFC per person-rem] that is most applicable to occupational exposures. The BEIR V report also estimates the number of cancer deaths expected to occur from a continuous lifetime exposure of 1 mSv/year [0.1 rem/year] above background, which results in a risk factor of $5.0 \times 10^{-2}$ LRFC per person-Sv [$5.0 \times 10^{-4}$ LRFC per person-rem] that is most applicable to exposures of the general public. Note that the general public LRFC risk factor is slightly higher than the occupational risk factor because the general public dose is assumed to be experienced by people of all ages while the occupational exposures are assumed to be experienced only by people from age 18 until age 65. Children and adolescents are presumed to be more susceptible to radiation-induced health effects than adults.

The analysis was designed to be conservative, that is, intentionally structured to overestimate the likely impacts. This approach is used in situations where the impacts are expected to be of little significance to avoid unproductive analytical effort and because it shows that the conclusions are very robust. The other side of conservative analysis is that it may lead the casual reader to the impression that the expected impacts are larger than could actually occur. To avoid such confusion, the conservative nature of that analysis is emphasized in the reminder of this section.

For purposes of this analysis, it is assumed that all SNF will be shipped by truck and that the trucks will be routed on interstate highways to the maximum possible extent, consistent with the U.S. Department of Transportation regulations for highway route controlled quantities of nuclear materials (49 CFR 397.101). Rail transport of SNF is also anticipated. However, rail transport would have smaller risks than truck transport (Dyer and Reich 1993). Evaluation of cumulative impacts in the vicinity of Las Vegas carried out in this analysis, therefore, represents an upper bound because it assumes all SNF would move by truck rather than by rail or a combination of rail and truck to reach the repository.

The regulations governing allowable radiation levels during transport of radioactive materials are found at 49 CFR 173.441 and 10 CFR 71.47. Those regulations require, in part, that the external radiation level be no more than 0.10 mSv/hour [10 mrem/hour] at any point 2 m [6.6 ft] from the outer surface of the vehicle. This analysis used the conservative assumption that the radiation level would be 0.10 mSv/hour [10 mrem/hour] at all points 1 m [3.3 ft] from the surface. This assumption corresponds to a radiation level of about 0.07 mSv/hour [7 mrem/hour] at all points 2 m [6.6 ft] from the surface.[1] Because shipment must be designed so that radiation levels do not exceed 0.10 mSv/hour [10 mrem/hr] at any point 2 m [6.6 ft] from the surface, average radiation levels must be much lower. Consequently, the assumption that the radiation level is 0.07 mSv/hour [7 mrem/hour] at all points 2 m [6.6 ft] from the surface, is conservative and actual average radiation levels are expected to be much lower than 0.07 mSv/hour [7 mrem/hour] at 2 m [6.6 ft] assumed in this analysis.

To examine the effects of license renewal, the staff used two estimates of SNF that would be transported to the repository. The first was based on the assumption that no nuclear plants have their licenses renewed, and the second was based on the assumption that all existing nuclear plants operate through a 20-year license renewal period. The assumption used for the second estimate is conservative because some plant owners have already decided not to request renewal of plant operating licenses.

As noted above, the NWPA prohibits DOE from accepting more than 70,000 MTHM at the Yucca Mountain repository. Based on this limit, DOE estimates 37,639 truck shipments of SNF to Yucca Mountain, assuming all SNF travels by truck in legal-weight casks (K. Skipper, Yucca Mountain Site Office, personal communication to D. P. Cleary, NRC, July 11, 1997). The Nuclear Waste Technical Review Board (1997) estimates that by the time the currently operating nuclear plants terminate operations (assuming no license renewal), about 85,000 MTHM of SNF will have been generated.

For this analysis, the staff assumed that all current and committed SNF, about 84,000 MTHM, would be disposed of at Yucca Mountain.[2] Scaling DOE's estimated number of shipments with the amount of SNF leads to an estimate of 50,185 truck shipments without license renewal. Assuming all plants renew their licenses and operate for

[1]The exact wording of the relevant requirement of §71.47(b) is that ... "radiation levels for such shipment must not exceed the following during transportation" ... "(3) 0.1 mSv/h (10 mrem/h) *at any point* 2 meters (80 in) from the outer lateral surfaces of the vehicle (excluding the top and underside of the vehicle); or in the case of a flat-bed style vehicle, *at any point* 2 meters (6.6 feet) from the vehicle (excluding the top and underside of the vehicle)." [Emphasis added]

[2]Although this estimate exceeds the 70,000 MTHM limit in the first repository in the NWPA, it represents a conservative assumption (i.e., an overestimate) that would define an upper bound of potential impact for a repository at Yucca Mountain.

an additional 20 years, the estimate increases to 75,278 truck shipments. Construction has begun on a beltway that would extend around much of Las Vegas. Two transportation route scenarios were analyzed: SNF is transported on the current freeway system, and SNF is transported on the proposed beltway. Because the beltway is expected to be complete before 2005 and because regulations require that spent fuel shipments avoid high population concentrations where possible, analysis of transportation on the route through downtown on the current interstate system yields higher exposure estimates than would actually occur.

The affected population is assumed to be those residents of Clark County, Nevada, who live within 0.8 km [0.5 mile] of the route followed by the trucks transporting SNF. Because doses fall off quickly with distance from the route, persons close to the route receive and account for much more of the population dose than those who live away from it. The contributions to population doses contributed by exposures to persons living more than 0.8 km [0.5 mile] from the route is negligible. The population density estimates were produced by the HIGHWAY computer code (Joy and Johnson 1983) based on 1990 census data. Because the action would occur over 40 to 60 years, population growth in Clark County is expected. For the purpose of this analysis, population densities in downtown urban areas and existing suburban areas are assumed to remain constant. Population growth is assumed to occur by development of the outlying areas; the population densities in the vicinity of the proposed beltway are assumed to be similar to those of other urban and suburban areas of Las Vegas.

## 2.3 CUMULATIVE HEALTH RISKS

Health risks associated with SNF transport include both those associated with radiation exposures and those associated with the movement of heavy trucks carrying SNF through the area (i.e., traffic accidents).

### 2.3.1 Radiological Risks

Radiation exposures can occur in two ways—exposure to radiation emitted by the SNF cask during normal (incident-free) transport and exposures in the event of an accident that leads to release of radioactive materials. For incident-free transportation, the staff used the RADTRAN computer model to calculate total body doses to the transport crew and the general population. The radiation source is characterized for RADTRAN by the radiation dose rate at 1 m from the package surface. The regulatory limit is 0.10 mSv/hour [10 mrem/hour] at 2 m [6.6 ft] from the vehicle or container surface (10 CFR 71.47). The rate of 0.10 mSv/hour [10 mrem/hour] at 1 m [3.3 ft] (which corresponds to about 0.07 mSv/hour [7 mrem/hour] at 2 m [6.6 ft]) was assumed because most shipments are not expected to be close to the regulatory limit, so the average dose rate was assumed to be lower than the regulatory limit.[3]

[3]The regulations at 10 CFR 71.47 also limit dose rate at any point on the outer surface of the package or vehicle to 2.0 mSv/hour [200 mrem/hour]. Doses rates at most parts of the surface would necessarily be much lower than 200 mrem/hour in order to meet the 0.10 mSv/hour [10-mrem/hour] at 2 m [6.6 ft] limit. To be exposed to a dose rate this high, an individual would have to be in contact with the package at its most radioactive spot. To receive a significant dose, an individual would have to lie in contact with the container at its most radioactive spot for a substantial time period. It is very unlikely that an individual would spend any time in physical contact with the package and even more unlikely that he or she would inadvertently choose the most radioactive spot on the package. Because such an occurrence is so unlikely, this exposure scenario is not considered relevant to analysis of cumulative impacts.

Potential radiological accident effects include both acute fatalities resulting from very high radiation exposures (as might occur in the unlikely event of failure of an SNF shipping container or cask), and the LRFC resulting from smaller radiation exposures that occur at the time of or after the hypothetical accident. Accident risk is estimated by summing the product of estimated dose and the associated probability of occurrence for each of the accident-severity categories analyzed by RADTRAN.

The expected population doses estimated by the staff (see Appendix) are displayed in Table 1. Table 2 shows the health risks implied by the doses listed in Table 1. It is important to note that LRFC figures represent cumulative health risks or more simply put, the total potential fatalities within the Clark County population over the period of shipment of spent nuclear fuel which assumes that all currently operating reactors renew their licenses for 20 years. An examination of Table 2 shows that the probability of excess fatal cancer among the public as a result of the entire campaign of SNF transport in the Las Vegas area is less than 0.2E-1 (0.2) for all scenarios. The sum of incident-free and accident risks is 0.1865E-1 (0.1865) LRFC for the city-route-with-license-renewal scenario; other scenarios have lower estimated risks.

For perspective, the natural incidence of lifetime fatal cancer in the U.S. is 0.20 [20 percent]. Assuming a Las Vegas population of about 300,000 and an average life expectancy of 70 years, this lifetime incidence of fatal cancer would correspond to about 900 LRFC/year. In the Las Vegas area, the average radiation exposures resulting from cosmic and naturally occurring terrestrial gamma radiation are 0.75 to 0.77 mSv/year [75 to 77 mrem/year].[4] Assuming a Las Vegas population of about 300,000, this natural radiation leads to a risk estimate of about 11 LRFC/year. The average annual excess risk to the Las Vegas area population from SNF transport is about 0.0031 LRFC/year which is a risk estimate of 3,000 times less than the estimate for background radiation and 300,000 times less than the normal incidence of fatal cancer.

[4] This outdoor dose rate estimate was provided by Harold L. Beck (Harold L. Beck, Director, Environmental Sciences Division, Environmental Measurements Laboratory, U.S. Department of Energy, New York, personal communication via electronic mail to Alan K. Roecklein, NRC, Rockville, Md., Nov. 4, 1998) and based on extensive background radiation measurements summarized, in part, in NCRP Report No. 94, *Exposure of the Population in the United States and Canada from Natural Background Radiation*, National Council on Radiation Protection and Measurements, Bethesda, Md., Dec. 30, 1987.

**Table 1. Estimated cumulative radiation exposure resulting from SNF transport in the Las Vegas area [a]**

| Radiation exposure (person-Sv)[b] | | |
|---|---|---|
| Incident-free transport | | Transport accidents |
| Crew [c] | Public [d] | Public |
| *Bypass without license renewal* | | |
| 2.068 | 0.58 | 0.338 |
| *Bypass with license renewal* | | |
| 3.102 | 0.87 | 0.506 |
| *City route without license renewal* | | |
| 2.206 | 0.85 | 1.63 |
| *City route with license renewal* | | |
| 3.309 | 1.27 | 2.46 |

[a] Transportation risks were calculated using RADTRAN (v. 4.0.19, Nov. 14, 1996).
[b] 1 person Sv = 100 person-rem.
[c] Truck crew size was assumed to be 2 persons. Crew dose is for the time spent driving approximately 161 km (100 miles) in the Las Vegas area; the dose involved in driving to the Las Vegas area is not included.
[d] The incident-free risk to the public does not include the risk to the crew.

**Table 2. Cumulative radiological transportation risks resulting from SNF transport in the Las Vegas area [a]**

| Estimated lifetime risk of fatal cancer [b] | | |
|---|---|---|
| Incident-free risk | | Accident risk |
| Crew [c] | Public [d] | Public |
| *Bypass without license renewal* | | |
| 0.0827 | 0.0290 | 0.0169 |
| *Bypass with license renewal* | | |
| 0.1241 | 0.0435 | 0.0253 |
| *City route without license renewal* | | |
| 0.0882 | 0.0425 | 0.0815 |
| *City route with license renewal* | | |
| 0.1324 | 0.0635 | 0.123 |

[a] Transportation risks were calculated using RADTRAN (v. 4.0.19, Nov. 14, 1996).
[b] For crew members, the dose conversion factor was 0.0004 estimated lifetime risk of fatal cancer (LRFC) per person-rem, and for the public, 0.0005 LRFC per person-rem. The U.S. average lifetime risk of fatal cancer from all causes is approximately 0.20.
[c] Truck crew size was assumed to be 2 persons. Crew risk is for the time spent driving approximately 161 km (100 miles) in the Las Vegas area; the risk involved in driving to the Las Vegas area is not included.
[d] The incident-free risk to the public does not include the risk to the crew.

The highest estimated risk to the crews is 0.2324 LRFC. This already-small risk is spread over the 40- to 60-year period during which SNF will be transported to the repository. On an annual basis, the crew risk averages about 0.0039 LRFC per year of SNF transport as a result of radiation exposures. This risk is spread among all the truck crew members, so the risk to any one driver is extremely small.

The hypothetical maximally exposed individual would receive 0.31 mSv [31 mrem] for a 60-year campaign, about 0.12 percent of the average 70-year dose from background sources.[5] The maximally exposed individual radiation dose is based on a hypothetical individual located 30 m [98 ft] from the highway during the entire shipment campaign (a very conservative assumption). This dose is the estimated risk from incident-free transport. The analysis overestimates impacts by assuming that all licensed nuclear power plants would operate for a 20-year license renewal term, although many plants will not renew their operating licenses. Also, if another repository were established, the already small effects on Las Vegas would be further reduced.

The above estimates of radiation dose are consistent with the doses reported in Table S-4. Table S-4 reports estimates of 0.04 person-Sv [4 person-rem] per reactor year for transportation workers, and 0.03 person-Sv [3 person-rem] per reactor year for the general public. Assuming that 100 power reactors operate for 60 years, Table S-4 leads to estimated worker and public doses of 240 person-Sv [24,000 person-rem] and 180 person-Sv [18,000 person-rem] for transportation workers and the general public, respectively. Comparing these dose estimates with the highest corresponding doses in Table 1 shows that the estimated cumulative dose from transportation of all SNF through the Las Vegas area is not greater than one percent of the cumulative dose from all fuel and waste transportation calculated from Table S-4.

Consequently, the cumulative doses for the Las Vegas area only a small fraction of the cumulative doses implied by Table S-4 for all transportation of SNF plus transportation of other nuclear power plant radwastes. It should be noted that the cumulative doses for both sets of estimates are comprised of annual doses to individuals that are well below the regulatory limits set by the NRC and by the Department of Transportation.

### 2.3.2 Nonradiological Risks

The nonradiological impact of concern is vehicle collisions. Based on recent national average truck accident rates, between 12 and 20 vehicle accidents can be expected during SNF transport through the Las Vegas area. The probability of a fatality from nonradiological transportation accidents is estimated to be about 0.023 without license renewal and about 0.035 with license renewal (see Appendix, Table A.2). These very low risks are smaller than the radiological risks of SNF transport in the Las Vegas area. Over a 40- or 60-year period, these risks amount to very small annual risks; approximately 0.0006 per year (with or without license renewal).

[5]The background radiation dose is assumed to be 3.6 mSv/year [360 mrem/year], the current estimate given for average background radiation dose in the U.S. The value is based upon the following assumptions from the National Council on Radiation Protection and Measurements as summarized in Eisenbud and Gesell (1997). Doses are given in mSv/year:

| | |
|---|---|
| Cosmic radiation that reaches the earth at sea level | 0.27 |
| Radiation from the natural elements in the earth | 0.28 |
| Radon gas in the home from ground sources | 2.00 |
| Radiation in the human body from food and water | 0.39 |
| Average medical exposure | 0.25 to 0.55 |
| Consumer products (e.g., smoke detectors) | 0.10 |

## 2.4 CONCLUSIONS

As shown in Table 2, the conservatively estimated LRFC resulting from radiation exposure related to transportation of SNF in the Las Vegas area much less than one, with or without license renewal. For comparison, about 25 percent of the Las Vegas population is expected to develop a fatal cancer from causes unrelated to SNF transport. The estimates produced by this analysis do not appreciably change the cumulative dose estimates in Table S-4.

Nonradiological truck-vehicle accidents are possible as a result of transporting SNF through Las Vegas. The probability of a fatality is estimated to be less than 0.04 under all scenarios. For license renewal, the combined radiological and nonradiological risk to the public is estimated to be between about 0.10 and 0.22 fatalities over the course of SNF transport through Las Vegas, including incident-free and accident risks. Without license renewal, the combined probability of a fatality is estimated to be between about 0.07 and 0.15.

The above analysis shows that even with conservative assumptions, the cumulative radiological and accident risks of SNF transport in the vicinity of Las Vegas are within regulatory limits and small. It also shows that there are opportunities to further reduce human health impacts. Transporting SNF by rail rather than by truck would reduce human health effects by reducing the number of shipments and the likelihood of accidents. Shipping SNF via the proposed beltway would reduce health impacts compared to shipping via the current interstate highway system. However, because DOE will address transportation impacts, mitigation measures, and alternative transportation modes in its EIS for the proposed repository at Yucca Mountain, mitigation is not appropriate for consideration as a part of license renewal decisions.

# 3. IMPLICATIONS OF HIGHER BURNUP FUEL FOR THE CONCLUSIONS IN TABLE S-4

## 3.1 BACKGROUND

The rule promulgated in 61 FR 66537 gave license renewal applicants the responsibility to comply with the existing requirements of 10 CFR 51.52. Section 51.52(a) specifies six conditions that must be met in order for an applicant to adopt the values in Table S-4, which represent the contribution of transportation to the environmental costs of licensing the reactor. If the six conditions are not met, an applicant must submit a full analysis of the environmental impacts of transportation of fuel and waste in accordance with §51.52(c). Two of the conditions limit the fuel enrichment level and the burnup rate. Paragraph 51.52(a)(2) requires a uranium-235 enrichment not exceeding 4 percent by weight in the fuel. Paragraph 51.52(a)(3) requires that "The average level of irradiation of the irradiated fuel from the reactor does not exceed 33,000 megawatt-days per metric ton, and no irradiated fuel assembly is shipped until at least 90 days after it is discharged from the reactor." These two limiting conditions have been exceeded through nuclear power plant license amendments permitting incremental increases in the burnup of fuel. During the 1990s, the NRC has reviewed and approved vendor topical reports requesting approval for higher burnup rates. (Letter from M. J. Virgilio, NRC, to N. J. Liparulo, Westinghouse Electric Corporation, "Acceptance for Referencing of Topical Report WCAP-12488, 'Westinghouse Fuel Criteria Evaluation Process," dated July 27, 1994; FCF-BAW 10186P-A, "Extended Burnup Evaluation," June 12, 1997; and Memorandum from T. E. Collins to B. W. Sheron, "Waiver of CRGR Review of EMF-85-74(P), Revision O, Supplements 1 and 2 Safety Evaluation," dated February 9, 1998). Approved average burnup for the peak rod now ranges from 50,000 to 62,000 MWd/MTHM. The higher burnup rates are associated with uranium-235 enrichment levels of up to 5 percent by weight. Thus, it is likely that at the time of a submittal of a license renewal application, many nuclear power plants will be operating at higher fuel burnup and will be using higher enrichment fuel.

## 3.2 ANALYSIS

The environmental consequences of incremental increases in the burnup of fuel and the associated use of higher enrichment fuel is discussed with respect to Table S-3 and Table S-4 on pages 6-24 and 6-25 of the GEIS. This discussion is based on the analyses in NUREG/CR-5009, which reviews the physical effects of extended burnup on

the fuel and the fuel assemblies and the associated potential for impacts during normal operation and accident events. The environmental effects were reviewed for each stage of the fuel cycle, including transportation of enriched fuel to reactors and extended burnup of SNF from reactors. This issue is discussed in Section 6.2.3 of the GEIS, which addresses the sensitivity of values in Table S-3 and in Table S-4 to recent changes in the fuel cycle, including higher burnup fuel and the use of higher enrichment fuel. The discussion relative to Table S-4 was not repeated in Section 6.3, which specifically addresses the incremental impacts of license renewal on the transportation of fuel and radioactive materials to and from nuclear power plants. Because of that omission, this supplemental treatment has been developed to clarify the public record regarding the Commission's findings on the sensitivity of values in Table S-4 to the use of higher enrichment fuel and extended fuel burnup.

Concurrent with the publication of NUREG/ CR-5009, the Commission published a notice: *Extended Burnup Fuel Use in Commercial LWRs; Environmental Assessment and Finding of No Significant Impact* (53 *Fed. Regist.* 6040). The environmental assessment was based on NUREG/CR-5009, an Atomic Industrial Forum report (AIF/NESP-032), and NUREG/CR-2325. On the basis of these studies, the staff concluded

> ". . .that the environmental impacts summarized in Table S-3 of 10 CFR 51.51 and in Table S-4 of 10 CFR 51.52 for a burnup level of 33 GWd/MtU are conservative and bound the corresponding impacts for burnup levels up to 60 GWd/ MtU and uranium-235 enrichments up to 5 percent by weight" (53 FR 6040).

The staff further concluded that a finding of no significant impact was supported by the collective studies:

> "The NRC staff has reviewed the anticipated widespread use of extended burnup fuel in commercial LWRs. Based upon the foregoing environmental assessment, the staff concluded that there are no significant adverse radiological or nonradiological impacts associated with the use of extended burnup fuel and that this use will not significantly affect the quality of the human environment" (53 FR 6040).

Subsequently, the staff has continued to perform plant-specific environmental assessments in reviews to raise fuel enrichment level, burnup rate, and longer fuel cycle limits in Operating Licenses and plant Technical Specifications. These assessments rely on the programmatic environmental assessment in 53 FR 6040 and on a staff assessment entitled *NRC Assessment of the Environmental Effects of Transportation Resulting From Extended Fuel Enrichment and Irradiation*, which was published in the *Federal Register* on Aug. 11, 1989 (53 FR 30355) in connection with the Shearon Harris Nuclear Power Plant, Unit 1, Environmental Assessment and Finding of No Significant Impact.

In assessing the environmental effects of transportation for 53 FR 30355, the staff reviewed the analyses in four studies (NUREG/CR-5009, NUREG/CR-2325, AIF/NESP-032, and WASH-1238) and compared the findings with the impacts given in Table S-4. The staff concluded that

> "The above evaluation sets forth the changes resulting from increased enrichment (up to 5 weight percent) and extended irradiation (up to 60 GWd/MT), in the environmental impacts of transportation of fuel and wastes to and from the light water reactors set forth in Table S-4, 10 CFR Part 51. The values set forth in this detailed analysis represent the contribution of the environmental effects of transportation of fuel enriched with uranium-235 above 4 weight percent and up to 5 weight percent, and irradiated to levels above 33 GWd/MT and up to 60 GWd/MT to the environmental costs of operating the reactors. As shown above, the environmental cost contributions of the stated increases in fuel enrichment and irradiation limits are either unchanged or may in fact be reduced from those summarized in Table S-4, as set out in 10 CFR 51.52(c)" (53 FR 30355).

In 53 FR 30355, the staff further stated that, until Table S-4 is revised to include the higher fuel enrichment and irradiation levels, it proposed to accept the analysis of the environmental effects of the transportation of such fuel and waste presented in that notice.

The values in Table S-4 and in the assessment of extended burnup fuel are calculated as annualized reference reactor year values. Because these values are independent of the number of years any given reactor operates, they apply to the license renewal period as well as to the period of the initial operating license.

### 3.3 CONCLUSIONS

The staff has extensively studied the environmental impacts associated with fuel enrichment up to 5 percent uranium-235 and fuel burnup to 60,000 MWd/MTU and has found that these impacts are no greater than and likely less than the impacts currently in 10 CFR 51.52(c). The analysis in the GEIS is consistent with the staff assessment of the environmental effects of transportation resulting from extended fuel enrichment and irradiation presented in 53 FR 30355. These findings are robust. Further, the staff has reviewed and approved vendor topical reports requesting average burnup for peak rod ranging from 50,000 to 62,000 MWd/MTHM. The higher burnup rates are associated with uranium-235 enrichment levels of up to 5 percent by weight. An increase in burnup from 60,000 Mwd/MTHM to 62,000 Mwd/MTHM will not significantly change dose levels associated with spent fuel transportation and may slightly reduce the number of shipments. Therefore, these conclusions are applicable to any nuclear power plant license renewal application. Further, these conclusions provide the bases for revision of 10 CFR 51.52(a)(2) and (3).

# 4. SUMMARY AND CONCLUSIONS

This addendum to the GEIS assesses (1) the cumulative impacts of transportation of high-level radioactive waste, specifically SNF, in the vicinity of the proposed repository at Yucca Mountain, Nevada, and (2) the impacts of transporting higher burnup fuel. The conclusions reached in these assessments provide the bases for revising the findings and the category designation of the Transportation issue in Table 9.1, "Summary of findings on NEPA issues for license renewal of nuclear power plants," of NUREG-1437. The findings and category designation for the transportation issue (NUREG-1437, p. 9-15) is revised as follows:

| Issue | Sections | Category | Findings |
|---|---|---|---|
| Transportation | Addendum 1, 2.4 3.3 | 1 | SMALL. The environmental impacts presented in Summary Table S-4 of Part 51.52 may be adopted in individual nuclear power plant license renewal reviews as long as the candidate site at Yucca Mountain is under consideration for licensing. The contribution to impacts of transportation of higher enrichment and higher burnup fuel need be assessed only when the fuel to be used during the license renewal term is enriched to greater than 5 percent uranium-235 or average burnup for the peak rod will be greater than currently approved by the NRC up to 62,000 MWd/MTU. If the applicant anticipates exceeding these values for enrichment or burnup during the renewal term and has received or applied for a license amendment for the values anticipated and an environmental assessment has been prepared by the NRC, which considers transportation of that fuel to and from the reactor, then that environmental assessment may be cited in the renewal application and no further information is required. |

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# APPENDIX

## Cumulative Impacts from the Transportation of Spent Nuclear Fuel in the Vicinity of Las Vegas, Nevada, Associated with Nuclear Reactor License Renewal

### Introduction

The purpose of this analysis is to supplement the analysis of transportation impacts in NUREG-1437 with estimates of cumulative radiological exposure and health risk resulting from spent nuclear fuel (SNF) shipments in the vicinity of the proposed high-level waste repository at Yucca Mountain, Nevada. The analysis addresses the impacts of transporting SNF generated by nuclear power plants during their initial license period, plus transporting SNF generated during a 20-year license renewal term. Conservative (i.e., overestimating) assumptions are used to ensure that the potential impacts are not underestimated.

This study describes the transportation risk assessment performed using the HIGHWAY routing code and the RADTRAN 4 risk assessment code to determine the cumulative transportation impacts near the Las Vegas area associated with the transport of commercial SNF to a proposed repository at Yucca Mountain, Nevada. The study considers the effects of nuclear reactor license extension that would extend existing 40-year operating licenses an additional 20 years and thus increase the amount of SNF being transported to a repository. The cumulative impacts considered were human health effects associated with both normal (incident-free) transport and with potential accidents severe enough to release radioactive material.

The focus of the analysis is on truck transportation since transport by rail would be expected to pose less risk to the general public. Rail lines tend to be located farther away from higher population densities than the comparable highway routes, rail transport allows a far greater payload and thus significantly reduces the number of shipments required, and the risk of accidents is less for rail shipments. When accident rates between truck and rail shipments are normalized for payload size and mileage, the accident rate for rail shipments is about 3 percent of the comparable accident rate for truck shipments (Dyer 1993).

For purposes of this analysis, it is assumed that all SNF generated by nuclear power plants is disposed of at Yucca Mountain. Current law prohibits NRC from licensing DOE's disposal of more than 70,000 metric tons (68,790 long ton) of heavy metal in a repository until a second repository is in operation. If another repository were established to accept additional SNF, the impacts on the area around the Yucca Mountain repository would be smaller than those estimated here because some of the SNF assumed to go to Yucca Mountain would go elsewhere.

## Background on the HIGHWAY Model

The HIGHWAY computer code model (Joy 1983) was used to select routes and analyze each transportation scenario. The HIGHWAY model is designed to simulate routes on the highway system in the United States The data base includes all interstates, most U.S. highways, and many roadways with state, county, or local classifications. It represents about 380,000 km [240,000 miles] of roadway. Several different routing options are available in the highway program, including probable commercial routes, routes on the interstate highway system, and routes that bypass major urbanized areas. Additional detailed routing analysis can be performed by blocking individual or sets of highway segments or intersections contained in the data base.

The selection of preferred routes assumes that each shipment consists of highway-route-controlled quantities of radioactive materials. Travel time is optimized based on maximum utilization of the interstate highway system, with preference given to bypasses around major cities, except where alternate routes have been designated by state or local officials. Selected output pages from the HIGHWAY computer code model are given in Attachment 1. These output pages supply additional information, including a detailed listing of each highway route as well as mileage and population density zones.

## Analysis of Routes Using the HIGHWAY Model

The total travel distance and the fraction of travel in each population density zone are necessary inputs to the RADTRAN 4 code and are given in Table A.1. The routing data from the HIGHWAY model, which makes use of 12 population density zones, have been collapsed into 3 zones (i.e., rural, suburban, and urban) to simplify the analysis performed by the RADTRAN code.

Factors such as population density, accident rates, and vehicle speed can be varied for different zones. Each population zone, along with an associated road type,

**Table A.1. Transportation route parameters used in RADTRAN analysis [a]**

| Roadway population density zone [b] | Distance (km) | Average population density (persons/km$^2$) |
|---|---|---|
| *Las Vegas N. bypass route* | | |
| Rural | 157.6 | 2.2 |
| Suburban | 8.2 | 357 |
| Other | 0 | 0 |
| Total | 165.8 | |
| *Las Vegas city route* | | |
| Rural | 153.8 | 1.7 |
| Suburban | 17.7 | 568 |
| Other | 5.4 | 2295 |
| Total | 176.9 | |

[a] Based on HIGHWAY analysis (see Attachment 1 to this appendix).

[b] "Rural" is defined as populations less than 54 persons/km$^2$. "Suburban" is defined as population densities between 54 and 1284 persons/km$^2$. "Urban" is defined as population densities greater than 1284 persons/km$^2$.

make up a RADTRAN 4 transport link. Population density estimates for the transport routes were based on 1990 Census data. The staff assumed that population growth of the Las Vegas area would occur primarily by expansion of urban and suburban areas, rather than increasing population densities. For the beltway route, population densities were assumed to be similar to those of other urban and suburban areas of Las Vegas to account for population growth induced by development of the beltway.

**The Proposed Las Vegas Beltway**

This section contains background information on the proposed Las Vegas beltway including a schematic shown in Figure A.1. Information in this section was obtained from the Clark County Department of Public Works World Wide Web page (Clark County 1997). The planned beltway will eventually consist of three connected segments including a southern, western, and northern route which together will create a freeway "ring" around the Las Vegas Valley to take vehicles around, rather than through, the congested urban core.

The southern segment of the beltway is being built in sections, with each segment opening to traffic upon completion. The first phase of the project, from I-15 to McCarran Airport (Airport Connector), was opened in 1994. Work on the second section, from Warm Springs Road to Windmill Lane, opened to traffic in Oct. 1995. In Feb. 1997, the third portion of the project—from Windmill Lane to Eastern Ave.—became fully operational. The fourth section of the southern beltway, Eastern Ave. to Pecos Road, was completed in 1997.

The proposed northern and western beltway may ultimately be a 10-lane facility (a combination of mixed use and high-occupancy vehicle lanes) with adequate right-of-way to permit construction of a fixed guideway facility. This is called the "ultimate facility" and will require a right-of-way width of 107 to 137 m [350 to 450 ft], plus land for interchanges or access to other transportation facilities. The planning horizon used for this transportation facility is 20 years. It is anticipated that within the next 20 years, a 4-lane freeway between

Tropicana Ave. and Decatur Blvd. and a 4-lane arterial with signalized intersections at future inter-change locations will be needed between Decatur Blvd. and I-15 in North Las Vegas.

**Cumulative Impacts of Spent Fuel Transportation in the Las Vegas Area**

This section describes the analysis of cumulative impacts associated with the transport of SNF to the repository near Las Vegas, Nevada. The methodology of the risk assessment is presented, along with an analysis of the transportation routes, a characterization of the SNF, a description of the RADTRAN 4 code used to perform the radiological risk assessment, and a summary of cumulative transportation risks.

There are four transportation scenarios considered in this analysis, consisting of two routes, each with and without license renewal shipment volumes. The first route assumes that fuel will be shipped around the urban Las Vegas area using the proposed beltway, and the second route assumes that the shipments will be routed through the center of the city using the existing interstate system. It was assumed that with license renewal, the shipment volume of SNF would increase 50 percent. Without license renewal, the estimated number of SNF shipments was 50,185. With license renewal, shipments were assumed to increase to 75,278. No consideration was given to the SNF volume limits being considered for the proposed repository. If such limits were maintained,


**Figure A.1. Proposed Las Vegas beltway.** *Source:* Clark County Department of Public Works informational drawing, http://www.co.clark.nv.us/PUBWORKS/gif/beltmap.jpg (accessed Oct. 14, 1997).

the risks calculated by this study would decrease accordingly. In addition, for the license renewal scenarios, it was assumed that population density along the beltway would increase because of future growth and expansion. Population density within the city center was assumed not to increase. It was assumed that growth in population density along the new beltway would increase about 30 percent above 1990 Census levels because there will be ample room and newly created access routes.

SNF was assumed to be packaged in the General Atomics Corp. GA-4 and GA-9 legal-weight truck transportation casks (DOE 1990; GA 1991) because they are the only legal-weight spent fuel casks that are close to being certified, and because larger casks that are being considered for certification would lead to lower dose estimates (i.e., less conservative dose estimates.) Radiological characteristics of the SNF were obtained from an analysis of the characteristics of potential repository wastes (DOE 1992). Table S-4 (10 CFR 51) was based on the assumption that the legal-weight truck was 33,182 kg [73,000 lb]; the current legal-weight limit is 36,364 kg [80,000 lb]. Higher-legal-weight trucks allow fewer shipments and lower risks.

## Truck Fatalities, Injuries and Accidents

The staff estimated the number of nonradiological truck accidents that may occur during the transport of SNF to the repository. A nonradiological accident is defined as a truck accident in which the injuries or fatalities are caused by the force of the impact; no release of or exposure to radiological materials occurs as a result of the truck accident. This is the most common type of accident expected to occur. Data on national accident statistics have been compiled from a number of sources by the U.S. Department of Transportation (DOT), Bureau of Transportation Statistics, between 1975 and 1995. Since 1990, data have been collected on the number of accidents, injuries, and fatalities per 100 million truck-miles (DOT 1997). Based upon the accident rate data from 1990 to 1995, the average rate of large truck accidents is 373 per 100 million truck-km [233 per 100 million truck-miles], the average rate of injury is 34 per 100 million truck-km [21 per 100 million truck-miles], and the average fatality rate is 0.67 per 100 million truck-km [0.42 per 100 million truck-miles]. On the basis of these statistics—along with the HIGHWAY route data—the expected number of nonradiological accidents, injuries, and fatalities is calculated as shown in Table A.2 for shipments during the 40-year (without license renewal) and 60-year (with license renewal) repository operations period.

**Table A.2. Truck fatalities, injuries, and accidents[a]**

| Fatalities | Injuries | Accidents |
|---|---|---|
| *Bypass without license renewal* | | |
| 0.022 | 1.09 | 12.0 |
| *Bypass with license renewal* | | |
| 0.033 | 1.63 | 18.1 |
| *City without license renewal* | | |
| 0.023 | 1.16 | 12.9 |
| *City with license renewal* | | |
| 0.035 | 1.74 | 19.3 |

[a] Estimates are based on mileages from HIGHWAY and rates from USDOT (1997).

## Background on the RADTRAN Model

The RADTRAN 4 computer code (Neuhauser 1984, 1992) was used to model the incident-free radiological exposure and the consequences of radiological releases resulting from accidents. The incident-free risks are dependent on the radiation dose rate from the shipment, number of shipments, package dimensions, route distance, vehicle speed, and population densities along the travel routes. The accident risks are dependent on the radiological inventory, accident severity, probability of occurrence for each accident category, and the amount of inventory released, aerosolized, and inhaled, as well as the dispersibility of the waste form.

For incident-free transportation, RADTRAN calculates total body doses for the transport crew and the general population. The radiation source is characterized for RADTRAN by the radiation dose rate at 1 m from the package surface. The regulatory limit is 0.1 mSv/hour [10 mrem/hour] at 2 m (6.6 ft) from the container surface. The 0.10 mSv/hour [10-mrem/hour] at 1 m (3.3 ft) rate (which corresponds to about 0.07 mSv/hour [7 mrem/hour] at 2 m (6.6 ft)) was assumed because most shipments are not expected to be close to regulatory limit, so the average dose rate was assumed to be lower than the regulatory limit.[1]

[1]10 CFR 71.47 also limits dose rate at any point on the outer surface of the package or vehicle to 2 mSv/hour [200 mrem/hour]. Doses rates at most parts of the surface would necessarily be much lower than 2 mSv/hour [200 mrem/hour] in order to meet the 0.10 mSv/hour [10 mrem/hour] at 2 m(6.6 ft) limit. To be exposed to a dose rate this high, an individual would have to be in contact with the package at its most radioactive spot. To receive a significant dose, he or she would have to lie in contact with the container at its most radioactive spot for a substantial time period. It is very unlikely that an individual would spend any time in physical contact with the package and even more unlikely that he or she would inadvertently choose the most radioactive spot on the package. Because such an occurrence is so unlikely, this exposure scenario is not considered relevant to the cumulative impacts analysis.

Both point- and line-source approximations were used based upon the distance between the exposed individuals and the radiation source. Each truck shipment of multiple fuel assemblies was modeled as a single package with a homogeneous distribution of the radiological inventory. The characteristic dimension (known in RADTRAN as the variable PKGSIZ) is the largest linear dimension of the configuration and is used in the line-source approximation to calculate total dose; 5 m [16.5 ft] was the assumed length of the source. Because transport casks are designed to absorb most neutron radiation and because neutron radiation is absorbed by the air in short distances, the radiation dose to the public from the casks was assumed to consist entirely of gamma radiation for calculation of the incident-free dose.

RADTRAN uses a dispersibility category that is based on the chemical and physical properties of the radiological inventory to determine the fractions of the total inventory that are aerosolized and respirable, and it contains default values for aerosolized and respirable fractions of the total inventory based on the assignment of dispersibility category. The user assigns a dispersibility category to each material and chooses release fractions based on the type of package as a function of accident severity.

Accident risks include acute fatalities and latent cancer fatalities (chronic) for both the current and future generations. The accident risk (expected value of dose from accidents) is the summation of the products of estimated dose for each accident severity category and the associated probability of occurrence for the category.

### Transportation Risk Assessment Using RADTRAN 4

The radiological health effects were estimated for two transportation routes (through Las Vegas on the current interstate system and on the proposed bypass) and for two license renewal scenarios [no license renewal (50,185 shipments) and all plants operate through one license renewal term (75,278 shipments)]. Table A.3 lists the estimated lifetime risk of fatal cancer (LRFC) for shipments of SNF expected to result from radiation exposure during incident-free transportation and accidents. Radiation doses to the population and truck crews were converted to LRFC using the upper limit risk coefficient suggested by the National Academy of Sciences (ICRP 1991; NAS 1990).

**Table A.3. Cumulative radiological transportation risks in the Las Vegas area [a]**

| Estimated lifetime risk of fatal cancer [b] | | | |
|---|---|---|---|
| | Incident-free risk | | Accident risk |
| | Crew [c] | Public [d] | Public |
| *Bypass without license renewal* | | | |
| | 0.0827 | 0.0290 | 0.0169 |
| *Bypass with license renewal* | | | |
| | 0.1241 | 0.0435 | 0.0253 |
| *City without license renewal* | | | |
| | 0.0882 | 0.0425 | 0.0815 |
| *City with license renewal* | | | |
| | 0.1324 | 0.0635 | 0.123 |

[a] Transportation risks were calculated using RADTRAN (v. 4.0.19, Nov. 14, 1996).

[b] The dose conversion factor for crew members was 0.04 estimated lifetime risk of fatal cancer (LRFC) per person-Sv [0.0004 LRFC/person-rem] and for the public, 0.05 LRFC/person-Sv [0.0005 LRFC/person-rem]. The U.S. average lifetime risk of cancer from all causes is approximately 0.25.

[c] Truck crew size was assumed to be 2 persons. Crew risk is for the time spent driving approximately 161 km (100 miles) in the Las Vegas area; the risk involved in driving to the Las Vegas area is not included.

[d] Incident-free risk to the total population does not include the risk to the crew.

The NAS report (1990, Table 4-2), commonly called the BEIR V report, gives statistics on the number of cancer deaths expected to occur from a continuous exposure of 10 mSv/year [1 rem/year] above background from age 18 until age 65. This value results in a risk factor of $4.0 \times 10^{-2}$ per person-Sv [$4.0 \times 10^{-4}$ LRFC per person-rem] that is most applicable to occupational exposures. The BEIR V report also considers the number of

cancer deaths expected to occur from a continuous lifetime exposure of 1 mSv/year [0.1 rem/year] above background,[2] which results in a risk factor of $5.0 \times 10^{-2}$ LRFC per person-Sv [$5.0 \times 10^{-4}$ LRFC per person-rem] that is most applicable to exposures of the general public. Note that even though the assumed general public exposure is less than the assumed occupational exposure, the general public LRFC risk factor is slightly higher—because the general public dose is assumed to be received by people of all ages rather than just by people in the workforce from age 18 until age 65. The younger population is more sensitive to radiation-induced health effects.

The results (Table A.3) show that the radiological risks of the truck shipments of SNF are low. The LRFC expected from the calculated exposures would not exceed 0.1324 LRFC for the crews or 0.0635 LRFC for members of the public exposed during incident-free transportation of SNF. It was assumed that each 2-person crew would perform 1 shipment per week over the lifetime of the 40- to 60-year shipment campaign (a very conservative assumption).

Even the hypothetical maximally exposed individual would receive only a small lifetime radiation dose due to SNF transport in the Las Vegas area. The maximally exposed individual radiation dose is based on exposure during incident-free transport to a hypothetical individual located 30 m (100 feet) from the highway during the entire shipment campaign. This is a very conservative assumption because the hypothetical person would have to live an entire life at the same spot to receive the calculated dose. The hypothetical maximally exposed individual would receive 0.31 mSv [31 mrem] for the entire campaign, which is 8.6% of the 3.6-mSv [360-mrem] average annual effective dose received from natural background radiation sources, or 0.12% of a 70-year dose from natural background sources.

The results of the RADTRAN analysis (Attachment 2) indicate that there would be no fatalities from acute radiation exposure as a result of the release of radioactive material from even the most severe hypothetical SNF transportation accident. The largest population risk due to radiological accidents for any of the SNF transportation scenarios would be 0.123 LRFC (Table A.3).

Attachment 2 provides a listing of selected pages from the RADTRAN 4 output files for each scenario including all necessary input parameters to duplicate the analysis, the incident-free summary showing the population exposure in person-rem along with the maximum individual in-transit dose, and the expected values of population risk in person-rem as a result of accidents.

The risk estimates listed on Table A.3 must be viewed in proper perspective. While the estimated risks are low, they are higher than usually seen for SNF shipments because of the extremely high volume of shipments assumed to pass through Las Vegas for purposes of this analysis. In addition, the analysis conservatively assumed that all

[2]The background radiation dose is assumed to be 3.6 mSv/year [360 mrem/year], the current estimate given for average background radiation dose in the U.S. The value is based upon the following assumptions from the National Council on Radiation Protection and Measurements as summarized in Eisenbud and Gesell (1997). Doses are given in mSv/year:

| | |
|---|---|
| Cosmic radiation that reaches the earth at sea level | 0.27 |
| Radiation from the natural elements in the earth | 0.28 |
| Radon gas in the home from ground sources | 2.00 |
| Radiation in the human body from food and water | 0.39 |
| Average medical exposure | 0.25 to 0.55 |
| Consumer products (e.g., smoke detectors) | 0.10 |

shipments would move by truck. In reality, many shipments are expected to move by rail which would significantly reduce the risk.

The study shows that use of the Las Vegas bypass would reduce the risk to the public. The analysis is also conservative because it assumes that virtually all licensed nuclear power plants would operate for a 20-year license renewal term; many plants will not renew their operating licenses. Finally, if another repository were established, the already small effects on Las Vegas would be further reduced.

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## Attachment 1. Listings of HIGHWAY routes examined in this study.

The following listings of the routes examined for this study have been captured from the HIGHWAY computer routing model developed at Oak Ridge National Laboratory (Joy 1983).

**Route 1. From I-15 northeast of Las Vegas through the spaghetti bowl.**

```
From: OVERTON        N  I15  X93  NV      Leaving : 10/02/97 at  9:14 PDT
to  : MERCURY        S  U95  LOCL NV      Arriving: 10/02/97 at 11:08 PDT

Route type: C with  2 driver(s)                      Total road time:  1:54
  Time bias:   .70  Mile bias:   .30  Toll bias:  1.00   Total miles:  110.0

The following constraints are in effect:
 1 - Links prohibiting truck use
 7 - Avoid ferry crossings
State mileage:
 NV  110.0
Mileage by highway sign type:
    Interstate:   51.0   U.S.:   59.0  State:      .0  Turnpike:      .0
        County:     .0  Local:     .0  Other:      .0
Mileage by highway lane type:
    Limited Access Multilane:   52.0  Limited Access Single Lane:      .0
          Multilane Divided:   58.0        Multilane Undivided:      .0
    Principal Highway:      .0    Through Highway:      .0   Other:      .0

From: OVERTON        N  I15  X93  NV      Leaving : 10/02/97 at  9:14 PDT
to  : MERCURY        S  U95  LOCL NV      Arriving: 10/02/97 at 11:08 PDT

  Routing through:
    .0             OVERTON        N  I15  X93  NV      .0   0:00  10/02 @  9:14
  51.0 I15         LAS VEGAS                    NV    51.0   0:47  10/02 @ 10:01
   1.0 [illegible]5  LAS VEGAS     W  U95  U95B NV    52.0   0:48  10/02 @ 10:02
   7.0 U95BU       LAS VEGAS      NW U95  U95B NV    59.0   0:59  10/02 @ 10:13
  51.0 U95         MERCURY        S  U95  LOCL NV   110.0   1:54  10/02 @ 11:08

Population Density from: OVERTON        N  I15  X93  NV
                    to : MERCURY        S  U95  LOCL NV

          ------------------ Mileage within Density Levels -------------------
                  <0.0   5.0  22.7  59.7   139   326   821  1861  3326  5815
St Miles     0  -5.0 -22.7 -59.7  -139  -326  -821 -1861 -3326 -5815 -9996 >9996
-------------------------------------------------------------------------------

NV 110.0 45.7  27.3  21.9    .3    .4   1.0   2.1   4.7   3.3   2.1   1.0    .3

Totals
   110.0 45.7  27.3  21.9    .3    .4   1.0   2.1   4.7   3.3   2.1   1.0    .3
Percentages
        41.5  24.8  19.9    .2    .4    .9   1.9   4.3   3.0   2.0    .9    .2
Basis: 1990 Census
Do you want RADTRAN input data (Y/n) ?

   RADTRAN Input Data      Rural Suburban    Urban

   Weighted Population
        People/sq. mi.       4.4   1471.7   5945.2
        People/sq. km.       1.7    568.2   2295.4

   Distance                                    Total
        Miles               95.6     11.0      3.4    110.0
        Kilometers         153.8     17.7      5.4    177.0
        Percentage          86.9     10.0      3.1

   Basis (people/sq. mi.)   <139 139-3326    >3326   1990 Census

   Note: Due to rounding, the sum of the mileages in the individual
         population categories may not equal the total mileage shown
         on this report.
```

**Route 2. From I-15 south of Las Vegas through the spaghetti bowl.**

```
From: NIPTON          W  I15  S164 CA      Leaving : 10/01/97 at 16:37 PDT
to  : MERCURY         S  U95  LOCL NV      Arriving: 10/01/97 at 18:38 PDT

Route type: Q with  2 driver(s)                          Total road time:  2:01
  Time bias:  1.00  Mile bias:   .00  Toll bias:  1.00   Total miles:  111.0

The following constraints are in effect:
 1 - Links prohibiting truck use
 6 - HM-164/State preferred routes
 7 - Avoid ferry crossings
11 - Nonintersecting Interstate Access
Weighting used with preferred highways: 10.0
State mileage:
 NV  101.0  CA   10.0
Mileage by highway sign type:
    Interstate:   52.0   U.S.:   59.0  State:      .0  Turnpike:      .0
       County:      .0  Local:     .0  Other:      .0
Mileage by highway lane type:
    Limited Access Multilane:   53.0  Limited Access Single Lane:      .0
          Multilane Divided:   58.0         Multilane Undivided:      .0
    Principal Highway:      .0    Through Highway:      .0   Other:      .0

From: NIPTON          W  I15  S164 CA      Leaving : 10/01/97 at 16:37 PDT
to  : MERCURY         S  U95  LOCL NV      Arriving: 10/01/97 at 18:38 PDT

  Routing through:
    .0              NIPTON          W  I15  S164 CA       .0   0:00  10/01 @ 16:37
  52.0 I15          LAS VEGAS                  NV       52.0   0:54  10/01 @ 17:31
   1.0 U95          LAS VEGAS       W  U95  U95B NV     53.0   0:55  10/01 @ 17:32
   7.0 U95BU        LAS VEGAS       NW U95  U95B NV     60.0   1:06  10/01 @ 17:43
  51.0 U95          MERCURY         S  U95  LOCL NV    111.0   2:01  10/01 @ 18:38

Population Density from: NIPTON          W  I15  S164 CA
                    to : MERCURY         S  U95  LOCL NV

          ------------------ Mileage within Density Levels -------------------
                <0.0   5.0  22.7  59.7   139   326   821  1861  3326  5815
St Miles     0  -5.0 -22.7 -59.7  -139  -326  -821 -1861 -3326 -5815 -9996 >9996
-------------------------------------------------------------------------------

NV 101.0 19.7  51.3  13.7    .9   1.8   3.0   2.6   4.2   2.0   1.0   1.0    .0
CA  10.0   .0  10.0    .0    .0    .0    .0    .0    .0    .0    .0    .0    .0

Totals
   111.0 19.7  61.3  13.7    .9   1.8   3.0   2.6   4.2   2.0   1.0   1.0    .0
Percentages
        17.7  55.2  12.3    .8   1.6   2.7   2.3   3.8   1.8    .9    .9    .0
Basis: 1990 Census

RADTRAN Input Data       Rural Suburban    Urban

   Weighted Population
        People/sq. mi.       5.7   1108.7   6181.1
        People/sq. km.       2.2    428.1   2386.5
   Distance                                          Total
        Miles               97.3     11.7      2.0   111.0
        Kilometers         156.6     18.9      3.2   178.6
        Percentage          87.6     10.6      1.8

   Basis (people/sq. mi.)   <139 139-3326    >3326   1990 Census
```

Note: Due to rounding, the sum of the mileages in the individual population categories may not equal the total mileage shown on this report.

**Route 3. From I-15 northeast of Las Vegas using bypass.**

```
From: OVERTON        N  I15  X93  NV      Leaving : 10/01/97 at 16:40 PDT
to  : MERCURY        S  U95  LOCL NV      Arriving: 10/01/97 at 18:23 PDT

Route type: C with  2 driver(s)                        Total road time:  1:43
  Time bias:   .70  Mile bias:   .30  Toll bias:  1.00   Total miles:  103.0

The following constraints are in effect:
 1 - Links prohibiting truck use
 7 - Avoid ferry crossings
State mileage:
 NV  103.0
Mileage by highway sign type:
    Interstate:   43.0   U.S.:   48.0  State:      .0  Turnpike:      .0
       County:     .0  Local:     .0  Other:   12.0
Mileage by highway lane type:
    Limited Access Multilane:   55.0  Limited Access Single Lane:      .0
          Multilane Divided:   48.0          Multilane Undivided:      .0
    Principal Highway:      .0    Through Highway:      .0   Other:      .0

From: OVERTON        N  I15  X93  NV      Leaving : 10/01/97 at 16:40 PDT
to  : MERCURY        S  U95  LOCL NV      Arriving: 10/01/97 at 18:23 PDT

  Routing through:
    .0              OVERTON        N  I15  X93  NV      .0   0:00  10/01 @ 16:40
  43.0 I15          N LAS VEGAS    N  I15  BYPS NV    43.0   0:40  10/01 @ 17:20
  12.0 BYPAS        LAS VEGAS      NW U95  BYPS NV    55.0   0:51  10/01 @ 17:31
  48.0 U95          MERCURY        S  U95  LOCL NV   103.0   1:43  10/01 @ 18:23


Population Density from: OVERTON        N  I15  X93  NV
                    to : MERCURY        S  U95  LOCL NV

          ----------------- Mileage within Density Levels ------------------
              <0.0   5.0  22.7  59.7   139   326   821  1861  3326  5815
St Miles    0 -5.0 -22.7 -59.7 -139  -326  -821 -1861 -3326 -5815 -9996 >9996
-------------------------------------------------------------------------------

NV 103.0 45.8  28.1  22.0    .2   1.8    .7   2.4   1.6    .4    .0    .0    .0

Totals
   103.0 45.8  28.1  22.0    .2   1.8    .7   2.4   1.6    .4    .0    .0    .0
Percentages
         44.5  27.3  21.4    .2   1.7    .6   2.3   1.6    .4    .0    .0    .0
Basis: 1990 Census

RADTRAN Input Data      Rural Suburban    Urban

   Weighted Population
        People/sq. mi.      5.7    924.0      .0
        People/sq. km.      2.2    356.7      .0

   Distance                                          Total
        Miles              97.9      5.1      .0    103.0
        Kilometers        157.6      8.2      .0    165.8
        Percentage         95.0      5.0      .0

   Basis (people/sq. mi.)   <139 139-3326    >3326   1990 Census

   Note: Due to rounding, the sum of the mileages in the individual population
categories may not equal the total mileage shown on this report.
```

## Route 4. From I-15 south of Las Vegas using bypass.

```
From: NIPTON          W  I15  S164 CA      Leaving : 10/01/97 at 16:44 PDT
to  : MERCURY         S  U95  LOCL NV      Arriving: 10/01/97 at 18:48 PDT

Route type: C with  2 driver(s)                        Total road time: 2:04
  Time bias:   .70  Mile bias:   .30  Toll bias:  1.00   Total miles: 118.0

The following constraints are in effect:
 1 - Links prohibiting truck use
 7 - Avoid ferry crossings
State mileage:
 NV  108.0  CA   10.0
Mileage by highway sign type:
    Interstate:   44.0   U.S.:   48.0  State:      .0  Turnpike:      .0
        County:     .0  Local:     .0  Other:   26.0
Mileage by highway lane type:
    Limited Access Multilane:   70.0  Limited Access Single Lane:      .0
          Multilane Divided:   48.0         Multilane Undivided:      .0
    Principal Highway:      .0    Through Highway:      .0   Other:      .0

From: NIPTON          W  I15  S164 CA      Leaving : 10/01/97 at 16:44 PDT
to  : MERCURY         S  U95  LOCL NV      Arriving: 10/01/97 at 18:48 PDT

  Routing through:
    .0              NIPTON          W  I15  S164 CA       .0   0:00  10/01 @ 16:44
  44.0 I15          LAS VEGAS       SW I15  X34  NV     44.0   0:46  10/01 @ 17:30
  26.0 BYPAS        LAS VEGAS       NW U95  BYPS NV     70.0   1:12  10/01 @ 17:56
  48.0 U95          MERCURY         S  U95  LOCL NV    118.0   2:04  10/01 @ 18:48


Population Density from: NIPTON          W  I15  S164 CA
                    to : MERCURY         S  U95  LOCL NV

          ------------------ Mileage within Density Levels -------------------
                 <0.0   5.0  22.7  59.7   139   326   821  1861  3326  5815
St Miles    0   -5.0 -22.7 -59.7 -139  -326  -821 -1861 -3326 -5815 -9996 >9996
-------------------------------------------------------------------------------

NV 108.0 20.1  50.8  13.6   4.1   4.5   4.8   5.2   4.3    .6    .0    .0    .0
CA  10.0   .0  10.0    .0    .0    .0    .0    .0    .0    .0    .0    .0    .0

Totals
   118.0 20.1  60.8  13.6   4.1   4.5   4.8   5.2   4.3    .6    .0    .0    .0
Percentages
         17.0  51.5  11.5   3.5   3.8   4.1   4.4   3.6    .5    .0    .0    .0
Basis: 1990 Census
RADTRAN Input Data       Rural Suburban    Urban

   Weighted Population
        People/sq. mi.       9.3    766.5       .0
        People/sq. km.       3.6    295.9       .0

   Distance                                          Total
        Miles              103.1     14.9       .0   118.0
        Kilometers         165.9     24.0       .0   189.9
        Percentage          87.4     12.6       .0

   Basis (people/sq. mi.)   <139 139-3326    >3326   1990 Census

   Note: Due to rounding, the sum of the mileages in the individual population
categories may not equal the total mileage shown on this report.
```

**Attachment 2. Selected pages from the RADTRAN 4 computer code runs.**

```
RRRR     AAA    DDDD    TTTTT  RRRR     AAA    N   N
R   R   A   A   D   D     T    R   R   A   A   NN  N
R   R   A   A   D   D     T    R   R   A   A   N N N
RRRR    A   A   D   D     T    RRRR    A   A   N  NN
R R     AAAAA   D   D     T    R R     AAAAA   N   N
R  R    A   A   D   D     T    R  R    A   A   N   N
R   R   A   A   DDDD      T    R   R   A   A   N   N
```

```
    4
4   4
4   4
44444
    4
    4
    4
```

RADTRAN 4.0.19  VERSION DATE: NOVEMBER 14, 1996

MODE DESCRIPTIONS

| NUMBER | NAME | CHARACTERIZATION |
|---|---|---|
| 1 | TRUCK | LONG HAUL VEHICLE |
| 2 | RAIL | COMMERCIAL TRAIN |
| 3 | BARGE | INLAND VESSEL |
| 4 | SHIP | OPEN SEA VESSEL |
| 5 | CARGO AIR | CARGO AIRCRAFT |
| 6 | PASS AIR | PASSENGER AIRCRAFT |
| 7 | P-VAN | PASSENGER VAN |
| 8 | CVAN-T | COMMERCIAL VAN |
| 9 | CVAN-R | COMMERCIAL VAN |
| 10 | CVAN-CA | COMMERCIAL VAN |

ECHO CHECK

```
&& Edited Thu Oct  2 16:57:21 1997
&& _Las_Vegas_bypass_without_license_renewal_
&& _Version_1.0_
TITLE _BYPASS_WITHOUT_RENEWAL_
FORM UNIT
DIMEN 21 8 3 10 18
PARM 1 3 2 1 0
PACKAGE
   LABGRP
        GAS       SOLID       VOLAT
SHIPMENT
   LABISO
      H3GAS        FE55        CO60        KR85        SR90       RU106
      SB125      TE125M       CS134       CS137       CE144       PM147
      SM151       EU154       EU155       PU238       PU239       PU240
      PU241       AM241       CM244
NORMAL
   NMODE=1
       8.069E-01  1.916E-01  1.500E-03  8.856E+01  4.032E+01  2.416E+01
       2.000E+00  1.000E+01  0.000E+00  0.000E+00  0.000E+00  0.000E+00
       0.000E+00  0.000E+00  2.000E+01  0.000E+00  0.000E+00  0.000E+00
       2.000E+00  1.000E-01  0.000E+00  1.000E+00  4.700E+02  7.800E+02
       2.800E+03
ACCIDENT
   SEVFRC
     NPOP=1
       NMODE=1
       4.62E-01  3.02E-01  1.76E-01  4.03E-02  1.18E-02  6.47E-03
       5.71E-04  1.13E-04
     NPOP=2
       NMODE=1
       4.35E-01  2.85E-01  2.21E-01  5.06E-02  6.64E-03  1.74E-03
       6.72E-05  5.93E-06
     NPOP=3
       NMODE=1
       5.83E-01  3.82E-01  2.78E-02  6.36E-03  7.42E-04  1.46E-04
       1.13E-05  9.94E-07
RELEASE
   RFRAC
     GROUP=1
       0.00E+00  0.00E+00  0.00E+00  1.00E-02  1.00E-01  1.10E-01
       1.10E-01  1.10E-01
     GROUP=2
       0.00E+00  0.00E+00  0.00E+00  1.00E-08  5.00E-08  5.00E-08
       5.00E-07  5.00E-07
     GROUP=3
       0.00E+00  0.00E+00  0.00E+00  1.00E-08  2.00E-04  2.80E-04
       1.00E-03  1.00E-03
EOF
ISOTOPES  -1 50185     1.00    10.000    1.00    0.00  FRRSNF
        H3GAS  9.99E+02       GAS  10
         FE55  3.64E+02     SOLID   2
         CO60  4.31E+03     SOLID   2
         KR85  1.08E+04       GAS  10
         SR90  1.30E+05     SOLID   2
        RU106  1.05E+03     VOLAT   7
        SB125  2.92E+03     SOLID   2
       TE125M  7.13E+02     SOLID   2
        CS134  1.54E+04     VOLAT   7
        CS137  1.93E+05     VOLAT   7
        CE144  2.40E+02     SOLID   2
```

```
          PM147   1.60E+04      SOLID    2
          SM151   9.07E+02      SOLID    2
          EU154   1.20E+04      SOLID    2
          EU155   4.59E+03      SOLID    2
          PU238   1.00E+04      SOLID    2
          PU239   7.30E+02      SOLID    2
          PU240   1.13E+03      SOLID    2
          PU241   1.88E+05      SOLID    2
          AM241   4.26E+03      SOLID    2
          CM244   8.29E+03      SOLID    2
LINK   1 1.58E+02 8.80E+01 2.20E+00 4.70E+02 1.37E-07 R 1
LINK   1 8.20E+00 8.80E+01 3.57E+02 7.80E+02 3.00E-06 S 1
PKGSIZ
          FRRSNF      5.00
EOF
```

_BYPASS_WITHOUT_RENEWAL_

INCIDENT-FREE SUMMARY
******** **** *******

INCIDENT-FREE POPULATION EXPOSURE IN PERSON-REM

| | PASSENGR | CREW | HANDLERS | OFF LINK | ON LINK | STOPS | STORAGE | TOTALS |
|---|---|---|---|---|---|---|---|---|
| LINK 1 | 0.00E+00 | 1.96E+02 | 0.00E+00 | 4.45E-01 | 4.97E+01 | 0.00E+00 | 0.00E+00 | 2.46E+02 |
| LINK 2 | 0.00E+00 | 1.02E+01 | 0.00E+00 | 3.26E+00 | 4.28E+00 | 0.00E+00 | 0.00E+00 | 1.77E+01 |
| RURAL | 0.00E+00 | 1.96E+02 | 0.00E+00 | 4.45E-01 | 4.97E+01 | 0.00E+00 | 0.00E+00 | 2.46E+02 |
| SUBURB | 0.00E+00 | 1.02E+01 | 0.00E+00 | 3.26E+00 | 4.28E+00 | 0.00E+00 | 0.00E+00 | 1.77E+01 |
| URBAN | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| TOTALS: | 0.00E+00 | 2.06E+02 | 0.00E+00 | 3.70E+00 | 5.40E+01 | 0.00E+00 | 0.00E+00 | 2.64E+02 |

MAXIMUM INDIVIDUAL IN-TRANSIT DOSE

LINK 1 2.07E-02 REM
LINK 2 2.07E-02 REM

RUN DATE: [ 2-OCT-97 AT 16:57:53 ] PAGE 6

_BYPASS_WITHOUT_RENEWAL_

EXPECTED VALUES OF POPULATION RISK IN PERSON REM

| | GROUND | INHALED | RESUSPD | CLOUDSH | *INGESTION | TOTAL |
|---|---|---|---|---|---|---|
| LINK 1 | 4.43E-01 | 2.04E-03 | 8.29E-03 | 5.89E-06 | 0.00E+00 | 4.54E-01 |
| LINK 2 | 3.25E+01 | 1.47E-01 | 5.95E-01 | 5.19E-04 | 0.00E+00 | 3.33E+01 |
| RURAL | 4.43E-01 | 2.04E-03 | 8.29E-03 | 5.89E-06 | 0.00E+00 | 4.54E-01 |
| SUBURB | 3.25E+01 | 1.47E-01 | 5.95E-01 | 5.19E-04 | 0.00E+00 | 3.33E+01 |
| URBAN | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| TOTALS: | 3.30E+01 | 1.49E-01 | 6.03E-01 | 5.25E-04 | 0.00E+00 | 3.37E+01 |

```
* NOTE THAT INGESTION RISK IS A SOCIETAL RISK;
  THE USER MAY WISH TO TREAT THIS VALUE SEPARATELY.

                          _BYPASS_WITHOUT_RENEWAL_

                      EXPECTED RISK VALUES - OTHER

                 LINK      ECON        EARLY
                             $$       FATALITY
                   1     0.00E+00    0.00E+00
                   2     0.00E+00    0.00E+00

                 TOTAL   0.00E+00    0.00E+00


                    TOTAL EXPOSED POPULATION: INCIDENT-FREE

                          LINK  1  5.56E+02 PERSONS
                          LINK  2  4.68E+03 PERSONS

                            TOTAL  5.24E+03 PERSONS


                      TOTAL EXPOSED POPULATION: ACCIDENT
                (PERSONS UNDER PLUME FOOTPRINT FOR A SINGLE ACCIDENT)

                          LINK  1  2.97E+03 PERSONS
                          LINK  2  4.82E+05 PERSONS
EOI
END OF RUN
```

```
                                ECHO CHECK

&& Edited Thu Oct  2 17:16:14 1997
&& _Las_Vegas_bypass_with_license_renewal_
&& _Version_1.0_
TITLE _BYPASS_WITH_RENEWAL_
FORM UNIT
DIMEN 21 8 3 10 18
PARM 1 3 2 1 0
PACKAGE
   LABGRP
        GAS       SOLID       VOLAT
SHIPMENT
   LABISO
      H3GAS        FE55        CO60        KR85        SR90       RU106
      SB125      TE125M       CS134       CS137       CE144       PM147
      SM151       EU154       EU155       PU238       PU239       PU240
      PU241       AM241       CM244
NORMAL
   NMODE=1
       8.069E-01  1.916E-01  1.500E-03  8.856E+01  4.032E+01  2.416E+01
       2.000E+00  1.000E+01  0.000E+00  0.000E+00  0.000E+00  0.000E+00
       0.000E+00  0.000E+00  2.000E+01  0.000E+00  0.000E+00  0.000E+00
       2.000E+00  1.000E-01  0.000E+00  1.000E+00  4.700E+02  7.800E+02
       2.800E+03
ACCIDENT
   SEVFRC
     NPOP=1
       NMODE=1
       4.62E-01  3.02E-01  1.76E-01  4.03E-02  1.18E-02  6.47E-03
       5.71E-04  1.13E-04
     NPOP=2
       NMODE=1
       4.35E-01  2.85E-01  2.21E-01  5.06E-02  6.64E-03  1.74E-03
       6.72E-05  5.93E-06
     NPOP=3
       NMODE=1
       5.83E-01  3.82E-01  2.78E-02  6.36E-03  7.42E-04  1.46E-04
       1.13E-05  9.94E-07
RELEASE
   RFRAC
     GROUP=1
       0.00E+00  0.00E+00  0.00E+00  1.00E-02  1.00E-01  1.10E-01
       1.10E-01  1.10E-01
     GROUP=2
       0.00E+00  0.00E+00  0.00E+00  1.00E-08  5.00E-08  5.00E-08
       5.00E-07  5.00E-07
     GROUP=3
       0.00E+00  0.00E+00  0.00E+00  1.00E-08  2.00E-04  2.80E-04
       1.00E-03  1.00E-03
EOF
ISOTOPES  -1 75278     1.00   10.000   1.00   0.00  FRRSNF
        H3GAS  9.99E+02       GAS  10
         FE55  3.64E+02     SOLID   2
         CO60  4.31E+03     SOLID   2
         KR85  1.08E+04       GAS  10
         SR90  1.30E+05     SOLID   2
        RU106  1.05E+03     VOLAT   7
        SB125  2.92E+03     SOLID   2
       TE125M  7.13E+02     SOLID   2
        CS134  1.54E+04     VOLAT   7
        CS137  1.93E+05     VOLAT   7
        CE144  2.40E+02     SOLID   2
        PM147  1.60E+04     SOLID   2
        SM151  9.07E+02     SOLID   2
        EU154  1.20E+04     SOLID   2
```

```
        EU155  4.59E+03      SOLID   2
        PU238  1.00E+04      SOLID   2
        PU239  7.30E+02      SOLID   2
        PU240  1.13E+03      SOLID   2
        PU241  1.88E+05      SOLID   2
        AM241  4.26E+03      SOLID   2
        CM244  8.29E+03      SOLID   2
LINK  1 1.58E+02 8.80E+01 2.20E+00 4.70E+02 1.37E-07 R 1
LINK  1 8.20E+00 8.80E+01 3.57E+02 7.80E+02 3.00E-06 S 1
PKGSIZ
         FRRSNF     5.00
EOF
```

_BYPASS_WITH_RENEWAL_

INCIDENT-FREE SUMMARY
******** **** *******

INCIDENT-FREE POPULATION EXPOSURE IN PERSON-REM

| | PASSENGR | CREW | HANDLERS | OFF LINK | ON LINK | STOPS | STORAGE | TOTALS |
|---|---|---|---|---|---|---|---|---|
| LINK 1 | 0.00E+00 | 2.94E+02 | 0.00E+00 | 6.67E-01 | 7.46E+01 | 0.00E+00 | 0.00E+00 | 3.69E+02 |
| LINK 2 | 0.00E+00 | 1.52E+01 | 0.00E+00 | 4.89E+00 | 6.42E+00 | 0.00E+00 | 0.00E+00 | 2.66E+01 |
| RURAL | 0.00E+00 | 2.94E+02 | 0.00E+00 | 6.67E-01 | 7.46E+01 | 0.00E+00 | 0.00E+00 | 3.69E+02 |
| SUBURB | 0.00E+00 | 1.52E+01 | 0.00E+00 | 4.89E+00 | 6.42E+00 | 0.00E+00 | 0.00E+00 | 2.66E+01 |
| URBAN | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| TOTALS: | 0.00E+00 | 3.09E+02 | 0.00E+00 | 5.55E+00 | 8.10E+01 | 0.00E+00 | 0.00E+00 | 3.96E+02 |

MAXIMUM INDIVIDUAL IN-TRANSIT DOSE

LINK 1 3.10E-02 REM
LINK 2 3.10E-02 REM

RUN DATE: [ 2-OCT-97 AT 17:16:36 ] PAGE 6

_BYPASS_WITH_RENEWAL_

EXPECTED VALUES OF POPULATION RISK IN PERSON REM

| | GROUND | INHALED | RESUSPD | CLOUDSH | *INGESTION | TOTAL |
|---|---|---|---|---|---|---|
| LINK 1 | 6.65E-01 | 3.06E-03 | 1.24E-02 | 8.84E-06 | 0.00E+00 | 6.81E-01 |
| LINK 2 | 4.88E+01 | 2.20E-01 | 8.92E-01 | 7.78E-04 | 0.00E+00 | 4.99E+01 |
| RURAL | 6.65E-01 | 3.06E-03 | 1.24E-02 | 8.84E-06 | 0.00E+00 | 6.81E-01 |
| SUBURB | 4.88E+01 | 2.20E-01 | 8.92E-01 | 7.78E-04 | 0.00E+00 | 4.99E+01 |
| URBAN | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| TOTALS: | 4.95E+01 | 2.23E-01 | 9.04E-01 | 7.87E-04 | 0.00E+00 | 5.06E+01 |

```
* NOTE THAT INGESTION RISK IS A SOCIETAL RISK;
  THE USER MAY WISH TO TREAT THIS VALUE SEPARATELY.
```

```
                    _BYPASS_WITH_RENEWAL_


                EXPECTED RISK VALUES - OTHER

                 LINK     ECON        EARLY
                            $$       FATALITY
                   1    0.00E+00    0.00E+00
                   2    0.00E+00    0.00E+00

                TOTAL   0.00E+00    0.00E+00


              TOTAL EXPOSED POPULATION: INCIDENT-FREE

                    LINK  1  5.56E+02 PERSONS
                    LINK  2  4.68E+03 PERSONS

                      TOTAL  5.24E+03 PERSONS


                TOTAL EXPOSED POPULATION: ACCIDENT
          (PERSONS UNDER PLUME FOOTPRINT FOR A SINGLE ACCIDENT)

                    LINK  1  2.97E+03 PERSONS
                    LINK  2  4.82E+05 PERSONS
EOI
END OF RUN
```

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```
                         ECHO CHECK


&& Edited Fri Oct  3 12:23:55 1997
&& _Las_Vegas_city_without_license_renewal_
&& _Version_1.0_
TITLE _CITY_WITHOUT_RENEWAL_
FORM UNIT
DIMEN 21 8 3 10 18
PARM 1 3 2 1 0
PACKAGE
   LABGRP
        GAS       SOLID       VOLAT
SHIPMENT
   LABISO
      H3GAS        FE55        CO60        KR85        SR90       RU106
      SB125      TE125M        CS134       CS137       CE144      PM147
      SM151       EU154       EU155       PU238       PU239      PU240
```

```
      PU241       AM241       CM244
NORMAL
   NMODE=1
       8.069E-01  1.916E-01  1.500E-03  8.856E+01  4.032E+01  2.416E+01
       2.000E+00  1.000E+01  0.000E+00  0.000E+00  0.000E+00  0.000E+00
       0.000E+00  0.000E+00  2.000E+01  0.000E+00  0.000E+00  0.000E+00
       2.000E+00  1.000E-01  0.000E+00  1.000E+00  4.700E+02  7.800E+02
       2.800E+03
ACCIDENT
   SEVFRC
     NPOP=1
       NMODE=1
       4.62E-01  3.02E-01  1.76E-01  4.03E-02  1.18E-02  6.47E-03
       5.71E-04  1.13E-04
     NPOP=2
       NMODE=1
       4.35E-01  2.85E-01  2.21E-01  5.06E-02  6.64E-03  1.74E-03
       6.72E-05  5.93E-06
     NPOP=3
       NMODE=1
       5.83E-01  3.82E-01  2.78E-02  6.36E-03  7.42E-04  1.46E-04
       1.13E-05  9.94E-07
RELEASE
   RFRAC
     GROUP=1
       0.00E+00  0.00E+00  0.00E+00  1.00E-02  1.00E-01  1.10E-01
       1.10E-01  1.10E-01
     GROUP=2
       0.00E+00  0.00E+00  0.00E+00  1.00E-08  5.00E-08  5.00E-08
       5.00E-07  5.00E-07
     GROUP=3
       0.00E+00  0.00E+00  0.00E+00  1.00E-08  2.00E-04  2.80E-04
       1.00E-03  1.00E-03
EOF
ISOTOPES  -1 50185     1.00   10.000   1.00   0.00  FRRSNF
        H3GAS  9.99E+02       GAS  10
         FE55  3.64E+02     SOLID   2
         CO60  4.31E+03     SOLID   2
         KR85  1.08E+04       GAS  10
         SR90  1.30E+05     SOLID   2
        RU106  1.05E+03     VOLAT   7
        SB125  2.92E+03     SOLID   2
       TE125M  7.13E+02     SOLID   2
        CS134  1.54E+04     VOLAT   7
        CS137  1.93E+05     VOLAT   7
        CE144  2.40E+02     SOLID   2
        PM147  1.60E+04     SOLID   2
        SM151  9.07E+02     SOLID   2
        EU154  1.20E+04     SOLID   2
        EU155  4.59E+03     SOLID   2
        PU238  1.00E+04     SOLID   2
        PU239  7.30E+02     SOLID   2
        PU240  1.13E+03     SOLID   2
        PU241  1.88E+05     SOLID   2
        AM241  4.26E+03     SOLID   2
        CM244  8.29E+03     SOLID   2
LINK  1 1.54E+02 8.80E+01 1.70E+00 4.70E+02 1.37E-07 R 1
LINK  1 1.77E+01 8.80E+01 5.68E+02 7.80E+02 3.00E-06 S 1
LINK  1 5.40E+00 7.20E+01 2.30E+03 2.80E+03 1.60E-05 U 1
PKGSIZ
        FRRSNF     5.00
EOF
```

_CITY_WITHOUT_RENEWAL_

INCIDENT-FREE SUMMARY
******** **** *******

INCIDENT-FREE POPULATION EXPOSURE IN PERSON-REM

| | PASSENGR | CREW | HANDLERS | OFF LINK | ON LINK | STOPS | STORAGE | TOTALS |
|---|---|---|---|---|---|---|---|---|
| LINK 1 | 0.00E+00 | 1.91E+02 | 0.00E+00 | 3.35E-01 | 4.84E+01 | 0.00E+00 | 0.00E+00 | 2.40E+02 |
| LINK 2 | 0.00E+00 | 2.19E+01 | 0.00E+00 | 1.12E+01 | 9.24E+00 | 0.00E+00 | 0.00E+00 | 4.24E+01 |
| LINK 3 | 0.00E+00 | 8.18E+00 | 0.00E+00 | 3.49E-01 | 1.53E+01 | 0.00E+00 | 0.00E+00 | 2.38E+01 |
| RURAL | 0.00E+00 | 1.91E+02 | 0.00E+00 | 3.35E-01 | 4.84E+01 | 0.00E+00 | 0.00E+00 | 2.40E+02 |
| SUBURB | 0.00E+00 | 2.19E+01 | 0.00E+00 | 1.12E+01 | 9.24E+00 | 0.00E+00 | 0.00E+00 | 4.24E+01 |
| URBAN | 0.00E+00 | 8.18E+00 | 0.00E+00 | 3.49E-01 | 1.53E+01 | 0.00E+00 | 0.00E+00 | 2.38E+01 |
| TOTALS: | 0.00E+00 | 2.21E+02 | 0.00E+00 | 1.19E+01 | 7.30E+01 | 0.00E+00 | 0.00E+00 | 3.06E+02 |

MAXIMUM INDIVIDUAL IN-TRANSIT DOSE

LINK 1 2.07E-02 REM
LINK 2 2.07E-02 REM
LINK 3 2.07E-02 REM

RUN DATE: [ 3-OCT-97 AT 12:24:15 ] PAGE 6

_CITY_WITHOUT_RENEWAL_

EXPECTED VALUES OF POPULATION RISK IN PERSON REM

| | GROUND | INHALED | RESUSPD | CLOUDSH | *INGESTION | TOTAL |
|---|---|---|---|---|---|---|
| LINK 1 | 3.34E-01 | 1.54E-03 | 6.24E-03 | 4.44E-06 | 0.00E+00 | 3.42E-01 |
| LINK 2 | 1.12E+02 | 5.03E-01 | 2.04E+00 | 1.78E-03 | 0.00E+00 | 1.14E+02 |
| LINK 3 | 4.75E+01 | 2.14E-01 | 8.68E-01 | 7.84E-04 | 0.00E+00 | 4.86E+01 |
| RURAL | 3.34E-01 | 1.54E-03 | 6.24E-03 | 4.44E-06 | 0.00E+00 | 3.42E-01 |
| SUBURB | 1.12E+02 | 5.03E-01 | 2.04E+00 | 1.78E-03 | 0.00E+00 | 1.14E+02 |
| URBAN | 4.75E+01 | 2.14E-01 | 8.68E-01 | 7.84E-04 | 0.00E+00 | 4.86E+01 |
| TOTALS: | 1.60E+02 | 7.19E-01 | 2.92E+00 | 2.57E-03 | 0.00E+00 | 1.63E+02 |

* NOTE THAT INGESTION RISK IS A SOCIETAL RISK;
THE USER MAY WISH TO TREAT THIS VALUE SEPARATELY.

_CITY_WITHOUT_RENEWAL_

EXPECTED RISK VALUES - OTHER

| LINK | ECON $$ | EARLY FATALITY |
|---|---|---|
| 1 | 0.00E+00 | 0.00E+00 |
| 2 | 0.00E+00 | 0.00E+00 |
| 3 | 0.00E+00 | 0.00E+00 |
| TOTAL | 0.00E+00 | 0.00E+00 |

TOTAL EXPOSED POPULATION: INCIDENT-FREE

LINK 1 4.19E+02 PERSONS
LINK 2 1.61E+04 PERSONS
LINK 3 1.99E+04 PERSONS

TOTAL 3.64E+04 PERSONS

TOTAL EXPOSED POPULATION: ACCIDENT
(PERSONS UNDER PLUME FOOTPRINT FOR A SINGLE ACCIDENT)

LINK 1 2.30E+03 PERSONS
LINK 2 7.67E+05 PERSONS
LINK 3 3.11E+06 PERSONS

EOI
END OF RUN

---

ECHO CHECK

```
&& Edited Fri Oct  3 12:21:37 1997
&& _Las_Vegas_city_with_license_renewal_
&& _Version_1.0_
TITLE _CITY_WITH_RENEWAL_
FORM UNIT
DIMEN 21 8 3 10 18
PARM 1 3 2 1 0
PACKAGE
   LABGRP
        GAS       SOLID       VOLAT
SHIPMENT
   LABISO
      H3GAS        FE55        CO60        KR85        SR90       RU106
      SB125      TE125M       CS134       CS137       CE144       PM147
      SM151       EU154       EU155       PU238       PU239       PU240
      PU241       AM241       CM244
NORMAL
   NMODE=1
       8.069E-01  1.916E-01  1.500E-03  8.856E+01  4.032E+01  2.416E+01
       2.000E+00  1.000E+01  0.000E+00  0.000E+00  0.000E+00  0.000E+00
       0.000E+00  0.000E+00  2.000E+01  0.000E+00  0.000E+00     00E+00
       2.000E+00  1.000E-01  0.000E+00  1.000E+00  4.700E+02  7. 0E+02
       2.800E+03
```

```
ACCIDENT
   SEVFRC
     NPOP=1
       NMODE=1
       4.62E-01  3.02E-01  1.76E-01  4.03E-02  1.16E-02  6.47E-03
       5.71E-04  1.13E-04
     NPOP=2
       NMODE=1
       4.35E-01  2.85E-01  2.21E-01  5.06E-02  6.64E-03  1.74E-03
       6.72E-05  5.93E-06
     NPOP=3
       NMODE=1
       5.83E-01  3.82E-01  2.78E-02  6.36E-03  7.42E-04  1.46E-04
       1.13E-05  9.94E-07
RELEASE
   RFRAC
     GROUP=1
       0.00E+00  0.00E+00  0.00E+00  1.00E-02  1.00E-01  1.10E-01
       1.10E-01  1.10E-01
     GROUP=2
       0.00E+00  0.00E+00  0.00E+00  1.00E-08  5.00E-08  5.00E-08
       5.00E-07  5.00E-07
     GROUP=3
       0.00E+00  0.00E+00  0.00E+00  1.00E-08  2.00E-04  2.80E-04
       1.00E-03  1.00E-03
EOF
ISOTOPES  -1 75278     1.00   10.000   1.00   0.00  FRRSNF
        H3GAS  9.99E+02       GAS  10
         FE55  3.64E+02     SOLID   2
         CO60  4.31E+03     SOLID   2
         KR85  1.08E+04       GAS  10
         SR90  1.30E+05     SOLID   2
        RU106  1.05E+03     VOLAT   7
        SB125  2.92E+03     SOLID   2
       TE125M  7.13E+02     SOLID   2
        CS134  1.54E+04     VOLAT   7
        CS137  1.93E+05     VOLAT   7
        CE144  2.40E+02     SOLID   2
        PM147  1.60E+04     SOLID   2
        SM151  9.07E+02     SOLID   2
        EU154  1.20E+04     SOLID   2
        EU155  4.59E+03     SOLID   2
        PU238  1.00E+04     SOLID   2
        PU239  7.30E+02     SOLID   2
        PU240  1.13E+03     SOLID   2
        PU241  1.88E+05     SOLID   2
        AM241  4.26E+03     SOLID   2
        CM244  8.29E+03     SOLID   2
LINK  1 1.54E+02 8.80E+01 1.70E+00 4.70E+02 1.37E-07 R 1
LINK  1 1.77E+01 8.80E+01 5.68E+02 7.80E+02 3.00E-06 S 1
LINK  1 5.40E+00 7.20E+01 2.30E+03 2.80E+03 1.60E-05 U 1
PKGSIZ
        FRRSNF     5.00
EOF
```

_CITY_WITH_RENEWAL_

INCIDENT-FREE SUMMARY
******** **** *******

INCIDENT-FREE POPULATION EXPOSURE IN PERSON-REM

| | PASSENGR | CREW | HANDLERS | OFF LINK | ON LINK | STOPS | STORAGE | TOTALS |
|---|---|---|---|---|---|---|---|---|
| LINK 1 | 0.00E+00 | 2.86E+02 | 0.00E+00 | 5.02E-01 | 7.27E+01 | 0.00E+00 | 0.00E+00 | 3.60E+02 |
| LINK 2 | 0.00E+00 | 3.29E+01 | 0.00E+00 | 1.68E+01 | 1.39E+01 | 0.00E+00 | 0.00E+00 | 6.36E+01 |
| LINK 3 | 0.00E+00 | 1.23E+01 | 0.00E+00 | 5.24E-01 | 2.29E+01 | 0.00E+00 | 0.00E+00 | 3.57E+01 |
| RURAL | 0.00E+00 | 2.86E+02 | 0.00E+00 | 5.02E-01 | 7.27E+01 | 0.00E+00 | 0.00E+00 | 3.60E+02 |
| SUBURB | 0.00E+00 | 3.29E+01 | 0.00E+00 | 1.68E+01 | 1.39E+01 | 0.00E+00 | 0.00E+00 | 6.36E+01 |
| URBAN | 0.00E+00 | 1.23E+01 | 0.00E+00 | 5.24E-01 | 2.29E+01 | 0.00E+00 | 0.00E+00 | 3.57E+01 |
| TOTALS: | 0.00E+00 | 3.32E+02 | 0.00E+00 | 1.78E+01 | 1.09E+02 | 0.00E+00 | 0.00E+00 | 4.59E+02 |

MAXIMUM INDIVIDUAL IN-TRANSIT DOSE

LINK 1 3.10E-02 REM
LINK 2 3.10E-02 REM
LINK 3 3.10E-02 REM

RUN DATE: [ 3-OCT-97 AT 12:22:11 ] PAGE 6

_CITY_WITH_RENEWAL_

EXPECTED VALUES OF POPULATION RISK IN PERSON REM

| | GROUND | INHALED | RESUSPD | CLOUDSH | *INGESTION | TOTAL |
|---|---|---|---|---|---|---|
| LINK 1 | 5.01E-01 | 2.31E-03 | 9.36E-03 | 6.66E-06 | 0.00E+00 | 5.13E-01 |
| LINK 2 | 1.68E+02 | 7.55E-01 | 3.06E+00 | 2.67E-03 | 0.00E+00 | 1.71E+02 |
| LINK 3 | 7.12E+01 | 3.21E-01 | 1.30E+00 | 1.18E-03 | 0.00E+00 | 7.28E+01 |
| RURAL | 5.01E-01 | 2.31E-03 | 9.36E-03 | 6.66E-06 | 0.00E+00 | 5.13E-01 |
| SUBURB | 1.68E+02 | 7.55E-01 | 3.06E+00 | 2.67E-03 | 0.00E+00 | 1.71E+02 |
| URBAN | 7.12E+01 | 3.21E-01 | 1.30E+00 | 1.18E-03 | 0.00E+00 | 7.28E+01 |
| TOTALS: | 2.39E+02 | 1.08E+00 | 4.37E+00 | 3.85E-03 | 0.00E+00 | 2.45E+02 |

* NOTE THAT INGESTION RISK IS A SOCIETAL RISK;
THE USER MAY WISH TO TREAT THIS VALUE SEPARATELY.

_CITY_WITH_RENEWAL_

EXPECTED RISK VALUES - OTHER

| LINK | ECON $$ | EARLY FATALITY |
|---|---|---|

```
          1     0.00E+00    0.00E+00
          2     0.00E+00    0.00E+00
          3     0.00E+00    0.00E+00

      TOTAL     0.00E+00    0.00E+00



          TOTAL EXPOSED POPULATION: INCIDENT-FREE

              LINK  1   4.19E+02 PERSONS
              LINK  2   1.61E+04 PERSONS
              LINK  3   1.99E+04 PERSONS

                TOTAL   3.64E+04 PERSONS



          TOTAL EXPOSED POPULATION: ACCIDENT
    (PERSONS UNDER PLUME FOOTPRINT FOR A SINGLE ACCIDENT)

              LINK  1   2.30E+03 PERSONS
              LINK  2   7.67E+05 PERSONS
              LINK  3   3.11E+06 PERSONS
EOI
END OF RUN
```

# ATTACHMENT 2

# STAFF REQUIREMENTS MEMORANDUM

Action: Collins, NRR

Cys: Travers
Knapp
Miraglia
Norry
Blaha
Papereillo, NMSS
Thadani, RES
Congel, IRO
Lohaus, SP
Lieberman, OE
Shelton, CIO
Meyer, ADM
Schrol, SECY
Cleary, NRR

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

OFFICE OF THE
SECRETARY

January 29, 1999

MEMORANDUM TO: William D. Travers
Executive Director for Operations

FROM: Annette Vietti-Cook, Secretary

SUBJECT: STAFF REQUIREMENTS - SECY-98-278, PROPOSED RULE – "CHANGES TO REQUIREMENTS FOR ENVIRONMENTAL REVIEW FOR RENEWAL OF NUCLEAR POWER PLANT OPERATING LICENSES (10 CFR PART 51)"

The Commission has approved for publication in the Federal Register the proposed amendments to 10 CFR Part 51 and the Notice of Availability of NUREG-1437, Addendum subject to the attached editorial corrections and clarifications.

(EDO) (SECY Suspense: 3/1/99) 199800003

cc: Chairman Jackson
Commissioner Dicus
Commissioner Diaz
Commissioner McGaffigan
Commissioner Merrifield
OGC
CIO
CFO
OCA
OIG
OPA
Office Directors, Regions, ACRS, ACNW, ASLBP (via E-Mail)
PDR
DCS

**Clarifications and Editorial Changes to the Attachments to SECY-98-278**

1. The proposed rule states, in part:

   (M) The environmental impacts presented in Summary Table S-4 of 51.52 may be adopted in individual power plant license renewal reviews as long as the candidate site at Yucca Mountain is under consideration for licensing.....

This could be interpreted that if additional sites are considered in the future, licensees can adopt the environmental impacts presented in S-4, as long as Yucca Mountain is under consideration. The staff should reword the proposed rule to ensure it is clear that a review, similar to that for Yucca Mountain, would need to be performed for any future site(s) under consideration. In addition, this issue should be clarified in the Background and Discussion sections of the Federal Register notices.

In addition, the quoted sentence in subsection (M) would appear to preclude reliance on any of the environmental impacts presented in Table S-4 if Yucca Mountain is no longer under consideration for licensing. That obviously is not the intent of this Subsection. The first sentence in Subsection (M) should be replaced with the following:

> The environmental impacts presented in Table S-4 of section 51.52 may be adopted in individual nuclear power plant renewal reviews. In addition, the cumulative impacts of shipments to a single repository must be addressed. To do so, the conclusions regarding the cumulative impacts of transporting high-level waste to a single repository in Appendix B to subpart A of this part may be adopted as long as Yucca Mountain is under consideration for licensing.

2. On page 8, last line correct to read "..higher exposure estimates..";

3. On page 9, 1st sentence of 1st full paragraph, correct spelling of "...Sievert..";

4. On page 10, 1st line, correct spelling of " ..occurring terrestrial .."

5. On page 18, Section 51.53, should be "Post-construction...."

6. On page 3 of NUREG-1437, Addendum 1, line 11 of second column, correct to read "..(person-~~m~~Sv [person-rem].."

7. On page 6 of the NUREG, revise second full paragraph to read "The expected population doses estimated by the staff (see Appendix) are displayed in Table 1. Table 2 shows the health risks implied by the doses listed in Table 1. It is important to note that LRFC figures represent cumulative health risks or more simply put, the total potential fatalities within the Clark County population over the period of shipment of spent nuclear fuel which assumes that all currently operating reactors renew their licenses for 20 years. An examination ...;

8. On page 6 of the NUREG, third paragraph, second and third sentences correct to read "....this lifetime incidence of fatal cancer would correspond to about 900 LRFC/year. In the ....naturally occurring terrestrial..."

9. On page 7 of the NUREG, Table 2, footnote b, last sentence correct spelling of "fatal";

10. On page 8 of the NUREG, third sentence of last full paragraph needs a space between "fatality" and "from";

11. Revise 1st sentence of press release to read "The U.S. Nuclear Regulatory Commission ~~(NRC)~~ is..."; and

12. Revise 1st sentence in letters Congress to read "In the near future, the U.S. Nuclear Regulatory Commission ~~(NRC)~~ intends..."

NRC FORM 335 (2-89) NRCM 1102, 3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

# BIBLIOGRAPHIC DATA SHEET

*(See instructions on the reverse)*

1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.)

NUREG-1437, Vol. 1, Addendum 1

2. TITLE AND SUBTITLE

Generic Environmental Impact Statement for License Renewal of Nuclear Plants
Main Report
Section 6.3—Transportation
Table 9.1 Summary of findings on NEPA issues for license renewal of nuclear power plants
Draft Report for Comment

3. DATE REPORT PUBLISHED

| MONTH | YEAR |
|---|---|
| February | 1999 |

4. FIN OR GRANT NUMBER

5. AUTHOR(S)

6. TYPE OF REPORT

Draft regulatory

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8. PERFORMING ORGANIZATION - NAME AND ADDRESS *(If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)*

Division of Reactor Program Management
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555-0001

9. SPONSORING ORGANIZATION - NAME AND ADDRESS *(If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)*

Same as above

10. SUPPLEMENTARY NOTES

11. ABSTRACT *(200 words or less)*

This addendum to NUREG-1437, Generic Environmental Impact Statement for License Renewal of Nuclear Plants, documents the staff's analysis of the potential cumulative impacts of human health of transporting spent nuclear fuel in the vicinity of the proposed Yucca Mountain high-level waste repository.

12. KEY WORDS/DESCRIPTORS *(List words or phrases that will assist researchers in locating the report.)*

Generic Environmental Impact Statement
License renewal
Nuclear Power Plant
Environmental Protection
Spent Nuclear Fuel

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unlimited

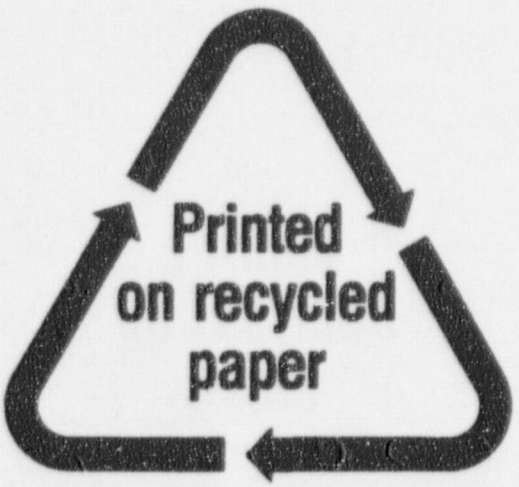
14. SECURITY CLASSIFICATION

*(This Page)*
unclassified

*(This Report)*
unclassified

15. NUMBER OF PAGES

16. PRICE

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