# SECTION 7.0
# ENVIRONMENTAL IMPACTS OF TRANSPORTATION OF NAVAL SPENT NUCLEAR FUEL

## TABLE OF CONTENTS



## TABLES

# 7.0 ENVIRONMENTAL IMPACTS OF TRANSPORTATION OF NAVAL SPENT NUCLEAR FUEL

## 7.1 Overview

This chapter describes representative environmental settings along the transportation routes (as shown in Appendix B, Figure B.2) for the naval spent nuclear fuel as it is shipped from INEL to a geologic repository or a centralized interim storage site. The environmental impacts and the radiological and nonradiological risks of these shipments are also described. The environment would be essentially unaffected by the transportation of naval spent nuclear fuel in the alternative container systems being considered under this EIS. The radiological impacts would be extremely small for incident-free transportation. The risks from a hypothetical transportation accident are also very small. The air quality effects from diesel exhaust are shown to be de minimis and therefore, the conformity regulations do not apply.

A range of routes to a repository or centralized interim storage site is used for the transportation analysis in this EIS in order to determine whether different routing characteristics, such as distance or differences in population distribution, would affect the comparison of the alternative container types. Since no repository or centralized interim storage site has yet been selected, the transportation routing in this EIS uses a site being evaluated by the Department of Energy pursuant to the Nuclear Waste Policy Act as the destination point for naval spent nuclear fuel shipments. For the sake of comparing a reasonable range of alternatives the current regulations have been applied conservatively in the EIS transportation analysis.

Specific transportation routes have not been evaluated for shipment of naval spent nuclear fuel to a repository or centralized interim storage site because that will be the subject of the site-specific EIS for the particular facility. Transportation of naval spent nuclear fuel to a repository or centralized interim storage site will be addressed in the repository EIS analysis. The Navy will participate and contribute to that EIS, as appropriate. This participation will include, at a minimum, the contribution of naval spent nuclear fuel to the cumulative impact for all of the spent nuclear fuel shipments to the designated repository.

In this EIS transportation of naval spent nuclear fuel from INEL to a geologic repository or a centralized interim storage site would be conducted primarily by railcar. These shipments would use existing rail systems and in general would be combined with routine freight trains. Short segments at the beginning and the end of the route, that is, between the DOE facility and the nearest rail switchyard, would likely use a dedicated locomotive over a spur track or, if necessary, heavy-haul truck transport. For purposes of evaluation, this EIS only evaluates rail transportation. The ultimate decision, however, on transportation options (legal-weight truck, some combination of legal-weight truck and rail, or rail/heavy-haul truck) will be made by the DOE on the basis of analyses to be performed in the repository EIS.

Transportation risk assessments pertaining to shipments that include special case waste are also included throughout this chapter for comparison purposes. Those cumulative assessments are identified in applicable tables and indicate no discernable increase in health risk.

Sections 7.3 and 7.4 of this chapter present a description of potential environmental impacts. Appendix B provides specific details on transportation, alternative container types, and analyses results for readers seeking more technical information.

## 7.2 Existing Environmental Settings of Transportation Route

The environmental settings along the transportation route would be a mixture of urban, suburban, and rural environments. Three possible routes were evaluated in this EIS for transport of naval spent nuclear fuel to a repository or centralized interim storage site to ensure the completeness of the calculations. All three routes originated at INEL. The Yucca Mountain site is the only site currently authorized by legislation, specifically the Nuclear Waste Policy Act, for site characterization as a geologic repository for spent nuclear fuel, including naval spent nuclear fuel. Its suitability as a repository has not yet been determined nor has it yet been authorized by law as a location for a centralized interim storage site. The three routes evaluated are designated as the “most direct” route, an “eastern” route and a “western” route. The three routes were evaluated not with the intent to select a route but with the intent to identify the range of potential impacts. It is not possible to select a route since the repository location is unknown.

All three routes pass through the Fort Hall Indian Reservation en route to Pocatello, Idaho. Shipping of naval spent nuclear fuel has occurred through these Native American lands since 1957 without impact. At Pocatello, the most direct route is south through Salt Lake City and then into Nevada. The eastern route heads east to Denver, Colorado and then south to Albuquerque, New Mexico and then into Las Vegas, Nevada. After leaving Pocatello, the western route again passes through the Fort Hall Indian Reservation, heads into Oregon, and then turns south to Sacramento, California and then into Las Vegas, Nevada. Table B.15 of Appendix B provides additional information for each route.

It is expected that over 90% of the transportation route would pass through rural areas and both the point of origin and destination would be in rural areas. The terrain, air quality, and other regional characteristics would vary over a wide range. To assess air quality impacts, Salt Lake City was chosen as a representative location for the analysis. Salt Lake City is a non-attainment area for ozone, carbon monoxide, and particulate matter.

## 7.3 Impacts of Transportation

This section describes the environmental impacts of transportation of naval spent nuclear fuel from INEL to a geologic repository or a centralized interim storage site for disposal. Although the total number of naval spent nuclear fuel shipments during the period covered by this EIS would range from a low of approximately 300 to a high of approximately 500, depending on the alternative selected, the environmental impacts are so small in each case that the differences among the alternatives are negligible. Details are presented in Appendix B. A projected shipping schedule for the years 2010 to 2035 for each alternative is presented in Table 7.1.

Table 7.2 presents a projected shipping schedule that includes the additional special case waste shipments. As indicated in the table, the total shipments (naval spent nuclear fuel and special case waste) would range from a low of approximately 360 to a high of approximately 585. Even with the additional shipments of special case waste, the environmental impacts for any of the alternatives selected remain minimal in each case, therefore, the differences among the alternatives also remain negligible.

TABLE 7.1 Naval Spent Nuclear Fuel Containers Shipped to a Centralized Interim Storage Site or a Geologic Repository, 2010 to 2035[a,b]

| Year | MPC | No Action | Current Technology/Rail | Transportable Storage Cask | Dual-Purpose Canister | Small MPC |
|---|---|---|---|---|---|---|
| 2010 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2011 | 1 | 2 | 1 | 1 | 1 | 3 |
| 2012 | 3 | 4 | 2 | 2 | 3 | 5 |
| 2013 | 6 | 7 | 4 | 4 | 6 | 8 |
| 2014 | 8 | 8 | 6 | 6 | 8 | 13 |
| 2015 | 9 | 10 | 8 | 8 | 9 | 15 |
| 2016 | 10 | 12 | 9 | 9 | 10 | 17 |
| 2017 | 11 | 15 | 11 | 11 | 11 | 19 |
| 2018 | 12 | 17 | 13 | 13 | 12 | 21 |
| 2019 | 14 | 19 | 15 | 15 | 14 | 23 |
| 2020 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2021 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2022 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2023 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2024 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2025 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2026 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2027 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2028 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2029 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2030 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2031 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2032 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2033 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2034 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2035 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 300 | 425 | 325 | 325 | 300 | 500 |

[a] Table is not additive across rows. Each column represents the total shipments for the year depending on the alternative selected.
[b] All container shipments are by rail.

TABLE 7.2 Naval Spent Nuclear Fuel and Special Case Waste Containers (Total) Shipped to a Centralized Interim Storage Site or a Geologic Repository, 2010 to 2035[a,b]

| Year | MPC | No Action | Current Technology/Rail | Transportable Storage Cask | Dual-Purpose Canister | Small MPC |
|---|---|---|---|---|---|---|
| 2010 | 1 | 1 | 1 | 1 | 1 | 1 |
| 2011 | 1 | 2 | 1 | 1 | 1 | 3 |
| 2012 | 3 | 4 | 2 | 2 | 3 | 5 |
| 2013 | 6 | 7 | 4 | 4 | 6 | 8 |
| 2014 | 8 | 8 | 6 | 6 | 8 | 13 |
| 2015 | 9 | 10 | 8 | 8 | 9 | 15 |
| 2016 | 10 | 12 | 9 | 9 | 10 | 17 |
| 2017 | 11 | 15 | 11 | 11 | 11 | 19 |
| 2018 | 12 | 17 | 13 | 13 | 12 | 21 |
| 2019 | 14 | 19 | 15 | 15 | 14 | 23 |
| 2020 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2021 | 15 | 22 | 17 | 17 | 15 | 25 |
| 2022 | 19 | 25 | 20 | 18 | 16 | 28 |
| 2023 | 19 | 25 | 20 | 19 | 17 | 28 |
| 2024 | 19 | 25 | 20 | 19 | 17 | 28 |
| 2025 | 19 | 25 | 20 | 21 | 19 | 31 |
| 2026 | 19 | 25 | 20 | 21 | 19 | 32 |
| 2027 | 20 | 27 | 22 | 21 | 19 | 32 |
| 2028 | 20 | 27 | 22 | 21 | 19 | 33 |
| 2029 | 20 | 27 | 22 | 21 | 19 | 33 |
| 2030 | 20 | 27 | 22 | 21 | 19 | 33 |
| 2031 | 20 | 27 | 22 | 21 | 19 | 33 |
| 2032 | 20 | 27 | 22 | 21 | 19 | 33 |
| 2033 | 20 | 27 | 22 | 21 | 19 | 33 |
| 2034 | 20 | 27 | 22 | 21 | 19 | 33 |
| 2035 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 360 | 480 | 380 | 370 | 345 | 585 |

[a] Table is not additive across rows. Each column represents the total shipments for the year depending on the alternative selected.

[b] All container shipments are by rail.

The average amount of naval spent nuclear fuel in each container shipped from INEL to a repository or centralized interim storage site over the period covered by the EIS is provided in Table 7.3.

TABLE 7.3 Average Amounts of Naval Spent Nuclear Fuel per Container Shipped

| Alternative[a] | Number of Containers Shipped | MTHM per Container |
|---|---|---|
| MPC | 300 | 0.22 |
| NAA | 425 | 0.15 |
| CTR | 325 | 0.20 |
| TSC | 325 | 0.20 |
| DPC | 300 | 0.22 |
| Sm MPC | 500 | 0.13 |

Notation: MPC = multi-purpose canister; NAA = no-action alternative; CTR = current technology/rail; TSC = transportable storage cask; DPC = dual-purpose canister; Sm MPC = small multi-purpose canister; MTHM = metric tons of heavy metal

All of the alternative container systems would be suitable for heavy-haul transportation, as illustrated by prior use of the M-140 containers in heavy-haul transport. However, it is accurate to state that the M-140 based alternatives would be less suitable due to size, height, and weight.

### 7.3.1 Impacts on Land Resources

No additional impact on land resources is expected due to the transportation of the naval spent nuclear fuel to a repository or centralized interim storage site. For this EIS, it is assumed that the transportation routes would use existing rail lines and rail spurs, or new rail spurs to be constructed on the INEL site. At a repository, the naval spent nuclear fuel will traverse rail systems developed for civilian spent nuclear fuel disposal if or when they are available at the facility. Construction of access routes to the facility will be required independent of the decision on the type of containers to use for transport and storage and, in fact, the access routes will be required for ultimate disposition of civilian spent nuclear fuel even if naval spent nuclear fuel were not to be shipped for disposal.

### 7.3.2 Impacts on Air Quality

Air emissions resulting from the transport of the naval spent nuclear fuel would be inconsequential. The shipping containers will be designed not to leak, even under severe accident conditions. They will meet the regulations specified in 49 CFR Part 173, entitled "Shippers - General Requirements for Shipments and Packaging" and the regulations specified in 10 CFR Part 71, entitled "Packaging of Radioactive Material for Transportation and Transportation under Certain Conditions." Furthermore, since the transport will generally be conducted with other routine commercial freight train shipments, the effect on air quality from the slight increase in locomotive emissions caused by the occasional shipment and the additional weight being pulled in the routine commercial shipments would be inconsequential.

Air pollutant emissions from rail transportation for the alternatives are discussed in Appendix B of this EIS. The representative route (or alternative routes) does include several non-attainment air pollution areas for carbon monoxide, ozone, or particulates. Impacts on a representative non-attainment area (Salt Lake City) are discussed in Appendix B and the effect is demonstrated to be de minimis and the conformity regulations do not apply.

If heavy-haul transporters were needed to move the shipping container from a rail head to a centralized interim storage site or repository site the air quality effects due to heavy-haul transporters would be expected to be small due to the distance traveled and the small number of shipments. As discussed earlier in this chapter, the ultimate decision on transportation options will be made by the DOE on the basis of analyses to be performed in the repository EIS.

### 7.3.3 Impacts on Occupational and Public Health and Safety

The calculated impacts on the health and safety of the affected workers (i.e., train crew and government escorts) and the general public are extremely small. Factoring in the total risk of normal transportation operations and the full range of possible accidents, no fatalities (either radiological or nonradiological related) are calculated over the entire 40-year period covered by this EIS (less than one fatality from all shipments over the 25-year shipment period). This holds true for the affected workers as well as the general public for all alternatives.

Table 7.4 shows the risk of latent cancer fatalities along with the risk of estimated nonradiological fatalities during incident-free transportation to a centralized interim storage site or a geological repository. For example, as indicated in Table 7.4, the risks associated with the 125-ton multi-purpose canister would be:

- 0.0075 ($7.5 \times 10^{-3}$) cancer fatalities in the 25-year shipment period for the general population along transportation routes. That is, during those 25 years, calculated risks indicate approximately one latent cancer fatality if the entire transport program for the shipments were to be repeated 135 times;

- an increase of about 0.00052 ($5.2 \times 10^{-4}$) non-radiological fatalities from hypothetical traffic accidents during transportation. That is, during the 25-year shipment period, calculated risks indicate approximately one nonradiological (e.g. emissions, pollution) fatality if the entire transport program for the shipments were to be repeated 2,000 times.

There are no noticeable differences among the alternatives for the estimated nonradiological fatalities. The latent cancer fatalities associated with incident-free transportation are noticeably lower for both the No-Action Alternative and the Current Technology/Rail Alternative because the calculations are based on actual historic measured dose rates for the M-140 casks. This indicates that the transportation impacts for the other alternatives have been calculated conservatively and as a group are about the same.

Table 7.5 shows the risks of latent cancer fatalities expected from hypothetical accidents during transportation. For consistency purposes, if the same example of the 125-ton multi-purpose canister were used to describe the accident risks that appear in Table 7.5, an accident occurring along the transportation route in conjunction with the shipment would be expected to result in:

- 0.0000032 ($3.2 \times 10^{-6}$) latent cancer fatalities during the 25-year period; and

- 0.055 estimated traffic fatalities during the 25-year shipment period.

TABLE 7.4 Incident-Free Transportation Risk for the Total Predicted Number of Shipments[b,c]

| Alternative[a] | Number of Casks | General Population: Latent Cancer Fatalities | Occupational Population: Latent Cancer Fatalities | Estimated Nonradiological Fatalities |
|---|---|---|---|---|
| MPC | 360 | $7.5 \times 10^{-3}$ | $4.4 \times 10^{-3}$ | $5.2 \times 10^{-4}$ |
| NAA | 480 | $1.0 \times 10^{-3}$ | $7.2 \times 10^{-4}$ | $6.9 \times 10^{-4}$ |
| CTR | 380 | $8.0 \times 10^{-4}$ | $5.7 \times 10^{-4}$ | $5.5 \times 10^{-4}$ |
| TSC[d] | 370 | $7.2 \times 10^{-3}$ | $4.3 \times 10^{-3}$ | $5.3 \times 10^{-4}$ |
| DPC[d] | 345 | $7.4 \times 10^{-3}$ | $4.2 \times 10^{-3}$ | $5.0 \times 10^{-4}$ |
| SmMPC | 585 | $1.2 \times 10^{-2}$ | $7.1 \times 10^{-3}$ | $8.4 \times 10^{-4}$ |

[a] Notation: MPC = multi-purpose canister; NAA = no-action alternative; CTR = current technology/rail; TSC = transportable storage cask; DPC = dual-purpose canister; SmMPC = small multi-purpose canister.
[b] Numbers in this table come from Table B.10, which includes shipments of naval spent nuclear fuel and special case waste.
[c] The number of shipments assumes 3 casks per train or 3 casks per shipment.
[d] NAC-STC and NUHOMS-MP187® are representative casks for these alternatives.

TABLE 7.5 Accident Risk for the Total Number of Shipments of Each Container[ab]

| Alternative | Number of Casks | Latent Cancer Fatalities | Estimated Traffic Fatalities[c] |
|---|---|---|---|
| MPC | 360 | $3.2 \times 10^{-6}$ | 0.055 |
| NAA | 480 | $2.5 \times 10^{-6}$ | 0.073 |
| CTR | 380 | $2.4 \times 10^{-6}$ | 0.058 |
| TSC[d] | 370 | $3.9 \times 10^{-6}$ | 0.056 |
| DPC[d] | 345 | $3.3 \times 10^{-6}$ | 0.052 |
| SmMPC | 585 | $3.0 \times 10^{-6}$ | 0.089 |

[a] Notation: MPC = multi-purpose canister; NAA = no-action alternative; CTR = current technology/rail; TSC = transportable storage cask; DPC = dual-purpose canister; SmMPC = small multi-purpose canister.
[b] Numbers in this table come from Table B.12 for naval spent nuclear fuel, and include shipments of special case waste.
[c] This assumes that shipment will be made via general freight and 3 out of 63 cars (the average length of a freight train) carry naval spent nuclear fuel.
[d] NAC-STC and NUHOMS-MP187® are representative casks for these alternatives, respectively.

Table 7.6 provides the average annual impacts of transportation operations on maximally exposed individuals, including the general public and workers.

Although there may be up to five transportation workers on the train, one worker (the inspector) will receive almost the entire occupational dose. This is because during transit, crew exposure is negligible due to the relatively long separation distance between the crew and the container and the shielding effects of intervening structures. Therefore, risk calculations for the occupational maximally exposed individual assumed one crew member received the entire occupational dose.

As shown in Table 7.6, the resulting latent cancer fatalities to the maximally exposed individual for the general population range from $2.8 \times 10^{-6}$ (about one in 350,000 years) for the Current Technology/Rail to $4.4 \times 10^{-5}$ (about one in 22,000 years) for the Small Multi-Purpose Canister. Occupational maximally exposed individual risks range from $2.3 \times 10^{-5}$ (about one in 43,000 years) for the Current Technology/Rail to $2.8 \times 10^{-4}$ (about one in 3,500 years) for the Small Multi-Purpose Canister.

Analytical Approaches. Two separate analytical approaches to transportation accidents are used. One is a probabilistic assessment of impacts to human health and the environment based on the Modal Study (NRC 1987) and the other is a deterministic estimate of maximum consequences of a severe hypothetical transportation accident. The results of both analytical approaches have been used for the comparison of alternatives. The results of the analysis of maximum consequence accidents are presented in Section B.6.3 and in Table B.13.

The range of accidents analyzed produces effects at least as large as the effects of a hypothetical heavy-haul transportation accident at an intersection in a major city on a week day during rush hour or an extremely severe terrorist attack. Severe hypothetical accidents have also been analyzed for the rural and suburban population densities.

Other Impacts. In addition to the possible human health effects associated with accidents described in the preceding sections, other effects such as the impacts on land use in the area and the costs of cleanup have been estimated in order to develop a perspective and to evaluate potential differences among alternatives. The analyses provided in Appendix A show that for the most severe hypothetical accidents associated with naval spent nuclear fuel, an area of approximately 629 acres (approximately 255 ha), extending about 2.2 mi (approximately 3.5 km) downwind of the accident location, might be contaminated to the point where exposure could exceed 100 mrem per year. Beyond this distance, exposures would be below 100 mrem per year, the Nuclear Regulatory Commission's standard for protection of the general population from radiation.

An accident might result in short-term restrictions on access to a relatively small area. It would not be expected to produce enduring impacts on cultural or similar resources or concerns such as Native American rights or interests, partially because the area involved would be small and partly because all remedial actions would be conducted in a careful, controlled manner and in full compliance with applicable laws and regulations. The affected area would vary only slightly among the alternatives considered. Overall, the risks are small, so these considerations do not assist in distinguishing among alternatives.

Accidents associated with any of the alternatives would not have an appreciable effect on the ecology of the area, considering the potential for human health effects and the amount of land which might be affected. There is little consensus among scientists on methods for estimating the effects of radiation on ecological resources such as plant or animal life. However, since human health effects for all the accidents analyzed are small, the affected area is small, the effects are temporary, and most plants and animals are not thought to be more sensitive to radiation than human beings, the small impacts on human health provide an indication that the impacts on animal and plant species in the area would also be small for all alternatives considered. The impacts of hypothetical accidents are limited in extent and small enough that there should be no long-term impact on tourism, marketability of products, or other economic or cultural activities. The possible environmental impacts of hypothetical accidents during shipment of naval spent nuclear fuel are very similar for all of the container systems.

TABLE 7.6 Average Annual Risk of Latent Cancer Fatalities in the Maximally Exposed Individuals in the General Population and in the Occupational Group Due to Incident-Free Transportation Operations[a]

| | Latent Cancer Fatalities to MEIs[b,c] | |
|---|---|---|
| Alternative | General Population | Occupational |
| Multi-Purpose Canister | $2.7 \times 10^{-5}$ | $1.8 \times 10^{-4}$ |
| No-Action | $3.6 \times 10^{-6}$ | $2.9 \times 10^{-5}$ |
| Current Technology/Rail | $2.8 \times 10^{-6}$ | $2.3 \times 10^{-5}$ |
| Transportable Storage Cask | $2.6 \times 10^{-5}$ | $1.7 \times 10^{-4}$ |
| Dual-Purpose Canister | $2.6 \times 10^{-5}$ | $1.7 \times 10^{-4}$ |
| Small Multi-Purpose Canister | $4.4 \times 10^{-5}$ | $2.8 \times 10^{-4}$ |

[a] Numbers in this table are based on values from Table B.10, which includes shipments of naval spent nuclear fuel and special case waste.
[b] Maximally exposed individual (MEI) is the person receiving the greatest exposure in the group analyzed.
[c] Values from Table B.10 divided by 25 years to estimate the average annual risk.

In addition to radiological risks (latent cancer fatalities) to maximally exposed individuals, there may also be a slight increase in nonradiological fatalities due to factors such as extra pollution. Table 7.7 presents the average annual risk of nonradiological fatalities to the general public. As noted in Table 7.7, the increase in nonradiological fatalities range from approximately $2.0 \times 10^{-5}$ (Dual-Purpose Canister) to $3.4 \times 10^{-5}$ (Small Multi-Purpose Canister).

TABLE 7.7 Average Annual Risk of the Estimated Nonradiological Fatalities to the General Population Due to Incident Free Transportation Operations[a]

| Alternative | Nonradiological Fatalities in the General Population[b] |
|---|---|
| Multi-Purpose Canister | $2.1 \times 10^{-5}$ |
| No-Action | $2.8 \times 10^{-5}$ |
| Current Technology/Rail | $2.2 \times 10^{-5}$ |
| Transportable Storage Cask | $2.1 \times 10^{-5}$ |
| Dual-Purpose Canister | $2.0 \times 10^{-5}$ |
| Small Multi-Purpose Canister | $3.4 \times 10^{-5}$ |

[a] Numbers in this table are based on values from Table B.10, which includes shipments of naval spent nuclear fuel and special case waste.
[b] Values from Table B.10 divided by 25 years to estimate the average annual risk.

The average probability of a fatality in the United States associated with the national average pollutant factor for trains is $1.3 \times 10^{-7}$ fatalities per kilometer. This factor is true for rural, suburban, and urban areas. This means that a fatality, based on train pollutants, may occur about once in 7,600,000 years. The risk factor, $1.3 \times 10^{-7}$ was obtained from "Non-Radiological Impacts of Transporting Radiological Material" (Rao, et al. 1982).

The results presented in the tables are for the most direct route which passes through Salt Lake City, Utah as described in Section 7.2. If the eastern or western route is chosen, the number of fatalities for incident-free transportation increases, but the number of fatalities remains much smaller than one in the 25-year transportation period. The increase is mainly due to the additional length of the route.

### 7.3.4 Impacts on Socioeconomics

The regional socioeconomic impacts of the transport of the naval spent nuclear fuel are expected to be very small. A typical rail shipment involves only a few workers (typically, three train crew members and two government escorts). No more than 585 shipments of naval spent nuclear fuel and special case waste to a repository would be expected to occur over the period covered by this EIS. On the average, there would be fewer than three shipments per month. This would not create an appreciable number of new jobs, nor would it appreciably affect the business activity in any region.

### 7.3.5 Impacts on Environmental Justice

Because of the nature of naval spent nuclear fuel, rail shipment is the only method that will be used to transport from INEL to a repository under all of the alternatives considered. The only exception to this is that heavy-haul transport might be used to move loaded shipping containers from the source at INEL a few miles to the nearest rail siding or to a centralized interim storage site or a repository from its nearest rail siding. Rail shipment used for naval spent nuclear fuel tends to limit the exposure to members of the general public during transportation. The shipments pass through urban, suburban, and rural areas, using routes selected by the railroads in accordance with applicable regulations and the requirements of the load. The fractions of the distance traveled in urban, suburban, and rural areas are about 1.2% urban, 5.8% suburban, and 93% rural for the most direct representative route.

Each of the routes studied passes through the Shoshone-Bannock Tribes' Fort Hall Indian Reservation. The effects of radiation exposure from the total number of incident-free shipments, which includes naval spent nuclear fuel and special case waste, to the residents of Fort Hall are summarized as follows:

- Residents on the Fort Hall Indian Reservation will receive between 3 person-millirem (for the Current Technology/Rail Alternative) and 34 person-millirem (for the Small Multi-Purpose Canister Alternative) of radiation exposure over 25 years of shipments within the 40 years analyzed in this EIS. This is about the same as a single chest x-ray.

- Note that during the same time period, residents (the entire population) of Fort Hall will receive approximately 72 million person-millirem of radiation exposure from naturally occurring sources of radiation.

This analysis was performed in response to concern expressed by the Shoshone-Bannock Tribes; however, this example is also expected to be typical of the potential for human health effects for any minority, low-income, or Native American populations located along the actual route traveled for the alternatives considered in this EIS, and demonstrates the small magnitude of human health impacts.

The impacts on human health or the environment resulting from routine transport of naval spent nuclear fuel and hypothetical transportation accidents would be small for all of the alternatives considered. For example, it is unlikely that a single latent fatal cancer case or health detriment would occur as a result of the transportation of naval spent nuclear fuel under any alternative. Shipping accidents could occur at any location along the routes used, so it is not possible to identify the specific impact on the minority or low-income composition of the populations along the routes. However, the fact that the potential impacts due to an accident for any of the alternatives considered would present no significant risk and do not constitute a credible adverse impact on the population along the shipping routes makes it possible to state that no adverse effects from accidents associated with the transportation of naval spent nuclear fuel would be expected for any specific segment of the population, minorities and low-income groups included.

The results of the accident analyses are provided in Table 7.5 and in Tables B.11-B.13 in Appendix B, including the maximum consequences of a hypothetical accident in rural, urban, and suburban zones. The assumptions and parameters used in the accident analysis make these results applicable to all population groups along the routes, including Native American, minority, and low income populations.

To place the impacts on environmental justice in perspective, the risk from routine shipping activities or hypothetical accidents associated with transportation of naval spent nuclear fuel under any of the alternatives considered would amount to less than one fatality per year in the affected population along transportation routes. For comparison, in 1990 there were approximately 40,000 traffic fatalities in the U.S. population and there were about 7,400 deaths caused by traffic accidents in minority populations in the United States. Even if all of the cancer deaths associated with an accident for any of the alternatives considered for naval spent nuclear fuel management were assumed to occur only in minority populations, they would experience far less than one fatality per year. The same conclusion can be drawn for low-income populations.

### 7.3.6 Other Areas of Impact

Since the transport of the naval spent nuclear fuel to a repository would present essentially no observable increase in traffic activity and would primarily use existing transportation links, the impacts on other aspects of the environment along the transportation routes, such as aesthetics, geology, water resources, ecology, and cultural resources, would be negligible.

### 7.3.7 Cumulative Impacts

In addition to the transportation effects noted in this chapter, and detailed in Appendix B, there is one other foreseeable contributor to the health risks due to transportation: the shipment of commercial spent nuclear fuel.

In addition to the naval spent nuclear fuel, there will be many shipments of civilian and DOE spent nuclear fuel. It is estimated that there could be between 3,000 to 17,000 rail shipments and 5,000 to 37,000 truck shipments to move the civilian spent nuclear fuel. There will be only 345 to 585 total shipments of naval spent nuclear fuel and special case waste, thus the impact of the transportation of Navy waste would be approximately 1 to 4% of the total impact of spent nuclear fuel shipments to a centralized interim storage site or geologic repository.

Appendix I of Volume 1 of the Programmatic SNF and INEL EIS (DOE 1995) provided cumulative impacts of the shipment of all nuclear material in the United States, including Navy, DOE, civilian spent nuclear fuel, and medical waste. Appendix I also provided an estimate of transportation effects to a geologic repository. It was estimated that the total number of latent cancer fatalities from all shipments of nuclear material in the United States from 1943 to 2035 would be 130 for workers and 160 for the general population. These 290 fatalities would be approximately 0.0010 percent of the total number of latent cancer fatalities in the United States over that 92-year period.

The incident-free and non-radiological risks, as measured by the latent cancer fatalities of Table 7-4, are extremely small when compared to Appendix I results. The largest estimate of latent cancer fatalities for transporting naval spent nuclear fuel to a centralized interim storage site or a geologic repository is approximately 0.01 worker death and 0.01 death in the general population for the 25-year transportation period within the 40-year period analyzed for this EIS. These are less than 0.01% of the total Appendix I latent cancer fatalities.

### 7.3.8 Unavoidable Adverse Effects

The unavoidable adverse effects of the transportation activities would be inconsequential. Since the transport will generally be conducted with other routine commercial freight train shipments, the effect on air quality from the slight increase in locomotive emissions caused by the occasional shipment and the additional weight being pulled during the routine commercial shipments would be negligible.

The calculated impacts on the health and safety of the affected transportation waters and general population are small. No fatalities (either radiological or nonradiological related) are expected over the entire 25-year shipment period.

### 7.3.9 Irreversible and Irretrievable Commitment of Resources

Transportation of naval spent nuclear fuel from INEL to a centralized interim storage site or geologic repository would be conducted primarily by diesel-operated railcar. Since the naval spent nuclear fuel would be transported over existing rail lines, or new rail lines built for other projects, there would be no appreciable commitment of resources that would be irreversible or irretrievable.

### 7.3.10 Relationship between Short-Term Use of the Environment and the Maintenance and Enhancement of Long-Term Productivity

As discussed throughout this chapter, the normal operations associated with the transport of naval spent nuclear fuel will result in some very small increases in radiation exposure, traffic, and associated air emissions. This use of the environment and the associated impacts on the environment would not affect the long-term productivity of any area.

## 7.4 Impact Avoidance and Mitigative Measures

Radiological emissions from containers and casks used for the transport or storage of naval spent nuclear fuel are avoided by design. The containers and casks are air-tight and essentially leak-proof, even under adverse conditions. Nonradiological emissions are also avoided by the same design features. Impacts due to construction are avoided by utilizing existing transportation systems, thus eliminating the need to construct new rail lines. The effects of the radiation from the naval spent nuclear fuel are minimized through the use of shielding to reduce the radiation fields. The potential consequences of an accident are minimized by the rugged design of the shipping containers and casks. In the unlikely event that a serious accident should occur, existing resources can be activated to quickly and safely bring the situation under control.